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Assessing IT-Supported Securities Trading: A Benchmarking Model and Empirical Analysis

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ABSTRACT

Information technology plays a major role to support the process of securities trading. Tactical trading decisions can be implemented more efficiently by gaining access to alternative trading systems, which provide access to additional liquidity and potentially better execution prices. This paper explores the business value provided by to so-called dark pools of liquidity, which can be accessed by adjusting the trading process and adopting new IT. With limited access to large investors, dark pools represent alternative trading systems with a focus on very large volumes between selected institutions. We aim at exploring the potential business value provided to investors deciding to implement the necessary requirements. Therefore, a benchmarking approach is presented to compare dark pool executions with prices which were available at traditional stock exchanges. The empirical results provide evidence for significant price improvements which can be realized when gaining access to darks pools, especially when trading very large orders.

Keywords

IT Business Value, Benchmarking, Electronic Markets, Securities Trading

INTRODUCTION

The process of securities trading, which aims at turning an investment decision into a portfolio position, has faced a significant change and gained much complexity in recent years. While access to more stock exchanges and to an increasing amount of alternative trading systems (ATS) provides new opportunities, this complexity demands for more IT to support the trading process. Adopting IT in this field for example means gaining access to additional markets and to new liquidity which was not available before.

Measuring the business value provided by IT is an important research subjects in IS research since many years (Brynjolfsson 1993; Chan 2000). One major research stream in this field has a focus on how IT improves business profitability and how this improvement can be measured, for example on the basis of performance metrics (Hitt and Brynjolfsson 1996). The concept of business profitability is derived from theory of competitive strategy, which states that companies are not able to capture the value of specific investments over time since all competitors will adopt or invest in new beneficial approaches or infrastructure, such as technology (Porter 1980). However, if there exists entry barriers (e.g. patents or capital intensive IT systems), which prevent other market players from adopting the same technology, this can lead to increased profitability (Philip, Gopalakrishnan and Mawalkar 1995).

In this paper, we will explore such an example which prevents some market players from adopting a certain technology which competitors are able to use. However, such a barrier does not automatically lead to increasing success. In securities trading, it might be the case that adopting a technology (providing access to a new market) does not lead to any benefits, because comparable prices and liquidity might be available at other markets which can be accessed easily. In securities trading, so-called dark pools represent such alternative markets which demand for changes in the traditional trading process and the underlying IT. Having a focus on very large trades (so-called block trades) these markets restrict access to large investors with a high value of assets under management (AuM), representing a significant barrier to entry.

Against this background, we aim at exploring whether investors who adopt the technology to access such dark pools can realize significant benefits. Our analysis is based on a benchmarking approach. Since benchmarking has the objective to measure and compare organizational performance (e.g. of the trading process) against competitors, we collected a dataset of trades which were reported by one exemplary large dark pool called Liquidnet. A conceptual model is presented for comparing the trading outcomes with prices which would have been available at traditional stock exchanges. Our research

will provide insights on how competing investors are implementing IT-enabled changes of the tactical investment management processes and whether – and, if so, under which conditions – they can realize substantial benefits.

The paper is organized as follows: in the next section, we will present an introduction to IT-supported securities trading and the success story of darks pools. Then, we will present a benchmarking model which provides means to compare and benchmark trades which have been executed via an alternative trading system. The case of Liquidnet, which we have chosen as a representative dark pool, is then presented including its characteristics, market model and the IT-based change of the securities trading process. After that we will provide insights into the analyzed datasets. The empirical results show the potential benefits and provide further evidence in which scenarios these benefits can be achieved. We conclude with a summary and an outlook on further research.

THE SUCCESS STORY OF DARK POOLS IN SECURITIES TRADING

Within the last decades traditional floor-based exchanges have undergone an IT-driven transformation towards fully automated electronic trading systems (Schwartz and Francioni 2004). No matter whether a quote-driven dealer market or an order-driven electronic order book is employed, there is no need to be present at an exchange's trading floor anymore. Nowadays, exchanges offer remote access and thus enable fast dissemination of price changes to its participants. Although this electronification of securities trading leads to increasing trade volumes, which are supposed to improve price discovery, (i.e. the determination of an instruments fair equilibrium value) one can observe a trend towards decreasing average transaction sizes among major exchanges (Grant 2010). For institutional investors who predominately trigger trading activity on nowadays security markets (Schwartz et al. 2004), this trend aggravates the *order exposure problem* (Harris 2003). Although their large trade intentions are instrumental for the determination of a consensus value, institutional investors are reluctant to expose their large orders (block orders) for price discovery. In transparent markets, this immediately will result in negative price movements (market impact). This phenomenon is caused by the information large trade intentions signal to security markets: firstly, they exert buy or sell pressure on the market during their execution. Secondly, the pure existence of large unfilled orders is interpreted as an imbalance of supply and demand by other market participants. This issue let block orders become vulnerable to front running. Here, other market participants who become aware of a large trade intention try to trade ahead of it. In doing so, they aim at taking advantage of the market impact induced by the original large volume. Simultaneously, this practice further influences prices negatively (Harris 2003). Thus, anonymity is of major importance for institutional investors. As volume discovery, i.e. finding of adequate counterparties, for large trade intentions is complex at nowadays transparent exchanges, specialized market models have evolved. One kind of these alternative trading facilities are dark pools of liquidity.

In general, dark pools represent IT-based extensions of traditional upstairs markets which are anonymous and fully confidential (Gresse 2006). Their objective is to allow institutional investors trading large order volumes without market impact. Therefore, these systems aim at minimizing information leakage concerning their members' trade intentions, i.e. they do not display quotations to the open market (Skinner 2007). Accordingly, dark pools do not participate in price discovery. Instead they often use derivative pricing rules.

The main distinctive feature among dark pools is their *market model*, i.e. the rules how information on trade intentions are matched to actual trades. The most traditional dark pool type are crossing networks like ITG's POSIT (Harris 2003): these systems are based on a closed order book. The actual trade prices are independent of the trade interests which are sent to the crossing network. Instead, actual trade prices are derived from another reference market. Thus, their price quality depends on the selected market's price discovery mechanism (Conrad, Johnson and Wahal 2003). Typically, crossing networks choose the midpoint, the day's closing price or the volume weighted average price of a predefined period. Further, fill rates are of particular importance as trading is characterized by strong network effects (Schwartz et al. 2004). Therefore, a successful dark pool requires exceeding a minimum trading volume (liquidity) to become attractive to its members (Conrad et al. 2003). Typically, crossing networks exhibit low fill rates below 10% of the submitted volume (Harris 2003; Næs and Ødegaard 2006).

To overcome this issue, multiple dark pool approaches have originated in the USA. Mittal (2008) provides a taxonomy and detailed description of their differences. Altogether, already more than 40 different dark pools operate in the US and cover approximately 9% of the overall trading volume (Spicer 2009; The Economist 2009). One type, which has attracted particular attention, are so called full service broker dark pools. They obtain the required minimum liquidity by executing client orders against the broker's own order flow (proprietary trading). Further, their executions are only reported as over-the-counter trades without indicating the actual trade venue. Because of this missing post-trade transparency and their ongoing market share growth, the US Securities and Exchange Commission investigates whether the segmentation of order flow caused by this kind of dark pools in combination with their low transparency negatively affects price discovery (Spicer 2009). In

contrast, traditional agency broker dark pools such as POSIT or Liquidnet allow only executions among client orders. Further, their trade reports allow identifying them as the trade venue employed, which is the basis for this research. To attract enough liquidity, agency broker dark pools require sophisticated market models, which provide value to their customers' trading.

Different to the US, dark pools are still establishing themselves in Europe. One important facilitator for their growth is the introduction of the Market in Financial Directive (MiFID) in November 2007. MiFID has ended the concentration of stock trading at national stock exchanges in various European member states. Thereby it fosters competition among trading venues as it allows off-exchange trading at so-called multilateral trading facilities. Accordingly, the number and trade volumes of dark pools are steadily increasing in Europe (The Economist 2009). Thomson Reuters (2010) reports trading volumes among European non-displayed order books to have risen from 2.2 bn € in January to 8.6bn € in December 2009, which is illustrated in Figure 1.
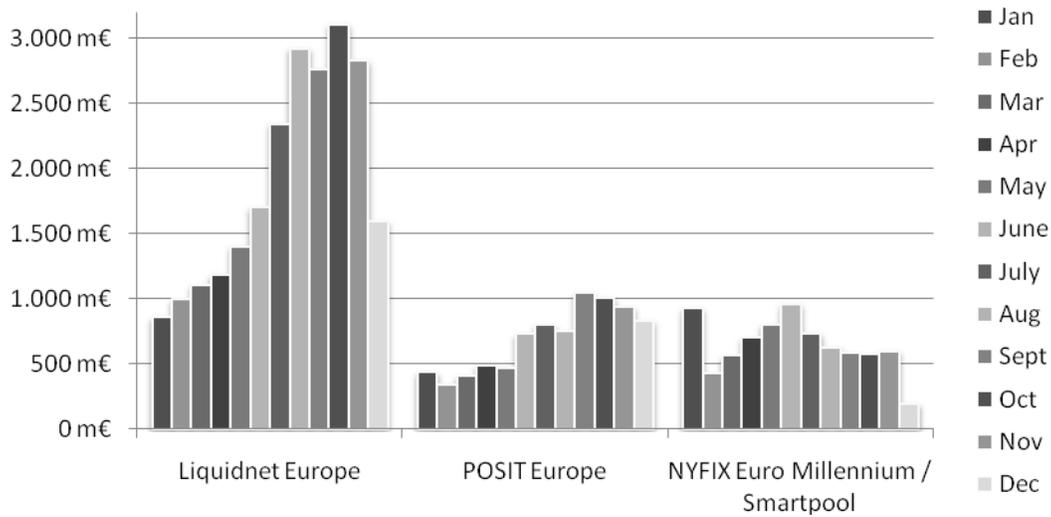

Figure 1. Execution Volumes among Selected European Dark Pools in 2009

A CONCEPTUAL MODEL ON SECURITIES TRADING BENCHMARKING

To benchmark trade executions which have been observed for a given dark pool, we have developed a conceptual model which compares and benchmarks prices with those being available at the home market of the corresponding security. In contrast to most benchmarking concepts, which have a focus on competitors in order to benchmark organizational performance compared to a peer group (Drew 1997), our conceptual model uses market data from a securities home market. This, for example, would be for US company shares quotes from NYSE or NASDAQ or for European company shares the corresponding limit prices and volumes from the national stock exchange.

The model is based on an assumption regarding the initiator-side of a trade and determines whether a trade is sell- or buy-initiated. If the price observed is lower (higher) than the midpoint price of the home market (which is the midpoint between the best bid and the best ask), a trade is defined as "sell-initiated" ("buy-initiated"). This assumption is based on two arguments: first, an initiator of a block trade will give price concession to attract liquidity (Harris 2003). Second, our benchmark should be a conservative measure and therefore has a focus on the side for which the negotiated price is less attractive (Sarkar and Schwartz 2009). Based on this assumption, we define a *price improvement PI* as follows:

$$PI_i = half\ spread - \left| p_{Venue,i} - p_{homemarket,\ Midpoint} \right| \tag{1}$$

$$\text{with: } half\ spread = \frac{best\ ask - best\ bid}{2}$$

where: PI_i =   *price improvement*

$$p_{Venue,i} \quad = \quad \textit{price observed at the ATS}$$

$$p_{homemarket,Midpoint} \quad = \quad \textit{midpoint observed at the home market of the security}$$

$$i \quad = \quad \textit{index of trade observed}$$

Figure 2 illustrates our model indicating two hypothetical executions. Trade *i*, which has been observed at $p_{Venue,i}$, is assumed to be sell-initiated because it is lower than the midpoint. Since $p_{Venue,i}$ is outside the bid-ask spread, it shows a negative *price improvement*. In contrast, $p_{Venue,i+1}$ is higher than the midpoint, i.e. a buy-initiated trade, which has been observed within the bid-ask spread. It consequently features a positive *price improvement*.
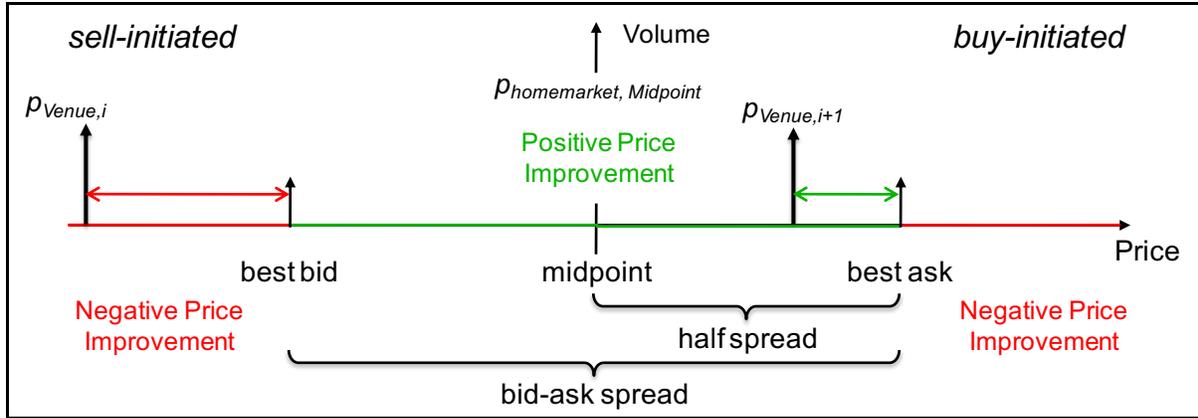

Figure 2. Securities Trading Benchmarking Model

To allow comparison among instruments with different values, we analyze this *price improvement PI* relative to the instrument's midpoint price measured in basis points (0.01%). Therefore we define a *relative PI* as:

(2)

$$relative\ PI_i = \frac{PI_i}{p_{midpoint}} \cdot 10.000$$

The *relative PI* is used in order to benchmark executions which have been observed on an alternative trading system, with one of them presented more detailed in the following.

THE CASE OF LIQUIDNET

Liquidnet belongs to the largest agency broker dark pools (Harris 2003). As depicted in Figure 1 its trading volume is still increasing. One reason for its acceptance is the unique market model Liquidnet employs (Harris 2003): basically this model attempts to add more flexibility to traditional crossing networks. Therefore traders do not need to submit orders to Liquidnet. Instead, the system searches for matching trade intentions from the investors order management systems (OMS). Further, potential matches are signaled to the respective traders, which can enter anonymous negotiations. This advertisement-based approach risks disclosing information about trade intentions. Thus, several mechanisms like a closed user group are incorporated to minimize information leakage.

Figure 3 highlights the information flow within Liquidnet's (2001) three-step market model: first, Liquidnet retrieves trade intentions from its clients' OMSs on a continuous basis. Besides the instrument and the buying or selling intention investors at a connected trading desk can specify their desired order size as well as a minimum tolerance level for potential counterparties. Based on the collected information, a decentralized search within Liquidnet's peer-to-peer network is performed. Up to that point, information concerning the trade intentions and involved investors are kept completely confidential. After suitable counterparties are identified, the system remains passive, i.e. no executions are triggered. The second step of indicating existing counterparties is triggered only when the trade volumes of both investors exceed the other's tolerance level. In doing so the involved institutions' identities are kept private. Further, the original trade volumes remain

undisclosed too (Mittal 2008). At this point the involved investors can decide to enter anonymous bilateral negotiations which are the third and final step. During these negotiations the actual trade volume as well as the price can be determined.
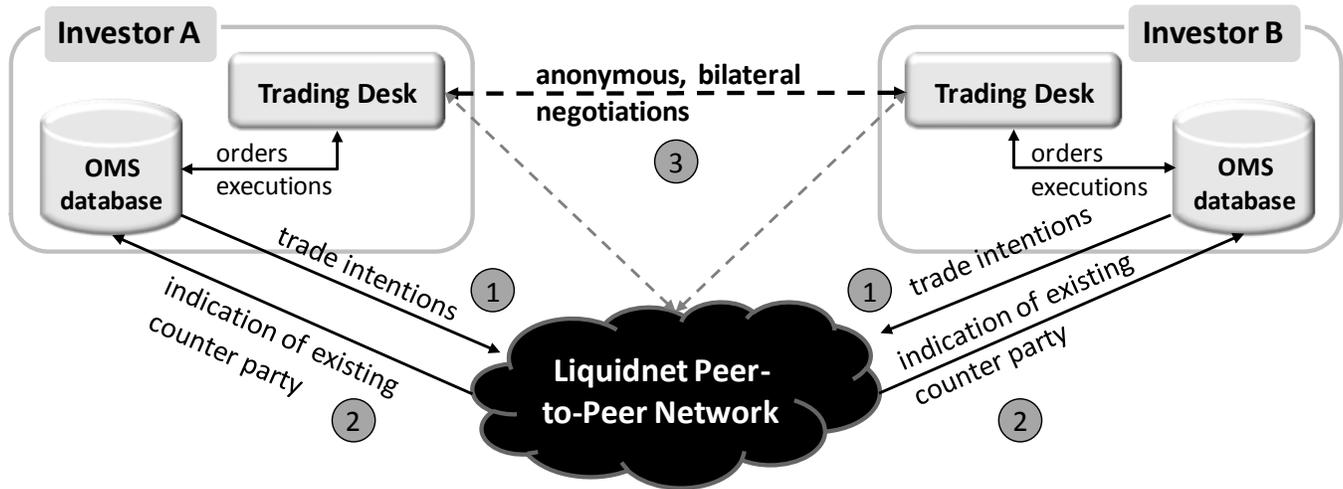

Figure 3. Market Model of Liquidnet

As mentioned above Liquidnet pursues multiple strategies to restrict the group of investors who are informed about its clients' trade intentions to minimize information leakage: first, Liquidnet employs barriers to entry to form a closed and homogenous user group of buy-side[1] only users. Further, customers are restricted to posses more than 500m$ AuM (Schwartz 2009). As of end 2009, these were 592 member firms worldwide with above 27bn€ AuM on average (Liquidnet 2009). The closed user group approach aims at avoiding trade intentions to be disseminated to market participants whose business is to take advantage of their existence. In addition, members are supposed to utilize OMSs. This restriction is a further safeguard against clients gaming the network as OMSs are said to exhibit only true trade intentions. On top, Liquidnet also monitors its members' trading activity. This is important as the indications of counterparties can be used to infer at least a lower boundary for existing trade intentions, namely one's own lower volume threshold. Thus members who are not interested in completing trades might take advantage of this information. To impede this practice known as fading, clients might be excluded from the network.

Another important aspect of Liquidnet's decentralized negotiation mechanism is that investors retain the control of their orders, i.e. no committed orders are used. In contrast, most dark pools are designed as centralized systems. Thus, trade intensions which are brought to these systems are always committed. Although unexecuted orders can be canceled, traders have no control until they receive a final acknowledgement of their cancelation. Consequently, if they send their orders to multiple of these systems, they risk their volume to be executed many times. Thus, an investor can interpret Liquidnet as a further option to trade. This nature is also incentivized by Liquidnet's pricing scheme: no installation or minimum fees are charged before actual executions take place (Liquidnet 2001). However, an adjustment of the IT which supports the trading process is required and traders have to be trained extensively to use the new venue appropriately. The commissions to be paid for negotiated trades are said to be 7bps (Mehta 2007). Compared to traditional exchanges or multilateral trading facilities in Europe like Chi-X (who charge below 0.5bps) these explicit costs appear quite high. But as conservative estimates by Bikker, Spierdijk and van der Sluis (2007) suppose average market impact costs to be 20bps for buy and even 30bps for large sell orders, the value of Liquidnet depends on its negotiated execution prices.

Finally, as the likelihood to fill an order is an important factor for a dark pool's quality, Liquidnet has recently been employing secondary strategies which aim at integrating sell-side liquidity. This increased the filled latent liquidity provided by its members – the following numbers are based on US equities only – from approximately 14% to 21.5% (SEC 2008).

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[1] Buy-side refers to investment companies that are *buying* trading services from the sell-side, i.e. investment banks and brokers (Harris 2003).

Nevertheless, as an optional offer to its members, this does not violate its general strategy of a closed buy-side user group.

DATASET DESCRIPTION

The employed dataset originates from the archives of Thomson Reuters Data Scope Tick History. It includes two types of information whose time stamps are based on milliseconds: first, from the boat data feed execution reports have been collected for the multilateral trading facility (agency broker dark pool) Liquidnet Europe Limited. They incorporate information on the execution's date and time as well as the traded volume and price. Because of Liquidnet's anonymous negotiation mechanism, no information is available whether an execution has been triggered by a buyer or seller. Second, for a valid indication of the traded instrument's true value (benchmark prices) we resort to the home markets principle in Europe (Schwartz and Francioni 2004), i.e. that the instrument's home market is the most liquid one. Therefore, snapshots of the instrument's home market's electronic order book are collected. They are made of the first ten quoted limits and volumes on both sides of the book, i.e. the ten highest bid and ten lowest ask limits. Each change within these limits results in a update record. From these the latest order book situation is selected which is valid at the reported time of the Liquidnet execution. Regarding our research approach, the order book data lacks secured information on volatility interruptions. This limitation requires to be dealt with during the data selection below.

As dark pools are expected to exhibit high individual trade volumes but low execution frequency we employed a broad data set. Its foundation is the DOW JONES EURO STOXX representing liquid instruments from 12 Eurozone countries traded in Euro currency. From its 316 constituents on September 14th, 2009 three subsamples for large-, mid- and small-caps each holding 20% (64 constituents) of the index have been chosen. The selection is based on the free float market capitalization. The analyzed time period starts on June 6th, 2008 when the first Liquidnet trade is reported on the boat data feed and ends on September 14th, 2009. Within these 15 months for 174 of the selected constituents 3,576 trades with an overall volume of 8,855,826,514€ have been observed.

To avoid outliers caused by abrupt price changes at the electronic order book trading systems of the 11 included home markets, only executions during continuous trading have been kept: for the case of scheduled auctions start and end times have been extended by a buffer of 2 minutes. Thereby, 100 Liquidnet records taking place in these time intervals have been excluded. As volatility interruptions last at the considered exchanges more than two minutes, all executions have been discarded whose corresponding home market's reference price is older than this period. This affected 26 additional records. Finally, two further trades had been deleted as the instrument's home market exhibits an invalid order book situation during their execution (crossed order book). Altogether, more than 97.5% of the original sample's trade value remains in the final data set, which consists of 3,448 Liquidnet executions.

Market Capitalization	Traded Instruments	Trades	Cumulative Value [m€]	Average per Trade		Executions at / within	
				Shares	Value [€]	Midpoint	Inside Market
Large	63	1,989	6,627	163,651	3,331,745	46.41%	81.13%
Medium	60	882	1,476	122,269	1,670,607	64.74%	92.74%
Small	51	577	537	74,434	930,471	69.15%	96.19%
All	174	3,448	8,641	138,136	2,504,504	54.90%	86.75%

Table 1. Liquidnet Trading Data Sample Characteristics

Table 1 aggregates the properties of these 3,448 executions: first of all the high trade values are striking. For a comparison to typical order book executions Table 2 provides an overview of large-, medium- and small-cap instruments traded at the XETRA system of Deutsche Boerse Group in 2009. In comparison to those executions the value of Liquidnet trades is about 475 times larger. Average Liquidnet execution values are also considerably higher than trades qualified as large compared to the Normal Market Size (NMS), i.e. 500,000€ for highly liquid stocks (CESR 2008), or compared to the common definition of block trades to exceed 10,000 shares (O'Hara 1997).

Concerning trade frequencies, highly capitalized instruments are the most liquid ones, too. The 63 large-cap instruments account for 57.69% of the trades and even for 76.7% of the execution value. Although medium- and small-caps are traded less frequently, the descriptive statistics indicate their executions to be even more favorable. Whereas for large-cap instruments only 46.41% are trades at the midpoint for mid-caps 64.15% and for small-caps even 69.15% of the trades are

executed at this price. For executions within the best bid/ask limit prices (inside market), these proportions persist. Thus, at Liquidnet 96.19% of small-cap trades are priced inside market.

Market Capitalization	Index	Trades	Cumulative Value [m€]	Average Value [€] per Trade
Large	DAX	104,465,966	732,661	7,013
Medium	MDAX	27,690,194	78,143	2,822
Small	SDAX	3,118,248	4,729	1,516
All		135,274,408	737,390	5,451

Table 2. Xetra Execution Statistics for 2009 (Source: Deutsche Börse Group)

Altogether the descriptive statistics indicate that finding counterparties for a given trade intention appears difficult: during the 15 months we have analyzed, 3,448 trades for the 192 DOW JONES EURO STOXX constituents have been observed only. However, since 86.75% of the Liquidnet executions are being priced inside market and even 54.9% correspond to the home market's midpoint, Liquidnet executions appear beneficial.

RESEARCH HYPOTHESES AND EMPIRICAL RESULTS

In our research, we aim at exploring the case of Liquidnet as an example of the success story of dark pools in recent years. This analysis should provide insights into the benefits gained by institutional investors when accessing these new trading venues by adopting the required IT which enables access to these venues. To assess these benefits, it is of major interest if agency broker dark pools provide better executions compared to the home market, at which a share is traded most frequently. To address this question, we aim at benchmarking executions observed at Liquidnet by applying our introduced conceptual model on benchmarking securities trading price improvements. With observing and comparing the outcome of IT-supported securities trading processes, we follow an approach with a focus on post-implementation IT benchmarking (Doll, Deng and Scazzero 2003). As a first research hypothesis, we address the question if significantly price improvements can be shown for Liquidnet executions observed (H1):

H1: *The average relative price improvement of Liquidnet executions is positive.*

Statistically, H1 is explored by the following null hypothesis $H1_0$, which we aim to reject in the following.

$H1_0$: *μ(relative Price Improvement) $\leq$ 0*

For the 3,448 Liquidnet executions observed, we have calculated the corresponding relative price improvements. Descriptive statistics for these relative *PI*s are provided in Table 3. Furthermore, the calculated *t*-statistic provides evidence that significant relative price improvements can be observed.

	Observations	Mean [bps]	Median [bps]	Std. dev. [bps]
relative PI	3,448	5.1343	3.4142	15.6712
t-Value ($H1_0$)	19.2381[***]			

Table 3. Price Improvement Sample Characteristics and Test Results

After showing that investors accessing Liquidnet can realize significant price improvements compared to the standard process of trading at the security's home market, we aim at further analyzing the determinants of these price improvements. Therefore, we aim at exploring trade characteristic, which most significantly lead to these price improvements.

First, we have a focus on trade sizes and therefore aim at comparing price improvements of block trades and non-block trades. Accordingly to the classification of trade difficulty by Kissel and Glantz (2003), we define block trades as those exceeding 15% of the respective instrument's Average Daily Volume (ADV) of the last 30 trading days. Such trades can be expected to take multiple days to be completed at traditional exchanges. Further, such large block trades should trade at

"worse" prices (O'Hara 1997). We consequently formulate our second hypothesis which aims at detecting a significant relative *PI* difference between block and non-block trades (H2a)

H2a: *The average relative Price Improvement of block and non-block trades on Liquidnet is different.*

H2a$_0$: $\mu(relative\ PI_{block}) = \mu(relative\ PI_{non\text{-}block})$

	Observations	Mean [bps]	Median [bps]	Std. dev. [bps]
block trades	335	11.4229	5.9964	22.6345
non-block trades	3,113	4.4576	3.2258	14.5713
t-Value (H2b$_0$)	5.5101[***]			

Table 4. Block Trade Sample Characteristics and Test Results

Table 4, showing descriptive sample characteristics and the statistical test result, outlines that – on the basis of the definition of block trades applied – trading large blocks via Liquidnet appears most beneficial.

Furthermore, we explore the initiator-side of a trade, for which we expect a significant impact. As pointed out by Kraus and Stoll (1972) for traditional exchanges, *"Blocks are sold, not bought"* (p. 573). Further arguments for hypothesis H2b are provided by asymmetries in negative price movements (market impact costs) which have been detected for buys and sell orders (Bikker et al. 2007; Keim and Madhavan 1997).

H2b: *The average relative Price Improvement of buy- and sell-initiated trades on Liquidnet is different.*

H2b$_0$: $\mu(relative\ PI_{buy}) = \mu(relative\ PI_{sell})$

	Observations	Mean [bps]	Median [bps]	Std. dev. [bps]
buy-initiated trades	791	0.6834	1.2423	10.2736
sell-initiated trades	765	1.0763	0.5302	18.5995
t-Value (H2a$_0$)	-0.5134			

Table 5. Initiator Side Sample Characteristics and Test Results

As shown in Table 5, only 1,556 observations were identified as buy- or sell-initiations. Since the remaining executions were executed at the home market's midpoint, they were not included in this analysis. The calculated *t*-value does not provide any evidence that there is a significant difference between buy- and sell-initiated trades, which contradicts the observations of Bikker et al. (2007) and Keim and Madhavan (1997) for traditional order book trading.

Finally, we explore the impact of market capitalization on relative price improvements using the definition of small-, mid-, and large-cap instruments presented in Table 1. As shown by Stoll (2001), lower market caps and the accompanied lower liquidity of an instrument can incur higher market impact costs, and therefore, we formulate hypothesis H2c.

H2c: *At least one of the medians of relative Price Improvement for large-, mid- or small-cap instruments differs from the others.*

H2c$_0$:   median($rel\ PI_{large}$) = median($rel\ PI_{mid}$) = median($rel\ PI_{small}$)

Given unequal variances (we rejected the corresponding *Bartlett-Test*), we applied an independent sample Kruskal-Wallis Test (*H*-Test) for heterogeneous variances.

Table 6 summarizes sample characteristics and test results providing evidence that there is a significant difference between the market capitalization samples and regarding the relative price improvement. This finding and the shown mean values provide evidence that Liquidnet trades of small- and mid-cap shares appear most beneficial compared to prices available at the home market.

	Observations	Mean [bps]	Median [bps]	Std. dev. [bps]
large-cap	1,989	1.6447	2.4954	8.0207
mid-cap	882	9.6339	5.8624	22.6266
small-cap	577	10.3021	7.5629	19.1226
H-Value (H2c$_0$)	5.5101[***]			

Table 6. Market Capitalization Sample Characteristics and Test Results

SUMMARY AND CONCLUSION

The securities trading process has gained much complexity in recent years, also due to an increasing amount of additional market places available. Supporting this process by IT and gaining for example access to additional trading venues requires changes in the trading process and the adoption of new technologies. One such additional venue which has gained much market share in recent years is dark pools. With the aim of analyzing if adapting processes and adopting new technology can be justified economically, we have explored such a dark pool called Liquidnet and explored the potential benefits it can provide to its customers. Our results provide strong evidence that – under certain conditions – dark pools can provide substantial benefits to investors. One major problem we have identified is that finding counterparties in dark pools appears difficult, implying high opportunity costs. However, actual executions appear beneficial, which we have measured by significant relative price improvements compared to trading at a traditional stock exchange. Further analyses provide evidence that these price improvements increase with the actual order size and are negatively related to market capitalization of the stock traded.

Since this is one of the first empirical studies on the business value of dark pools, there is much room for further research and improvements. As a next step, we aim at further analyzing the determinants of the business value provided, which will provide further explanation of relative price improvements in dark pool trading.

ACKNOWLEDGMENT

REFERENCES

1. Bikker, J.A., Spierdijk, L., and van der Sluis, P.J. (2007) Market Impact Costs of Institutional Equity Trades, *Journal of International Money and Finance*, 26, 6, 974-1000.
2. Brynjolfsson, E. (1993) The Productivity Paradox of Information Technology, *Communications of the ACM*, 36, 12, 66-77.
3. CESR (2008) Shares admitted to trading on EU Regulated Markets, http://mifiddatabase.cesr.eu/Index.aspx?Sectionlinks _id=14&language=0&pageName=MiFIDLiquidSearch, 2009/02/19.
4. Chan, Y.E. (2000) IT Value: The Great Divide Between Qualitative and Quantitative and Individual and Organizational Measures, *Journal of Management Information Systems*, 16, 4, 225-261.
5. Conrad, J., Johnson, K.M., and Wahal, S. (2003) Institutional Trading and Alternative Trading Systems, *Journal of Financial Economics*, 70, 99-134.
6. Doll, W.J., Deng, X., and Scazzero, J.A. (2003) A Process for Post-Implementation IT Benchmarking, *Information & Management*, 41, 2, 199-212.
7. Drew, S.A.W. (1997) From Knowledge to Action: The Impact of Benchmarking on Organizational Performance, *Long Range Planning*, 30, 3, 427-441.
8. Grant, J. (2010) Smaller orders breed dark pools and higher post-trade costs, Financial Times, http://www.ft.com/cms/s/0/768b4e12-1f52-11df-9584-00144feab49a.html?nclick_check=1, 2010-02-26.
9. Gresse, C. (2006) The Effect of Crossing-Network Trading on Dealer Market's Bid-Ask Spreads, *European Financial Management*, 12, 2, 143-160.
10. Harris, L. (2003) Trading and Exchanges: Market Microstructure for Practitioners, Oxford University Press, USA.
11. Hitt, L.M., and Brynjolfsson, E. (1996) Productivity, Business Profitability, and Consumer Surplus: Three Different Measures of Information Technology Value, *MIS Quarterly*, 20, 2, 121-142.
12. Keim, D.B., and Madhavan, A. (1997) Transactions Costs and Investment Style: An Inter-exchange Analysis of Institutional Equity Trades, *Journal of Financial Economics*, 46, 3, 265-292.

13. Kissell, R., and Glantz, M. (2003) Optimal Trading Strategies: Quantitative Approaches for Managing Market Impact and Trading Risk, AMACOM, New York, NY, USA.
14. Kraus, A., and Stoll, H.R. (1972) Price Impacts of Block Trading on the New York Stock Exchange, *Journal of Finance*, 27, 3, 569-588.
15. Liquidnet (2001) Liquidnet, An Overview: Business Functionality Report.
16. Liquidnet (2009) Web Presence, www.liquidnet.com/aboutMembership/Community.html, 2009-02-20.
17. Mehta, N. (2007) Europe Overhauled: MiFID Pushes Trading into New Era, Traders Magazine, September, www.tradersmagazine.com/issues/20070910/2909-1.html?page=5, 2009-02-18.
18. Mittal, H. (2008) Are You Playing in a Toxic Dark Pool? A Guide to Preventing Information Leakage, *Journal of Trading*, 3, 3, 20-33.
19. Næs, R., and Ødegaard, B.A. (2006) Equity Trading by Institutional Investors: To cross or not to cross?, *Journal of Financial Markets*, 9, 2, 79-99.
20. O'Hara, M. (1997) Market Microstructure Theory, Blackwell, Malden, MA, USA
21. Philip, G., Gopalakrishnan, M., and Mawalkar, S.R. (1995) Technology Management and Information Technology Strategy: Preliminary Results of an Empirical Study of Canadian Organizations, *International Journal of Information Management*, 15, 4, 303-315.
22. Porter, M.E. (1980) Competitive Strategy, Free Press, New York, NY, USA.
23. Sarkar, A., and Schwartz, R.A. (2009) Market Sidedness: Insights into Motives for Trade Initiation, *Journal of Finance*, 64, 1, 375-423.
24. Schwartz, R. (2009) Crossing Continents, The Trade, www.thetrade.ltd.uk/archive_001_Crossing.asp, 2009-02-22.
25. Schwartz, R., and Francioni, R. (2004) Equity Markets in Action: The Fundamentals of Liquidity, Market Structure & Trading, John Wiley & Sons, Hoboken, NJ, USA.
26. Skinner, C. (2007) The Future of Investing in Europe's Markets after MiFID, Wiley, Chichester, USA.
27. Spicer, J. (2009) SEC Spotlight puts "Dark Pool" Venues on Defensive, Thomson Reuters, http://www.reuters.com/article/idUSTRE55I5V020090619, 2010-02-28.
28. Stoll, H.R. (2001) Market Fragmentation, *Financial Analysts Journal*, 57, 4, 16-20.
29. The Economist (2009) The rise of dark pools – Attack of the clones, in: *The Economist Newspaper Limited*, London, 2009-07-02.
30. Thomson Reuters (2010) Thomson Reuters MiFID Market Share Reports December 2009, http://www.exchange-handbook.co.uk/index.cfm?section=news&action=detail&id=87831&search=1, 2010-02-28.