Why Do Larger Orders Receive Discounts on the London Stock Exchange?[1]

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Abstract

We argue that competition between dealers in a classic dealer market is intertemporal: A trader identifies a particular dealer and negotiates a final price with only the intertemporal threat to switch dealers imposing pricing discipline on the dealer. In this kind of market structure, we show that dealers will offer greater price improvement to more regular customers, and, in turn, these customers optimally choose to submit larger orders. Hence price improvement and trade size should be negatively correlated in a dealer market. We confirm our model's predictions using unique data from the London Stock Exchange during 1991.

Introduction

A central empirical finding on the NYSE, regional U.S. exchanges, and exchanges with open limit order books is that, larger orders receive worse prices. Key papers that document this relationship include Bernhardt and Hughson (2002), Glosten and Harris (1989), Easley, Kiefer and O'Hara (1997), Foster and Viswanathan (1990, 1993), Lee (1993), Harris and Hasbrouck (1996), Blume and Goldstein (1997), and Biais, Hillion, and Spatt (1995). Theoretical models have highlighted two factors that could explain why larger orders receive worse prices—asymmetric information and inventory considerations. If liquidity providers know less on average than agents who actively submit orders, they protect themselves by providing less favorable prices for larger orders.[2] If liquidity providers are risk-averse, higher prices on larger orders compensate liquidity providers for holding more unbalanced inventory positions.[3]

In recent years, it has become evident that in traditional equity dealer markets like the London Stock Exchange (LSE), NASDAQ, and foreign exchange markets, the opposite pricing pattern obtains. Quite strikingly, Reiss and Werner (1996) find that *larger* trades receive more price improvement than smaller ones in London's dealer market. Only for unusually large orders does price improvement begin to fall with order size. The finding that larger trades get better execution in a dealer market clearly defies conventional wisdom. After all, asymmetric information concerns and inventory problems are certainly present on the LSE, so whatever is different about the LSE must be significant enough to overwhelm the effects of inventory concerns and asymmetric information on pricing. The question is: what? This paper argues that structural features of dealer markets provide an explanation.

The key feature in market design that we identify is the timing of competition for an order. On the NYSE floor and in open limit order markets such as the Paris Bourse, price competition is simultaneous. Everyone willing to fill the order—limit order traders and dealers—bids simultaneously. The best quoted price prevails, and the liquidity provider with the best quote handles the order. In contrast, on a traditional dealer market, although dealers post price quotes that are broadly disseminated, a trader placing an order typically selects a dealer with whom to trade and then negotiates a final price one-on-one. During the negotiation phase, there are no additional dealers to spur competition. If unhappy with a final negotiated price offer, a trader has limited options. He can accept the offer and make the trade, but switch dealers in the future. Alternatively, the trader can seek out another dealer and bargain anew. This process takes time, information can leak out, and there is no guarantee that a new dealer will make a better offer. The qualitative consequence of the market design is to *reduce* temporal competition among dealers. This lack of temporal competition is evidenced by the fact that traders typically do not even first contact the dealer with the best quote.[4]

Although an individual order may not be exposed to competition among dealers at a moment in a dealer market, there is still competition intertemporally. Over time, traders submit multiple orders; and we show that it is the intertemporal competition for future orders that generates the pricing relationships highlighted in Reiss and Werner (1996). Because regular traders have more valued business, dealers are willing to offer more price improvement to secure their continued patronage.

We develop a model that analyzes the impact of enduring trading relationships on price improvement and trading decisions. Traders, dealers, and brokers are symmetrically informed about the value of an asset. A broker receives a steady flow of orders from his customers and immediately submits them. The broker's equilibrium strategy is to switch dealers if, for a given order size, he does not receive sufficient price improvement on the dealer's quotes. The dealer weighs the value of maximizing his one-time revenue from the broker by offering no price improvement against the value from future trade that he would retain by offering enough price improvement. We then show that the price improvement offered on each trade (a) rises with the value of the relationship, and, (b) holding the relationship fixed, falls with the size of the current order. Thus, the model implies that (1) ceteris paribus the more valuable is the trading relationship, the more price improvement offered on an order of any given size but (2), fixing the relationship, larger orders are given worse prices. Empirically, the only way to reconcile both (1) and (2) with the fact that large orders receive greater price improvement on average is for those large orders to come disproportionately from brokers who provide the dealer more business.[5] In fact, we find that these relationships do hold in the data.

We then generate testable implications. Because dealers could uncover a regular broker's identity on the LSE during our sample period, we can test directly for the importance of broker-dealer trading relationships for the price improvement offered. Holding the value of the trading relationship fixed, large orders should receive worse prices. Holding order size fixed, more-valued brokers (as captured by measures such as past volume) should receive better prices. Moreover, for larger trades there should be more dispersion in price improvements as Reiss and Werner (1996) document. The reason is that the temptation to refuse to offer price improvement rises with trade size, but most larger orders come from (more-valued) regular brokers to whom dealers give greater price improvement. Consequently, the variance of price improvement may rise with order size. Further, the mean level of price improvement should *only* rise up to those levels that are unusually large even for regular brokers. In particular, we can reconcile the decrease in price improvement for large orders illustrated in Reiss and Werner (1996).

We test the model's predictions using a sample of 25 FTSE-100 stocks traded in London during 1991 (see Reiss and Werner (1998,1999)). Our data show that *for all order size groupings*, average price improvements significantly increase with variables such as past volume that capture an enduring trading relationship between a dealer and a broker. This indicates that London dealers screen broker identities and that it is not order size *per se* but rather the enduring relationship that determines the price improvement offered. We also find that a broker concentrates trade among very few dealers. Collectively, this evidence indicates that enduring trading relationships are paramount to understanding pricing and trade in a traditional dealer market. The next section describes the model and details its predictions. We test these predictions in Section 2. Section 3 concludes.

1 The Model

Consider risk-neutral brokers who exogenously receive customer orders for a particular asset and seek to minimize their customers' lifetime trading costs by choice of dealer. Customers, dealers, and brokers are symmetrically informed about the asset's value. Brokers and dealers know each other's identities.[6] Without loss of generality we focus on the buy side of the market for a given broker. Every t units of time, the broker receives an order of size w from customers, where w is distributed according to distribution function $G(\cdot)$ on $[0, W]$. We assume that brokers do not combine or repackage order flow, but instead pass received customer orders directly on to dealers.[7] Hence, the distribution of orders that a dealer gets if he is retained by the broker is also $G(\cdot)$.

When the broker submits an order, the dealer can extract a share of the trade. Dealers post quotes, y, $0 \leq y \leq 1$, about the maximum share that they will exact. These quotes are good for all order sizes. We take y as exogenous. It could be, but need not be, the result of collusion.[8] Alternatively, in asymmetric information settings, one can justify y using a variant of Admati and Pfleiderer's (1989) equilibrium concept.[9]

Each period with probability $1-p$ the broker receives a shock that induces him to sever his existing dealer relationships. That is, with probability $1-p$, the broker ceases to trade via a particular dealer for reasons other than insufficiently attractive prices. For simplicity, we assume that neither dealers nor brokers discount the future, but p can be reinterpreted as a dealer's discount factor.

The value to a dealer of a broker's order flow is captured by the triple (G, p, t). If the broker's order size is w, let $y - z(w; G, p, t)$ be the price improvement in percent that the dealer gives the broker, where $0 \leq z(w; G, p, t) \leq y$. Given the price improvement $y - z(w; G, p, t)$ offered by a dealer, the broker decides whether or not to use that dealer for future investments. The broker uses a simple rule: Retain the dealer if and only if he offers price improvement of at least $y - z^*(w; G, p, t)$. A dealer therefore chooses between offering price improvement of $y - z^*(w; G, p, t)$ in order to receive future business and offering no price improvement. The competition the dealer faces is intertemporal: If a dealer does not provide enough price improvement, he loses all future business from the broker.

Equilibrium price improvement. The future value that a dealer expects if he offers sufficient price improvement to the broker is given by

$$V(G, p, t) = \sum_{\tau=1}^{\infty} (p^t)^\tau E_{G(\cdot)}[z(\tilde{w}; G, p, t)\tilde{w}] = \frac{p^t}{1-p^t} E_{G(\cdot)}[z(\tilde{w}; G, p, t)\tilde{w}], \tag{1}$$

where we explicitly index expectations by the distribution of order flow. If, instead, the dealer gives the broker the posted quote of y, the dealer's income is yw. It follows that the dealer offers price improvement to the broker if and only if

$$yw \leq z(w; G, p, t)w + \frac{p^t}{1-p^t} E_{G(\cdot)}[z(\tilde{w}; G, p, t)\tilde{w}]. \tag{2}$$

We next determine how much price improvement a dealer offers the broker in equilibrium. We focus on the equilibrium in which a broker's trading costs are smallest. Equilibrium trading costs are minimized when the broker employs the harshest feasible threat: A broker threatens to never again patronize a dealer who fails to offer enough price improvement. In this equilibrium, dealers are indifferent between offering their posted quote of y, which generates income of yw and providing price improvement of $y - z^*(w; G, p, t)$ to maintain the trading relationship. The requisite price improvement, $y - z^*(w; G, p, t)$ solves equation (**??**) at equality, so that

$$y - z^*(w; G, p, t) = \frac{V(G, p, t)}{w} = \frac{p^t}{w(1 - p^t)} E_{G(\cdot)}[z(\tilde{w}; G, p, t)\tilde{w}]. \tag{3}$$

Inspection of equation (**??**) reveals immediately that

1. $\frac{\partial z^*}{\partial t} > 0$: The future relationship is less valuable if the broker submits orders less frequently.
2. $\frac{\partial z^*}{\partial p} < 0$: The future relationship is more valuable when the exogenous probability that the broker severs a dealer relationship, $1 - p$, falls.
3. $\frac{\partial z^*}{\partial w} > 0$: The temptation for a dealer to forego price improvement is larger when the current order size is larger.
4. If $\hat{G}$ first order stochastically dominates G, then $z^*(w; \hat{G}, p, t) < z^*(w; G, p, t)$: The future relationship is more valuable if the broker tends stochastically to submit larger orders, and this leads to more price improvement.

For any given order size, a dealer offers more-valued, regular clients greater price improvement. The price improvement offered depends on both the order size and the broker's identity. Recall that $V(G, p, t)$ is the future value that a dealer expects from maintaining a particular enduring relationship. The price improvement that a dealer offers a broker when he submits an order of size w solves $(y - z^*(w; G, p, t))w = V(G, p, t)$: For any given value of the trading relationship, the larger is the order w, the less price improvement a dealer offers. Phrased differently, fixing the value of a relationship, larger orders receive *less* price improvement.

Thus, the key predictions of this model are:

1. The greater the value of a broker-dealer relationship, the greater is the price improvement given for all order sizes.
2. Fixing the value of a particular relationship, larger orders get worse prices, because all else equal, a dealer's incentive not to provide price improvement rises with order size.

To reconcile these two predictions with the empirical regularity that larger orders receive better prices on average, it must be that larger orders disproportionately come from brokers with established relationships. We will establish that these relationships do, in fact, hold in the data. It is not large orders *per se* that receive price improvement. Rather, the empirical regularity holds because larger orders tend to be submitted by more-valued customers. Discussions with FX dealers provide further support. FX dealers tend to give better prices to larger orders, but they give particularly bad prices to orders from customers in foreign countries whose currency demands are irregular. An implication is that integrating over all traders, the variance of price improvement conditional on order size may rise with order size.

Equation (3) details the equilibrium outcome when the broker has all of the bargaining power. When a dealer has more bargaining power, the equilibria remain qualitatively similar, but a broker's threat to switch dealers is less severe: A broker does not switch unless his customary dealer offers price improvement that is less than $y - z'(w; G, p, t)$, where $y > z'(w; G, p, t) > z^*(w; G, p, t)$. As a result, a dealer expects to receive more surplus from a broker over time in their relationship.

Similar results obtain if a broker uses multiple dealers. If π is the exogenous probability with which a broker submits an order to a given dealer, then the equilibrium price improvement is $y - z^*(w; G, \pi p, t)$: All else equal, the more likely a dealer is to receive an order from a broker—i.e., the greater is πp—the more valuable is their trading relationship, and hence the more price improvement the dealer provides.

1.1 Discussion of Model Assumptions

We purposely presented a sparse theoretical model to highlight how enduring broker-dealer trading relationships affect equilibrium price improvement. Before taking the model to the data, it is important to discuss how introducing other 'real world' features would affect the relationship between price improvements and trade size.

Inventory Concerns. When inventory matters, larger orders will tend to receive worse prices all else equal. However, if there are also enduring broker-dealer relationships, a dealer may still offer some price improvement even to large orders, in order to reduce the probability of losing *future* business from that broker. In the data, in contrast to our simple model, brokers establish multiple dealer relationships. But, this is precisely what one would expect when inventory concerns stochastically affect the costs of handling relationship-based order flows: Different dealers will have different inventories, and hence different valuations of order flows at different points in time. In response to such heterogeneity, a broker may establish trading relationships with multiple dealers, and then submit an order to the relationship dealer offering the best quote. In particular, in the data, a broker typically does not submit an order to a non-relationship dealer who offers the best quote. Our theory suggests that this is because such a dealer has no incentive to offer price improvement, while his relationship dealer still cares about future business. In addition, if a broker sends an order to a dealer offering the best current quote, this is one less order to a relationship dealer, which reduces the perceived value of the trading relationship, leading to worse future prices. This latter consideration may mean that a broker may submit an order to his customary dealer even though he expects less price improvement (relative to the best quote) on *that* order due to the dealer's inventory concerns. Since our estimation approach does not incorporate this relationship-building feature, we likely under-estimate the impact of enduring relationships on price improvement.

Asymmetric Information. In our model, there is no asymmetric information among dealers or among brokers. With asymmetric information, as footnote 8 describes, dealers post wider quotes, y, to protect themselves from informed brokers. In such a market, it is potentially even more valuable to establish a relationship with a dealer to obtain price improvements. The value of the relationship reflects the value of future order flow, and this value depends on whether a particular broker is informed or not. Desgranges and Foucault (2002) formalize this argument.

Search. Another plausible explanation for why larger orders receive greater price improvement is search. Consider a broker with an order size w, who via continued search, may find a dealer who values the order more highly, and hence is willing to offer more price improvement. Continued search has a time cost that a broker is more willing to endure if the order size is larger so that the stakes of finding more price improvement are higher. Because brokers with larger orders are prepared to search more extensively, larger orders may receive better prices. However, if search drives price improvement, there should be no systematic relationship between past broker-dealer trading and price improvements; and brokers should not concentrate trade with a few dealers.

Fixed Trading Costs. We abstract from dealer fixed trading costs. These can reduce the attraction of giving price improvement to brokers who submit primarily small orders, as such trading costs reduce the value of the relationship.

2 Empirical Tests of the Trading Relationship Model

We use intraday data on prices and quotes for 25 FTSE-100 stocks traded in London during 1991 to test whether enduring relationships between brokers and dealers in London drive the empirical regularity that large orders get more price improvement (Reiss and Werner (1996)). The data set is described in detail in Reiss and Werner (1998).[10] These stocks are at the mid to lower end of the FTSE-100 index stocks in terms of market capitalization. The average stock price in sample is £2.75, the average inside spread is 3 pence (or 110 basis points of the mid-quote), and the median (average) minimum quote size is 50,000 (42,000) shares. Minimum quote sizes are regulated to one Normal Market Size (NMS) in London. One NMS for a given stock corresponds to roughly 2.5 percent of average daily trading volume in that stock during the previous quarter.

We first identify all ordinary agency trades between brokers and dealers during regular trading hours (8:30am-4:30pm).[11] These trades are then matched with the inside quotes based on the trade's time stamp. Trades are time stamped to the nearest minute, while quotes are time stamped to the second. Moreover, trade reports may be delayed by up to 3 minutes. This gives rise to possible errors in matching up trades and quotes. We therefore screen out trades less than the quote size (exceeding the quote size) where the trade price is both 100 basis points and 3 pence (200 basis points and 6 pence) outside the inside spread at the time of the trade. While these cutoffs are arbitrary, they only serve to eliminate egregious outliers.[12] In the end, we work with 585,841 trades representing a total trading volume of roughly £8.7 billion. We use the month of January 1991 to generate estimates of trading relationship variables. Therefore, when we condition on relationship variables we use the 561,209 trades executed between February and December 1991.

Our theory focuses on the enduring trading relationships that brokers have with dealers. That is, we investigate, from the dealer's perspective, the tradeoff between offering more price improvement to maintain an enduring relationship with a *broker* and the one-time gain from offering little price improvement. To capture the value of a trading relationship, we use different measures of past broker-dealer volume. Past broker-dealer volume should be a reliable indicator of the future value of their relationship, and hence observed price improvement. For any *given* order size, brokers with more valuable broker-dealer relationships should receive more price improvement.

2.1 Summary Statistics

Table 1 reports the quartiles for three different forms of price improvement by trade size. To gauge the price improvements, note that the median inside spread in the sample is 110 basis points. Information on the distribution of trades across trade sizes is reported in the first three columns. Roughly two-thirds of trades are smaller than 2.5 percent of the quote size, and only 2.4 percent of trades exceed the quote size. We measure price improvements (i) in pence, (ii) relative to the quote midpoint, and (iii) relative to the inside spread at the time of the trade. The pattern of greater price improvements for larger orders is present for all three measures. For very large trades, however, median price improvements start to fall. In addition, the dispersion of price improvements rises with trade size: The first quartile of observations in every size-bin receives no price improvement while the third quartile of observations obtains price improvements of up to 50.0% of the inside spread. Thus, as suggested by our theory, the distribution of price improvements fans out.

To verify that the pattern of price improvement for large trades that we find in Table 1 is not simply driven by price improvement in one or a few stocks, or by the pricing strategy of one or a few dealers, we report the price improvement for small, medium, and large orders by stock and dealer in Figures 1 and 2 respectively. The figures reveal that the pattern of price improvement for large trades is pervasive across both stocks and dealers.

2.2 Measuring Trading Relationships

We next try to capture the value of a broker-dealer trading relationship. Our data allows us to identify brokers and dealers both over time and across stocks, and hence to track trades by a particular broker across dealers. There are 245 brokers in our sample and the number of dealers per stock ranges from nine to sixteen (see Table 2). We focus on five relationship variables and define relationship variables over a 20-day rolling window.[13] Our primary relationship variables are: $VOLUME$, the stock-specific broker-dealer volume in shares normalized by the NMS; $XVOL$, the average stock-specific trade size a broker submits to a dealer normalized by the NMS; and $BDVOL$, the sum over all stocks of $VOLUME$ traded by a broker with a particular dealer. We view $VOLUME$ as the best measure of the value of a broker-dealer relationship. Both $VOLUME$ and $XVOL$ measure broker-dealer volume in the specific stock and should better measure the relationship value than $BDVOL$, which aggregates broker-dealer volume across all stocks. Because there is considerable variation across stocks in $VOLUME$, stock-specific broker-dealer volume, aggregation means that $BDVOL$ is determined primarily by volume in the few stocks with the highest $VOLUME$. Further, $VOLUME$, which reflects both past trade size and past trade frequency, should better measure the value of a relationship than $XVOL$, which measures average past trade size alone.

Table 3 reports distributional statistics for the primary relationship variables. The median monthly volume between a broker and a dealer in a particular stock is 0.174 NMS or roughly 7,308 shares at the average NMS (quote size) of 42,000 shares. The percentiles range considerably: The interquartile range is from 1,428 shares (25^{th}) to 22,764 shares (75^{th}). Thus, there is significant variation in the business an individual broker delivers to a particular dealer. Part of this variation is due to the fact that some brokers—institutions—have more customer order flow. The interquartile range for the mean trade size ranges from 1,260 (25^{th}) to 12,600 (75^{th}) shares with a median of 4,998 shares. For total volume traded by a broker with a particular dealer across all sample stocks, the interquartile range is 9,870 to 235,956, with a median of 60,354 shares.

That a broker delivers substantial trading volume does not, itself, guarantee that the relationship is profitable for the dealer. For example, a broker with informed clients may deliver significant order flow to the dealer, but the dealer will on average lose money on such orders. Desgranges and Foucault (2002) develop a model that includes both enduring relationships and asymmetric information. They argue that brokers direct only non-informative order flow to relationship dealers so as not to endanger the value of the relationship. Dealers provide more price improvement to brokers who give them more profitable trades. We try to capture dealer profits from a relationship with two additional relationship variables: $PROFIT$, the dealer profit in £1,000 from the broker in the stock; and $PROFITBD$, the dealer profit in £1,000 from the broker across stocks. We define the daily dealer profit for a broker buy as the purchase price minus the value of those shares at the closing mid-quote. Profits for broker sells are defined analogously.

Table 3 reveals that the average cumulative daily profit in a stock that a dealer extracts from a broker is -£116. This is consistent with Hansch et al. (1999) who find that London market makers on average lose money during our sample period, and hints at the challenges of finding a profit measure that properly captures the relationship's expected value. Note also that the dispersion in dealer profits generated from a particular broker in a stock is enormous, ranging from -£691,780 to £466,248, and aggregate profits across stocks for a broker-dealer pair have even more dispersion.

The correlations between $VOLUME$, and $XVOL$ and $BDVOL$ are 0.665 and 0.538 respectively, suggesting that all our primary relationship variables may capture similar phenomena. Our two profit measures are positively correlated, 0.355, and their correlations with $VOLUME$, $XVOL$, and $BDVOL$ are also significant at 0.201, 0.137, and 0.189 respectively. Trade size, $SVOL$, is somewhat correlated with $VOLUME$ (0.177) and $XVOL$ (0.305), indicating that the effect of trade size on price improvement may change when both trade size and the relationship variables are included in the regression. The other control variables are minimally correlated both with the relationships variables and with each other, so that introducing them should not alter our qualitative findings.

We begin our analysis of the effect of relationsip variables on price improvements by dividing the sample into three sub-samples: small trades (less than or equal to 0.25NMS), medium trades (from 0.25NMS to 1.00NMS), and large trades (exceeding 1.00NMS). We do this because the effect of relationship variables on price improvements is likely to differ by trade size. Tables 4 to 6 present the regression results for small, medium, and large trades. The benchmark model includes variables related to the current trade. Specifically, we regress $\frac{100 \times PriceImprovement}{Touch}$ on trade size in NMS units $SVOL$ and $SVOL^2$, the inside spread in pence $TOUCH$ and $TOUCH^2$, an interaction term $TOUCHxSVOL$, the midquote price-level in pounds MID, (minus) the inventory of the dealer taking the broker buy (sell) in units of 100NMS, INV, morning and afternoon dummies, a dummy variable capturing aggregated trades $SHAPE$, plus 24 stock dummies and 15 dealer dummies that control for stock and dealer fixed effects. We construct all test statistics using robust standard errors.

The benchmark regressions (i.e., without relationship variables) in Tables 4 to 6 reveal that: (i) until orders become large, price improvement rises significantly with order size; and (ii) price improvement increases significantly in the inside spread. The other control variables also affect price improvements. Price improvements tend to fall with the stock price, but only for large trades is the effect economically significant. A large order in a stock with a £1.00 higher price would, on average, receive 2.49 percent *less* price improvement. The touch and price-level have a significant positive correlation of 0.610. Hence, the negative coefficient on MID is picking up the effect of discreteness in price improvements (the numerator in the left-hand side variable). The significant positive coefficient on INV means that a broker buy (sell) order that arrives when a dealer has a long (short) inventory position gets a larger price improvement all else equal. This effect is especially strong for large trades—on average, a dealer with a 10 NMS higher inventory would give a large trade that would reduce his inventory a 0.92 percent greater price improvement, all else equal. Indeed, this is what we would predict based on previous evidence concerning inventory management by London dealers (see Reiss and Werner (1998), Hansch et. al. (1998)). Price improvements for small trades are higher in the morning; but for medium and large trades, average price improvements are as much as 2.1 percent higher in the afternoon. Medium-sized aggregated trades (shapes) have significantly lower price improvements while aggregated large trades have significantly higher price improvements all else equal. It is important to control for all these effects so that we do not mistakenly attribute price improvements to broker-dealer trading relationships.

We then add the relationship variables to the benchmark regression in the following functional form, REL, REL^2, $REL \times SVOL$, and $REL \times TOUCH$.[14] Our primary relationship variable $VOLUME$ is significant and with the predicted sign for all trade-size groupings. For example, the estimates for (small) large trades show that a broker that has traded 10 NMS with the dealer in the stock during the past 20 days receives an average price improvement that is (0.99) 3.48 percentage points higher than a broker who has not traded with the dealer recently. The results for relationship variables $XVOL$, and $BDVOL$ are qualitatively similar. In sum, specifications 1 to 3 all support the hypothesis that stronger broker-dealer trading relationships lead to greater price improvement.

We next examine the relationship between dealer profits and price improvement. Profits are measured in £1,000,000 in the regressions. While brokers who have helped generate trading profits for dealers in the past (both for a single stock and across stocks) receive significantly higher price improvements for small trades, profits do not significantly affect price improvements for medium-sized trades. For large trades, only aggregate dealer profits across stocks are associated with significantly higher price improvements. A brokerage firm that has generated £100,000 in trading profits for a dealer over the past 20 days receives a average price improvement for a large trade that is 10.66 percentage points higher than a brokerage firm that has generated no profits for the dealer, all else equal. While the profit variables sometimes are significant, their incremental explanatory power is smaller than what we achieve with the volume-based variables. This suggests that realized profits are not a good measure of relationships, as one would conjecture given that on average a dealer loses £116 in daily profit over our sample period on a per broker basis (see Table 3).

To understand better the impact of the relationship variables on price improvement, we fix all regressors except for the relationship variables at their median values. In Figure 3, we compare the difference in the estimated average price improvement in percent of the touch when the relationship variable is at the 75^{th} percentile versus the 25^{th} percentile. We do this for small, medium, and large trades. For all variables except $PROFIT$, price improvement rises uniformly with the measure of the value of the relationship. Further, the value of the relationship matters more for price improvement on larger orders. For large orders, increasing $VOLUME$ ($XVOL$) by the interquartile range implies a 2.39 (3.97) percentage point increase in the price improvement. While this might seem small, it corresponds to about 12 (20) percent of the average price improvement (Table 1). Figure 3 provides support for Foucault and Degranges (2002). Their model suggests that brokers should direct their non-informative order flow to relationship dealers so as not to endanger the value of the relationship. To understand this result in the context of Figure 3, suppose that informed agents submit primarily large orders. Then, when brokers submit large orders to their relationship dealers, because this order flow is not information based, they will receive far more price improvement than when brokers submit (informationally-based) orders to non-relationship dealers. This is precisely what Figure 3 reveals.

The other issue that is important to explore is how introducing relationship variables affects the impact of trade size on price improvement. Tables 4 and 5 reveal that for small and medium trades, introducing relationship variables modestly reduces the effect of trade size on price improvement. More significantly, Table 6 reveals that for large orders, controling for relationships causes larger orders to get even worse prices, and sufficiently large orders get increasingly bad prices. Our basic theoretical model predicts that controlling for the relationship, price improvement should decline uniformly with order size. We only find this to be so for large orders. This could just reflect that our relationship measures are imperfect. It is also plausible that this reflects that our basic theoretical model does not incorporate fixed dealer costs of handling an order. Fixed dealer costs may lead to price improvement rising with order size for sufficiently small orders, but falling with order size for sufficiently large orders, which is what we find.

We check the robustness of our results to clustering by dividing the sample into quartiles based on daily returns, daily volatility, daily trading volume (£), and broker (£) volume across dealers and stocks. The results of regressions where the relationship variable is $VOLUME$ are reported in Table 7. The effect is significant for all quartiles of daily returns, daily volatility, and daily volume. The effect of the relationship on price improvements is lower for high return and high volatility days and it is non-linear in volume (the maximum price improvement is on medium volume days). While these are crude measures of information flow, the results suggest that when lots of new information is being incorporated into stock prices, relationships are relatively less important in determining price improvements.

Most importantly, the last panel of Table 7 reveals that for the top two quartiles of brokers ordered by total broker volume across dealers and stocks, a stronger broker-dealer trading relationship leads to far greater price improvements for orders. That is, relationships are especially important for price improvement for the largest 120 of the 245 brokers in our sample. This indicates that broker size does not drive our findings, as controling for larger brokers only magnifies the importance of trading relationships for price improvement. In contrast, for the smallest brokers in the sample, greater past volume actually reduces price improvement slightly. This likely reflects that for such brokers, their total order flow is too insubstantial to support significant trading relationships: Such brokers may be best off bottom fishing for the best quotes.[15]

We also run the same regressions by stock and dealer (without fixed effects), and find that the $VOLUME$ is positively related to price improvements for virtually all dealers and stocks.[16] That is, the importance of enduring broker-dealer trading relationships for price improvement is pervasive.

In sum, the empirical evidence strongly suggests that enduring relationships are important for explaining the cross-sectional variation in price improvements in London. Measures of volume traded between a broker and a dealer in the recent past are particularly important for determining whether or not the broker receives better execution.

3 Conclusion

We have shown that in dealer markets such as the LSE, where competition is largely intertemporal, enduring relationships between dealers and brokers matter for price improvements.

Specifically, we show that the price improvement received on each trade (a) rises with the value of the relationship, and, (b) holding the relationship fixed, decreases with the size of the current order. Thus, the model implies that (1) *ceteris paribus* the better the relationship, the more price improvement on an order of any particular size but (2), fixing the relationship, larger orders are given worse prices. Empirically, the only way to reconcile (1) and (2) with the fact that large orders receive greater price improvement on average is for those large orders to come disproportionately from brokers who provide the dealer more business. We document empirically that precisely these relationships hold for the LSE. We also find that high levels of variables that capture the value of the broker-dealer relationship lead to significantly greater price improvement. These empirical regularities are consistent with the predictions of our theoretical model.

Several aspects of the data do suggest that in addition to broker-dealer relationships, inventory concerns also matter. Specifically, brokers often have a few relationship dealers, suggesting that they target within their relationship group according to inventory concerns. So, too, the variable amount of price improvement for the same-sized order, after controlling for relationships, suggests that inventory concerns affect price improvement order by order. Inventory concerns combined with relationship trading can explain the high interdealer retrading that Reiss and Werner (1998) document occurs after the arrival of large customer trades.

Past profitability of the broker-dealer relationship is not consistently significant in explaining observed price improvements. By contrast, our simple volume-based relationship variables are remarkably successful in capturing the patterns of price improvements. Still, the pattern of price improvement for larger orders is consistent with asymmetric information playing a role in relationship building as suggested by Desgranges and Foucault (2002).

We find it more challenging to reconcile our empirical evidence with a story based on search. While a broker with large order has an incentive to search more extensively to obtain more price improvement, we see no reason why such search would imply that the broker consistently gets the best price improvement from the *same* dealer, as we observe. Further, search to identify the dealer whose inventory position makes him most eager to offer price improvement appears inconsistent both with the significant amount of retrading following large trades in London that Reiss and Werner (1999) find, and the fact that brokers trade with the dealer offering the best quote less than 30% of the time (Hansch *et al* (1999)).

The model we develop has predictions that we intend to explore in future research. When a broker submits an order to a standard dealer, it is less likely that the dealer is offering the best price, than when the broker submits an order to someone else. From an inventory perspective, this suggests that the standard dealer is less likely to value the order flow the most, implying that there is more likely to be retrading following orders from customers to their relationship dealers.

Also, we can explore the quote sensitivity of traders as a function of the value of trading relationships. Using our measure of price improvement, we can determine empirically how sensitive different types of traders are to observed disparities in quotes. Because traders with more valuable enduring relationships should receive greater price improvement, we expect that their dealer choice should be less "quote-sensitive" than that of traders who have not established such relationships.

To conclude, we note that enduring relationships may also matter on the NYSE for trades that are negotiated off-the-floor, such as block trades. When the parties negotiating the price of a block are likely to trade again in the future, and there is competition among liquidity providers, there is less incentive for a liquidity provider to alienate his counterparty by offering bad trading terms.

Figure Legends

Figure 1. Average Price Improvement in Percent of the Touch by Stock
The figure shows the average price improvement for small (less than or equal to 0.25NMS), medium (between 0.25 and 1.00NMS), and large (1.00NMS and above) customer trades in stocks 1 through 25.

Figure 2. Average Price Improvement in Percent of the Touch by Dealer
The figure shows the average price improvement for small (less than or equal to 0.25NMS), medium (between 0.25 and 1.00NMS), and large (1.00NMS and above) customer trades granted by dealer 1 through 17.

Figure 3. Effect on Price Improvment of Varying Relationship Variables
The figure illustrates the change in the estimated price improvement as a percent of the touch when a relationship variable moves from the first to the third quartile of its distribution. The relationship variables are: VOLUME - trading volume between the broker and the dealer; XVOL - average trade size between the broker and the dealer; BDVOL - trading volume between the broker firm and dealer firm across stocks; PROFIT - the dealer's trading profit from trading with the broker; and PROFITBD - the dealer firms' trading profit from trading with the broker firm across stocks. All relationship variables are measured over the 20-day window preceeding the trade. VOLUME, XVOL, and BDVOL are measured in NMS units, and PROFIT and PROFITBD are measured in £1,000. The numbers are derived from the regression coefficients reported in Table 4 (small trades - less than 0.25NMS), Table 5 (medium trades - between 0.25 and 1.00NMS), and Table 6 (large trades - 1.00NMS and above).

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Notes

[1] We are grateful to Laurent Germain, Paul Pfleiderer, Patrik Sandas, S. Viswanathan, and seminar participants at the University of California, Berkeley, the University of Colorado, the University of Illinois, University of Pennsylvania, Stanford University, and the University of Utah, the 1999 SFS Conference on Price Formation, the 2000 WFA meetings for their helpful suggestions. All errors are ours.

[2] It does not matter whether the liquidity providers are: Competing market makers (see, e.g., Admati and Pfleiderer (1988)), Glosten and Milgrom (1985) or limit order traders as in Glosten (1994); or a combination as in Parlour and Seppi (2003); or whether the economy is dynamic as in Kyle (1985).

[3] See, e.g., Ho and Stoll (1983), Biais (1993), Madhavan and Smidt (1993), or Viswanathan and Wang (2002).

[4] Hansch *et al.* (1999) find evidence from the LSE that more than 70 percent of orders go to dealers that are not posting the best quotes at the time of order submission. This empirical regularity cannot be derived in models such as Rhodes-Kropf (1999) or Viswanathan and Wang (2002), where customers always trade with the dealer offering the best quote, and this dealer most values the order.

[5] In a previous draft we also provided a model in which we endogenize the result that, *in equilibrium*, traders who have more valuable trading relationships with dealers *choose* to submit both larger and more frequent orders. This dynamic model can be used to endogenize assumptions made in this paper and by Rhodes-Kropf (1999).

[6] The limited number of brokers and dealers on the LSE ensures that the transacting parties know each other's identities. See Forster and George (1992) for a model of how limited information about trader identities affects outcomes.

[7] In practice, brokers rarely aggregate orders on the LSE. We control for aggregation in our empirical work.

[8] Christie and Schultz (1994) document such collusion on NASDAQ, and Werner and Reiss (1996) do so for the LSE. Private communications with currency traders indicate that they too systematically collude on quotes.

[9] In fact, a range of quotes can be supported in equilibrium. Suppose one group of brokers is known to be uninformed—these are the brokers who establish enduring trading relationships. These brokers are essentially Admati and Pfleiderer's (1991) "sunshine traders"; in a dynamic environment, Desgranges and Foucault (2002) show how brokers can establish reputations as sunshine traders. In addition, there is a second group of brokers that may have private information. Such informed brokers will seek out a dealer offering the best quote, as they will not be offered price improvement. An equilibrium in which each dealer quotes y can be supported if (i) the losses a dealer expects from the quote y it gives to potentially-informed brokers are less than the profits from uninformed brokers when uninformed brokers receive equilibrium levels of price improvement,

and (ii) no dealer has an incentive to offer a better quote y' that draws enough uninformed broker trade to offset the concentration of informed broker trade that will arrive.

[10] Table 2 lists the stocks and provides summary characteristics. See also Reiss and Werner (1999).

[11] We exclude all options related trades and all trades with special condition codes.

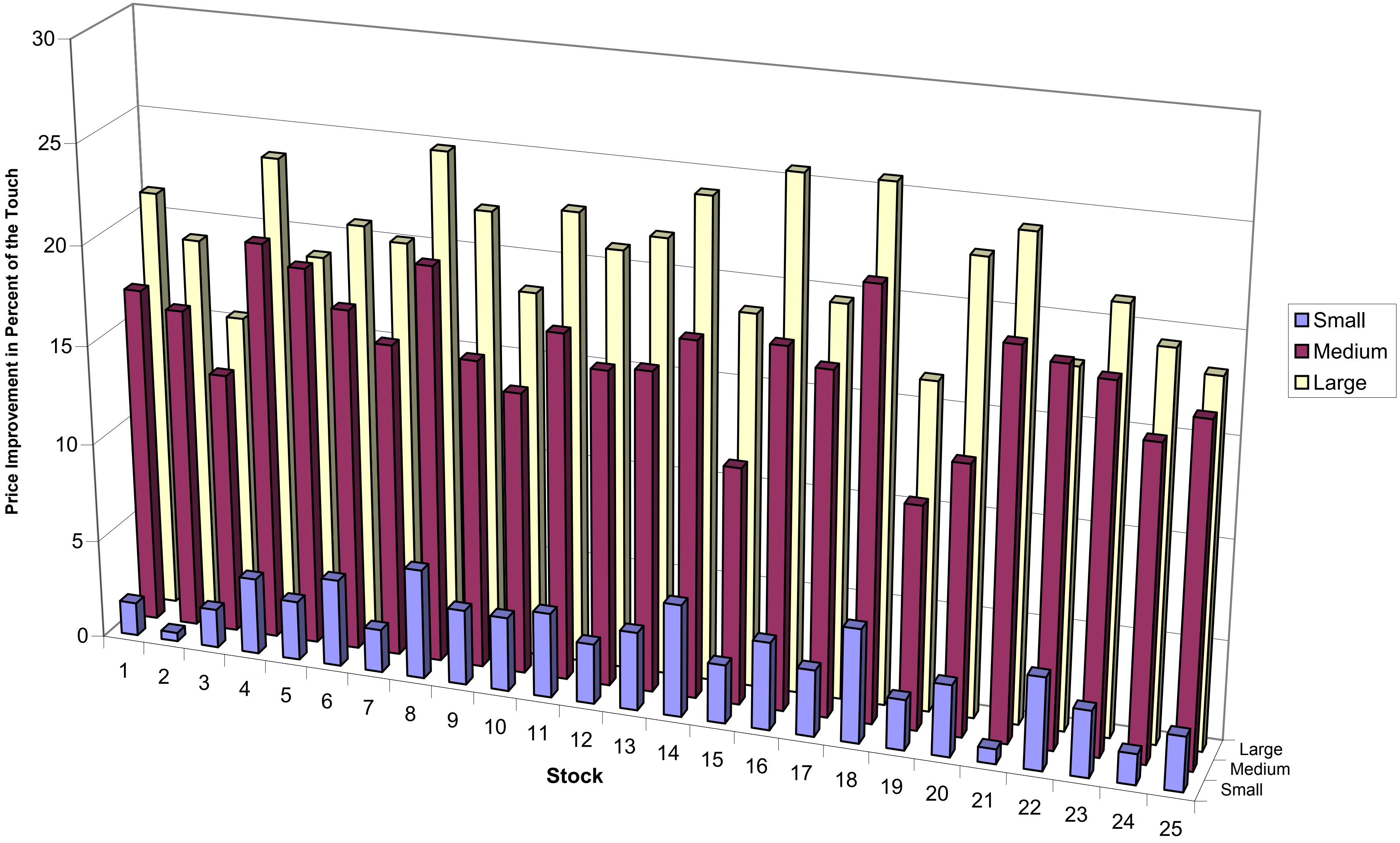
[12] 576 trades (0.11 %) are eliminated due to the screen.

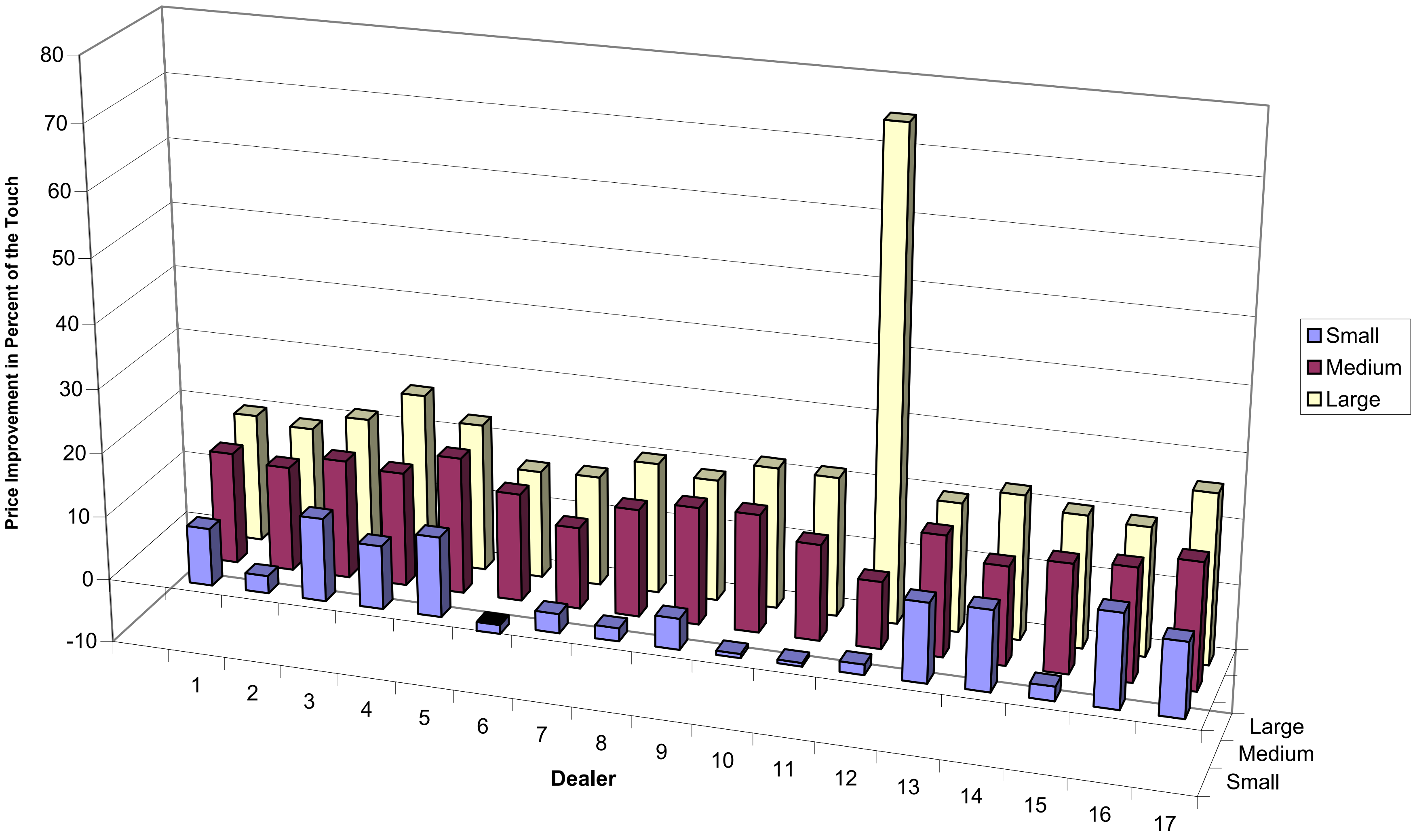
[13] Results are similar based on a 10-day rolling window.

[14] Robustness checks indicate that the results are not particularly sensitive to the specification. It matters little whether price improvement is measured in pence, rather than in percentage of the touch, as presented here. Further, the results are not qualitatively affected if the relationship variables are measured in logs. The results of the pence (and logged) regressions are available from the authors on request.

[15] A broker must choose how many dealer relationships to establish. Increasing the number of relationships raises the probability of "matching" with a dealer who values order flow due to his existing inventory, but reduces the value of any given relationship. If a broker's order flow is too slight, a broker may be best off establishing no relationships. While the number of relationships established may be monotone in a broker's total order flow, this implies that the order flow any individual dealer handles will not be monotone in a broker's total order flow (there is a reduction when the broker establishes more relationships). We don't control for the improved targeting of order flow to a dealer valuing the order more that is associated with establishing more relationships. This leads us to underestimate further the impact of relationships in the data.

[16] Results are available from the authors on request.


Price Improvement in Percent of the Touch
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Stock
Large
Medium
Small
Small
Medium
Large



Price Improvement in Percent of the Touch
80
70
60
50
40
30
20
10
0
-10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Dealer
Large
Medium
Small
Small
Medium
Large

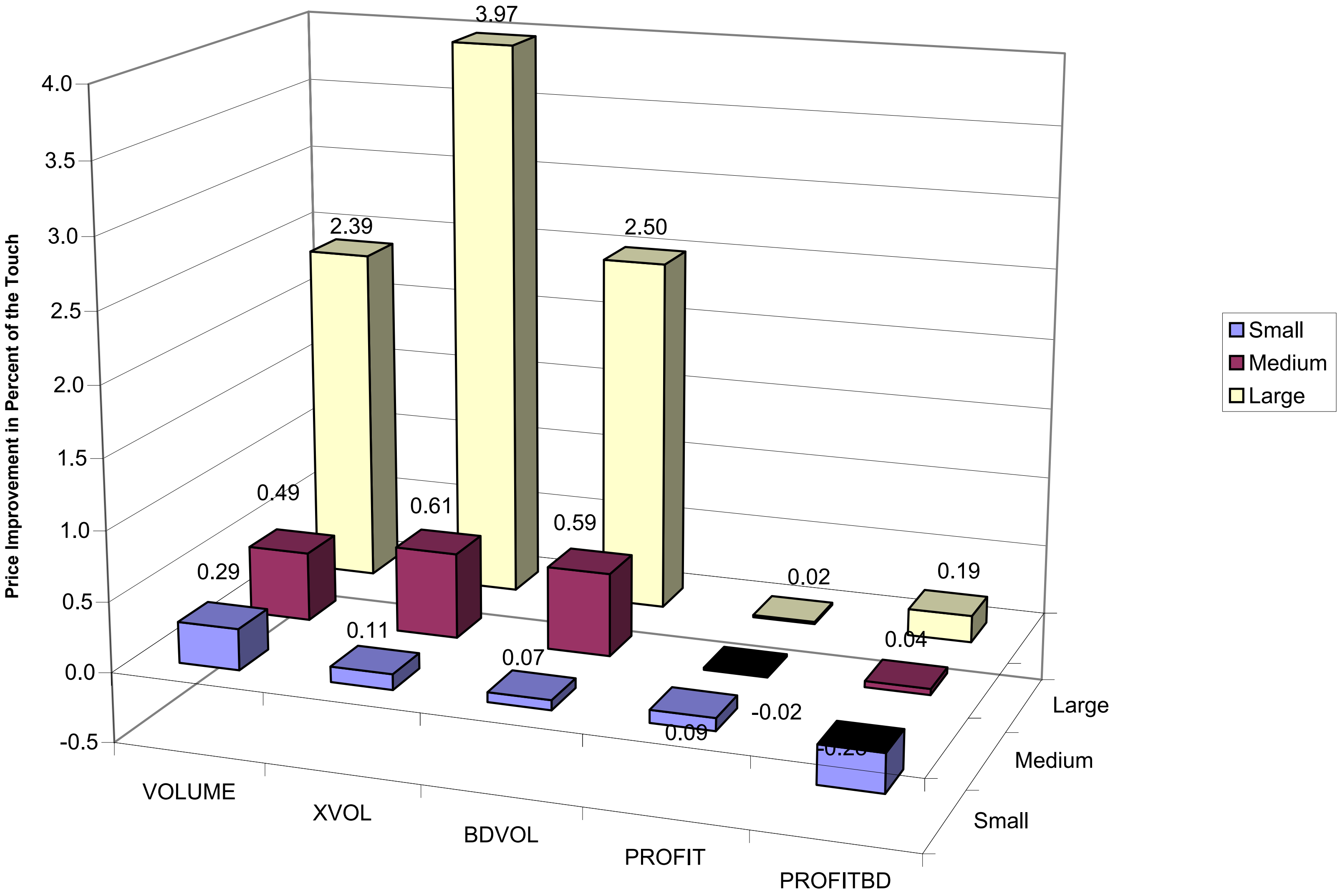

Price Improvement in Percent of the Touch
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
3.97
2.39
2.50
0.49
0.61
0.59
0.29
0.02
0.19
0.11
0.07
0.04
-0.02
0.09
-0.20
VOLUME
XVOL
BDVOL
PROFIT
PROFITBD
Large
Medium
Small
Small
Medium
Large

Table 1
Price Improvements and the Trade Size Distribution

				Percentiles of Price Improvements								
Shares/NMS	Frequency	Percent	Cumulative	In Pence			In Percent of Quote Midpoint			In Percent of Touch		
				25th	50th	75th	25th	50th	75th	25th	50th	75th
0.000 < size < 0.010	262,204	44.8	44.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.010 <= size < 0.025	134,943	23.0	67.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.025 <= size < 0.050	80,665	13.8	81.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.050 <= size < 0.100	47,516	8.1	89.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.100 <= size < 0.250	30,381	5.2	94.9	0.000	0.000	1.000	0.000	0.000	0.250	0.000	0.000	25.000
0.250 <= size < 1.000	14,539	2.5	97.3	0.000	0.500	1.000	0.000	0.178	0.368	0.000	16.667	30.000
size = 1.000	1,910	0.3	97.7	0.000	0.500	1.000	0.000	0.243	0.458	0.000	25.000	33.333
1.000 < size <= 2.000	5,776	1.0	98.7	0.000	0.500	1.000	0.000	0.207	0.449	0.000	20.000	33.333
2.000 < size <= 3.000	1,815	0.3	99.0	0.000	0.500	1.000	0.000	0.199	0.467	0.000	16.667	33.333
3.000 < size <= 6.000	4,441	0.8	99.7	0.000	0.500	1.000	0.000	0.199	0.495	0.000	20.000	42.857
6.000 < size	1,651	0.3	100.0	0.000	0.500	1.500	0.000	0.166	0.516	0.000	16.667	50.000

This table reports the distribution of sizes of agency trades between London brokers and market makers for a sample of 25 FTSE-100 stocks traded in London during 1991 (See Reiss and Werner (1998)). Trade sizes in shares are normalized by each stock's normal market size (NMS). One NMS is the minimum quote size and it corresponds to roughly 2.5 percent of average daily trading volume for the stock. The table also reports the quartiles of three different definitions of price improvements. Price Improvement in Pence is simply the difference between the best ask and the purchase for a customer buy order and the difference between the sale price and the best bid for a customer sell order. Price Improvement in Percent of the Quote Midpoint is the previous measure divided by the quote midpoint at the time of trade. Price Improvement in Percent of Touch instead divides Price Improvement in Pence by the touch which is defined as the best ask minus the best bid.

Table 2
Characteristics of Sample Stocks

Name	EPIC Code	Market Capitalization £ million	Average Price £.p	NMS 1,000 shares	Maximum Number of Dealers
Abbey National	ANL	3,564.0	2.72	50	14
BAA	BAA	2,042.4	4.07	50	15
BICC	BICC	1,230.1	4.46	25	13
Blue Circle Industries	BCI	1,497.6	2.70	50	16
Commerical Union	CUAC	2,209.6	5.09	25	13
Enterprise Oil	ETP	2,681.6	5.88	25	16
Forte	FTE	2,121.4	2.67	50	15
General Electric Co.	GEC	5,424.2	2.01	100	15
Guardian Royal Exchange	GARD	1,863.2	2.16	50	13
Kingfisher	KGF	2,052.2	4.52	25	14
Land Securities	LAND	2,708.5	5.37	25	11
Legal & General Group	LGEN	2,242.2	4.65	25	13
Lloyds Bank	LLOY	4,171.2	3.36	50	15
MEPC	MEPC	1,677.1	5.20	15	9
Midland Bank	MID	2,567.3	2.00	50	15
Pilkington	PILK	1,409.5	1.88	50	13
RMC Group	RMC	1,347.7	6.94	10	14
Royal Insurance Holdings	ROYL	2,156.2	4.45	25	13
Scottish & Newcastle	SCTN	1,485.2	3.74	25	15
Sears	SEAR	1,324.5	0.88	75	14
Smith & Nephew	SN.	1,286.7	1.29	50	16
Sun Alliance Group	SUN	3,002.0	3.78	25	13
Tarmac	TARM	1,825.9	2.51	50	15
TSB Group	TSB	2,240.1	1.49	75	14
Arjo Wiggins Appleton	AWA	1,793.4	2.15	50	11

Table 3
Distribution of Raw Relationship Variables

		N	Mean	Std.Dev.	Min	Q1	Median	Q3	Max
Between Broker and Same Market Maker									
VOLUME	Volume Traded (shares/NMS)	282,515	1.020	4.713	0.000	0.034	0.174	0.542	230.320
XVOL	Average Trade Size (shares/NMS)	282,515	0.552	2.417	0.000	0.030	0.119	0.300	133.125
BDVOL	Volume Traded Across Stocks (shares/NMS)	282,515	7.641	24.041	0.000	0.235	1.437	5.618	482.567
PROFIT	Profit Relative to Closing Mid-Quote (£1,000)	282,515	-0.116	11.050	-691.780	-0.392	-0.037	0.053	466.248
PROFITBD	Profit Across Stocks (£1,000)	282,515	-2.232	31.331	-1010.322	-2.403	-0.208	0.209	644.315

This table reports the distribution of variables that capture the relationship between a broker and a market maker for a sample of 25 FTSE-100 stocks traded in London February-December, 1991. Each relationship variable is computed using a rolling 20 day window. VOLUME is the stock specific amount the broker traded with a particular market maker expressed in shares divided by NMS. XVOL is the stock specific mean trade size between the broker and the specific market maker expressed in shares divided by NMS. BDVOL is the aggregate volume across stocks between broker and a particular market maker expressed in shares divided by NMS. PROFIT is defined as the cumulative daily value of the shares sold minus the value of those shares at the closing mid-quote (market maker sales), and minus the cost of share purchases plus the value of those shares at the closing mid-quote (market maker purchases). PROFITBD is similarily defined, except it is aggregated daily profit across all stocks for the broker-market maker pair.

Table 4
Regressions of Price Improvement in Percent of the Touch: Trades Less Than or Equal to 0.25 NMS

		Relationship Specifications				
	Benchmark	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5
		REL=VOLUME	REL=XVOL	REL=BDVOL	REL=PROFIT	REL=PROFITBD
INTERCEPT	-0.011	-0.094	-0.190	-0.109	-0.053	-0.207
	-0.02	-0.20	-0.41	-0.23	-0.12	-0.44
TOUCH	**2.929**	**2.938**	**2.934**	**3.003**	**2.950**	**3.019**
	28.73	**28.65**	**28.79**	**29.44**	**28.89**	**29.61**
TOUCH^2	**-0.265**	**-0.266**	**-0.266**	**-0.265**	**-0.266**	**-0.266**
	-19.68	**-19.77**	**-19.74**	**-19.71**	**-19.74**	**-19.75**
TOUCH*SVOL	**8.059**	**8.253**	**8.136**	**7.795**	**8.033**	**7.653**
	13.06	**13.42**	**13.16**	**12.65**	**13.01**	**12.34**
SVOL	**54.234**	**50.091**	**51.207**	**53.075**	**54.171**	**55.716**
	20.27	**18.89**	**19.19**	**19.79**	**20.24**	**20.58**
SVOL^2	**-142.240**	**-141.183**	**-143.501**	**-138.869**	**-141.995**	**-142.196**
	-12.97	**-12.94**	**-13.03**	**-12.67**	**-12.95**	**-12.86**
MID	**-0.245**	**-0.210**	**-0.219**	**-0.242**	**-0.246**	**-0.260**
	-3.34	**-2.86**	**-2.98**	**-3.29**	**-3.35**	**-3.55**
INV	**0.433**	**0.397**	**0.450**	**0.390**	**0.429**	**0.380**
	2.88	**2.63**	**2.99**	**2.59**	**2.85**	**2.52**
MORNING	**0.272**	**0.283**	**0.262**	**0.258**	**0.273**	**0.257**
	6.38	**6.64**	**6.16**	**6.05**	**6.40**	**6.02**
AFTERNOON	-0.001	-0.004	-0.005	-0.004	-0.001	-0.005
	-0.03	-0.11	-0.12	-0.09	-0.03	-0.12
SHAPE	0.066	0.119	0.077	0.063	0.070	0.048
	0.57	1.03	0.67	0.55	0.61	0.42
REL		**0.099**	**0.536**	0.001	**85.612**	**18.770**
		5.84	**7.99**	0.59	**2.37**	**3.36**
REL^2		**-0.001**	**-0.006**	**0.000**		
		-3.42	**-3.65**	**4.12**		
REL*SVOL		**1.040**	**0.867**	**0.109**	158.146	**-186.155**
		7.30	**2.39**	**4.84**	0.67	**-2.69**
REL*TOUCH		-0.005	-0.001	**-0.004**	**-26.533**	**-11.785**
		-0.91	-0.03	**-5.99**	**-2.48**	**-7.38**
No. Obs.	532,333	532,333	532,333	532,333	532,333	532,333
DF	50	54	54	54	53	53
Adj. R2	0.0941	0.0954	0.0961	0.0943	0.0941	0.0945
F(Relationship Variables)		190.47	301.45	40.11	6.48	86.94

This table reports GMM regression results for price improvements as percent of the touch for a sample of a sample of 25 FTSE-100 stocks traded in London during February-December, 1991. The benchmark regression includes the first and second order trade size in NMS units (SVOL) and the inside spread (TOUCH), plus an interaction term. It also includes the following control variables: MID the mid-quote at the time ofthe trade; INV the signed inventory of the dealer taking the trade; IMPACT the percent change in the ask (bid) between the time of the buy (sell) and the last trade of the day; MORNING a dummy that is equal to one if the trade occurs between 8:30am and 11:30am; AFTERNOON a dummy that is equal to one if the trade occurs between 1:30pm and 4:30pm; a dummy variable that takes on the value of one if the broker aggregated several orders into one trade (SHAPE); 24 individual firm dummies (not reported), and 15 individual market maker dummies (not reported) as independent variables. The intercept captures the effect of dealer 1 in Abbey National (ANL) during the middle of the day (11:30am-1:30pm). The relationship variables include: VOLUME, the aggregate number of shares traded between the broker and the dealer in the stock; XVOL, the average trade size between broker and dealer in the stock; BDVOL, the aggregate number of shares traded between the broker firm and the market making firm across stocks; PROFIT, the cumulative daily profit of past trades between the broker and market maker in the stock (e.g., value of position at the closing mid-quote minus the purchase price for a market maker buy); and PROFITBD, the cumulative daily profit of past trades between the broker firm and the market making firm across stocks. F(Relationship Variables) tests the joint significance of the relationship variables in each regression.

Table 5
Regressions of Price Improvement in Percent of the Touch: Trades between 0.25 and 1.00 NMS

		Relationship Specifications				
	Benchmark	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5
		REL=VOLUME	REL=XVOL	REL=BDVOL	REL=PROFIT	REL=PROFITBD
INTERCEPT	**-12.567**	**-13.384**	**-13.140**	**-12.753**	**-12.501**	**-12.660**
	-3.76	**-4.06**	**-3.98**	**-3.84**	**-3.74**	**-3.79**
TOUCH	**10.122**	**10.122**	**10.179**	**10.136**	**10.098**	**10.126**
	11.77	**11.79**	**11.80**	**11.75**	**11.74**	**11.77**
TOUCH^2	**-0.855**	**-0.857**	**-0.859**	**-0.857**	**-0.854**	**-0.853**
	-9.34	**-9.39**	**-9.35**	**-9.38**	**-9.33**	**-9.30**
TOUCH*SVOL	-0.293	-0.341	-0.375	-0.422	-0.312	-0.281
	-0.35	-0.40	-0.44	-0.50	-0.37	-0.33
SVOL	**28.687**	**27.987**	**28.224**	**28.570**	**28.781**	**28.636**
	4.12	**4.03**	**4.07**	**4.11**	**4.13**	**4.11**
SVOL^2	**-17.117**	**-17.211**	**-17.605**	**-17.256**	**-16.958**	**-17.155**
	-2.83	**-2.88**	**-2.94**	**-2.86**	**-2.80**	**-2.84**
MID	0.224	0.258	0.290	0.206	0.199	0.235
	0.41	0.47	0.53	0.38	0.36	0.43
INV	**3.988**	**3.888**	**3.957**	**4.024**	**4.049**	**3.952**
	3.45	**3.39**	**3.43**	**3.47**	**3.51**	**3.42**
MORNING	0.546	0.538	0.521	0.541	0.540	0.555
	1.10	1.09	1.06	1.10	1.09	1.12
AFTERNOON	**1.202**	**1.188**	**1.161**	**1.142**	**1.184**	**1.206**
	2.22	**2.20**	**2.15**	**2.12**	**2.19**	**2.23**
SHAPE	**-3.090**	**-3.040**	**-2.962**	**-2.945**	**-3.072**	**-3.085**
	-6.66	**-6.57**	**-6.41**	**-6.35**	**-6.62**	**-6.64**
REL		**0.239**	0.310	**0.059**	51.461	48.886
		2.64	1.39	**3.13**	0.40	0.86
REL^2		**-0.002**	-0.004	**0.000**		
		-4.00	-0.79	**-6.00**		
REL*SVOL		0.160	0.373	0.023	**-381.856**	18.328
		1.00	1.22	0.83	**-2.28**	0.21
REL*TOUCH		-0.001	-0.011	0.002	42.386	-11.630
		-0.07	-0.31	0.65	1.49	-1.09
No. Obs.	13,930	13,930	13,930	13,930	13,930	13,930
DF	50	54	54	54	53	53
Adj. R2	0.0505	0.0558	0.056	0.0545	0.0511	0.0505
F(Relationship Variables)		20.30	21.13	15.46	3.64	0.90

This table reports GMM regression results for price improvements in percent of the touch for a sample of a sample of 25 FTSE-100 stocks traded in London during February-December, 1991. The benchmark regression includes the first and second order trade size in NMS units (SVOL) and the inside spread (TOUCH), plus an interaction term. It also includes the following control variables: MID the mid-quote at the time ofthe trade; INV the signed inventory of the dealer taking the trade; MORNING a dummy that is equal to one if the trade occurs between 8:30am and 11:30am; AFTERNOON a dummy that is equal to one if the trade occurs between 1:30pm and 4:30pm; a dummy variable that takes on the value of one if the broker aggregated several orders into one trade (SHAPE); 24 individual firm dummies (not reported), and 15 individual market maker dummies (not reported) as independent variables. The intercept captures the effect of dealer 1 in Abbey National (ANL) during the middle of the day (11:30am-1:30pm). The relationship variables include: VOLUME, the aggregate number of shares traded between the broker and the dealer in the stock; XVOL, the average trade size between broker and dealer in the stock; BDVOL, the aggregate number of shares traded between the broker firm and the market making firm across stocks; PROFIT, the cumulative daily profit of past trades between the broker and market maker in the stock (e.g., value of position at the closing mid-quote minus the purchase price for a market maker buy); and PROFITBD, the cumulative daily profit of past trades between the broker firm and the market making firm across stocks. F(Relationship Variables) tests the joint significance of the relationship variables in each regression.

Table 6
Regressions of Price Improvement in Percent of the Touch: Trades Exceeding 1.00 NMS

		Relationship Specifications				
	Benchmark	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5
		REL=VOLUME	REL=XVOL	REL=BDVOL	REL=PROFIT	REL=PROFITBD
INTERCEPT	0.023	-1.174	-1.215	-1.365	0.072	-0.228
	0.01	-0.28	-0.29	-0.33	0.02	-0.05
TOUCH	**13.040**	**13.041**	**13.046**	**13.095**	**13.042**	**13.119**
	10.04	**10.01**	**10.07**	**10.15**	**10.04**	**10.10**
TOUCH^2	**-1.062**	**-1.048**	**-1.034**	**-1.059**	**-1.065**	**-1.064**
	-7.71	**-7.65**	**-7.59**	**-7.68**	**-7.72**	**-7.74**
TOUCH*SVOL	**0.208**	**0.192**	**0.201**	**0.196**	**0.215**	**0.211**
	2.48	**2.24**	**2.32**	**2.31**	**2.54**	**2.48**
SVOL	**-0.964**	**-1.240**	**-1.348**	**-1.159**	**-1.019**	**-0.996**
	-2.76	**-3.44**	**-3.72**	**-3.28**	**-2.88**	**-2.82**
SVOL^2	-0.001	0.002	0.002	0.000	-0.001	-0.002
	-0.22	0.34	0.34	0.04	-0.18	-0.30
MID	**-2.487**	**-2.196**	**-2.259**	**-2.277**	**-2.467**	**-2.472**
	-2.92	**-2.57**	**-2.65**	**-2.68**	**-2.90**	**-2.91**
INV	**9.209**	**8.678**	**8.961**	**8.884**	**9.013**	**9.082**
	5.58	**5.21**	**5.36**	**5.36**	**5.47**	**5.49**
MORNING	1.093	1.012	0.963	1.118	1.104	1.146
	1.30	1.20	1.15	1.34	1.31	1.37
AFTERNOON	**2.098**	**2.260**	**2.249**	**2.354**	**2.125**	**2.146**
	2.22	**2.40**	**2.41**	**2.52**	**2.25**	**2.29**
SHAPE	**1.367**	1.221	1.195	1.267	1.355	1.355
	1.97	1.77	1.73	1.83	1.95	1.95
REL		**0.348**	**0.888**	**0.110**	-47.296	**106.610**
		5.67	**7.46**	**4.76**	-0.60	**2.25**
REL^2		**-0.002**	**-0.010**	**0.000**		
		-6.25	**-7.66**	**-6.23**		
REL*SVOL		**0.012**	**0.024**	0.003	12.239	3.775
		2.60	**2.44**	1.54	1.75	0.77
REL*TOUCH		-0.012	**-0.056**	-0.003	11.686	-19.738
		-1	**-2.45**	-0.69	0.6	-1.74
No. Obs.	14,733	14,733	14,733	14,733	14,733	14,733
DF	50	54	54	54	53	53
Adj. R2	0.0359	0.0444	0.0481	0.0427	0.0362	0.037
F(Relationship Variables)		33.92	48.33	27.02	2.74	5.615

This table reports GMM regression results for price improvements in percent of the touch for a sample of a sample of 25 FTSE-100 stocks traded in London during February-December, 1991. The benchmark regression includes the first and second order trade size in NMS units (SVOL) and the inside spread (TOUCH), plus an interaction term. It also includes the following control variables: MID the mid-quote at the time ofthe trade; INV the signed inventory of the dealer taking the trade; MORNING a dummy that is equal to one if the trade occurs between 8:30am and 11:30am; AFTERNOON a dummy that is equal to one if the trade occurs between 1:30pm and 4:30pm; a dummy variable that takes on the value of one if the broker aggregated several orders into one trade (SHAPE); 24 individual firm dummies (not reported), and 15 individual market maker dummies (not reported) as independent variables. The intercept captures the effect of dealer 1 in Abbey National (ANL) during the middle of the day (11:30am-1:30pm). The relationship variables include: VOLUME, the aggregate number of shares traded between the broker and the dealer in the stock; XVOL, the average trade size between broker and dealer in the stock; BDVOL, the aggregate number of shares traded between the broker firm and the market making firm across stocks; PROFIT, the cumulative daily profit of past trades between the broker and market maker in the stock (e.g., value of position at the closing mid-quote minus the purchase price for a market maker buy); and PROFITBD, the cumulative daily profit of past trades between the broker firm and the market making firm across stocks. F(Relationship Variables) tests the joint significance of the relationship variables in each regression.

Table 7
Price Improvement and Relationship Variables: Robustness Checks

	VOLUME	VOLUME^2	VOLUME*SVOL	VOLUME*TOUCH	Adj. R^2	OBS.
Daily Return Quartiles						
Q4 (High)	**0.160**	**-0.001**	0.000	**0.030**	0.097	139,167
	3.99	**-3.45**	-0.01	**2.71**		
Q3	**0.263**	**-0.001**	-0.016	0.004	0.123	135,902
	7.07	**-2.02**	-3.15	0.32		
Q2	**0.241**	**-0.002**	-0.001	0.017	0.111	149,272
	5.29	**-4.87**	-0.12	1.30		
Q1 (Low)	**0.249**	**-0.002**	-0.005	0.008	0.100	136,655
	6.54	**-4.06**	-0.69	0.79		
Daily Volatility Quartiles						
Q4 (High)	**0.194**	**-0.001**	-0.003	0.015	0.094	141,116
	4.83	**-3.39**	-0.36	1.36		
Q3	**0.169**	**-0.001**	-0.005	**0.026**	0.099	135,973
	4.21	**-3.96**	-0.79	**2.19**		
Q2	**0.313**	**-0.002**	-0.003	0.004	0.121	142,397
	8.15	**-6.47**	-0.39	0.35		
Q1 (Low)	**0.238**	-0.001	-0.009	0.016	0.124	141,510
	6.44	-1.15	-0.95	1.21		
Daily Volume Quartiles						
Q4 (High)	**0.179**	**-0.001**	0.004	0.014	0.086	165,073
	5.64	**-4.83**	0.66	1.50		
Q3	**0.255**	-0.001	**-0.013**	0.010	0.107	146,907
	6.17	-1.63	**-2.16**	0.85		
Q2	**0.258**	**-0.002**	-0.013	0.014	0.127	133,156
	5.70	**-4.16**	-1.91	1.12		
Q1 (Low)	**0.249**	**-0.002**	-0.006	0.019	0.132	115,860
	5.43	**-3.15**	-0.61	1.41		
Broker Volume Quartiles						
Q4 (High)	**0.247**	**-0.002**	**-0.014**	**0.023**	0.132	235,821
	10.27	**-6.69**	**-3.79**	**3.48**		
Q3	**0.299**	**0.040**	**-0.116**	0.025	0.101	140,714
	2.30	**3.97**	**-2.52**	1.54		
Q2	**-1.012**	**0.169**	**-0.509**	**0.480**	0.110	103,876
	-3.35	**3.25**	**-2.85**	**5.22**		
Q1 (Low)	**-3.912**	**3.383**	-1.290	0.406	0.095	80,585
	-3.64	**5.21**	-1.76	1.41		

This table reports GMM regression results for price improvements in percent of the touch for a sample of a sample of 25 FTSE-100 stocks traded in London during February-December, 1991. Daily stock returns, volatility, and trading volume are sorted into quartiles in Panels A-C. In Panel D, the observations are sorted into quartiles based on broker volume in NMS units during the past 20 days. The benchmark regression includes the first and second order trade size in NMS units (SVOL) and the inside spread (TOUCH), plus an interaction term. It also includes the following control variables: MID the mid-quote at the time ofthe trade; INV the signed inventory of the dealer taking the trade; MORNING a dummy that is equal to one if the trade occurs between 8:30am and 11:30am; AFTERNOON a dummy that is equal to one if the trade occurs between 1:30pm and 4:30pm; a dummy variable that takes on the value of one if the broker aggregated several orders into one trade (SHAPE); 24 individual firm dummies (not reported), and 15 individual market maker dummies (not reported) as independent variables. The intercept captures the effect of dealer 1 in Abbey National (ANL) during the middle of the day (11:30am-1:30pm). The relationship variable is VOLUME, the aggregate number of shares traded between the broker and the dealer in the stock.