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Abstract

On many equity markets, designated market makers (DMMs) supply additional liquidity for small and mid cap stocks. Whereas prior research has focused on their role in continuous trading, we analyze their activity in call auctions. Using data from Germany's Xetra system, we find that DMMs are most active when they can provide the greatest benefits to the market, i.e., in relatively illiquid stocks and at times of elevated volatility. They stabilize prices and earn positive profits. These results imply that DMMs provide a valuable service to the market, and that they charge an implicit price for that service.

Keywords: Designated market makers, Call auctions

JEL classification: G10

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1 Introduction

Many equity markets operate a hybrid market structure that combines continuous trading in the electronic open limit order book during most of the trading day with call auctions at the open and the close. While liquidity voluntarily provided by market participants is usually sufficient for large cap stocks, many exchanges rely on designated market makers (DMMs) for mid and small caps. We are the first to study the activity of DMMs in call auctions in the context of a hybrid market structure. We find beneficial effects of DMM participation. Their activity is negatively related to the liquidity of the stocks and increases at times of high volatility and uncertainty. By leaning against the market, DMMs limit transitory price movements and thus stabilize prices. Their trades predict future returns and, hence, are profitable. This suggests they are implicitly compensated for their services. Thus, despite the fact that they have binding obligations such as maximum spread requirements, DMM activity in call auctions appears viable even in the absence of payments from the issuer or the exchange. In addition to the results immediately related to DMM activity, we show that the closing auction generally accounts for a much higher fraction of the total trading volume than the opening auction, and that the relative importance of the closing auction is increasing in firm size while the relative importance of the opening auction is decreasing in size.

Previous empirical evidence on designated market making is almost exclusively based on data from the continuous trading sessions. Little is known about whether and how designated market makers contribute to the liquidity of the call auctions. Call auctions form an important part of today's hybrid trading systems for at least three reasons: they attract a signficiant share of the daily trading volume, they serve to impound important information into prices at the open, and they define the closing price, which is increasingly relevant, e.g., for mutual funds' daily determination of their net asset values. Thus, an understanding of whether and how DMMs can improve call auction outcomes is critical.

We use data from the Xetra system operated by Deutsche Börse. Trading in Xetra opens and closes with a call auction. Further, there is a regular intraday call auction. Finally, trading is restarted with a call auction after volatility-induced trading halts. Our data identifies the trades of designated market makers. We are therefore able to analyze to which extent designated market makers participate in the auction, and to analyze the cross-sectional and time-series determinants of their trading activity.

Our paper contributes to the literatures on designated market makers and on call market trading. The former has mostly focused on DMMs in continuous limit order books. The theoretical models by Bessembinder et al. (2015) and Sabourin (2006) predict that the presence of a designated market maker increases liquidity. These theoretical predictions are supported by a growing body of empirical evidence which suggests that designated market makers indeed improve liquidity (e.g. Anand et al. (2009), Anand and Venkataraman (2016), Clark-Joseph et al. (2016), Declerck and Hazart (2002), Eldor et al. (2006), Hengelbrock (2011), Menkveld and Wang (2013), Nimalendran and Petrella (2003) and Skjeltorp and Ødegaard (2015)).

The relative advantages of electronic call auctions have been discussed theoretically by Cohen and Schwartz (1989), Economides and Schwartz (1995) and Schwartz (2000). Several papers (e.g. Pagano and Schwartz (2003), Chang et al. (2008), Chelley-Steeley (2008), Chelley-Steeley (2009), Kandel et al. (2012), Pagano et al. (2013)) provide evidence that the introduction of an opening and / or a closing call auction improves market quality, particularly for small caps.[1] Abad and Pascual (2010) and Zimmermann (2014) analyze call auctions subsequent to volatility-induced trading halts, an institutional feature that also plays a role in the present paper.

While all the above papers analyze trading in call auctions, none of them considers the role of designated market makers in these auctions. The only papers we are aware of that explicitly

[1] Interest in this issue has been reignited recently when the London Stock Exchange introduced a midday call auction. Note that our setting does not allow analyzing the effect of introducing a midday call auction because such an auction was conducted for all our sample stocks during the entire sample period.

consider designated market makers in call auctions are Madhavan and Panchapagesan (2000), Kehr et al. (2001) and Venkataraman and Waisburd (2007). Madhavan and Panchapagesan (2000) and Kehr et al. (2001) analyze floor-based trading systems in which the designated market maker (the NYSE specialist and the "amtlicher Kursmakler" on the Frankfurt Stock Exchange, respectively) had exclusive access to the limit order book and had discretionary power in setting the auction price, which is entirely absent in today's electronic call markets. Venkataraman and Waisburd (2007) use data from the French equity market which operates an electronic call auction. They find that firms with designated market makers have better market quality and that share prices increase upon the announcement that a designated market maker will be introduced. Our paper differs from theirs in two important ways. First, the French stocks analyzed in Venkataraman and Waisburd (2007) are traded *only* in call auctions while the stocks we analyze are traded continuously. Second, the data set analyzed in Venkataraman and Waisburd (2007) does not identify trades made by designated market makers. Therefore, they can test whether the existence of a designated market maker affects market quality, but they cannot analyze the trading activity of designated market makers. In a sense, then, our results complement theirs because we show in detail *how* designated market makers improve the market quality in the call auctions.

The remainder of this paper is organized as follows. Section 2 describes the institutional setting. Section 3 develops our hypotheses. Section 4 describes our data set and presents descriptive statistics. Section 5 contains the empirical analysis of market maker participation, section 6 concludes.

2 The Institutional Setting

Xetra, operated by Deutsche Börse, is the dominant market for German stocks. Stocks can be traded either continuously or in a call auction-only mode. Which trading protocol applies for a particular stock is determined in a two-step procedure. In a first step the exchange sorts stocks into two liquidity categories, A and B, according to the turnover and the transaction costs[2] measured over a period of four months. Stocks categorized as liquid are traded continuously. The issuer may voluntarily contract with a designated market maker.[3] Stocks categorized as illiquid, on the other hand, are traded in a call auction-only mode unless they have a designated market maker. As explained in more detail below, employing a designated market maker is costly. Firms may be willing to incur these costs because a switch to continuous trading has been shown to improve market quality and to result in an increase in share prices (Amihud et al. (1997) and Kalay et al. (2002)).

From this it follows that there are four groups of stocks: (1) illiquid stocks that do not have a designated market maker and that are traded in a call auction-only mode, (2) illiquid stocks that do have a designated market maker and are traded continuously, (3) liquid stocks that have a designated market maker (on a voluntary basis) and (4) liquid stocks that do not have a designated market maker. Since the focus of this paper is the participation of designated market makers in call auctions we only include stocks from groups 2 and 3 in our sample. Consequently, all our sample stocks are traded continuously, and all sample stocks have at least one designated market maker.

The trading day in Xetra starts at 9 a.m. with an opening call auction and ends at 5:30 p.m. with a closing auction. A third call auction takes place in the middle of the trading day (between 1 p.m. and 1:17 p.m.[4]). The continuous trading session, which comprises the remainder of the trading day, is organized as an electronic open limit order book. Trade execution is governed by price and time priority. Continuous trading is halted when the

[2]Transaction costs are measured by the roundtrip cost of a trade of size 25,000 Euros.

[3]The official name of designated market makers in Xetra is "designated sponsors". We use the term designated market maker (DMM) instead, which is more common in the academic literature.

[4]The intraday call auction is held between 1:00 and 1:02 for DAX and TecDAX stocks, between 1:05 and 1:07 for MDAX and SDAX stocks, and between 1:15 and 1:17 for other stocks. The MDAX, SDAX and TecDAX are indices calculated by Deutsche Börse AG. They comprise stocks which are listed in the prime standard segment of the Frankfurt Stock Exchange and which are (as measured by free float and trading volume) smaller than the 30 stocks included in the blue-chip index DAX. The MDAX and SDAX each comprise 50 stocks from non-technology sectors. The 50 stocks in the MDAX are the next 50 stocks outside the technology sector after the DAX stocks while the 50 stocks in the SDAX are those that follow after the MDAX stocks. The TecDAX comprises the 30 largest technology stocks outside of the DAX.

price hits a predefined (but undisclosed) price limit. After such a volatility interruption trading is restarted with a call auction. There are thus four types of call auctions, namely, opening auctions, closing auctions, (regular) intraday auctions, and auctions after volatility interruptions.

Orders submitted to Xetra belong to one of three account types, "agency", "principal" or "market maker". Agency orders are submitted by Xetra members on behalf of other traders (i.e. orders submitted by Xetra members acting as brokers for their customers). Principal orders are orders submitted by Xetra members on their own behalf. Market maker orders are orders submitted by Xetra members in their capacity as designated market makers.

The designated market making arrangement is specified in a contract between the issuer and the market maker. The issuer pays the market making firm a fee. The market making firm, in turn, commits to register as a designated market maker for the issuer's stock. The minimum standards for designated market makers are defined in the "Designated Sponsor Guide" published by Deutsche Börse. They are required to submit buy and sell limit orders (referred to as "quotes" hereafter) to the call auctions and to quote bid and ask prices during the continuous trading session. They have to meet a minimum participation rate in the call auctions and a minimum quotation time in the continuous trading session. For a quote to count towards the minimum participation rate and minimum quotation time requirements, it must satisfy maximum spread and minimum depth requirements. The details of these requirements are outlined in the Designated Sponsor Guide. Designated market makers do not have an informational advantage (such as exclusive access to the limit order book, as the NYSE specialists had), and their quotes are subject to the same price and time priority rules as orders submitted by agency and principal traders.

Provided designated market makers fulfill their obligations, they benefit from a rebate on the execution fees for illiquid stocks (group 2). Deutsche Börse monitors the performance of the designated market makers and publishes a quarterly rating.[5]

[5] See Theissen and Westheide (2015) for details.

Many firms have more than one market maker. There are two reasons why a firm can have several market makers. First, the issuer can voluntarily contract with more than one market maker. Second, market making firms can register as market makers in a particular security without entering into a contract with the issuer. In this case, they have to comply with the full set of requirements for designated market makers but do not receive a fee from the issuer. We cannot differentiate between these two cases because the existence (and the terms) of a contract between the issuer and the market maker are not disclosed.

3 Hypotheses

While the liquidity of a pure order-driven market is usually sufficient for large and high-volume stocks, it often is not for small caps. In fact, the intention of integrating designated market makers into (continuous and/or call) auction markets has been to increase liquidity for stocks that are inherently illiquid (see e.g Nimalendran and Petrella (2003) and Menkveld and Wang (2013)). By this argument, we expect that the relative importance of designated market makers, measured by their share in the auction trading volume, is inversely related to firm size.

Hypothesis 1 *Designated market makers account for a higher share of the total auction volume for stocks that are inherently less liquid (i.e., stocks with lower market capitalization).*

As we will document in the next section, there are significant differences in trading volume between the four auction types (opening, intraday and closing auction, and auctions after volatility interruptions). By a similar argument as above, we expect the services of designated market makers to be in relatively higher demand in those auctions that attract less volume.

Hypothesis 2 *The share of designated market makers in the total auction volume is higher in those auctions that attract less overall volume.*

We expect this hypothesis to hold in two dimensions. First, at an aggregate level, it should hold across auction types. If, for example, opening auctions generally attract less volume than closing auctions, then we expect market maker participation to be higher in the opening auction. Second, the hypothesis should hold in the time series. For a given stock and a given auction type, designated market maker participation should be higher on days with lower auction volume.

Designated market makers have an affirmative obligation to submit buy and sell orders to the auction, and they are subject to maximum spread requirements. Principal and agency traders, on the other hand, can withdraw from the market at times of high volatility or increased informational asymmetry. We thus have the following hypothesis.

Hypothesis 3 *Designated market maker participation is increasing in both return volatility and adverse selection risk.*

The NYSE specialists had the affirmative obligation to stabilize prices (e.g. Hasbrouck and Sofianos (1993), Panayides (2007)). Even though the designated market makers in Xetra do not have such an affirmative obligation, they can nevertheless be expected to contribute to price stabilization. As suppliers of liquidity they will typically trade on the short side whenever there is an order imbalance. To the extent that the imbalance causes temporary price pressure, designated market makers will thus trade against the temporary price change.

Hypothesis 4 *Designated market makers stabilize prices, i.e., they trade against temporary price changes.*

Designated market makers provide liquidity to the market and thus provide a valuable service to other traders. Providing this service is both costly and risky. Consequently, DMM should expect a compensation. We thus have

Hypothesis 5 *Designated market makers earn positive trading profits.*

4 Data and Descriptive Statistics

Our data set contains all transactions executed in stocks that are traded continuously in Xetra during the months of July and August 2011 (44 trading days) and July and August 2013 (45 trading days). We exclude all stocks that do not have a designated market maker. Note that the most liquid stocks (in particular the component stocks of the DAX index) did not have a designated market maker during our sample period. Therefore, our dataset is tilted towards small and mid caps. We further exclude foreign stocks (defined as stocks with an ISIN country code different from DE) and stocks that do not have at least one call auction with non-zero volume on at least 50% of the trading days in our sample period. We match the transactions data with intraday data on best bid and ask prices provided by Deutsche Börse. We further obtain data on firm characteristics from Thomson Reuters Datastream. After the exclusion of five stocks because of missing data, the final sample contains 250 stocks in 2011 and 209 stocks in 2013.

Table 1 provides summary statistics for the stocks in our sample. Columns 1-5 [6-10] show data for the first [second] sample period. The average sample stock has a market capitalization of 689.8 [993.1] million Euros in the 2011 [2013] sample, and an average daily trading volume of 2.80 [2.15] million Euros. There is considerable cross-sectional variation in the sample. While the firm at the 5th percentile has a market capitalization of 25.4 [30.3] million Euros and an average daily volume of 11,719 [17,166] Euros, the corresponding values for the firm at the 95th percentile are 3,050.2 [4,715.8] million Euros for the market capitalization and 14.7 [9.6] million Euro for the average daily volume. The average share price is 21.68 [25.77] Euros in the 2011 [2013] sample. The average quoted bid-ask spread is 1.10% [0.74%] while the average 5-minute price impact (a proxy for losses to informed traders) is 0.54% [0.40%]. The large differences in the bid-ask spreads and price impacts for the two sample periods are a reflection of the fact that 2011 was a much more volatile period than 2013. This is evidenced by the average volatility (as measured by the standard deviation of daily returns) which amounts to 3.5% in the 2011 sample and 2.5% in the 2013 sample. The cross-sectional differences in volatility are substantial. The return standard deviation of the stock at the 95th percentile is more than three [more than five] times as large as the corresponding value for the stock at the 5th percentile in 2011 [2013].

The trading volume reported above relates to the total volume in the continuous trading session and the call auctions. On average the call auctions account for 12.2% of the total volume in the 2011 sample and for 11.9% in the 2013 sample. The closing auction is by far the most important auction in terms of volume. It accounts for 50.9% [58.7%] of the auction volume in the 2011 [2013] sample.[6] The high volume share of the closing auction is consistent with the stylized fact that many institutional traders prefer to trade at or near the close (e.g. Cushing and Madhavan (2000)). The opening auction accounts for 25.5% [25.7%] of the auction volume, the intraday auction for 3.0% [3.9%] and auctions after volatility interruptions for the remaining 20.8% [11.7%]. When interpreting the last figure one needs to take into account that there are, on average, 0.51 [0.17] volatility interruptions per stock and day. Thus, conditional on a volatility interruption occurring, the call auction conducted to restart trading accounts for a considerable fraction of the volume.

The table also reveals the percentage of auctions with positive volume. Averaged over all stocks, 79.5% [82.1%] of the closing auctions, 71.3% [72.5%] of the opening auctions and 35.6% [55.1%] of the intraday auctions have non-zero volume in the 2011 [2013] sample. There is considerable cross-sectional variation. The stock at the 95th percentile always has positive volume in the opening and closing auction. In contrast, the stock at the 5th percentile has positive volume in the opening and closing auctions on less than one third of the trading days in the sample period. The fraction of intraday auctions with positive volume is even lower. These figures indicate that some of our sample stocks are very illiquid

[6] Note that these figures were obtained by first calculating the volume share for each stock and then averaging over all sample stocks. If we first aggregate the volume in the different auctions and then calculate the volume shares based on the aggregate volume, we obtain much higher volume shares for the closing auction. This is because the share of the closing auction is higher for stocks with higher total auction volume.

indeed.

While the number of opening, intraday and closing auctions is fixed at one per stock and day, the same does not hold for auctions after volatility interruptions. As noted above, these auctions are triggered by large price changes. Their number is thus endogenous. Therefore, the figures provided for this auction type have to be interpreted differently. They indicate that, on average, there were 0.51 [0.17] such auctions per stock and day in 2011 [2013].[7] The higher number of volatility auctions in the 2011 sample is a reflection of the higher volatility in 2011 already documented above. Again, there is considerable cross-sectional variation. The stock at the 5th percentile has 0.07 [0] auctions after volatility interruptions per day while the stock at the 95th percentile has 1.20 [0.64] such auctions per day in 2011 [2013]. These numbers reflect the large differences in return volatility across the sample stocks documented above.

Table 1 about here

Table 2 provides more insight into the relative importance of the four different types of auctions. It shows the fraction of the total trading volume accounted for by the call auctions for five groups of stocks. The groups are created as follows. Those stocks that are categorized as liquid by the exchange are sorted into one group denoted "Liquid". As noted in section 2 these stocks do not require a market maker to be traded continuously. The remaining stocks are sorted into size quartiles.

The table reveals a remarkable pattern. The volume share of the closing auction increases almost monotonically as we move from small to larger stocks. In 2011 [2013] the closing auction accounts for 3.16% [2.05%] of the total volume in stocks of the smallest size-quartile. This fraction increases to 7.4% [9.46%] for the stocks in the largest volume quartile and to 10.30% [15.40%] in the "liquid" group. A potential explanation for this finding is that (as will

[7]Note that our dataset only contains information on auctions after volatility interruptions with positive volume. It is conceivable that there are additional volatility interruptions in which the auction conducted to restart trading yielded zero volume. We do not observe these cases.

be discussed in the next section) principal traders have a much higher market share in large and high volume stocks and, at the same time, display a revealed preference for trading in the closing auction (possibly because they use the closing price as benchmark and/or want to avoid holding inventory overnight). Consequently, the closing auctions accounts for a higher fraction of the total volume in larger stocks. We find the opposite pattern for the opening and intraday auctions. Here, the auction accounts for a higher share of the total volume for smaller stocks than it does for larger ones. The same is true for auctions after volatility interruptions. For these auctions, the pattern is partially explained by the fact that smaller stocks tend to have more volatile returns and therefore experience more frequent volatility interruptions.[8]

Table 2 about here

5 Results

5.1 Market Shares and Trading Patterns

We start our empirical analysis by considering the participation of the three groups of traders (agency traders, principal traders, and designated market makers) in the call auctions.[9] The results are shown in Table 3. Panel A shows results for groups of stocks sorted by market capitalization (using the procedure described above) while Panel B presents results for the four different types of call auctions. In each panel, columns 1-6 show the results for the 2011 sample while columns 7-12 show those for the 2013 sample. Columns 1-3 and 7-9 (denoted "any participation") show how often traders of the respective group participate in an auction. Take as an example the figure 89.54 in the upper left cell of Panel A. It indicates that agency

[8]In fact, the number of auctions after volatility interruptions decreases almost monotonically across the size groups.

[9]We use the term *participation rate* to measure how frequently the traders in a group participate in an auction. We use the term *participation share* to measure the fraction of the auction volume the traders in a group account for.

traders participated in 89.54% of the auctions for the group of stocks of the smallest firms. Columns 4-6 and 10-12 show market shares as a percentage of the Euro trading volume. The figure 69.84 in column 4 of the first line in Panel A indicates that transactions by agency traders account for 69.84% of the volume in the auctions for the stocks of the smallest firms.

Table 3 about here

Agency traders are the most active auction participants. They participate in more than 89% of the auctions even in the stocks of the smallest size group. Principal traders participate less in auctions for small-cap stocks. Their participation rates increase monotonically as we move towards more liquid stocks. The pattern for designated market makers is the exact opposite. In line with hypothesis 1, they have the highest participation rates (37.0% in the 2011 sample and 25.0% in the 2013 sample) in the smallest firms, whereas their participation rates are only 13.6% and 9.0% in the 2011 and 2013 sample, respectively, for the group of "liquid" stocks. Designated market makers thus appear to provide relatively more liquidity to stocks that are inherently illiquid.

When considering market shares in terms of the Euro trading volume we find that trading is dominated by agency and principal traders. Together they account for 90.2% to 99.7% of the trading volume. Considering the five groups of stocks reveals a remarkable pattern. Agency traders have the largest market shares in the least liquid market capitalization group. Their market share then decreases monotonically as we move to the more liquid sample stocks. For principal traders we observe the reverse pattern. As for the agency and principal traders, the market shares of the designated market makers vary systematically across size groups. They account for 9.8% (2011) and 4.4% (2013), respectively, of the volume in the smallest size group. Consistent with hypothesis 1, their market shares decrease almost monotonically across the size groups and amount to only 0.3% (0.1%) in the 2011 (2013) sample in the most liquid group.

The market shares for the different auction types displayed in Panel B of Table 3 show a distinct pattern. Agency traders dominate the opening auctions and the call auctions after volatility interruptions. Principal traders, by contrast, dominate the closing auctions. Designated market makers have a low market share in the closing auction. It amounts to 0.35% of the Euro volume in the 2011 sample and to 0.21% in the 2013 sample. Their share in the opening auction is much larger, at 2.1% [1.6%] in the 2011 [2013] sample. Their market shares are highest in the intraday auctions (7.1% and 1.8%) and in auctions after volatility interruptions (4.5% and 4.0%). It is interesting to compare the results on market maker participation to those on the market shares of the four auction types shown in Table 1. Market maker participation appears to be inversely related to the total volume transacted in the auction. In particular, the closing auction is by far the most important auction in terms of volume, but it has the lowest market maker participation share. The intraday auction, in contrast, is the least important auction in terms of volume and has the highest market maker participation share in the 2011 sample and the second highest share in the 2013 sample. This pattern is consistent with hypothesis 2. It also appears that market makers have a comparably high participation share in those auctions where price uncertainty is likely to be higher, namely, opening auctions and auctions after volatility interruptions. This finding is in line with hypothesis 3. This may, of course, partly be due to the market makers' affirmative obligation to participate in call auctions. While agency and principal traders can withdraw from the markets in times of high uncertainty, market makers are bound to stay.

The analysis so far has focused on market maker participation across the four different auction types. A related question is whether, within one type of auction, market maker participation varies systematically with the trading volume in the auction. To address this issue we estimate panel regressions in which we regress the market maker participation share on the logarithm of the auction volume. We estimate separate regressions for each auction type and we include firm fixed effects. Therefore, identification comes from the within-stock variation in the auction volume. The results are presented in Table 4. For three of the four auction types (opening and closing auctions and auctions after volatility interruptions) the coefficient on the log auction volume is significantly negative. Thus, designated market makers participate relatively more when the trading volume in the auction is lower. This result is consistent with hypothesis 2. For the intraday auctions we obtain a positive coefficient, implying that market makers trade more when the auction volume is higher. It should be kept in mind, though, that the volume of the intraday auctions is generally very low. As shown in Table 1, they account for less than 4% of the total call auction volume on average.

Table 4 about here

The fixed effects panel regressions do not allow us to identify the effect of variables with no or little time-series variation. We therefore also estimate cross-sectional regressions. Table 5 reports the results of a cross-sectional fractional logit model. The dependent variable is the average participation share of the designated market makers. The independent variables include the log of the average market value of equity during the sample period, the share turnover (defined as the ratio of share trading volume and market capitalization[10]), the 5-minute price impact (averaged over the sample period) as a measure of adverse selection risk, and three dummy variables which indicate whether the stock is a constituent stock of the mid cap index MDAX, the technology stock index TecDAX, or the small cap index SDAX. The coefficients are the marginal effects in percentage points, measured per standard deviation for the continuous independent variables. Table 5 reports separate results for the opening, the closing and the intraday auctions, and for auctions after volatility interruptions. Columns 1-4 [5-8] show the results for the 2011 [2013] sample.

Consistent with hypothesis 1, market maker participation rates are decreasing in the market capitalization and in the turnover ratios. A coefficient of -1.5 for market capitalization implies

[10]The correlation between market capitalization and turnover is 0.26 (-0.11) in the 2011 (2013) sample.

that a one standard deviation increase in the log of market capitalization decreases market maker participation by 1.5 percentage point. Relative to the participation rates shown in Table 3 (all well below 10%) this is an economically significant decrease. In the 2013 sample there is, in line with hypothesis 3, some evidence that market maker participation rates are higher for stocks with higher adverse selection risk as measured by the 5-minute price impacts. The respective coefficients in the 2011 sample are insignificant. The results further imply market maker participation tends to be lower in the component stocks of the MDAX and TECDAX indices (which are the largest and most liquid stocks in our sample).

Table 5 about here

The results presented thus far suggest that designated market maker participation is higher in those auctions where trading interest from agency and principal traders is lower and where price uncertainty is likely to be higher. We elaborate on this point by analyzing the time-series determinants of market maker participation using logit regressions. We define a dummy variable that is set to 1 if the designated market maker buys or sells shares in an auction and is 0 otherwise. We then regress this dummy variable on the absolute change in the quote midpoint in the 5-minute interval of the continuous trading session immediately preceeding the call auction. We repeat the analysis using 30-minute intervals instead of 5-minute intervals. Given the differences between the auction types documented above, we estimate separate models for closing auctions, intraday auctions, and auctions after volatility interruptions.[11]

The results for our two samples, the 2011 and the 2013 sample, are qualitatively similar. Therefore we report the results for the pooled data set here. They are presented in Table

[11] Note that opening auctions cannot be included in the analysis because we do not observe price changes prior to the opening auction. Note further that the number of observations differs between the three auction types. This is because, as documented in Table 1, the fraction of auctions with non-zero volume differs across auction types. For auctions after volatility interruptions the number of observations is lower when we include the price change in a 30-minute interval as explanatory variable because some volatility interruptions occur during the first 30 minutes of the trading day.

6.[12] The coefficients on the absolute price change in the 5-minute and 30-minute intervals prior to the auctions are always positive and are significant in five out of six cases. This indicates that, consistent with hypothesis 3, the designated market makers are more likely to participate in auctions that take place at times of elevated volatility. The magnitude of the marginal effects implies that a one standard deviation change in the absolute midquote return increases the likelihood of market maker participation by 0.5 to 1.2 percentage points. These numbers should be related to the average market maker participation rates (shown in Table 3) which range between 8.8% (for the intraday auctions in the 2013 sample) and 37.6% (for auctions after volatility interruptions in the 2013 sample). Thus, in relative terms the likelihood of market maker participation increases by 1.4% to 6.3% upon a one standard deviation change in the absolute midquote return.

Table 6 about here

5.2 Price Stabilization

One important aspect of market making is whether market makers stabilize or destabilize prices. The NYSE specialists had the explicit affirmative obligation to preserve price continuity (e.g. Hasbrouck and Sofianos (1993), Panayides (2007)). We therefore analyze whether designated market makers exacerbate or dampen price changes. We proceed as follows. We calculate the signed price change from the last quote midpoint prior to the auction to the auction price. We then regress this variable on the signed market maker participation, defined as the market maker's trade in the auction divided by the total volume of the auction. In an alternative model specification we also include the quote midpoint return in the 5 [30] minutes prior to the auctions.[13] We estimate separate regressions for the intraday auctions,

[12] We also estimate Tobit models where the dependent variable is the fraction of the auction volume accounted for by trades of designated market makers. The results are consistent with those shown in Table 6 and are therefore omitted.

[13] Below we report results for pooled OLS estimation. We also estimate panel regressions with (a) firm fixed effects and (b) firm and quarter fixed effects. The results are very similar to those reported below and are thus omitted.

closing auctions, and for auctions after volatility interruptions. We cannot report results for the opening auction because the dependent variable (the price change from the previous quote midpoint to the auction price) is not defined for the opening auction.

The results are shown in Table 7. The coefficient on the signed market share of designated market makers is always negative and is significant at the 1% level in every case. This implies, in line with hypothesis 4, that designated market makers sell shares when prices go up and buy shares when prices go down. E.g., in the hypothetical case that they are the buyers of half of the trading volume in an auction after a volatility interruption, the regression results suggest that the immediate return will be about 30 basis points lower than in an otherwise similar auction without market maker participation. Thus, designated market makers appear to "lean against the wind" and stabilize prices.

Table 7 about here

The analysis documented in Table 7 considers short-term price stabilization. In order to broaden the perspective we now consider close-to-open (overnight) returns and open-to-close returns. We regress the close-to-open returns on the market makers' signed buying volume in the closing auction of day $(t-1)$ and the opening auction on day t. A negative close-to-open return can obtain when there is negative fundamental news, or when there is transitory upward pressure on prices in the closing auction and/or transitory downward pressure on prices in the opening auction. In the latter cases, a price-stabilizing market maker would sell in the closing auction and/or buy in the opening auction. Consequently, we expect a positive coefficient on the market makers' net buying volume in the closing auction of day $(t-1)$ and a negative coefficient on the net buying volume on the opening auction on day t. A similar argument (resulting in the same expected coefficient signs) applies in the case of positive overnight returns.

In a second regression we regress the open-to-close return on the market makers' signed net buying volume in the opening and closing auctions of day t. By a similar argument as above, price stabilization implies a positive coefficient on the market makers' net buying volume in the opening auction and a negative coefficient on the signed net buying volume in the closing auction.

The results are shown in Table 8. They are fully consistent with price stabilization and thus provide additional support for hypothesis 4. Market makers, on average, trade "against the trend". When the overnight return is positive, they have been buying in the closing auction, and they sell in the opening auction (and vice versa for negative overnight returns). Thus, their trading activity in both auctions contributes to a reduction of the magnitude of the overnight return. We find similar results for open-to-close returns. When the return is positive, market makers have been buying in the opening auction and selling in the closing auction. The results presented in Table 8 thus corroborate those documented in Table 7. Designated market makers trade in call auctions in a way that contributes to price continuity.

Table 8 about here

5.3 Profitability

An obvious question is whether designated market makers earn trading profits. To address this question we calculate price impacts, measured by the return from the auction price to a post-auction benchmark price. We use three different benchmark prices. The first is the quote midpoint 5 minutes after the auction, the second is the quote midpoint one hour after the auction and the third is the closing price of the trading day. Obviously, none of these benchmark prices is defined for the closing auction. Therefore, we assess the profitability of trades in the closing auction by relating the closing price to the opening price on the next trading day. Price impacts after sales are multiplied by (-1). Therefore, positive [negative] price impacts always imply profitable [unprofitable] trades.

In Table 9 we report the overall value-weighted mean, standard deviation and median price impact (columns 10-12). More importantly, we also report price impacts for trades conducted by agency traders, designated market makers, and principal traders in the auction (columns 1-3, 4-6 and 7-9, respectively). We report separate results for buys and for sales.[14]

Results for the opening auctions are reported in Panel A. There appears to be a negative price drift after the opening auction which continues over the day. On average prices drop by 10.9 basis points in the 5 minutes after the auction. The price decline increases to 16.8 basis points after one hour and to almost 42 basis points until the close of trading. Agency traders suffer substantial losses when they buy (62.4 basis points until the close of trading). They make small profits when they sell, but these profits are insufficient to compensate the losses they incur after buying. Principal traders, on the other hand, earn substantial profits when they sell. These profits overcompensate the small losses they incur when they buy. Designated market makers are the only group that manages to buy profitably. The 5-minute price impact after market maker buys is negative, but it turns positive after one hour. The 5-minute price impact after market maker sales is essentially zero. It turns negative (at 9.2 basis points) after one-hour, implying a loss for market makers. However, this loss is reversed by the end of the trading day. The price impact measured with respect to the closing auction is 39 basis points. We thus conclude that designated market makers trade profitably in the opening auctions.

Table 9 about here

Panel B shows the results for auctions after volatility interruptions. The average price change after the auction is positive. In the five-minute interval after the auction the price increaes by 21 basis points. On average prices continue to rise. The average one-hour price impact is 36.9 basis points, and the price increases by 89.6 basis points until the close of trading. The majority of volatility interruptions are triggered by price declines. The positive price impact indicates that prices tend to revert after the trading halt, and that this reversal continues

[14]The results in Table 9 do not differentiate between "liquid" stocks (i.e. those that do not require a designated market maker to be traded continuously) and other stocks. We repeat the analysis for both groups of stocks separately and obtain consistent results.

for the entire trading day. When we consider the three groups of traders separately, we find that agency traders tend to lose money. Although they buy profitably, these profits are overcompensated by the losses they incur after selling. Principal traders, on the other hand, tend to buy profitably. They also make small short-term profits when selling, but the profit turns to a loss of 47.6 basis points when the closing price is used as benchmark. However, this loss is overcompensated by the gain after principal buys (63.3 basis points when the closing price is used as benchmark). The group that trades most profitably in auctions after volatility interruptions are the designated market makers. Prices increase strongly after market makers buy (by 26.1 basis points within 5 minutes, by 50.9 basis points within an hour and by 118 basis points until the end of the trading day). When designated market makers sell they earn small short term profits. These profits turn to a small loss until the end of the trading day. However, the magnitude of the loss is small relative to the profits that market makers earn after buying (14.7 basis points as compared to 118 basis points).

Panel C reports the results for the closing auctions. As noted above, we use the opening price on the next trading day as reference price to calculate the price impact. There is no noticeable price drift in the overnight period. On average prices drop by less than one basis point. Agency traders appear to win. They earn 3.4 basis points when they buy and 4.2 basis points when they sell. This pattern is reversed for principal traders. Market makers suffer a small loss of 4.8 basis points when they buy in the closing auction. This loss, however, is overcompensated by the 24.4 basis points which they gain on average after selling in the closing auction.

Panel D shows the results for the regular intraday auctions. Price impacts are slightly lower than those after the opening auction. On average prices drop by 5 basis points. Agency traders lose slightly, principal traders roughly break even, and market makers trade profitably.

To put the market maker profits into perspective we compare them to the bid-ask spread in the continuous trading session. To this end, we add up the price impact after market maker buys and sales (using the closing price or, in the case of the closing auction, the next opening price as benchmark). We obtain mean [median] values of 11.5 [29.1] basis points for the opening auction, 19.6 [14.6] basis points for the closing auction, 82.9 [25.3] basis for the regular intraday auctions and 103.3 [82.5] basis points for auctions after volatility interruptions. The mean [median] bid-ask spread in the continuous trading session amounts to 109.8 [61.6] basis points in the 2011 sample and 73.5 [40.1] basis points in the 2013 sample (see Table 1). Thus, market maker profits in the call auctions appear to be of a reasonable magnitude. However, considering percentage numbers only does not allow us to estimate the profits that market makers actually earn. Therefore, Table 10 shows the average Euro profit per auction. The figures reveal that market makers, conditional on participating in a closing auction, earn 11.77 Euro on average. The corresponding figures for the intraday auctions, opening auctions and auctions after volatility interruptions are 25.46 Euros, 22.28 Euros and 31.84 Euros, respectively. These figures translate into earnings per stock and year of 2,623.84 Euros. The modest size of this number[15] supports the conclusion that market makers are not extracting excessive rents from their activity.

Table 10 about here

The results of the profitability analysis can be summarized as follows. Consistent with hypothesis 5 market makers trade profitably in the call auctions. Their profits exceed those of principal traders (while agency traders lose money on average). The profits of market makers are a reflection of the fact that they provide liquidity to other traders, and that liquidity supply is a valuable service that has its price. Some simple back-of-the-envelope calculations suggest that market maker profits are not excessive.

[15]Note that this is the estimated gross profit from the market makers' trading activity. The cost of doing business has not yet been deducted.

6 Conclusion

Many equity markets employ designated market makers to supply additional liquidity for small and mid cap stocks, and they use a hybrid trading system that combines a continuous trading session and call auctions. In this paper we use data from Germany's Xetra system to analyze designated market maker activity in the call auctions. There are four different types of call auctions in Xetra - opening auctions, closing auctions, one regular intraday auction per stock and per day, and auctions after volatility-induced trading halts. Taken together, the call auctions account for approximately 12% of the total trading volume of the stocks in our sample.

We find that trading in the call auctions is dominated by principal traders and agency traders while the share of designated market makers is much lower. We further find that their share in the total auction volume is inversely related to firm size. Thus, in the cross-section market makers tend to trade relatively more in less liquid stocks. A similar pattern holds across the four auction types. Market makers are relatively least active in the closing auction (which is by far the most liquid of the four auction types) and are relatively more active in the less liquid auctions. Taken together it appears that market makers trade relatively more actively precisely in those stocks and on those occasions where their contribution to liquidity is needed more. Results of a time-series analysis provide further support for this interpretation, revealing that market makers tend to trade more in times of higher volatility. These results are likely, at least in part, the result of their affirmative obligation to quote. When we relate returns to signed market maker trading activity we find clear evidence that market makers stabilize prices. They thus contribute to price continuity.

We further document that market maker trades are profitable. Prices increase on average after market makers buy, and they decrease on average after market makers sell. Taken together our results indicate that designated market makers provide a valuable service to the market. The trading profits which they earn can be interpreted as the implicit price that they charge for this service.

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Table 1: Descriptive statistics

	2011					2013				
	Mean	Median	Std. dev.	5th pct	95th pct	Mean	Median	Std. dev.	5th pct	95th pct
Company and stock statistics										
Market cap. (mio euros)	689.801	219.308	1062.131	25.417	3050.164	993.122	293.850	1565.321	30.328	4715.898
Price (euros)	21.681	12.573	29.486	1.273	69.876	25.770	15.481	33.976	1.252	82.154
Volatility (daily std)	0.035	0.033	0.013	0.016	0.054	0.025	0.019	0.021	0.011	0.058
Price impact 5m	0.539	0.395	0.473	0.080	1.415	0.398	0.228	0.506	0.052	1.184
Bid-ask spread	1.098	0.616	1.088	0.127	3.164	0.735	0.401	0.810	0.070	2.488
ADV total (euros)	2796464	372706	5972757	11719	14666964	2151163	315215	4280445	17166	9601774
Call auction trade statistics										
Volume share of auctions	12.23	10.68	5.81	6.06	24.83	11.93	10.62	5.22	5.27	22.16
ADV Open (euros)	37181	9275	74923	443	172748	30523	6788	58957	455	135793
ADV Close (euros)	271666	15356	625619	379	1788802	303031	16547	676227	504	1529346
ADV Intraday (euros)	6950	1221	12363	24	36761	3976	1472	5697	21	16610
ADV Volatility (euros)	8170	4500	13292	444	25838	4601	1723	10885	100	18225
Open share of auctions	25.45	23.80	15.07	5.31	52.59	25.74	22.70	17.07	4.50	58.50
Close share of auctions	50.95	49.40	26.24	11.85	92.13	58.74	60.31	27.01	14.66	94.26
Intraday share of auctions	3.01	2.29	2.71	0.41	9.46	3.88	2.56	4.13	0.50	10.91
Volatility share of auctions	20.85	14.02	20.11	0.20	61.87	11.69	4.15	15.97	0.00	47.58
Intraday > 0	35.62	27.27	31.90	0.00	93.18	55.07	62.22	36.19	2.22	100.00
Close > 0	79.54	97.73	27.75	27.27	100.00	82.13	100.00	26.06	28.89	100.00
Open > 0	71.26	79.55	28.14	22.73	100.00	72.45	82.22	28.45	22.22	100.00
Volatility > 0	51.22	40.91	46.29	6.82	120.46	17.08	6.67	27.34	0.00	64.44

This table shows descriptive statistics for the firms in our sample. The top panel provides information on the companies, their stocks, and their trading overall. The left part of the table is summarizing data for our sample in 2011, the right part for 2013. *Market cap.* is the market value of equity, *Price* is the stock price, and *Volatility* is the standard deviation of daily returns. *Price impact 5m* is the average price impact during continuous trading, *Bid-ask spread* is the time-weighted average quoted spread in percent, and *ADV total* is the daily trading volume in euros aggregated over the continuous and call auction phases. The bottom panel of the table summarizes trading activity in call auctions. *ADV auction type* is the average daily Euro trading volume in the different types of call auctions. *Volume share of auctions* is the percentage of call auction trades relative to total trading volume. *Auction type share of auction volume* is the relative share, in percent, of the respective auction type in total call auction trading. *Auction type* > 0 is the percentage of auction of the respective type with a non-zero trading volume. For volatility auctions, it is the number of volatility auction with trading volume expressed in percent.

Table 2: Market shares of types of call auctions by market capitalization quartile and liquidity class

	Open	Close	Intraday	Vola	All Auctions
			2011		
Small	3.67	3.16	0.38	5.41	12.63
2	3.78	2.89	0.22	2.02	8.91
3	2.70	4.60	0.31	1.46	9.06
Big	1.80	7.40	0.30	0.75	10.26
Liquid	1.18	10.30	0.22	0.15	11.84
			2013		
Small	2.81	2.05	0.27	1.50	6.64
2	2.79	3.89	0.52	1.50	8.71
3	2.72	5.35	0.32	0.77	9.17
Big	1.59	9.46	0.29	0.35	11.69
Liquid	1.29	15.40	0.16	0.09	16.94

This table shows the fraction of trading, measured by the volume in euros, conducted in call auctions and relative to the total trading volume, for non-liquid stocks, sorted by market capitalization quartiles at the beginning of the two sample periods, and liquid ones.

Table 3: Market shares in call auctions

	2011						2013					
	any participation			volume in euros			any participation			volume in euros		
	Agency	DMM	Principal	A	DMM	P	A	DMM	P	A	DMM	P
A: Participation by market capitalization quartile and liquidity class												
Small	89.54	36.98	47.47	69.84	9.80	20.36	89.54	25.02	65.36	72.09	4.44	23.46
2	89.16	32.31	63.61	65.16	6.12	28.72	89.86	27.64	70.21	57.80	6.19	36.01
3	92.25	30.65	76.05	57.21	5.37	37.42	93.92	20.73	81.66	49.73	4.27	46.00
Big	94.13	27.74	85.07	44.91	3.03	52.06	94.81	15.30	91.34	43.61	1.69	54.71
Liquid	97.50	13.57	95.88	39.47	0.34	60.19	96.82	8.98	99.41	43.44	0.11	56.45
B: Participation by type of call auction												
Open	97.35	30.32	76.29	61.70	2.09	36.21	94.55	22.36	84.63	56.48	1.58	41.94
Close	91.03	22.13	95.19	37.10	0.35	62.54	93.58	15.26	96.74	42.14	0.21	57.65
Intraday	92.21	13.47	73.35	40.83	7.08	52.09	93.06	8.77	77.72	54.44	1.82	43.75
Volatility	92.02	36.07	56.78	67.14	4.49	28.37	94.50	37.61	60.05	64.90	4.04	31.06

This table shows the fractions of call auctions with non-zero participation and the share of trading, measured by the trading volume in Euros, for agency traders, designated market makers (DMM), and principal traders. The left part of the tables shows data from 2011, the right part from 2013. Panel A reports results separately for non-liquid stocks, sorted by market capitalization quartiles at the beginning of the two sample periods, and liquid ones. Panel B reports results sorted by type of call auction.

Table 4: Panel regression of participation share of designated market makers

	Open	Close	Intraday	Volatility
Log Auction Volume	-0.863***	-1.362***	0.433***	-3.755***
	(-6.29)	(-10.15)	(2.61)	(-16.97)
Constant	18.025***	18.836***	4.471***	44.530***
	(19.91)	(18.32)	(5.07)	(33.87)
Observations	15515	17445	9653	7785

This table shows the results of panel regressions, separately for each type of call auction, explaining the share of DMM trading. The regressions include stock fixed effects and the coefficients are expressed in percentage points. Standard errors are clustered at the stock level. ***, ** and * denote statistical significance at the 1%, 5% or 10% level.

Table 5: Cross-sectional fractional logit regression of participation shares of designated market makers

	2011				2013			
	Open	Close	Intraday	Volatility	Open	Close	Intraday	Volatility
Log Market cap.	-1.542**	-1.296**	-3.671**	-1.369	-1.559**	-1.836***	-1.296	1.074
	(-1.97)	(-2.11)	(-2.11)	(-1.45)	(-2.25)	(-4.41)	(-1.48)	(0.81)
Share turnover (relative)	-5.743***	-2.849***	-2.540**	-3.423***	-4.990***	-2.583***	-5.836***	-3.614***
	(-5.48)	(-3.60)	(-2.40)	(-3.19)	(-5.34)	(-4.51)	(-4.69)	(-2.67)
Price impact 5m	-0.839	-0.056	-1.947	-0.072	0.564***	0.157	0.606***	0.614
	(-1.04)	(-0.10)	(-0.97)	(-0.08)	(3.62)	(1.39)	(2.91)	(1.06)
MDAX	-3.396**	-3.514***	9.889***	-5.592***	-2.839**	-2.251**	-1.432	-7.810***
	(-2.57)	(-3.69)	(2.65)	(-3.80)	(-2.07)	(-2.39)	(-0.81)	(-3.13)
TecDAX	-0.826	-2.998***	-3.598***	-3.670*	0.203	-1.131	1.041	-4.575*
	(-0.49)	(-3.17)	(-3.01)	(-1.78)	(0.13)	(-1.20)	(0.49)	(-1.66)
SDAX	1.907	-0.393	3.191	-0.737	2.606**	0.419	0.189	-3.388
	(1.50)	(-0.38)	(1.49)	(-0.55)	(1.97)	(0.51)	(0.16)	(-1.38)
Observations	250	250	229	246	209	209	207	174

This table shows marginal effects obtained from fractional logit regressions explaining the share of designated market maker trading in each type of call auction. The left part of the table provides results for 2011, the right part for 2013. The explanatory variables comprise the natural logarithm of the market value of equity as of the beginning of the respective sample period, share turnover, the ratio of total trading volume and the market value of equity, the average five minute price impact, and dummy variables indicating whether a stock is among the constituent stocks of the midcap index MDAX, the technology stock index TexDAX, or the smallcap index SDAX. The independent variables, except for the indicator variables, are standardized and the coefficients are expressed in percentage points. Standard errors are robust to heteroskedasticity. ***, ** and * denote statistical significance at the 1%, 5% or 10% level.

Table 6: Logit regressions of participation of designated market makers

	Close	Close	Intraday	Intraday	Volatility	Volatility
Abs. return 5m	0.517**		0.539**		0.996*	
	(2.46)		(2.22)		(1.92)	
Abs. return 30m		1.238***		0.551*		0.530
		(4.52)		(1.90)		(0.65)
Observations	17035	17035	9464	9462	7217	6408

This table shows marginal effects obtained from logit regressions explaining the participation of designated market makers in closing auctions, regular intraday auctions, and auctions after volatility-induced trading halts. The independent variable is the standardized absolute value of the quote midpoint return in the 5 or 30 minute interval immediately preceeding the auction. Standard errors are clustered at the stock level. ***, ** and * denote statistical significance at the 1%, 5% or 10% level.

Table 7: Determinants of auction returns

	Close	Close	Close	Intraday	Intraday	Intraday	Volatility	Volatility	Volatility
DMM share (signed)	-0.332***	-0.337***	-0.335***	-0.245***	-0.247***	-0.247***	-0.585***	-0.603***	-0.614***
	(-4.70)	(-4.75)	(-4.74)	(-6.17)	(-6.20)	(-6.17)	(-3.70)	(-3.67)	(-3.68)
Return previous 5m		-0.180***			-0.093*			-0.090***	
		(-4.05)			(-1.68)			(-3.08)	
Return previous 30m			-0.025			-0.037**			-0.050**
			(-1.31)			(-2.38)			(-2.08)
Constant	0.031**	0.034***	0.032***	0.010	0.011	0.012	-0.059	-0.059	-0.069
	(2.58)	(2.80)	(2.61)	(1.38)	(1.47)	(1.63)	(-1.10)	(-1.10)	(-1.38)
Observations	17035	17035	17035	9464	9464	9462	7456	7217	6408

This table shows results of OLS regressions explaining the signed return from the quote midpoint immediately prior to the auction to the auction price. Explanatory variables are the signed market maker participation, computed as the signed market maker trading volume divided by the total volume traded in the respective auction, and standardized quote midpoint returns in either the 5-minute or the 30-minute interval immediately preceeding the auction. Standard errors are clustered at the stock level. ***, ** and * denote statistical significance at the 1%, 5% or 10% level.

Table 8: Market Maker impact on Close-Open and Open-Close Returns

	Close-Open	Open-Close
DMM Open Net-Buying	-0.724***	0.327***
	(-7.31)	(2.84)
DMM Close Net-Buying	0.315***	-0.506***
	(3.39)	(-3.58)
Constant	-0.007	0.007
	(-0.33)	(0.24)
Observations	12159	12766

This table shows results of OLS regressions of the returns from the previous close to the open and from the open to the close as explained by designated market makers' signed trading, as a share of total volume in the respective opening and closing auction. Returns are adjusted for the corresponding sample average on the day. Standard errors are clustered at the stock level. ***, ** and * denote statistical significance at the 1%, 5% or 10% level.

Table 9: Price impacts when different participants trade in call auctions

	Agency			DMM			Principal			All		
	Mean	Std. dev.	Median	Mean	Std. dev.	Median	Mean	Std. dev.	Median	Mean	Std. dev.	Median
A: Opening Auctions												
Buying												
PI 5m	-0.155	1.323	-0.083	-0.046	1.223	0.024	-0.035	1.071	-0.008	-0.109	1.235	-0.040
PI 1h	-0.253	2.410	-0.039	0.100	1.858	0.071	-0.039	2.033	0.006	-0.168	2.272	-0.023
PI Cl.	-0.624	4.437	-0.085	0.161	2.997	0.000	-0.099	3.403	0.035	-0.419	4.077	0.000
Selling												
PI 5m	0.072	1.331	0.010	0.001	1.088	0.034	0.164	1.094	0.099	0.109	1.235	0.040
PI 1h	0.120	2.460	-0.061	-0.092	1.823	0.019	0.246	2.002	0.071	0.168	2.272	0.023
PI Cl.	0.233	4.221	-0.045	0.390	3.095	0.291	0.681	3.900	0.161	0.419	4.077	0.000
B: Volatility Auctions												
Buying												
PI 5m	0.194	1.877	0.196	0.261	1.739	0.198	0.249	1.719	0.197	0.214	1.824	0.196
PI 1h	0.492	3.035	0.465	0.509	2.871	0.406	0.271	2.893	0.369	0.426	2.986	0.426
PI Cl.	0.995	4.655	0.848	1.180	4.456	0.825	0.633	4.897	0.589	0.896	4.723	0.758
Selling												
PI 5m	-0.364	1.918	-0.313	0.143	1.801	0.184	0.096	1.533	0.010	-0.214	1.824	-0.196
PI 1h	-0.666	3.049	-0.674	0.090	2.868	0.131	0.071	2.776	-0.046	-0.426	2.986	-0.426
PI Cl.	-1.113	4.826	-1.139	-0.147	4.099	0.000	-0.476	4.508	-0.260	-0.896	4.723	-0.758

(continued on next page)

Table 9: Price impacts when different participants trade in call auctions *(continued from previous page)*

	Agency			DMM			Principal			All		
	Mean	Std. dev.	Median	Mean	Std. dev.	Median	Mean	Std. dev.	Median	Mean	Std. dev.	Median
C: Closing Auctions												
Buying												
PI Op.	0.034	1.839	0.019	-0.048	2.276	0.106	-0.036	1.978	0.000	-0.009	1.926	0.012
Selling												
PI Op.	0.042	2.091	-0.012	0.244	2.494	0.040	-0.014	1.807	-0.012	0.009	1.926	-0.012
D: Intraday Auctions												
Buying												
PI 5m	-0.081	0.472	-0.068	0.178	0.484	0.151	-0.041	0.369	-0.060	-0.053	0.420	-0.059
PI 1h	-0.025	0.943	-0.044	0.498	1.160	0.232	0.261	0.805	0.067	0.145	0.887	0.020
PI Cl.	-0.006	2.152	0.043	0.761	1.750	0.614	0.419	1.639	0.299	0.246	1.890	0.166
Selling												
PI 5m	0.024	0.450	0.020	0.221	0.305	0.219	0.050	0.398	0.050	0.053	0.420	0.059
PI 1h	-0.098	0.934	-0.030	0.109	0.583	0.139	-0.243	0.873	-0.063	-0.145	0.887	-0.020
PI Cl.	-0.127	1.990	-0.129	0.068	1.297	0.034	-0.434	1.861	-0.316	-0.246	1.890	-0.166

This table provides (separately for purchases and sales) information on returns (i.e. price impacts) earned by traders of the three different categories (agency traders, principal traders and designated market makers) when trading in the different types of call auctions. For closing auctions, returns are computed from the auction price to the next day's opening price. For the other auctions, returns are computed based on quote midpoints 5 minutes and 60 minutes after the auction, and for the return based on the same day's closing price.

Table 10: Market Maker Profit per auction

	Close	Intraday	Open	Volatility
Profit (Euro)	11.772	25.457	22.277	31.840
Observations	2238	919	3393	1966

This table shows the profits per auction earned by designated market makers in call auctions. The profit is calculated by multiplying the signed trade size by the return from the call auction to the closing price, with the exception of call auctions, for which the return is calculated to the next day's opening price.

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