Spread Components in the Hungarian Forint-Euro Market*

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Abstract
We apply the spread decomposition model by Huang and Stoll (1997) to a new data set on the Hungarian Forint- Euro market. Our results show differences between the small and less liquid HUF/EUR market and previous results on more developed markets. Our results suggest that the share of cost components other than order processing costs is substantially higher in the HUF/EUR market. Furthermore, we find a significant inventory effect, which can be explained by the low number of trades per day and thus the long time between offsetting trades. The spread size increases with trade size, while the order processing component of the spread remains more or less constant.

Finally, our findings of declining spreads over time reflect the increasing liquidity on the HUF/EUR market that goes hand in hand with the transition process. This decline in spreads is due to a smaller order processing component as well as a decline in the other components.

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Keywords: microstructure, foreign exchange, spread, Hungary, inventory, adverse selection

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1. Introduction

The decomposition of the bid-ask spread on financial markets has attracted increasing attention during the last decades for several reasons. It is important as an indicator of market liquidity and competition, but also reflects the way information is processed in the market. This is important because a different market structure changes the “game played between the market participants” (Rime 2003, p. 471). It is therefore relevant for market participants, but also for the operators of markets in terms of an evaluation of the market design. The microstructure approach to foreign exchange markets has made some promising steps towards a better understanding of the foreign exchange market. Since a well-functioning foreign exchange market is of crucial importance for the economy, which is particularly true in the case of small open economies as most of the Central and Eastern European Countries (CEEC), there is a deep interest in the way it works. The microstructure approach to foreign exchange (see Lyons 2001) allows for market frictions, like imperfect information and heterogeneous agents, and tries to explain the processing of news (price discovery), liquidity and transaction cost. In this context the bid-ask spread and its determinants play a crucial role.

The bid-ask spread is the difference between the price an active buyer must pay, and the revenue an active seller receives\(^1\). It is common to relate the size of the spread to various kinds of cost components: the order processing (or handling) component, the adverse selection component and the inventory holding component\(^2\). While most early papers focused on order processing and adverse selection costs, the inventory holding component has recently gained much attention.

We contribute to the literature by exploiting a new data set on the Hungarian foreign exchange market. Since this is the first detailed data set available for a transition economy, it enables us to compare the spread components on a small and less liquid market to those of previous studies that mainly focused on major currencies. One may expect that components that are directly related to the liquidity of the market, namely the adverse selection and the inventory holding component,

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1 One counterpart of a trade can be viewed as an active party and one counterpart as a passive party. The party that posts quotes and waits until they will be hit by another market participant is the passive party. The party that matches an existing limit order by a market or another limit order is the active party.

2 One may also distinguish components for the option effect and non competitive pricing (see for example Stoll 2003). This is, however, less common. Therefore we do not follow these directions. We see the option effect as part of the adverse selection component.
will be more important in transition economies than in the foreign exchange market for major currencies. Furthermore the sample size of our data set exceeds the size of most other data sets used in the literature by far (see also the comparison in Table 4). Finally, we will re-examine the relation between trade size and spread, which has been controversially discussed in the literature and which we will shortly review in section 3.

The paper proceeds as follows: the subsequent section 2 gives some key facts on the foreign exchange market and our data set on the Hungarian Forint/Euro market. In section 3 we will briefly discuss the components of the bid-ask spread and review the literature for the foreign exchange market. Section 4 presents the widely used spread decomposition model by Huang and Stoll (1997), hereafter referred to as HS1997. Section 5 presents our empirical results and Section 6 summarizes and concludes.

2. The Foreign Exchange Market and Data Description

Trades on the foreign exchange market can be divided into customer trades, i.e. trades between a bank and customers (the ultimate end-users, for instance importing and exporting firms, hedge funds, governments and central banks) and interbank trades. In the following we focus on the interbank market, as the price formation takes place here and customers do not have access to the interbank market.

In the interbank market trades may be performed directly on a bilateral basis, or indirectly using brokers. While voice brokers were dominating in the past, the majority of trades are nowadays done via electronic brokering systems. Since their introduction in 1992 their share in total transaction volume has steadily increased from 12 to 17 per cent in 1995 to 50 to 80 percent in 2001 (BIS 2001).

Furthermore the foreign exchange market works continuously 24 hours per day and seven days per week. While this holds for the major currencies, the picture may be substantially different for less important currencies, such as the HUF, accounting in 2004 for only 0.22% of the global turnover on the FX market (BIS 2007). For many small currencies there is no trading activity outside the business hours, but even during day these markets are characterized by a low degree of liquidity.

Further characteristics of the foreign exchange market are the decentralized trading and a high number of dealers providing liquidity, compared for example with specialists on equity trading floors. Particularly the decentralized structure has supported the emergence of electronic brokerage systems as they provide an efficient matching to decentralized markets.
Accordingly the foreign exchange market was one of the first to introduce electronic trading (see Rime 2003 for a detailed overview on electronic currency trading). Electronic trading has been the most remarkable change in the structure of the foreign exchange market and has led to a substantially higher price transparency. Dealers can now observe the best quotes (although not the whole order book) and information about the most recent transactions. There are two main platforms competing in the foreign exchange market: Reuters D3000 and EBS (Electronic Broking System). In our analysis we rely on the Reuters D3000 system. As an electronic limit order book it contains buy and sell orders in a price-time priority. Euro sale and purchase offers are placed at limit prices. Besides these limit orders, consisting of the maximum respectively minimum price and the quantity offered to be traded, it is also possible to place a market order, i.e., an order without a specified price. They are immediately matched with the best corresponding limit order and thus more aggressive. Therefore the following matches may lead to a trade: two limit orders that are matched up by the system, or a market order that is matched up with the best limit order on the opposite side.

Our data set consists of all quotes, i.e., limit and market orders, on the HUF/EUR interbank market that have been placed during the years 2003 and 2004 via the Reuters D3000 brokering system. We observe the price, the quantity in Euro that was offered or asked and the exact time when the order was placed and when it disappeared, either because it was withdrawn or because it was executed, i.e., matched with another limit or market order. Using this information we can identify the executed trades that we need for the estimation of the empirical model by Huang and Stoll (1997), see section 4. For the evolution of the exchange rate and traded volumes see Figure 1. Because at this time the competing system EBS did not offer services for the HUF/EUR market, the data set covers the complete trading on electronic brokerage platforms, and thus the major part of market activity.

For descriptive statistics of the data set see Table 1. An in-depth description of the data set can be found in Gereben and Kiss M. (2006). Since there are almost no quotes during night we only use the trades executed during the daytime (9 a.m. - 5 p.m. local time) and executed on days with a sufficiently high number of trades. This last restriction is implemented by neglecting the trades on days with trading volumes below 100 million EUR (with these 100 million EUR being roughly half of the average trading volume per day) to avoid potential biases due to low trading activity.

Our dataset contains 722 days on which orders were placed. By cancelling out the days without any trade at all (weekends and public holidays) there remain 516 days. The above mentioned constraint for days with a low trade volume restricts the sample to 496 days. While
the procedure seems to be restrictive at first sight, our selected sample covers 99.74% of the total volume traded over 2003 and 2004.

3. The analysis of spreads

This section briefly describes the different components of the spread. For a detailed discussion of these components see Stoll (2003).

The order processing component (OPC) is the cost component that is most closely linked to the provision of services. OPC include the costs of labour and capital needed to participate in the market, such as the floor space rent, computer and informational service, and labour costs. It is often argued that in highly competitive markets (unlike the HUF/EUR market) order processing costs are irrelevant, since the bid/ask spread should equal the expected marginal cost of supplying liquidity.

The inventory holding component (IHC) compensates dealers for taking an unwanted inventory. If a dealer located in the Euro area for example buys Hungarian Forint, he has to carry costs. These costs mainly stem from two sources: First, there may be opportunity costs of tying up funds in the inventory. However, one may assume that the opportunity costs of the inventory are low on foreign exchange markets in comparison to equity markets. Second, a dealer experiences a substantial amount of risk: The price may change due to the arrival of news before he is able to offset his undesired inventory in Forint. Thus, the inventory holding component represents this fundamental risk. The magnitude of the inventory costs depends on price volatility, since higher volatility means a higher risk of an undesired price change, and on the expected time the inventory has to be held. Both are determined by the trading frequency. Therefore the inventory holding component is obviously expected to be higher on small, less liquid markets as the HUF/EUR market where on average only every three minutes one deal is executed, whereas the time between subsequent trades on major markets does not span more than few seconds.

Finally, market participants face the risk of trading with a counterpart that is better informed. If an investor has superior information, he will sell forint if he has information justifying a lower price than the current one, or vice versa. The market participants may take this possibility into account when offering their quotes and ask an additional compensation, to which we will refer as the adverse selection component (ASC) of the spread. The existence of an ASC is justified by a couple of theoretical papers, such as Kyle (1985), Easley and O’Hara (1987) or Admati and Pfeiderer (1988). Besides these theoretical papers, empirical research provides evidence for the existence of an ASC, see the brief survey below.
Note the fundamental difference in the nature of the IHP and the ASC (Stoll 2003): Inventory costs occur due to *public and symmetric* information that becomes available *after* the trade, in which inventory has been acquired. Of course the potential losses and gains resulting from holding the inventory must cancel out on average, but the dealer will nevertheless ask a premium to get compensated for his risk. In contrast to the inventory costs, the ASC results from *private and asymmetric* information *before* the trade takes place. It is thus the risk to deal with a counterparty owning superior information.

Previous research on spreads on the foreign exchange market focused on larger, more liquid markets. In a seminal paper Lyons (1995) applies microstructure models to the USD/DEM market and finds evidence for both, an inventory and asymmetric information effect, and again evidence for inventory control in Lyons (1998). The result of both effects in the data is supported by Yao (1998). In contrast, Mende (2005) only finds a significant adverse selection component, but no consistent inventory effect. Using a VAR approach Payne (2005) finds that about 60 per cent of the spread is due to asymmetric information. All these studies focus on the most liquid Deutsche Mark (Euro)/US Dollar market. McGroarty et al. (2007) compare the results achieved by the HS1997 model for different major currencies (Euro, US Dollar, Japanese Yen and Swiss Franc)\(^3\).

In contrast few studies have been performed on spreads on smaller foreign exchange markets. An exception is Bjønnes and Rime (2005), who investigate the behaviour of a Norwegian crown/Deutsche Mark dealer. They find again a significant asymmetric information component, but no inventory effect. To our knowledge there is no similar work on Central and Eastern European countries.

Another strand of literature deals with the relationship between order size and bid-ask spread. There are essentially three theoretical directions which can be followed to link order size and spread: processing cost models, inventory risk models and information cost models. While the first direction suggests that trade size and spreads are inversely related (see Stoll 1978, Hartmann 1999), inventory risk models and information cost models conclude that there should be a positive relation between trade size and spreads (see for instance Ho and Stoll 1981 for inventory costs, Kyle 1985, Admati and Pfleiderer 1988 for adverse selection costs). Similarly, the empirical research on the relation between trade size and spread has provided mixed results. While Lyons (1995) finds a positive relation between order size and spreads, most studies conclude that there is little or no relationship between spread and order size (Yao 1998, Bjønnes and Rime 2005).

\(^3\) They do, however, get implausible high, negative results for the inventory holding component or the adverse selection component in seven out of ten cases in their three-way decomposition.
Other studies find a relation between order size and spread that depends on the type of counterpart: Mende (2005) distinguishes between commercial customers (mainly nonfinancial corporations), financial customers (such as investment funds), and interbank trades. He finds that the asymmetric component of spreads increases with order size only for more informed counterparties, i.e., financial customers and other banks, although the spreads for these trade partners are smaller than those for commercial customers. Ding (2009) discriminates between the interdealer and the customer market for an online FX dealer on the USD/EUR market and reports that the spread is independent from order size in the interdealer market, but negatively related in the customer market.

4. Empirical Model

There have been various attempts to estimate the different spread components, which can be broadly categorized into covariance based models (Stoll 1989, George et al. 1991) and models based on trade indicators (e.g. Madhavan et Smidt 1991, HS 1997). The model by Madhavan and Smidt (1991) and the model by HS1997 have become the workhorse of spread decomposition. We apply the well established HS1997 model, which has the advantage of being widely used and at the same time to provide estimates for the adverse selection and the inventory holding component separately (in contrast to the Madhavan and Smidt 1991 model). The HS1997 is based on the assumptions shown in the following three equations (see HS1997):

\[
V_t = V_{t-1} + \alpha \cdot S/2 \cdot Q_{t-1} + \varepsilon_{t-1}
\]  (1)

Equation (1) means that the fundamental value \( V_t \) equals the fundamental value \( V_{t-1} \) of the previous period plus the change in value \( \alpha \cdot S/2 \cdot Q_{t-1} \) that is due to private information, reflected in the previous trade, plus the change in value \( \varepsilon_{t-1} \) that is due to public information. The component \( \alpha \cdot S/2 \cdot Q_{t-1} \), where \( S/2 \) is the half spread and \( Q_t \) is a trade indicator, taking the value 1, if the trade was buyer initiated and -1 if it was seller initiated\(^4\), can be derived from the models by Copeland and Galai (1983) and Glosten and Milgrom (1985). Therefore, \( \alpha \) is the proportion of the half spread due to asymmetric information.

\(^4\) A trade is buyer initiated, if a buyer hits an existing limit sell order from the order book with a buy market order or by placing a limit buy order that is matched by the system with a sell order.
According to equation (2) the midpoint $M_t$ of the bid-ask spread differs from the fundamental value by the cumulated inventory, i.e. the cumulated inventory on the respective day\(^5\). If there were neither inventory costs nor private information the midpoint was equal to the fundamental value. Equation (2) is based on inventory theories of the spread (e.g. Ho and Stoll 1981) and means that liquidity providers adjust their midpoints on the basis of accumulated inventory in order to induce inventory equilibrating trades. Thus, $\beta$ is the proportion of the half spread due to inventory holding costs.

$$P_t = M_t + S/2 \cdot Q_t + \eta_t \quad (3)$$

$P_t$ is the quote on the market, and $M_t$ is the observable midpoint between bid and ask price. Equation (3) means nothing else than that the HUF/EUR quote fluctuates around the midpoint by the half-spread, depending on whether we observe a buy or sell\(^6\).

Differencing equation (2) and substituting $\Delta V_t$ by its expectation $\alpha \cdot S/2 \cdot Q_{t-1}$ (equation 1) and substituting the whole expression into the differenced version of equation (3) leads then to a two-way decomposition by the following regression:

$$\Delta P_t = S/2 \cdot (Q_t - Q_{t-1}) + \lambda S/2 \cdot Q_{t-1} + e_t \quad (4)$$

where $\Delta P_t$ is the price change between two subsequent trades. It may therefore be interpreted as the (private) information that is potentially incorporated in the last trade. $S/2 \cdot (Q_t - Q_{t-1})$ is the price movement due to switches between buy and sell orders, thus a jump between the two edges of the spread, if a buyer initiated order is followed by a seller initiated order and vice versa, $\lambda$ is the joint effect of asymmetric information and inventory holding and $e_t$ reflects the arrival of public information. For details of the derivation see HS1997.

\(^5\) Note that equation (2) assumes trades of the standard size one. Since on the HUF/EUR market 85% of all trades are of the minimum size of 1 million EUR this assumption seems to be justified.

\(^6\) The estimated spread does not necessarily equal the real spread (HS 1997). The difference with observed posted spreads is that the estimated spread reflects trades inside the spread but outside the midpoint.
In a second step, an analysis for different trade sizes can be useful. To derive equation (4), the assumption, given by equation (3), was used. As trade size is not included in equation (3), it implicitly states that the spread is independent of the trade size. Explicitly considering trade size in all assumptions is thus necessary. For three size categories, this results in the following regression equation:

\[
\Delta P_t = \left(\frac{S_s}{2}\right) \cdot D_s(t) \cdot Q_t + \left(\frac{\lambda - 1}{2}\right) \cdot \left(\frac{S_s}{2}\right) \cdot D_s(t) \cdot Q_t + \left(\frac{S_m}{2}\right) \cdot D_m(t) \cdot Q_t + \left(\frac{\lambda - 1}{2}\right) \cdot \left(\frac{S_m}{2}\right) \cdot D_m(t) \cdot Q_t + \left(\frac{S_l}{2}\right) \cdot D_l(t) \cdot Q_t + \left(\frac{\lambda - 1}{2}\right) \cdot \left(\frac{S_l}{2}\right) \cdot D_l(t) \cdot Q_t + e_t
\]  (5)

\(D_s\) is a dummy variable that equals 1 if the size of the trade falls in the “small” category and 0 when this is not the case. The same applies for \(D_m\) and \(D_l\).

As equation (4) does not allow distinguishing between the inventory effect and the asymmetric information effect, Huang and Stoll suggest taking a potential serial correlation between trade flows into account. This three-way decomposition (for the derivation we again refer to HS 1997) is performed by simultaneous estimation of the following model:

\[
E(Q_{t-1} | Q_{t-2}) = (1 - 2\pi)Q_{t-2}
\]  (6)

\[
\Delta P_t = S/2 \cdot Q_t + (\alpha + \beta - 1) \cdot S/2 \cdot Q_{t-1} - \alpha \cdot S/2 \cdot (1 - 2\pi)Q_{t-2} + e_t
\]  (7)

allowing to decompose the joint effect \(\lambda = (\alpha + \beta)\) of asymmetric information (\(\alpha\)) and inventory holding (\(\beta\)) into its components. Equations (4) and (6-7) serve as our baseline regressions in the subsequent analysis.
5. Empirical Results

This section presents the results from the two-way and three-way decomposition of the spread as described in section 2. We begin with the two-way decomposition followed by the three-way decomposition.

According to the basic two-way decomposition from HS1997 average spread is 0.10 HUF for the whole sample period (2003-2004) with the order processing component accounting for 42.30% of the spread and the sum of the adverse selection component and inventory holding component for 57.70% (see Table 2).

In order to check the robustness of these results the spreads are decomposed for two obvious subsamples, namely the trades executed in 2003 and the trades executed in 2004 (see Table 2). For 2003 the spread is estimated to be 0.13 HUF, whereas it declines in 2004 to 0.08 HUF. The sum of the adverse selection and inventory holding component accounted for 56.44% of the total spread in 2003 and for 58.54% of it in 2004. Despite the slight relative increase for this component it lowers in absolute value in 2004 compared to 2003. The order processing component slightly decreases relatively and absolutely: from 43.56% in 2003 to 41.46% in 2004. Thus the relative spread components only show slight differences between 2003 and 2004.

We performed the same analysis for each half year in order to get a better view on the evolution of the spread and its components during the observed period. Figure 2 visualizes the results of this analysis. The estimated spread declines each half-year, particularly during the last year. This applies to both components and every half year period, except the sum of the adverse selection component and inventory holding component during the second half year of 2003. An explanation for this decrease can be provided by the increased liquidity in the course of the transition process over the sample period and some turmoil on the HUF/EUR market in 2003 (see Gereben and Kiss M. 2006).

As an extension and to check the relation between spread and trade size, we also perform the two-way decomposition for different trade sizes separately. We do this using a dummy variable for each trade size category. The information on the frequency of trades provided in Table 1 suggests that it is reasonable to split up the trades into trades of 1 million Euro (the minimum trade size: small trades), trades exceeding 1, but less than 3 million Euro (medium trades) and trades of 3 million Euro or more (large trades). For this trade size specific analysis we use equation (3).
Our results for the HUF/EUR market are presented in figure 3. We find that the spread is positively related with trade size. By decomposing the spread we search for the component that is responsible for this positive relationship. While there seems to be no relation between trade size and the order processing component, we find a strong positive relation between trade size and the sum of adverse selection and inventory holding component is found. This is in accordance to what one should expect theoretically when you combine the different in section three mentioned theoretical directions.

Applying the *three-way decomposition* from HS1997 the estimated spread is 0.11 HUF on average for the whole sample period. When we decompose it in three components by using equations (2) and (3), we find that order processing costs account for 38.51% of the spread, adverse selection costs account for 21.45% of the spread and inventory holding component for 40.04% of the spread. We do the analysis again for 2003, 2004 and for each half year separately. The results can be found in Table 3. The half year analysis suggests that the inventory holding component decreases quite strong and almost constantly. The adverse selection stays more or less constant. The order processing cost, again, decreases. This finding can possibly be explained by the increased trade frequency, and thus decreased time between offsetting trades. The time between trades influences the inventory holding risk directly, but not the adverse selection risk.

The link between trade size and the total spread has already been visited in the previous paragraph. We evaluate how the three components of the spread behave when the trade size changes. The result is puzzling. While the order processing cost does not change a lot, the inventory holding component increases a lot with the trade size and the adverse selection component becomes very small for large trades. The latter finding seems to be counterintuitive, but is related to the low estimates for $\pi$, see table 3. While microstructure theory suggests that $\pi$ exceeds 0.5, i.e., there is negative autocorrelation in the order flow, many empirical studies find positive autocorrelation on very different markets (Huang and Stoll 1997, Van Ness et al. 2001, McGroarty et al. 2007). HS1997 explain this puzzle by order splits: Splitting large orders into several subsequent, smaller ones induces positive autocorrelation in the order flow. They therefore emphasize that the estimated $\pi$ forms a lower, while the estimated adverse selection component forms an upper boundary for the true values. Since order splitting results in small order sizes, we conclude that our calculated

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7 HS1997 suggest matching orders that potentially result from order splitting. However, since order splitting is not observable, their way of matching the orders may underestimate the autocorrelation in the order process.
adverse selection component for small trades is likely to be overestimated and the true components are more realistically reflected in the estimates for large trades, i.e., the adverse selection component is comparatively small and dominated by order processing and inventory holding costs. Thus the differences between small and large trades may be driven by two factors: The absence of trade splitting and the original relation between order size and spread as suggested by microstructure theory, see the discussion in section 2.1.

Table 4 compares our results to those of various recent studies. First, our study joins the group of those studies that confirm the inventory effect on the FX market. Second, the adverse selection component we find is in line with previous studies. Third and in contrast, the share of the order processing cost component is comparatively low (only Yao 1998 finds a much lower order processing component). This may be due to the larger absolute spread size. Thus, our results indicate a lower importance of order processing costs compared to other spread components. This is mainly due to the high weight of the inventory holding component, which obviously stems from the low market liquidity and the long time between offsetting trades (there is on average only one trade every three minutes).

6. Concluding Remarks

In this paper we apply the well established spread decomposition model by Huang and Stoll (1997) to a new and large dataset on the Hungarian Forint/Euro market. The main results are in line with existing studies on more liquid markets. However, the importance of adverse selection and inventory holding components seems to be higher, stressing the special characteristics of small and illiquid markets. Furthermore, we find a substantial effect of the increasing liquidity, that the market experienced during the transition process, on both, the spread size and its composition: While the size of all components declines, the relative share of the inventory and adverse selection component slightly increases.

Finally, we find a close relation between the spread and order size: The spread considerably increases with order size. While the order processing component remains stable, the other components show a substantial increase.

and introduces negative autocorrelation that is not in the trading process. We therefore decide not to rely on trade bunching and not to add the additional uncertainty from this approach.
Summing up, our analysis confirms most of the results from previous studies, but also points at the differences between minor market segments with low liquidity, competition and trading activity compared to major currency markets.
References


**TABLES AND FIGURES**

**TABLE 1: Descriptive Statistics of the Data Set**

<table>
<thead>
<tr>
<th></th>
<th>Whole sample</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of quotes</td>
<td>437,421</td>
<td>193,449</td>
<td>243,972</td>
</tr>
<tr>
<td>Number of trades(^{a,b})</td>
<td>72,126</td>
<td>31,738</td>
<td>40,388</td>
</tr>
<tr>
<td>Average trade size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trades ≤ 1 million €</td>
<td>1,284.792 EUR</td>
<td>1,304.229 EUR</td>
<td>1,266.569 EUR</td>
</tr>
<tr>
<td>Trades &gt;1 million € and &lt;3 million €</td>
<td>80.36%</td>
<td>79.75%</td>
<td>81.54%</td>
</tr>
<tr>
<td>Trades ≥ 3 million €</td>
<td>13.80%</td>
<td>14.12%</td>
<td>13.23%</td>
</tr>
<tr>
<td>Average number of quotes per day</td>
<td>5.84%</td>
<td>6.13%</td>
<td>5.23%</td>
</tr>
<tr>
<td>Average number of trades per day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average daily trading volume</td>
<td>881.90</td>
<td>806.04</td>
<td>953.02</td>
</tr>
<tr>
<td>Average daily trading volume</td>
<td>145.42</td>
<td>132.24</td>
<td>157.77</td>
</tr>
<tr>
<td>Average spread (basis points)(^{c})</td>
<td>4.35</td>
<td>5.11</td>
<td>3.58</td>
</tr>
</tbody>
</table>

\(^{a}\) The buy and sell are together counted as 1 trade  
\(^{b}\) On days with a minimum volume and during the office hours  
\(^{c}\) Estimated with the two way decomposition

**TABLE 2: Two-Way Decomposition of the Spread**

<table>
<thead>
<tr>
<th></th>
<th>Spread</th>
<th>(\lambda)</th>
<th>ASC+IHC(^{a})</th>
<th>OPC(^{b})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole sample</td>
<td>0.11</td>
<td>0.57</td>
<td>57.33%</td>
<td>42.67%</td>
</tr>
<tr>
<td>2003</td>
<td>0.13</td>
<td>0.56</td>
<td>56.23%</td>
<td>43.77%</td>
</tr>
<tr>
<td>2004</td>
<td>0.09</td>
<td>0.58</td>
<td>57.91%</td>
<td>42.09%</td>
</tr>
<tr>
<td>2003 jan-jun</td>
<td>0.13</td>
<td>0.54</td>
<td>53.70%</td>
<td>46.30%</td>
</tr>
<tr>
<td>2003 jul-dec</td>
<td>0.13</td>
<td>0.58</td>
<td>58.19%</td>
<td>41.81%</td>
</tr>
<tr>
<td>2004 jan-jun</td>
<td>0.11</td>
<td>0.58</td>
<td>57.68%</td>
<td>42.32%</td>
</tr>
<tr>
<td>2004 jul-dec</td>
<td>0.07</td>
<td>0.57</td>
<td>57.42%</td>
<td>42.58%</td>
</tr>
<tr>
<td>Small trades</td>
<td>0.10</td>
<td>0.55</td>
<td>54.82%</td>
<td>45.18%</td>
</tr>
<tr>
<td>Medium trades</td>
<td>0.12</td>
<td>0.63</td>
<td>62.99%</td>
<td>37.01%</td>
</tr>
<tr>
<td>Large trades</td>
<td>0.13</td>
<td>0.66</td>
<td>66.33%</td>
<td>33.67%</td>
</tr>
</tbody>
</table>

\(^{a}\) Adverse selection component + inventory holding component  
\(^{b}\) Order processing component
TABLE 3: Three-Way Decomposition of the Spread

<table>
<thead>
<tr>
<th></th>
<th>( \pi )</th>
<th>Spread</th>
<th>OPC(^a)</th>
<th>ASC(^b)</th>
<th>IHC(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole sample</td>
<td>0.27</td>
<td>0.11</td>
<td>38.51%</td>
<td>21.45%</td>
<td>40.04%</td>
</tr>
<tr>
<td>2003</td>
<td>0.26</td>
<td>0.13</td>
<td>40.28%</td>
<td>17.34%</td>
<td>42.37%</td>
</tr>
<tr>
<td>2004</td>
<td>0.28</td>
<td>0.09</td>
<td>37.06%</td>
<td>26.43%</td>
<td>36.51%</td>
</tr>
<tr>
<td>2003 jan-jun</td>
<td>0.26</td>
<td>0.14</td>
<td>43.19%</td>
<td>15.65%</td>
<td>41.16%</td>
</tr>
<tr>
<td>2003 jul-dec</td>
<td>0.27</td>
<td>0.13</td>
<td>37.97%</td>
<td>18.86%</td>
<td>43.17%</td>
</tr>
<tr>
<td>2004 jan-jun</td>
<td>0.27</td>
<td>0.11</td>
<td>37.79%</td>
<td>22.59%</td>
<td>39.62%</td>
</tr>
<tr>
<td>2004 jul-dec</td>
<td>0.29</td>
<td>0.07</td>
<td>36.88%</td>
<td>31.29%</td>
<td>31.82%</td>
</tr>
<tr>
<td>Small trades</td>
<td>0.28</td>
<td>0.10</td>
<td>38.50%</td>
<td>24.62%</td>
<td>36.89%</td>
</tr>
<tr>
<td>Medium trades</td>
<td>0.26</td>
<td>0.13</td>
<td>40.25%</td>
<td>14.77%</td>
<td>44.98%</td>
</tr>
<tr>
<td>Large trades</td>
<td>0.26</td>
<td>0.14</td>
<td>39.45%</td>
<td>5.51%</td>
<td>55.05%</td>
</tr>
</tbody>
</table>

\(^a\) Order processing component  
\(^b\) Adverse selection component  
\(^c\) Inventory holding component

TABLE 4: Comparison with selected previous studies

<table>
<thead>
<tr>
<th></th>
<th>Market</th>
<th>Spread components</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IHC(^c)</td>
<td>ASC(^c)</td>
</tr>
<tr>
<td>This study</td>
<td>HUF/EUR</td>
<td>40.04%</td>
<td>21.45%</td>
</tr>
<tr>
<td>Lyons (1995)</td>
<td>DEM/USD</td>
<td>30%</td>
<td>15%</td>
</tr>
<tr>
<td>Yao (1998)</td>
<td>DEM/USD</td>
<td>70%</td>
<td>23%</td>
</tr>
<tr>
<td>Mende (2005)</td>
<td>EUR/USD</td>
<td>0%</td>
<td>&lt;40(^d)</td>
</tr>
<tr>
<td>Bjønnes/Rime (2005)</td>
<td>DEM/USD(^a)</td>
<td>0%</td>
<td>72%</td>
</tr>
<tr>
<td>Bjønnes/Rime (2005)</td>
<td>NOK/DEM(^b)</td>
<td>0%</td>
<td>49%</td>
</tr>
<tr>
<td>McGroarty et al. (2007)</td>
<td>various</td>
<td>45-91(^e)%</td>
<td>9-55(^e)%</td>
</tr>
</tbody>
</table>

\(^a\) Dealer 2 in the sample  
\(^b\) Dealer 1 in the sample  
\(^c\) IHC: inventory component, ASC: adverse selection component, OPC: order processing component  
\(^d\) Depending on counterpart  
\(^e\) Depending on sub-period and market
**Figure 1:** Daily volume and daily average quote on the HUF/EUR market for 2003 and 2004

**Figure 2:** Decomposition by Half-Year

**Figure 3:** Decomposition by Trade Size