

The Relationship between Market-making Revenue, Payment for Order Flow, and Trading Costs for Market Orders

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First draft: May 1998
Current draft: February 2000

We thank Knight-Trimark Securities Group, Inc. for providing data, Kenneth Pasternack and Walter Raquet for their time, and two anonymous referees, Thomas Arnold, David Smith, Jeffrey Smith, Matthew Spiegel, Andrew Waisburd, and participants at Georgetown University's finance workshop and the 1999 University of Utah Winter Finance Conference for their comments on earlier drafts of the paper. Battalio was Visiting Economist and Selway was Associate Chief Economist at the National Association of Security Dealers, Inc. when work began on this paper. Opinions expressed in this paper are those of the authors and not Knight-Trimark Securities, the National Association of Security Dealers, or Goldman, Sachs & Co.

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Abstract

We study the division of market-making revenue among dealer, broker, and trader. When Knight Securities, a major Nasdaq dealer, interacts with market orders in actively-traded stocks during the fourth quarter of 1996, we estimate that market-making revenue is \$0.057 per share. Knight pays brokers at least \$0.025 per share (44% of revenue) for orders. To examine whether brokers appear to share these payments with traders, we compare net trading costs (trade price net of commissions) for traders using brokers routing Knight orders to estimated net trading costs for traders using the only discount broker we can determine did not directly receive market-making revenue. We find that many orders routed based on order-flow inducements enjoy lower net trading costs, which suggests that payment for order flow does not unambiguously harm traders and challenges the conclusions of extant studies using only trade prices to assess market quality.

1. Introduction.

Preferencing, internalization, and payment for order flow have reshaped domestic equity markets.¹ Retail brokers regularly share in the market-making revenue associated with executing their customers' orders and order-routing arrangements, not quote competition, determine where many orders execute.² We examine the division of market-order market-making revenue among dealer, broker, and trader using data from a major purchaser of Nasdaq-security order flow. Specifically, we: 1.) use order audit-trail data and known payment-for-order-flow agreements to estimate the portion of the dealer's market-making revenue paid to the broker and 2.) investigate the association between order-flow payments and commissions.

¹ Preferencing involves automatically routing orders to a particular market maker, in return for either cash payments (payment for order flow) or other consideration. Internalized orders are those sent from the brokerage unit of a vertically integrated broker-dealer to the market-making unit.

² Securities and Exchange Commission (1997) finds that over 90% of Cincinnati Stock Exchange volume was preferenced in the first quarter of 1995 and that over 80% of the stocks traded by the Boston, Cincinnati, and Pacific Stock Exchanges in February 1997 were traded by specialists affiliated with retail brokerage firms (Tables II-2 and II-4). Battalio (1997), Battalio, Greene and Jennings (1997) and Battalio, Greene and Jennings (1998) show the importance of payment for order flow, preferencing, and internalization, respectively, in determining where orders in NYSE-listed securities execute. Huang and Stoll (1996) note that virtually all Nasdaq-security orders are preferenced.

Market-making revenue comes primarily from the bid-ask spread (see Sofianos [1995]) and frequently is estimated by measuring post-trade changes in quoted prices (see, e.g., Huang and Stoll [1996], Easley, Keifer, and O'Hara [1996], and Bessembinder and Kaufman [1997]). We use this approach to calculate market-making revenue from market orders and compare that figure to known order-flow payments to assess how much revenue dealers share with brokers.

Critics claim that order-flow payments compromise brokers' duty to provide customers the best execution (e.g., Macey and O'Hara [1997]). Many academic studies (e.g., Blume and Goldstein [1992], Lee [1993], Easley, Keifer, and O'Hara [1996], Bessembinder and Kaufman [1997], Huang and Stoll [1997], and Battalio, Greene, and Jennings [1998]), seem to justify these claims by finding that the trading venues most closely associated with order-flow inducements typically produce the worst execution-quality statistics. Defenders of order-flow payments, however, argue that best execution is an order/investor-specific concept that includes execution speed, commissions, opportunity costs, and price impact, in addition to trade price.³ Of interest here is the claim that brokers use these payments to reduce brokerage commissions, suggesting that commissions and execution quality may be inversely related.⁴ If this is true, then order-flow payment shifts the focus of order-flow competition from dealers competing with trade prices to brokers competing with commissions. To minimize trading costs, traders may want brokers

³ Lee (1993) and Harris (1995) discuss this broader concept of best execution and Keim and Madhavan (1998) notes that studies of institutional trading costs include non-price measures.

⁴ Anecdotal evidence supports this claim. Regarding commissionless trading, *New York Daily News* (1997) notes "...because brokerage revenues come from more than just commissions, those [zero-commission] trades still may be profitable." In addition, when we collected our data, PT Discount Brokerage offered two commission choices for market orders in NYSE stocks: \$35 if sent to a third-market dealer or \$35 plus \$0.0325/share if sent to the NYSE. Finally, by August 1999, the sample broker not taking order-flow payments provided customers routing options for over-the-counter securities. Orders are preferenced to particular market maker, receive no price improvement, and pay a low commission. Alternatively, orders are exposed to a process to obtain price improvement for a higher commission.

maximizing order-flow payments rather than finding the best prices. To address this, we combine nominal brokerage commissions with trade prices to produce a more complete trading-cost measure than extant retail-trade execution quality studies employ. We use this measure to compare the trading costs for customers of brokers selling order flow to estimated trading costs associated with the only discount brokerage firm we can find not accepting such payments.

With estimated market-making revenue of \$0.057 per share and known per share order-flow payments of \$0.025, we find that Knight pays brokers 44% of its revenue in the sample period. More importantly from a policy perspective, we find little evidence that traders using brokers taking order-flow payments are uniformly worse-off than traders using a broker that does not accept such payments. Depending on order size and quoted spread, three to eight of the ten most active Knight-affiliated brokers provide lower net trading costs than the broker refusing payment. This finding suggests that studies of execution quality across market centers focusing exclusively on trade prices may be flawed. Because we find only one broker not taking order-flow payments, we cannot view our experiment as a strict test of the hypothesis that brokers selling order flow offer lower trading costs than brokers who do not. Instead, we interpret this result as implying that at least some brokers share the market-making revenue obtained via order-flow payments with investors, which suggests that selling order flow does not necessarily harm investors and that studies of execution quality must consider more than price.

2. Data Description.

Estimating market-making revenue requires quote, order, and trade data. We also need brokerage commissions. We obtain order and trade data from Knight, quote data from the National Association of Security Dealers (NASD), and commissions from public sources.

2.1 Knight Securities, L.P.

Knight was founded on July 24, 1995, as a consortium of 25 corresponding brokers. The consortium members in September 1996 (the beginning of our sample period) appear in Table 1.⁵

[Insert Table 1.]

During our sample period, consortium members receive \$0.025/share plus a portion of Knight's net income for orders. Non-members routing Knight orders receive only the fixed payment.

2.2 Order, Quote, and Trade Data.

We obtain audit-trail data for each order Knight receives in the fourth quarter of 1996.⁶ Each record contains the security's identity, order type (e.g., market or limit), order quantity and (if applicable) price, a buy/sell indicator, execution price and quantity, the order's receipt time to the second, to-the-minute execution time, and the identity of the broker routing Knight the order. Quotation data covering the same period are obtained from the NASD.

During the sample period, Knight receives 1,013,317 orders (289,809 for stocks in the Nasdaq-100 Index). Our analysis requires us to examine comparable orders in stocks that are quoted on a comparable basis. Market orders demand liquidity and limit orders supply liquidity, suggesting that the market-making revenue associated with executing market orders may differ from that associated with limits. We examine market orders. In addition, we need order-time quotes and quotes 330 seconds after execution. To be included in our study, an order must: 1.)

⁵ See *Traders* (1996). Firms sending orders directly to Knight are called corresponding brokers. A correspondent may receive order flow from several retail brokers. For example, Ameritrade is the corresponding broker for Accutrade, Aufhauser, Ceres, and Ebroker during our sample period.

⁶ For technical reasons, December 11 data are unavailable. Throughout the paper, we use only orders sent by a corresponding broker directly to Knight. We exclude orders Knight receives via Nasdaq's Small Order Execution System and SelectNet and Knight's proprietary trades.

be an automatically executed, regular market order, 2.) be in a stock priced at \$10.00 or more per share, 3.) arrive between 9:30 a.m. and 4:00 p.m., and 4.) have valid quotes at order arrival and 330 seconds after execution. The first filter eliminates 625,419 (167,944 Nasdaq-100) limit orders, 13,744 (5,990 Nasdaq-100) stop orders,⁷ 1,649 (471 Nasdaq-100) orders that are canceled before executing or undone after execution, and 420 (120 Nasdaq-100) orders exceeding 5,000 shares. Orders exceeding 5,000 shares execute manually and are excluded to avoid execution-quality differences between manually- and automatically-executed orders. Because stocks priced below \$10.00 per share can be quoted in \$0.03125-increments and stocks priced at \$10 or greater can be quoted only in \$0.125-increments during this period, comparing dollar trading revenues/ costs between these groups may be misleading. Therefore, we ignore 138,830 (15,200 Nasdaq-100) orders in stocks priced below \$10.00 per share. We also eliminate 29,116 (6,478 Nasdaq-100) orders submitted outside of business hours and 9,100 (2,664 Nasdaq-100) orders for which we cannot find valid benchmark quotes. Finally, we find 1,649 (471 Nasdaq-100) orders with apparent data errors. Over 19% of all orders (193,390 orders) and 31% of the Nasdaq-100 orders (90,471) survive these screens. Because there are differences in liquidity across Nasdaq-listed securities and because market-making revenue is related to the value of providing that liquidity, we focus our attention on the Nasdaq-100 issues in the remainder of the paper.

2.3 Brokerage Commission Data.

We combine published commissions from brokers listed in Table 1 with Knight's data to compute net trading costs for brokers selling order flow. Although many full-service brokers do

⁷ Stop orders are market orders that do not become effective until the stock's price reaches a specified level.

not sell order flow, it is inappropriate to compare full-service brokers' net trading costs with that of the discounters routing to Knight. To find low-commission brokers not directly receiving dealer revenue, we investigate brokers from surveys in *Smart Money*, *AII Journal*, *Barron's* weekly magazine, or Online Investment Services (see www.sonic.net/donaldj/brokers.html). These surveys include on-line, deep discount, and discount brokers. Table 2 lists the brokers for which we could definitively determine that the broker did or did not directly share in the market-making revenue associated with executing customers' orders.

[Insert Table 2.]

Of 40 brokers identified, only Trade Fast receives no dealer revenue via order-flow payment or internalization. The paucity of discount brokers not directly receiving market-making revenue suggests an intriguing correlation between order-flow inducements and low commissions.

We obtain fourth quarter 1996 commissions for the ten brokers routing Knight the most market orders in Nasdaq-100 issues and for Trade Fast (our benchmark broker) from websites and through written and verbal requests. When possible, we validate these data with commission data from the November 1996 Online Investment Services brokerage survey. Table 3 lists these brokers' commissions for orders of 50, 250, 750, 1000, 1750, and 3750 shares.

[Insert Table 3.]

Panel A lists the cost of on-line market orders, Panel B the cost of non-intermediated telephone orders, and Panel C the cost of intermediated orders.⁸ Aside from Aufhauser's special rate, 250-share commissions range from \$9.00 to \$33.00 for on-line orders, from \$18.00 to \$35.00 for non-

⁸ In an intermediated order, the investor speaks directly to a broker. Non-intermediated orders are transmitted (typically through the use of touch-tone phones) directly to traders.

intermediated telephone orders, and from \$18.00 to \$50.00 for intermediated orders. Per share commission differences decrease in order size. For example, the per share difference between the most and the least expensive on-line sample brokers falls from \$0.40 for 50-share orders to \$0.0276 for 3750-share orders. Trade Fast is typically the third most expensive on-line broker.

Trade Fast's business model differs from most discount brokers. Instead of advertising low commissions, it touts savings from better execution prices. For example, obtaining a \$0.125 better price on a 1000-share trade results in saving \$125, which swamps commission differences in Table 3. Compared to low commissions, this message is arguably more sophisticated and almost certainly more difficult to communicate. Trade Fast's appeal seems strongest among traders submitting large orders in liquid stocks with spreads wide enough to allow opportunities for price improvement. If Trade Fast captures even a fraction of one percent of the order flow with this approach, then they can generate a substantial amount of revenue. Trade Fast uses electronic market linkages (e.g., SelectNet) to send orders to where past experience suggests that the opportunities for price improvement are greatest.

3. Market-making Revenue, Payment for Order Flow and Net Trading Costs

We estimate the portion of dealer revenue shared with brokers in a payment-for-order-flow arrangement and ask whether brokers appear to share the payments with traders. To address the first issue, we proxy the dealer revenue Knight's market orders generate with the realized liquidity premium and compare that to the amount Knight pays for orders. With respect to the second issue, we estimate trading costs for customers of Knight-affiliated brokers and compare that to the trading cost for Trade Fast's customers. Trading costs include the liquidity premium and commissions. Finding that the Knight-affiliated brokers offer lower trading costs than Trade

Fast suggests that payment for order flow is not necessarily harmful to investors.

3.1 Defining the Liquidity Premium and Realized Liquidity Premium

As defined by Lee (1993), the liquidity premium (LP) frequently is used to measure the cost of timely market-order executions. The LP is the trade price minus the order-time quoted spread mid-point multiplied by +1 (-1) for buy (sell) orders. If the mid-point proxies for security value, then the LP measures how much more (less) than fair value investors pay (receive) to buy (sell). Although the LP assesses what customers pay for immediacy, Knight's revenue depends on the price at which it reverses the position acquired when executing customers' orders. When Knight executes a customer sell (buy) order, Knight increases (reduces) its inventory from what it held before the trade. The change in value of this marginal inventory position represents dealer revenue. We use the realized liquidity premium (RLP) to estimate this revenue. A buy order's RLP is the trade price minus the spread midpoint 330 seconds after the minute in which the order executes. For sell orders, the RLP is the difference between the spread midpoint 330 seconds after the minute in which the order executes and the trade price. In measuring dealer revenue, we assume that Knight unwinds trades or values marginal inventory positions still held at the stock's value (as proxied by the spread mid-point) five minutes after execution.⁹

Consider an example. Suppose that a security's order-time quotes are \$20.00 bid and \$20.25 offered, so the mid-point is \$20.125. If customers buy (sell) at the offer (bid) price, then the LP is \$0.125 (\$20.25 - \$20.125 for buy orders and \$20.125 - \$20.00 for sells). Traders pay

⁹ Although order receipt times are documented to the second, only to-the-minute execution times are recorded. On average, the RLP compares trade price to quotes five minutes later. The holding period is selected to be consistent with the short holding period for most dealers' inventory position and with extant work. Qualitatively similar results obtain when intervals from 2 to 15 minutes are used and when the spread midpoint is replaced by the volume weighted average price of trades occurring after the trade of interest. Intervals less than 2 minutes suggest larger trading revenue. Huang and Stoll (1996) also find that the RLP is relatively insensitive to the time period used to compute it.

\$0.125 to get the trade done quickly. If customers trade at the mid-point (receive price improvement), then the LP is zero; the customer pays nothing for immediacy. The RLP depends on the quotes 330 seconds later. Suppose orders execute at the relevant quoted price (sells for \$20.00 and buys for \$20.25). If the spread is constant for five minutes, then the RLP equals the LP. Knight charges traders \$0.125 for immediacy and realizes that amount either by unwinding the position or by valuing the retained position at the mid-point in five minutes. Of course, quotes may change after Knight executes an order. Consider a customer sell order. If the quotes fall to \$19.875 and \$20.125, then the quote mid-point is \$20.00 and the RLP and revenue are zero (Knight paid \$20.00 to acquire shares worth \$20.00).

3.2 Dividing Market-making Revenue between the Dealer and Broker Functions

We use RLP to measure Knight's revenue and compare that to the known order-flow payment to estimate how market-making revenue is shared between dealer and broker. Given the relationship between RLP and bid-ask spread, we report RLP conditional on spread in Table 4. Because only 6,492 orders arrive when the spread exceeds \$0.25, we have no confidence in these estimated RLP and report RLP for only \$0.125- and \$0.25-spread markets.

[Insert Table 4.]

Consistently with the idea that informative trades are mid-sized (Barclay and Warner [1993]), RLP fall through order sizes of 2499 shares and increase for larger orders. RLP generally are less than the quoted half-spread. Despite large sample sizes, many individual brokers' RLP are not statistically different from zero in \$0.125-spread markets for 1000 to 2499-share orders, suggesting that Knight just breaks-even trading them. Recalling that Knight pays to obtain these orders only lessens their attractiveness to Knight. Overall, Knight earns an average revenue of

\$0.057 per share (the share-weighted RLP) and gives 44% (\$0.025/share) to the broker. After subtracting the \$0.025 payment for order flow, Knight's net revenue for market orders with which it interacts is \$0.032 per share.¹⁰

It is important to recognize that this revenue estimate is valid only for market orders for which Knight takes the other side. Customer limit orders at the same price as Knight's trading interest must receive priority. This implies that customers interact with market orders, denying Knight market-making revenue on market orders it pays to obtain. There are 35,021 limit orders matching or bettering quoted prices in our sample, suggesting that Knight's customers frequently compete with Knight to provide market-making services and earn the associated revenue.

3.4 Net Trading Costs

We define an investor's net trading cost (NTC) as the liquidity premium plus the per share nominal brokerage commission. Adding the commission to the liquidity premium gives the investor's net cost (relative to the security's value) of trading the security. Comparing brokers with this measure assumes that factors such as execution speed, fill rates, liquidity enhancement, margin requirements, the negotiability of commissions, and check-writing services are either roughly comparable across brokers or dominated by liquidity cost and commissions.¹¹

Table 5 reports the liquidity premium for orders arriving when quoted spreads are \$0.125

¹⁰ Our estimated income is the same order of magnitude obtained from Knight's S-1 filing. Using our estimated net revenue (\$0.032/share) and Knight's estimate of costs, we obtain a net income of \$0.008/share. Their S-1 indicates net income of \$0.0033 per share. Because we consider only market orders with which Knight interacts and ignore the profit-sharing portion of order-flow payments, we expect to obtain a higher estimate than that disclosed in the S-1.

¹¹ See "The Best and Worst Discount Brokers" in the July 1997 issue of *Smart Money* magazine for a detailed description of the direct and indirect costs associated with trading through brokers. Anecdotal evidence suggests our omission of these factors is not egregious. For example, Waterhouse Securities and Lombard Online Brokerage, two of the lowest net cost brokers in our sample, are rated the number one discount broker and the number one online broker in 1997 by *Smart Money* and *Barrons* respectively.

and \$0.25. Each cell contains the share-weighted mean LP and the total number of shares.

[Insert Table 5.]

LP are reliably positive for most order sizes and brokers, indicating that liquidity is costly. LP generally exceed one-half the quoted spread in \$0.125-spread markets and are less than the half-spread in \$0.25-spread markets, suggesting that Knight provides price improvement in \$0.25-spread markets. Chi-squared tests generally reject the null hypotheses that LP are equal across brokers and across order sizes. In \$0.125-spread markets, LP increase monotonically in order size. In \$0.25-spread markets, small-to-medium sized round lots appear to receive more price improvement than odd lots or large orders.¹²

Our data allow us to compute the Knight brokers' LP. We must estimate the LP for our benchmark broker not taking order-flow payments because we cannot obtain Trade Fast's order audit-trail data. Based upon conversations with Trade Fast officials, we initially assume that its orders trade at the order-time price quote (i.e., no price improvement) and then ask how much price improvement is required before Trade Fast's NTC is comparable to the Knight-affiliated brokers. Trade Fast used Nasdaq's SelectNet and Small Order Execution System (SOES) to execute market orders in the sample period. With no queue, SOES provides executions at the quote, implying LP equal to the half-spread. With a queue, SOES orders may trade at prices less favorable to customers than order-time quotes. SelectNet converts market orders into marketable limit orders (e.g., a market buy order becomes a buy limit order with a limit price equal to the

¹² We should note that the quality of executions in the Nasdaq market have improved dramatically between the sample period and now. Competition has led Knight to offer considerably more price improvement in markets where spreads are wider than the minimum price variation. Knight still offers no price improvement in one-tick markets.

current offer). If immediately executed, then the trade occurs at the quoted price. Should the initial order not fill quickly, Trade Fast alters the limit price to the new quote (suggesting that the market has moved to a less favorable price for the investor) and resubmits the order. This implies that SelectNet limit orders also may execute at prices worse than order-time quotes. Thus, initially assuming that Trade Fast's LP are equal to one-half the order-time quoted spread seems reasonable (any biased is probably in Trade Fast's favor).

Table 6 contains estimates of NTC for ten Knight-affiliated brokers.

[Insert Table 6.]

We add the lowest commission offered by the Knight-affiliated brokers (from Table 3) to the firm's LP for a given spread and order size (from Table 5) to compute NTC. Commissions represent between 1% and 90% of NTC, depending upon order size and broker. The contribution of the commission to NTC declines with order size. NTC for a 250-share order in a \$0.125-spread (\$0.25-spread) market range from \$0.0796 to \$0.2024 (\$0.1380 to \$0.2567) per share.¹³

Panel A of Table 7 combines Trade Fast's commissions (from Table 3) with an assumed LP of the quoted half-spread to estimate the NTC incurred by investors using Trade Fast.

[Insert Table 7.]

Comparing Tables 6 and 7, we find that between three and eight of the ten Knight-affiliated brokers offer lower NTC than Trade Fast for a given trade size and spread width. Panel B of Table 7 reports the median NTC for the Knight-affiliated brokers. Differences between the NTC offered by Trade Fast and the median NTC of the Knight-affiliated brokers in \$0.125-spread

¹³ These brokers may or may not be different than the corresponding brokers listed in Table 1. For example, because Accutrade, Aufhauser, Ceres, and Ebroker have separate commission structures, they are considered separately.

markets range from a \$0.0633 advantage in favor of the Knight brokers to a \$0.0104 advantage for Trade Fast. In \$0.25-spread markets, the median Knight-broker NTC is always lower than Trade Fast's. This evidence is consistent with the claim that order-flow payments need not harm investors relative to the alternative of trading with brokers not accepting payment for order flow.

Figure 1 provides a visual comparison of the NTC of Trade Fast and the ten Knight brokers. Each bar is Trade Fast's NTC minus the indicated broker's NTC, so the bar's height represents the additional expense to execute through Trade Fast relative to the indicated broker.

[Insert Figure 1.]

B1 is cheaper than Trade Fast for all order-size categories. B9 and B10 are more expensive than Trade Fast. B6, B7, and B8 exhibit NTCs that are nearly identical to Trade Fast's. Most of the large advantages of the Knight brokers over Trade Fast occur in the smallest order size.

Concluding that investors are not necessarily worse off with brokers selling order flow as with Trade Fast depends on our assumption regarding Trade Fast's execution quality. As a robustness check, we compute the price improvement rates required for Trade Fast to obtain NTC equal to the Knight-broker median NTC from Table 7.¹⁴ We assume no price disimprovement and that price-improved trades execute at prices \$0.125 better than the relevant quote (i.e., the customer buys at \$0.125 less than the offer and sells at \$0.125 more than the bid). In \$0.25-spread markets and for 50-share orders in \$0.125-spread markets, Trade Fast cannot obtain sufficient price improvement to match the median Knight-broker NTC (over 100% is required). In \$0.125-spread markets, Trade Fast needs, a 64% price improvement rate in 250-share orders

¹⁴ This is the fraction of shares that must receive a price better than the relevant order-time quoted price in order for Trade Fast to provide lower NTC than the Knight-affiliated brokers.

and a 55% rate in 1000-share and 1750-share orders (Trade Fast offers lower NTC than the median in 750-share and 3750-share orders). Securities and Exchange Commission (1997) finds that the NYSE price improvement rate in \$0.125-spread markets is 13.5% on orders of 201-300 shares, 11.1% on orders of 501-1000 shares, and 9% on orders of 1001-5000 shares. Because the NYSE typically offers the best execution-quality statistics across trading venues, this suggests that our conclusions are robust to assuming that Trade Fast executes trades at the quote.

Our analysis suggests that it is not difficult to find examples of brokers accepting order-flow payment offering investors lower trading costs than the broker not sharing in the market-making revenue generated by executing its customers' orders during our sample period. (At least it is not as difficult as finding a low-commission broker that does not sell order flow.) This suggests that commissions and execution quality may be inversely related: low-commission brokers route order flow to order-flow-purchasing market makers who do not provide the same execution price offered by market makers not paying for order flow. If different trading venues attract different broker types, then ignoring commissions in comparisons of trading costs across venues may be misleading. Our results also suggest that selling order flow may allow brokers to reduce commissions, and that these lower commission compensate investors for the (possibly) less favorable trade price on trading venues paying for order flow.

4. Conclusions.

We use data from Knight Securities, a major Nasdaq dealer purchasing order flow, to determine the split of market-making revenue between the broker and dealer functions and to investigate whether traders using brokers accepting order-flow payments are unambiguously worse off than traders using brokers who do not accept such payments. In the fourth quarter of

1996, we estimate that Knight's gross market-making revenue is \$0.057 per share for market orders in Nasdaq-100 stocks. During this period, Knight pays \$0.025 per share (44% of revenue) for order flow. This revenue estimate is for market orders with which Knight interacts. It does not apply to market orders interacting with customer limit orders held by Knight (for which Knight earns no market making revenue). Thus, \$0.032 is likely to be an upper bound on net revenue for Knight's market orders.

From a large sample of low-commission brokers, we find only one not receiving market-making revenue through order-flow payments or internalization. That broker, Trade Fast, acts as our benchmark broker. We compare the estimated net trading cost (liquidity premium plus commission) of trading through Trade Fast to the net cost of trading with Knight-affiliated brokers. Several brokers selling order flow offer lower net trading costs than Trade Fast, which is consistent with the claim that brokers accepting order-flow payments share these revenues with traders through lower commissions. We believe that this evidence suggests that trading with brokers taking payment for order flow is not unambiguously harmful to investors relative to trading through brokers not accepting such order-routing inducements and that conclusions regarding across-market execution quality based solely on transaction prices may be misleading.

One must exercise caution in extrapolating our results. We have only one broker not directly sharing in the dealer revenue associated with executing its orders. This means that the results comparing Trade Fast's net trading costs with those of the Knight-affiliated brokers cannot be thought of as statistical tests. We also examine brokers associated with but a single purchaser of order flow over only three months. Knight had a reputation as an aggressive purchaser of order flow, paying a large per share amount. This may allow Knight-affiliated brokers to lower

commissions more than brokers associated with other market makers offering less generous payments. We deliberately select a time before the recent changes in the Nasdaq market to allow payment for order flow to have the greatest effect. Nasdaq's Order Handling Rules and the move to pricing stocks in \$0.0625 increments significantly decreased market-making revenues and order flow payments (see Los Angeles Times [1998]). In addition, we focus on the ten Knight-affiliated brokers routing Knight the most order flow, suggesting that they are the most successful brokers. Finally, our sample stocks are the higher-priced, most liquid of Nasdaq's stocks. With the wider spreads associated with other stocks, our assumptions about Trade Fast's execution quality would be more critical.

There are other limitations of our study. We have no detailed data from Trade Fast. It may be that Trade Fast customers submit orders in exactly the spread:order-size categories that Trade Fast provides lower trading costs. Finally, we ask only whether investors are necessarily hurt by using brokers taking order-flow inducements rather than using brokers not accepting these payments. This presumes the existence of payment for order flow. Given the existence of payment for order flow, we believe our results provide a counter-example to the claim that dealing with a broker selling order flow is not in the investor's best interests. It is possible, of course, that the existence of order-flow payments increase the cost of liquidity for all traders.

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Table 1

The 25 Brokerage Firm Owners of Knight Securities L.P. in September 1996 ¹

Ameritrade, Inc (Accutrade, Aufhauser, Ceres, Ebroker)
BHC Securities Inc.
BHF Securities
Bidwell & Co.
Brown & Co.
Burke, Christensen & Lewis Securities
Cowles Sabol
Direct Access
E*Trade Securities
Gruntal Financial Corp.
Hanifen Imhoff Clearing Corp.
Howe Barnes Investments
J. W. Charles Securities, Inc.
Lombard Institutional Brokerage (now Discover Brokerage)
R.J. Forbes Group
R.P. Assignee Corp.
R.P.R Clearing Services
Richardson Greenshields
Sanders Morris Mundy
Scottsdale Securities
Southwest Securities
Stockcross
Thomas F. White & Co.
Van Kasper & Co.
Waterhouse Securities

¹ Source: *Traders Magazine*, September 1996.

Table 2
Our Sample of On-Line, Deep Discount, and Discount Brokers in the Fourth Quarter 1996

Broker	Appear in Brokerage Ranking by				Issues in which Broker Directly Receives Market-making revenue ⁵
	Barrons ¹	Online Invest. Services ²	Smart Money ³	AII Journal ⁴	
Accutrade	Y	Y	Y	Y	Nasdaq & NYSE
American Express	Y	Y	Y	Y	Nasdaq & NYSE
Atlantic Financial		Y			Nasdaq & NYSE
Aufhauser	Y	Y	Y	Y	Nasdaq & NYSE
Bidwell		Y	Y		Nasdaq & NYSE
Brown		Y	Y	Y	Nasdaq & NYSE
Bull & Bear	Y	Y			Nasdaq & NYSE
Ceres	Y	Y		Y	Nasdaq & NYSE
CompuTel	Y	Y		Y	Nasdaq & NYSE
Datek Online	Y	Y			Nasdaq & NYSE
E*Trade	Y	Y	Y	Y	Nasdaq & NYSE
E-Broker	Y	Y		Y	Nasdaq & NYSE
Empire Financial	Y	Y		Y	Nasdaq & NYSE
Fidelity		Y	Y	Y	Nasdaq & NYSE
FMR Corp	Y	Y			Nasdaq & NYSE
Investex		Y			Nasdaq & NYSE
Jack White	Y	Y	Y	Y	Nasdaq & NYSE
JB Oxford	Y	Y		Y	Nasdaq & NYSE
Kennedy-Cabot		Y	Y		Nasdaq & NYSE
Lombard	Y	Y	Y	Y	Nasdaq & NYSE
Marquette de Barry				Y	Nasdaq & NYSE
Max Ule				Y	Nasdaq & NYSE
Muriel Siebert	Y	Y	Y	Y	Nasdaq & NYSE

Table 2 (continued)

Broker	Appear in Brokerage Ranking by				Issues in which Broker Directly Receives Market-making revenue
	Barrons	Online Invest. Services	Smart Money	AAIL Journal	
National Discount	Y	Y	Y	Y	Nasdaq & NYSE
Net Investor	Y	Y		Y	Nasdaq & NYSE
Pacific Brokerage	Y	Y	Y	Y	Nasdaq & NYSE
PCFN (DLJ Direct)	Y	Y	Y		Nasdaq & NYSE
Quick & Rielly	Y	Y	Y	Y	Nasdaq & NYSE
Regal	Y	Y		Y	Nasdaq & NYSE
Savoy (Tradestar)	Y	Y	Y	Y	Nasdaq & NYSE
Schwab One	Y	Y	Y	Y	Nasdaq & NYSE
Scottsdale		Y	Y	Y	Nasdaq & NYSE
Stock Cross		Y			Nasdaq
T. Rowe Price			Y	Y	Nasdaq & NYSE
Trade Fast				Y	
Vanguard		Y	Y		Nasdaq & NYSE
Wall Street Access	Y	Y		Y	Nasdaq & NYSE
Wall Street Electronica	Y	Y			Nasdaq & NYSE
Wall Street Equities		Y			Nasdaq & NYSE
Waterhouse Securities	Y	Y	Y		Nasdaq & NYSE

¹ Refers to the online brokerage survey by Theresa W. Carey titled ‘Surf’s up,’ published in the March 17, 1997 issue of *Barron’s* magazine.

² Refers to the November 1996 monthly brokerage commission ranking published by Don Johnson of Online Investment Services (www.sonic.net/donaldj/brokers.html).

³ Refers to the discount brokerage survey by James R. Hagy and Laura M. Holson titled ‘The Best and Worst Discount Brokers,’ published in the June 1997 issue of *Smart Money* magazine.

⁴ Refers to the discount broker survey by Marie Swick and Jean Henrich titled ‘The 1997 Discount Broker Survey: A Guide to Commissions and Services,’ published in the January/February 1997 issue of the *AAIL Journal*.

⁵ Market-making revenue may come in the form of payment for order flow or internalization.

Table 3**Stated Market-Order Brokerage Commissions for Knight-Affiliated Brokers and Trade Fast during the Fourth Quarter 1996¹**

Panel A: Online trading.

Broker	Order Size					
	50 Shares	250 Shares	750 Shares	1000 Shares	1750 Shares	3750 Shares
Accutrade	\$29.00	\$33.00	\$43.00	\$48.00	\$63.00	\$103.00
Aufhauser	\$22.49 (\$3.33) ²	\$22.49 (\$3.33)	\$30.60 (\$3.33)	\$30.60 (\$3.33)	\$31.50 (\$3.33)	\$67.50 (\$3.33)
Brown & Company	\$19.00	\$19.00	\$19.00	\$19.00	\$19.00	\$19.00
Ceres	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00
Ebroker	\$12.00	\$12.00	\$12.00	\$12.00	\$12.00	\$12.00
E*Trade	\$19.95	\$19.95	\$19.95	\$19.95	\$19.95	\$19.95
Lombard	\$14.95	\$14.95	\$14.95	\$14.95	\$14.95	\$14.95
Scottsdale	\$9.00	\$9.00	\$9.00	\$9.00	\$9.00	\$9.00
Trade Fast	\$19.95	\$19.95	\$22.50	\$30.00	\$52.50	\$112.50
Waterhouse Securities	\$12	\$12	\$12	\$12	\$12	\$12

Table 3 (continued)

Panel B: Non-Intermediated trade placed via telephone.

Broker	Order Size					
	50 Shares	250 Shares	750 Shares	1000 Shares	1750 Shares	3750 Shares
Accutrade	\$29.00	\$33.00	\$43.00	\$48.00	\$63.00	\$103.00
Aufhauser	\$22.94	\$22.94	\$30.60	\$30.60	\$31.50	\$67.50
Brown & Company	\$19.00	\$19.00	\$19.00	\$19.00	\$19.00	\$19.00
Ceres	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00
Waterhouse Securities	\$35	\$35	\$35	\$35	\$35	\$35

Panel C: Intermediated trade placed via telephone.

Broker	Order Size					
	50 Shares	250 Shares	750 Shares	1000 Shares	1750 Shares	3750 Shares
Accutrade	\$36.00	\$40.00	\$50.00	\$55.00	\$70.00	\$110.00
Aufhauser	\$24.99	\$24.99	\$34.00	\$34.00	\$35.00	\$75.00
Bidwell	\$22.50	\$32.50	\$57.50	\$70.00	\$107.50	\$207.50
Ceres	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00
Scottsdale Securities (SuperSaver)	\$50.00	\$50.00	\$50.00	\$50.00	\$65.00	\$121.75
Waterhouse Securities	\$45	\$45	\$45	\$45	\$45	\$45

¹ Assuming stock price is \$25.² Assumes 20 trades are placed per month, which yields the lowest per share commission.

Table 4
Realized Liquidity Premia for Market Orders in Nasdaq-100 Securities
Routed to Knight During the Fourth Quarter of 1996¹

Panel A: Realized Liquidity Premia² for market orders submitted in \$0.125-spread markets.

Corresponding Broker	Order Size					
	Odd Lots	100 to 499	500 to 999	1000	1001 to 2499	2500 to 5000
CB1	\$0.0672* ³ 134 ⁴	\$0.0472* 1,492	\$0.0300* 518	\$0.0288 397	\$0.0333 225	\$0.0748* 140
CB2	\$0.0598* 42	\$0.0394* 700	\$0.0348* 601	-\$0.0081 1,239	\$0.0187 499	\$0.0383 340
CB3	\$0.0643* 39	\$0.0595* 660	\$0.0665* 489	\$0.0499* 672	\$0.0240 335	\$0.0437 382
CB4	\$0.0793* 23	\$0.0484* 377	\$0.0663* 283	\$0.0530* 369	\$0.0412* 256	\$0.0928* 227
CB5	\$0.0746* 82	\$0.0696* 380	\$0.0505* 180	-\$0.0355 146	\$0.0158 129	\$0.0376 86
CB6	\$0.0548* 24	\$0.0600* 357	\$0.0578* 181	\$0.0407* 185	\$0.0541 180	\$0.0710* 122
CB7	\$0.0908* 8	\$0.0555* 277	\$0.0496* 243	\$0.0110 525	\$0.0478* 893	\$0.0481 507
CB8	\$0.0771* 28	\$0.0742* 310	\$0.0461* 162	-\$0.0333 192	-\$0.0073 65	\$0.0091 24
CB9	\$0.0520* 12	\$0.0560* 159	\$0.0762* 90	\$0.0091 130	-\$0.0025 89	\$0.1208* 28
CB10	\$0.0602* 14	\$0.0590* 139	\$0.0717* 105	\$0.0335 110	\$0.1135* 128	\$0.0908 139
ALL	\$0.0668* 461	\$0.0546* 5,775	\$0.0454* 3,610	\$0.0167* 4,857	\$0.0316* 3,528	\$0.0620* 2,356
χ^2 Test for RLP differences over order size	536 ⁵ 40 ⁶ 0.001 ⁷					
χ^2 Test for RLP differences over brokers within order size	282 80 0.001	599 80 0.001	266 80 0.001	264 80 0.001	165 80 0.001	79 80 0.51

Table 4 (continued)

Panel B: Realized Liquidity Premia for market orders submitted in \$0.25-spread markets.

Corresponding Broker	Order Size					
	Odd Lots	100 to 499	500 to 999	1000	1001 to 2499	2500 to 5000
CB1	\$0.1168* 63	\$0.1132* 717	\$0.1162* 241	\$0.0827* 148	\$0.1052* 71	\$0.0714* 45
CB2	\$0.1230* 24	\$0.0949* 339	\$0.0837* 267	\$0.0468* 389	\$0.0644* 198	\$0.1574* 92
CB3	\$0.1144* 21	\$0.1112* 323	\$0.0945* 250	\$0.0931* 309	\$0.0453 147	\$0.1269* 145
CB4	\$0.1208* 18	\$0.1110* 233	\$0.1060* 134	\$0.1113* 161	\$0.0667* 163	\$0.0312 78
CB5	\$0.1213* 21	\$0.1004* 148	\$0.0920* 61	\$0.1019* 45	\$0.1214 26	\$0.2109 8
CB6	\$0.1066* 14	\$0.1191* 184	\$0.1090* 105	\$0.0848* 98	\$0.0827* 74	\$0.0560 65
CB7	\$0.0725 3	\$0.0970* 112	\$0.0961* 113	\$0.1014* 210	\$0.0960* 500	\$0.1254 172
CB8	\$0.1207* 11	\$0.1251* 139	\$0.0533 75	\$0.0458 55	-\$0.0719 19	no orders
CB9	\$0.1311 9	\$0.1215 84	\$0.0945 62	\$0.0471 73	\$0.0057 44	\$0.1924 25
CB10	\$0.1195* 5	\$0.1363* 59	\$0.1048* 40	\$0.1339* 40	\$0.1185* 43	\$0.1628* 66
ALL	\$0.1174* 221	\$0.1107* 2,840	\$0.0953* 1,725	\$0.0764* 1,926	\$0.0710* 1,663	\$0.1000* 850
χ^2 Test RLP differences over order sizes	279 40 0.001					
χ^2 Test for RLP differences over brokers within order size	138 80 0.001	233 80 0.001	124 80 0.001	118 80 0.003	128 80 0.001	84 72 0.156

¹ Excludes orders in securities priced below \$10, orders outside normal hours, orders lacking a valid quote when submitted or 330 seconds after the minute in which the order executes.

² Difference between an order's execution price and the bid-ask spread midpoint 330 seconds afterwards.

³ Share-weighted mean RLP. An asterisk indicates that the estimate is statistically different from zero and bold indicates that the estimate is statistically different from the half-spread (two-tailed t-test, 99% confidence level).

⁴ Thousands of shares.

⁵ Chi-Square test statistic.

⁶ Degrees of freedom.

⁷ p-value.

Table 5
Liquidity Premia (LP) for Market Orders in Nasdaq-100 Securities routed to Knight
During the Fourth Quarter of 1996¹

Panel A: Share-Weighted Liquidity Premia² for market orders submitted in \$0.125-spread markets.

Corresponding Broker	Order Size					
	Odd Lots	100 to 499	500 to 999	1000	1001 to 2499	2500 to 5000
CB1	\$0.0653* ³ 134 ⁴	\$0.0720* 1,492	\$0.0773* 518	\$0.0768* 397	\$0.0791* 225	\$0.0841* 140
CB2	\$0.0626* 42	\$0.0674* 700	\$0.0657* 601	\$0.0706* 1,239	\$0.0654* 499	\$0.1125* 340
CB3	\$0.0667* 39	\$0.0638* 660	\$0.0711* 489	\$0.0702* 672	\$0.0702* 335	\$0.1213* 382
CB4	\$0.0706* 23	\$0.0663* 377	\$0.0659* 283	\$0.0745* 369	\$0.0843* 256	\$0.0989* 227
CB5	\$0.0665* 82	\$0.0724* 380	\$0.0691* 180	\$0.0762* 146	\$0.0733* 129	\$0.0858* 86
CB6	\$0.0627* 24	\$0.0629* 357	\$0.0624* 181	\$0.0546* 185	\$0.0717* 180	\$0.0594* 122
CB7	\$0.0788* 8	\$0.0643* 277	\$0.0676* 243	\$0.0704* 525	\$0.0658* 893	\$0.0837* 507
CB8	\$0.0737* 28	\$0.0756* 310	\$0.0811* 162	\$0.0721* 192	\$0.0725* 65	\$0.1423 24
CB9	\$0.0714* 12	\$0.0654* 159	\$0.0664* 90	\$0.0688* 130	\$0.0649* 89	\$0.1038* 28
CB10	\$0.0637* 14	\$0.0658* 139	\$0.0673* 105	\$0.0665* 110	\$0.0620* 128	\$0.0893* 139
ALL	\$0.0664* 461	\$0.0684* 5,775	\$0.0698* 3,610	\$0.0704* 4,857	\$0.0702* 3,528	\$0.0996* 2,356
χ^2 Test for LP differences over order size	3829 ⁵ 40 ⁶ 0.001 ⁷					
χ^2 Test for LP differences over brokers within order size	73 60 0.118	199 80 0.001	84 70 0.121	117 70 0.001	108 70 0.003	75 60 0.088

Table 5 (continued)

Panel B: Share-Weighted Liquidity Premia for market orders submitted in \$0.25-spread markets.

Corresponding Broker	Order Size					
	Odd Lots	100 to 499	500 to 999	1000	1001 to 2499	2500 to 5000
CB1	\$0.1228* 63	\$0.1209* 717	\$0.1263* 251	\$0.1207* 148	\$0.1165* 71	\$0.1412* 45
CB2	\$0.1265* 24	\$0.1116* 339	\$0.1137* 267	\$0.1093* 389	\$0.1129* 198	\$0.1580* 92
CB3	\$0.1187* 21	\$0.1195* 323	\$0.1151* 250	\$0.1267* 309	\$0.1241* 147	\$0.1618* 145
CB4	\$0.1256* 18	\$0.1247* 233	\$0.1214* 134	\$0.1179* 161	\$0.1192* 163	\$0.1387* 78
CB5	\$0.1184* 21	\$0.1168* 148	\$0.1092* 61	\$0.1087* 46	\$0.1012* 26	\$0.1250* 8
CB6	\$0.1226* 14	\$0.1158* 184	\$0.1263* 105	\$0.1078* 98	\$0.1208* 74	\$0.1250* 65
CB7	\$0.1123* 3	\$0.1137* 112	\$0.1189* 113	\$0.1312* 210	\$0.1272* 500	\$0.1430* 172
CB8	\$0.1197* 11	\$0.1258* 139	\$0.1132* 75	\$0.1129* 55	\$0.1620* 19	no orders
CB9	\$0.1214* 9	\$0.1184* 84	\$0.1209* 62	\$0.1070* 73	\$0.0730 44	\$0.1419* 25
CB10	\$0.1204* 5	\$0.1202* 59	\$0.1168* 40	\$0.1573* 40	\$0.1204* 43	\$0.1316* 66
ALL	\$0.1223* 221	\$0.1190* 2,840	\$0.1182* 1,725	\$0.1181* 1,926	\$0.1227* 1,663	\$0.1455* 850
χ^2 Test for LP differences over order sizes	1522 40 0.001					
χ^2 Test for LP differences over brokers within an order size	106 50 0.001	159 80 0.001	106 80 0.026	88 70 0.071	100 50 0.001	48 63 0.918

¹ Excludes orders in stocks priced below \$10, orders entered when the market is closed, orders lacking a valid quote when submitted or 330 seconds after the minute in which the order executes.

² Difference between an order's execution price and the midpoint of the bid/ask spread at order receipt time.

³ Share-weighted mean LP. An asterisk indicates that the estimate is statistically different from zero and bold indicates that the estimate is statistically different from the half-spread (two-tailed t-test, 99% confidence level).

⁴ Thousands of shares.

⁵ Chi-Square test statistic.

⁶ Degrees of freedom.

⁷ p-value.

Table 6
Market-Order Per Share Net Trading Costs (NTC) for Knight-Affiliated Brokers¹

Panel A: Per Share Net Trading Costs in \$0.125-Spread Markets.

Broker ¹	Order Size					
	50 Shares	250 Shares	750 Shares	1000 Shares	1750 Shares	3750 Shares
B1	\$0.1372	\$0.0796	\$0.0703	\$0.0778	\$0.0862	\$0.0998
B2	\$0.2537	\$0.1116	\$0.0931	\$0.0811	\$0.0776	\$0.1447
B3	\$0.3106	\$0.1143	\$0.0819	\$0.0865	\$0.0912	\$0.1021
B4	\$0.3053	\$0.1200	\$0.0933	\$0.0888	\$0.0860	\$0.0873
B5	\$0.3657	\$0.1236	\$0.0910	\$0.0852	\$0.0787	\$0.1253
B6	\$0.4306	\$0.1383	\$0.0899	\$0.0925	\$0.0946	\$0.1037
B7	\$0.4588	\$0.1403	\$0.0929	\$0.0894	\$0.0767	\$0.0888
B8	\$0.4655	\$0.1522	\$0.0957	\$0.0962	\$0.0847	\$0.0911
B9	\$0.6506	\$0.1983	\$0.1232	\$0.1225	\$0.1203	\$0.1264
B10	\$0.5165	\$0.2024	\$0.1458	\$0.1462	\$0.1347	\$0.1411

Panel B: Per Share Net Trading Costs in \$0.25-Spread Markets.

Broker ¹	Order Size					
	50 Shares	250 Shares	750 Shares	1000 Shares	1750 Shares	3750 Shares
B1	\$0.1922	\$0.1380	\$0.1258	\$0.1212	\$0.1211	\$0.1396
B2	\$0.2997	\$0.1618	\$0.1252	\$0.1219	\$0.1671	N.A.
B3	\$0.3656	\$0.1727	\$0.1374	\$0.1299	\$0.1261	\$0.1419
B4	\$0.3628	\$0.1689	\$0.1423	\$0.1327	\$0.1234	\$0.1444
B5	\$0.4177	\$0.1793	\$0.1350	\$0.1417	\$0.1326	\$0.1658
B6	\$0.4856	\$0.1967	\$0.1454	\$0.1359	\$0.1295	\$0.1435
B7	\$0.4923	\$0.1897	\$0.1442	\$0.1502	\$0.1381	\$0.1481
B8	\$0.5255	\$0.1914	\$0.1403	\$0.1293	\$0.1243	\$0.1633
B9	\$0.7056	\$0.2567	\$0.1787	\$0.1659	\$0.1552	\$0.1662
B10	\$0.5684	\$0.2468	\$0.1859	\$0.1787	\$0.1626	\$0.1803

¹ NTC = Liquidity Premium + lowest per share brokerage commission available from broker. The liquidity premia are obtained from Table 5 and the brokerage commissions are obtained from Table 3.

Table 7

Market-Order Per Share Net Trading Costs for Trade Fast and the Median Knight-Affiliated Broker during the Fourth Quarter 1996¹

Panel A. Trade Fast

Spread	Order Size					
	50 Shares	250 Shares	750 Shares	1000 Shares	1750 Shares	3750 Shares
\$0.125	\$0.4615	\$0.1423	\$0.0925	\$0.0925	\$0.0925	\$0.0925
\$0.25	\$0.5240	\$0.2048	\$0.1550	\$0.1550	\$0.1550	\$0.1550

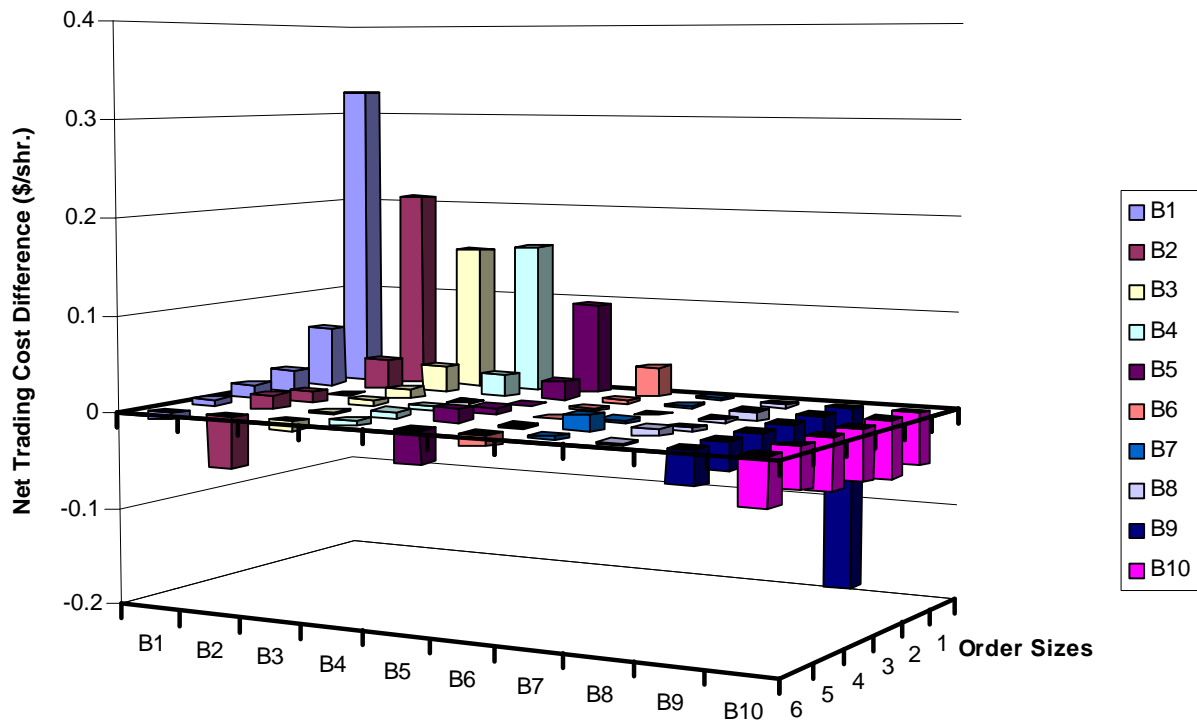
Panel B. Median Knight-affiliated broker.²

Spread	Order Size					
	50 Shares	250 Shares	750 Shares	1000 Shares	1750 Shares	3750 Shares
\$0.125	\$0.39815	\$0.1310	\$0.0930	\$0.0891	\$0.0861	\$0.1029
\$0.25	\$0.45165	\$0.1845	\$0.1413	\$0.1343	\$0.1311	\$0.1435

¹ We assume that traders placing market orders in Nasdaq-100 securities via Trade Fast pay liquidity premia equal to the quoted half-spread.

² We examine the ten brokers routing Knight the largest number of market orders in Nasdaq-100 securities.

**Figure 1 - Net Trading Cost (NTC) Comparison in \$0.125-Spread Markets: TradeFast's
NTC minus Knight-Affiliated Firms' NTC**



NTC is the liquidity premium associated with the broker's trades plus the per share commission. Each bar's height represents how much lower the indicated Knight-affiliated broker's NTC is than Trade Fast, our benchmark broker not selling order flow. Broker codes indicate the ten brokers sending Knight the largest number of market orders in Nasdaq-100 stocks. Order size categories are: 1 = less than 100 shares, 2 = 100 to 499 shares, 3 = 500 to 999 shares, 4 = 1000 shares, 5 = 1001 to 2499 shares, and 6 = 2500 to 5000 shares. Our sample period is the fourth quarter of 1996.