Payment for Order Flow, Trading Costs, and Dealer Revenue for Market Orders at Knight Securities, L.P.

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Abstract

Payments from market makers to brokers, not price quotes, determine where much domestic equity-security trading occurs. We use data from Knight Securities, L.P., a major purchaser of Nasdaq-security order flow, to document the division of market-making revenue among dealer, broker, and investor. When Knight interacts with a market order in an actively traded stock during the fourth quarter of 1996, we estimate that the realized gross market-making revenue is $0.057 per share. Knight paid the broker $0.025 per share to obtain the order. To estimate the effect of order-flow payments on investors, we compare net trading costs (trade price net of commissions) for investors using brokers executing through Knight to estimated net trading costs for investors using a broker not receiving order-flow payments and find that many trades routed based on order-flow inducements enjoy lower costs. This result suggests that order-flow payments are shared with investors via lower commissions and acts as a counter-example to claims that payment-for-order-flow arrangements are unambiguously harmful to investors.

1. Introduction.

Preferencing, internalization, and payment for order flow have dramatically impacted domestic equity markets.[1] Retail brokers regularly share in the dealer revenue associated with executing a customer's order and the primary determinant of an order's execution venue is an order-routing arrangement, not quote competition.[2] Hansch, Naik, and Viswanathan (1998), however, find little extant empirical work examining order-flow inducements' effects despite the prevalence of these practices. We use data from a major purchaser of Nasdaq-security order flow to examine the division of market-order market-making revenue among dealer, broker, and

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[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) notes that virtually all Nasdaq-security orders are preferenced.

investor. Specifically, we: 1.) investigate whether brokers seem to use order-flow payments to reduce commissions and 2.) use known payment-for-order-flow agreements and proprietary order audit-trail data to estimate the portion of realized market-maker revenue paid to the broker. The paucity of information in the academic literature regarding many practical aspects of market making in the presence of payment for order flow dictates that we also provide a descriptive analysis of the order flow and business practices of our example dealer.

Critics claim that order-flow inducements compromise brokers' fiduciary responsibility to obtain the best executions for customers (see, e.g., Macey and O'Hara [1997]). Except for Securities and Exchange Commission (1997), hereafter SEC (1997), the academic literature appears to substantiate these claims by finding that the trading venues most closely associated with order-flow inducements typically produce the worst traditionally-measured execution-quality statistics.[3] Often, these findings are used to argue for legislating quote-based price competition. Proponents of order-flow inducements, however, argue that "best execution" is a more complicated, order/investor-specific concept that includes commissions, opportunity costs, liquidity enhancement (trading more than the quoted number of shares at the quoted price), price impact, and execution speed, in addition to transaction prices. Lee (1993) and Harris (1995) discuss this broader definition of best execution and Keim and Madhavan (1998) note that most studies of institutional trading costs include non-price measures. Of particular interest to us is the claim that order-flow payments allow brokers to decrease retail-order brokerage commissions,

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[3] See, for example, Blume and Goldstein (1992), Lee (1993), Easley, Keifer, and O'Hara (1996), Bessembinder and Kaufman (1997), and Huang and Stoll (1997). Macey and O'Hara (1997) note that, despite the many trading-cost measures used, academic studies consistently find that the NYSE produces better execution-quality statistics than the regional stock exchanges and third market dealers. They note that payment for order flow, preferencing, and internalization often are presumed to be responsible for these across-venue execution quality differences. SEC (1997), however, finds that the Cincinnati Stock Exchange offers execution-quality statistics comparable to the NYSE.

suggesting that commissions and execution quality may be inversely related.[4] Accordingly, investors wishing to minimize trading costs may be better served by brokers maximizing order-flow payment rather than finding the best execution price. We address this issue by combining nominal brokerage commissions with execution prices to produce a more comprehensive measure of trading costs than that used in the extant retail-trade execution quality literature. We use this measure to compare the trading cost for customers of brokers selling order flow to estimated trading costs associated a discount brokerage firm not accepting such payments.

From a dealer's perspective, a natural issue is the portion of market-making revenue paid to brokers in a "typical" payment-for-order-flow arrangement. A dealer's gross revenue is derived primarily from the bid-ask spread. A naive approach to estimate total per share revenue might examine the quoted spread and assume that a dealer makes one-half of that amount (the half-spread) on each trade. This approach is misleading, however, because some transactions occur inside of (price improvement) and outside of (when the order size exceeds the quoted size) the quoted spread. Furthermore, to realize the spread as revenue, a dealer must reverse the inventory position acquired when filling an investor's order. A dealer's reward for supplying liquidity (gross trading revenue) frequently is estimated as the signed difference between the trade price and the quoted price a fixed time following the trade (see, e.g., Huang and Stoll [1996], Bessembinder and Kaufman [1997], and Easley, Keifer, and O'Hara [1997]). We use order audit-trail order data from Knight Securities L.P., a major purchaser of Nasdaq-security order flow, to

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[4] Anecdotal evidence is consistent with this claim. Regarding commissionless trading, *New York Daily News* (1997) notes that "...because brokerage revenues come from more than just commissions, those [zero-commission] trades still may be profitable." Additionally, at the time we collected data for this paper, PT Discount Brokerage offered traders placing market orders in NYSE-listed securities a choice of commissions: $35 to route the order to a third-market dealer or $35 plus $0.0325 per share to route the order to the NYSE.

estimate realized dealer revenue from market orders. After subtracting the known direct cash payment associated with the order, we can estimate the realized net dealer revenue and estimate the relative values of the brokerage and dealership functions.

Our goal of comparing trading costs associated with brokers selling order flow to trading costs associated with brokers not selling order flow is complicated by the fact that there appear to be few low-commission brokers not accepting payment for order flow. We examine only on-line, deep discount, and discount brokers in order to more closely control for other services (e.g., research). When we do this, we can identify only one broker claiming to not capture at least a portion of dealer revenue despite an extensive search. The fact that few low-commission brokers appear to not share in dealer revenues is interesting, but it limits us to a single benchmark broker.

We find little evidence that investors using brokers accepting payment for order flow are worse-off than investors using a broker that does not. Depending on order size and quoted spread width, between 3 and 8 of the 10 most active sample brokers receiving order-flow payments provide investors lower trading costs than our benchmark broker not accepting payments. We interpret this result as implying that brokers share a portion of the market-making revenue obtained via order-flow payments with investors, which suggests that selling order flow is not necessarily inconsistent with investors' best interests. We also find that quoted and effective spreads overestimate market-maker revenue because security prices typically move against Knight immediately after executing customers' orders (increasing after dealer sales and decreasing after purchases), which reduces realized revenue. Assuming that Knight unwinds inventory positions acquired when executing customers' market orders after a five-minute holding period, we estimate that Knight realizes gross market-making revenue of about $0.057 per share. During our

sample period, Knight paid at least $0.025 per share to obtain the order, suggesting that the brokerage function is nearly as valuable as the dealer function in the sample period. This implies that Knight has $0.032 per share to pay other expenses (including the market-making revenue lost when customer market orders interact with customer limit orders). Net realized market-order revenue varies among routing brokers, with some order flow generating *negative* net revenue according to our measure.

2. Data Description.

Estimating market-making revenue requires quote, order, and trade data. In addition, to compute net trading costs, we need brokerage-commission data. We obtain order and trade data from Knight, quote data from the National Association of Security Dealers (NASD), and brokerage commissions from various public sources.

2.1 Knight Securities, L.P.

Knight was founded on July 24, 1995 as a market maker in Nasdaq and other over-the-counter securities and traded 93 million shares (a 0.9% market share) its first full month of existence. In June 1998, Knight averaged 75,000 trades per day with over 800 broker-dealers and 150 institutions. Its June 1998 trading volume of 1.8 billion shares in 5,631 securities gave Knight a 9.93% market share of trading volume. This ranked Knight as the largest market maker by volume and second only to Schwab in number of securities traded.

Knight originated as a consortium of 25 corresponding brokerage firms. The consortium members in September 1996 (the first month of our sample period) are listed in Table 1.[5]

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[5] See *Traders* (1996). Knight's June 10, 1998, S-1 filing with the SEC indicates that the consortium consisted of 28 firms as of March 31, 1998. Firms sending orders directly to Knight are called corresponding brokers. A corresponding broker may receive order flow from several retail brokers. For example, Ameritrade is the corresponding broker for Accutrade, Aufhauser, Ceres, and Ebroker.

[Insert Table 1.]

Four of these firms (E*Trade, Waterhouse, Ameritrade, and Discover) are listed in *Wall Street Journal* (1998) as being among the eight on-line brokers with the largest market share, trading a combined 32% of on-line volume. In return for their order flow, consortium members received a fixed, per share payment of $0.025 and shared in Knight's net income during our sample period. Non-consortium firms routing Knight orders received only the fixed payment.

During our sample period, Knight guaranteed executions at the National Best Bid or Offer (NBBO) for 5,000 shares, regardless of quoted size at order-submission time for the securities in which it made markets. In addition, Knight provided guaranteed execution of orders received at least 5 minutes before the market opens at the opening price (the first valid quote). These guaranteed trades occurred against other customer orders or against Knight's inventory. By mid-1998, Knight made markets in over 5,600 securities and accepted orders in all Nasdaq, Bulletin Board, and pink-sheet stocks. It continued to guarantee a single opening price for pre-open orders. Because of the decrease in minimum price variation (tick size) from $0.125 to $0.0625 it decreased its NBBO-price execution guarantee to between 2,000 and 3,000 shares (depending on the security), but offered opportunities for price improvement.

2.2 Order, Quote, and Trade Data.

We obtain order 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), a buy/sell indicator, order quantity and (if applicable) price, execution price and quantity, the order's receipt

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[6] December 11 data are unavailable. A time prior to the implementation of Nasdaq's new order handling rules and trading in increments of $0.0625 is selected to maximize the potential effects of payment for order flow.

time to the second, to-the-minute execution time, and the corresponding broker's identity. Quotation data covering the same period are obtained from the NASD.

During the sample period, Knight receives ten or more orders from 226 correspondents, but the 25 firms listed in Table 1 account for 89.42% of the total order flow and 91.08% of the orders in the actively traded stocks comprising the Nasdaq-100. In these three months, Knight receives 1,013,317 orders (289,809 in Nasdaq-100 securities).[7] To be included in our study, an order must: 1.) be a regular market or limit order, 2.) be in a stock priced at $10.00 per share or more, 3.) arrive between 9:30 a.m. and 4:00 p.m., and 4.) arrive when the bid-ask spread is positive (i.e., the market is not locked or crossed). The first filter eliminates 35,903 (14,246 Nasdaq-100) stop orders.[8] 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 costs between these groups may be misleading. Our data contain 362,669 (36,148 Nasdaq-100) orders in stocks priced below $10.00 per share that we ignore. We eliminate 76,061 (15,405 Nasdaq-100) orders submitted outside of trading hours because we require valid contemporaneous quotes. Finally, 237 (198 Nasdaq-100) orders arrive when the market is locked or crossed. Over one-half of all orders (538,501 orders) and three-fourths of the orders (223,812) in Nasdaq-100 issues survive these screens.

Table 2 provides a descriptive analysis of order types for all orders sent to Knight (Panel A) and orders in Nasdaq-100 issues (Panel B) by correspondent. The ten corresponding brokers sending Knight the most market orders in Nasdaq-100 securities are assigned identifying codes

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[7] 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.

[8] A stop market or limit order becomes effective only if the stock's price reaches a specified value.

(CB1 through CB10).

Knight receives 50% of its order flow from three brokers and 63% from five. The ratio of market orders to limit orders varies considerably by correspondent. For example, market orders are two-thirds of CB5's orders, but less than one-third of CB7's. If limit orders are less profitable to Knight than market orders, then the differences in order-flow mix across brokers documented in Table 2 suggest that the value of the brokers' order flows to Knight varies. Although Knight receives a slightly greater fraction of market orders in Nasdaq-100 issues than overall, each firm routes approximately the same order-flow mix in Nasdaq-100 issues as overall (compare Panels A and B). Overall, Knight's order-flow mix is about 40% market orders, 15% marketable limit orders (limit orders that are immediately executable given contemporaneous quotes), and 45% non-marketable limits. Because there are substantial differences in liquidity across Nasdaq-listed securities, we focus our attention on the Nasdaq-100 issues in the remainder of the paper.

Limit orders are divisible into two categories based on their time in force: day and good-'til-canceled (GTC). Day orders expire at the end of the trading day submitted and GTC orders remain in effect until actively canceled. Day limit orders comprise over 75% of the limit orders Knight receives in Nasdaq-100 issues. Figure 1 characterizes the distribution of GTC and day limit order prices relative to the quotes prevailing when the order arrives.

Over 30% of day limit orders are marketable, 9% improve existing quotes (are above the bid price or below the offer price), and 19% are on-the-quote (the limit price equals the existing bid or offer price). In contrast, less than 8% of Knight's GTC limit orders are marketable, 4% are quote

improving, and 11% are on-the-quote. Over half of the GTC limit orders have limit prices more than $0.50 from the relevant quote (bid for buys and offer for sells). Conversely, only 18% of day limit orders have limit prices $0.50 from the relevant quote. This suggests that investors using GTC limit orders follow different trading strategies than traders using day limit orders.

Our data suggest that investors' orders vary by aggressiveness. Aggressive orders demand liquidity and Knight provides that liquidity at a price. Passive orders supply liquidity and earn the price of liquidity for the investor submitting the order, denying Knight the opportunity to interact with an order demanding liquidity. Because differences in aggressiveness suggest differences in Knight's dealer revenue, we focus on market orders in the remainder of the paper. Assuming that market orders are the most profitable to Knight, our analysis should be viewed as estimating an upper bound on market-making revenue.

Table 3 provides descriptive statistics on the size of market orders received by Knight and the execution price of market orders executed by Knight conditional on correspondent.

[Insert Table 3.]

The volume-weighted average price (VWAP) is the market value of market-order trades divided by the number of shares traded. The fact the VWAP varies from under $40 per share to over $70 among correspondents suggests that different brokers route Knight orders in different stocks.

Average market-order order size also varies considerably, from 261 shares to 965 shares. About 19% of Knight's market orders are odd lots (less than 100 shares), 68% are round lots or partial round lots for fewer than 1000 shares, 8% are for exactly 1000 shares, and about 5% are orders for more than 1000 shares. During our sample period, 1000 shares corresponds is the minimum-sized quote allowed for Nasdaq-100 securities. Harris and Schultz (1998) find that

1000-share trades typically are profitable for the party submitting the order, suggesting that these orders' realized dealer revenue may be less than the typical market order. The fraction of market orders for exactly 1000 shares varies across brokers from less than 3% to over 16%.

2.3 Brokerage Commission Data.

To compare the net cost of trading through Knight-affiliated brokers to the net cost of trading through brokers not selling order flow, we require commission data. We use published commissions from the brokers listed in Table 1 combined with Knight's proprietary order audit-trail data to compute the net trading cost of brokers selling order flow. After identifying a low-commission broker not receiving market-making revenue, we use public commission data and *estimated* liquidity costs to compute its net trading costs. To give us a chance to identify low-commission brokers not directly sharing in market-making revenue, we investigate all brokers listed in the *Smart Money*, the *AAII Journal*, *Barron's* weekly magazine, or Online Investment Services (*www.sonic.net/donaldj/brokers.html*) broker surveys. These surveys include on-line, deep discount, and discount brokers. Table 4 lists brokers from this universe for which we could definitively determine whether the broker did or did not directly receive at least a portion of the market-making revenue associated with their customers' orders.

[Insert Table 4.]

Of the 40 brokers identified, only Trade Fast does not receive market-making revenue via internalization or payment for order flow. The scarcity of low-commission brokers not directly receiving market-making revenue suggests an intriguing correlation between order flow inducements and low commissions.

Fourth quarter 1996 commission data for the brokers listed in Table 4 are obtained from

websites and through written and verbal requests. We validate these data when possible with commission data from the November 1996 Online Investment Services brokerage survey. Table 5 contains commission schedules for the ten brokers routing Knight the most market orders and our benchmark broker, Trade Fast.

[Insert Table 5.]

Commissions are listed for orders of 50, 250, 750, 1000, 1750, and 3750 shares. Panel A lists the cost of placing market orders on-line, Panel B the cost of non-intermediated telephone market orders, and Panel C the cost of intermediated telephone orders.[9] Aufhauser's special rate is the lowest commission for market orders under 5000 shares during our sample period. Aside from this special rate, brokerage commissions on a market order for 250 shares range from $9.00 to $33.00 for on-line orders, from $18.00 to $35.00 for non-intermediated telephone orders, and from $18.00 to $50.00 for intermediated telephone orders. On a per share basis, commission differences decrease in order size. For example, the per share difference in market-order commissions between the most and the least expensive on-line broker in our sample falls from $0.40 per share for 50 share orders to $0.0276 per share for 3750 share orders. Focusing on on-line brokers, Trade Fast is typically the second most expensive broker.

3. Examination of Net Trading Costs

We define an investor's net trading cost (NTC) as the difference between the execution price and the mid-point of the receipt-time bid-ask spread (i.e., the liquidity premium) plus the per share nominal brokerage commission. That is,

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[9] 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.

$$NTC \; = \; \text{Liquidity Premium} + \text{Per Share Brokerage Commission,} \qquad (1)$$

where the liquidity premium (LP) is an order's execution price minus the receipt-time quoted

spread's mid-point multiplied by +1 for buy orders and -1 for sell orders. If the spread's mid-point

represents the security's "true value," then the LP measures how much more (less) a investor

wishing to buy (sell) pays (receives).[10] Adding the commission to the liquidity premium produces

the investor's net cost (relative to the "true value") of trading the security. Comparing brokers

with this measure assumes that factors such as the ability to negotiate commissions, margin

requirements, trading accessibility, and check-writing services are dominated by liquidity and

stated-commission costs.[11] Our order audit-trail data allow us to compute the LP of Knight-

affiliated brokers' trades. With the commission data, we can estimate the NTC of using brokers

selling order flow. We compare these trading costs to estimates of the cost of trading Nasdaq-

listed securities through Trade Fast.

3.1 Data Screens

To be included in our sample, the Knight-routed market order must: (1) be executed, (2)

be for 5,000 or fewer shares, (3) be submitted when the quoted spread is $0.125 or $0.25 (4)

have a recorded execution time after the recorded receipt time and (5) have a valid quote 330

seconds after the minute in which the order executes. Because orders must execute in order to

compute a LP, we eliminate the fewer than one-half of one percent of submitted market orders

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[10] See Lee (1993) for a more complete discussion of the liquidity premium.

[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.

that are "busted" (undone after execution) or canceled before executing. The maximum order size receiving Knight's automatic execution guarantee in our sample period is 5,000 shares. Thus, to control for potential differences between "automatic" and "manual" executions, we eliminate the 120 orders not eligible for this guarantee. Given the relationship between LP and order size documented by Lee (1993), Petersen and Fialkowski (1994) and others, we condition reported LP on order size. Because a small number of orders are submitted when the benchmark spread exceeds $0.25 (only 6,492 orders in total), we have no confidence in estimated LP. We also discard 271 trades for which the order-receipt time is more than 65 seconds *after* the minute in which the order executes; reasoning these data are errors For comparability with profitability statistics developed in the next section, we eliminate 2,580 trades without a valid quote 330 seconds after the minute in which the trade executes.

3.1 Liquidity Premia

Panel A (B) of Table 6 reports the LP distribution for orders arriving when the quoted spread is $0.125 ($0.25).

[Insert Table 6.]

For both spread widths, over 95% of odd-lot orders have LP equal to the half-spread. In $0.125-spread ($0.25- spread) markets, orders for fewer than 2500 shares have LP of the half-spread 93.8% (74%) of the time. For orders of fewer than 2500 shares, mean LP across our order-size categories range from $0.0664 to $0.0704 in $0.125-spread markets and from $0.1181 to $0.1227 in $0.25-spread markets. Chi-squared tests reject the null hypothesis that the LP

distributions conditional on order size are equal across brokers.[12] Consistently with prior

research, P^2 tests also reject the null that the LP distributions are equal across order sizes.

Our NTC comparisons require estimated LP for orders in Nasdaq-listed securities from

our benchmark broker not receiving market-making revenue. Because we cannot obtain order

audit-trail data from Trade Fast, we assume that orders execute at the receipt-time quoted price,

i.e., no price improvement/disimprovement. Trade Fast typically used Nasdaq's SelectNet and

Small Order Execution System (SOES) to execute market orders during this time period. With

no order queue, SOES provides executions at the quote, implying LP equal to one-half the

spread. If there is a queue, then SOES orders may trade at prices different from receipt-time

quotes. SelectNet converts market orders into marketable limit orders. When prices are stable,

this suggests no price improvement. In moving markets, SelectNet limit orders also may execute

at prices better or worse than submission-time quotes. Thus, initially assuming LP equal to one-

half the receipt-time quoted spread for Trade Fast seems reasonable.

3.2 Results

Panels A and B of Table 7 contain estimates of market-order NTC in $0.125- and $0.25-

spread markets, respectively, for the ten Knight-affiliated brokers from Table 5.[13]

[Insert Table 7.]

The lowest commission offered by these Knight-affiliated brokers is added to that firm's LP for a

given spread and order size (from Table 6) to compute NTC. Commissions comprise as much as

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[12] This result is not surprising because Knight may receive order flow from different brokers in different market conditions. In addition, we have evidence that different brokers send Knight order flow in different stocks.

[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.

90% and as little as 1% of NTC, depending upon order size and broker. The commission's contribution to NTC declines with order size. NTCs for a 250-share market order in a $0.125-spread ($0.25-spread) market range from $0.0796 to $02024 ($0.1380 to $0.2468) per share.

In Table 8, we combine Trade Fast's per share stated commissions (from Table 5) with an assumed LP equal to the quoted half-spread to estimate the NTC incurred by investors placing Nasdaq market orders with Trade Fast.

[Insert Table 8.]

No fewer than three and as many as eight of the ten Knight-affiliated brokers offer lower NTC than Trade Fast for a given trade size and spread width. 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. Differences between the NTC offered by Trade Fast and the median NTC of the Knight-affiliated brokers in $0.125-spread 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 consistently lower than Trade Fast's. Some Knight-affiliated brokers offer a NTC savings exceeding the $0.025 order-flow payment.

The conclusion that investors are at least as well off with brokers selling order flow as with our benchmark broker who does not depends on our assumption regarding the execution quality Trade Fast obtains. As a robustness check, we compute price improvement rates required for Trade Fast to obtain NTCs equal to the median Knight-affiliated broker's NTC from Table 7. We assume no price disimprovement and that all price-improved trades in $0.25-spread markets are executed at the spread's mid-point. In $0.25-spread markets, Trade Fast cannot obtain sufficient price improvement to match the median Knight-affiliated broker's NTC (over 100% is

required). In $0.125-spread markets, Trade Fast needs a 127% price improvement rate in 50-share orders, a 64% rate in 250-share orders, and a 55% rate in 1000-share and 1750-share orders (Trade Fast offers lower NTC than the median firm in 750-share and 3750-share orders). From SEC (1997), we note that the NYSE's 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 receiving payment for order flow offering investors lower trading costs than a broker not sharing in the dealer revenue generated by executing their customers' orders. (At least it is not as difficult as finding a low-commission broker that does not obtain dealer revenue.) This suggests that commissions and execution quality may be inversely related: low-commission brokers route order flow to order-flow-purchasing market makers who cannot afford to provide the same execution quality offered by market makers not paying for order flow. If different trading venues attract different types of brokers, then ignoring commissions in across-venue trading cost comparisons may be misleading. Our results also suggest that selling order flow may allow brokers to reduce commissions, and that these commissions compensate investors for the (potentially) lower-quality executions on trading venues paying for order flow.

4. Estimation of Realized Dealer Revenues.

The previous analysis suggests that brokers appear to share order-flow payments with

investors. We also are interested in what portion of market-making revenue passes from dealer to broker in a typical payment-for-order-flow arrangement. To examine this issue, we estimate the market-making revenue generated from Knight's market-order order flow and compare that to the payments Knight makes to obtain the orders. We use the realized liquidity premium (RLP) associated with market orders to estimate Knight's revenue. We define the per share RLP for a market buy order to be the difference between the order's execution price and the bid-ask spread's midpoint 330 seconds after the minute in which the order executes. For market sells, the per share RLP is the difference between the spread's midpoint 330 seconds after the minute in which the order executes and the order's execution price.[14] Interpreted as a measure of dealer revenue, the RLP assumes Knight unwinds trades at the stock's true value (as proxied by the spread's midpoint) five minutes after execution.

Table 9 summarizes the RLP distribution for market orders received in $0.125- and $0.25-spread markets for the ten correspondents routing the most market orders to Knight during our sample period. We condition our RLP calculations on broker because we previously found that order flow varies among brokers on characteristics we anticipate may affect Knight's profitability (e.g., stocks traded and order size).

[Insert Table 9.]

Average RLP are consistently less than the quoted half-spread ($0.0625 and $0.125) and LP (see Table 6), implying that the quoted spread and LP are poor estimates of Knight's dealer revenue.

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[14] Although order receipt times are documented to the second, Knight records execution times to the minute during our sample period. On average, the RLP compares execution prices to quotes prevailing five minutes after execution. The five minute holding period is selected to be consistent with the generally short holding period for most market makers' inventory position and with extant literature. Qualitatively similar results obtain when longer intervals are used (e.g., 7.5, 10, and 15 minutes) and when the spread's midpoint is replaced by the volume weighted average price of trades occurring after the trade of interest.

Because the average RLP is less than the average LP, we conclude that prices typically move against Knight immediately after a trade. Thus, on average, Knight buys from investors just before prices fall and sells just before prices rise.[15] Knight "charges" market order customers about $0.073 per share, on average, for liquidity (the LP) but, because prices move against them, only recognizes revenue of $0.057 per share (the RLP). 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. Because Knight also pays the consortium brokers a portion of its net income, we conclude that market-making revenue is split relatively evenly between the dealer and broker functions.

It is important to note that Knight cannot interact with all of the market orders it receives. In particular, customer limit orders at the same price as Knight's trading interest receive priority over Knight. This implies that customer limit orders frequently interact with incoming market orders, denying Knight a profit on market orders it paid to obtain. Indeed, there are 35,021 on-the-quote and quote improving limit orders submitted for Nasdaq-100 issues in our sample, representing over 37% of market orders. If all of these limit orders interact with a market order, then Knight realizes the $0.057 revenue on only 63% of its market orders. On the market orders with which Knight does not interact, it pays $0.025 but realizes no revenue. In this worst case scenario, Knight's per share revenue for market orders falls to $0.036 (= $0.057 × .63).

We also find considerable variation in RLP across brokers. For example, the mean RLP associated with CB2's market orders in $0.125-spread markets is only about 40% of CB5's. We

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[15] For example, suppose the quotes are $20 bid and $20.125 ask when a buy order is executed, so Knight sells to the customer at $20.125. If the quotes move to $20.125 bid and $20.25 ask before Knight can rebalance its inventory position, then the value of the security has increased to $20.1875 and Knight suffers a "loss" on its short position. Our conclusions are not sensitive to lengthening the assumed holding period. If Knight trades out of a position more quickly than 3-4 minutes, then the loss in realized revenue is less than observed in our calculations.

strongly reject the hypothesis that the mean across-broker RLP are equal. Table 2 reveals that CB2's orders are larger than average and more likely to be for exactly 1000 shares than most of the other correspondents. The fact that Knight's revenue is lowest for CB2 is consistent with Harris and Schultz (1998) who show that 1000-share trades successfully anticipate short-term price movements and Easley and O'Hara (1987) who argue that informed traders submit larger orders. Interestingly, the estimated realized market-order dealer revenue from CB2 ($0.0178) is less than the $0.025 Knight paid to receive the order, suggesting that Knight loses money when executing market orders for this customer.[16] This is true even before Knight pays transaction fees (14% of 1997's revenue according to Knight's June 1998 S-1 filing), employee compensation (21% of revenue), and other expenses (7%).

5. Conclusions.

We use proprietary data from Knight Securities L.P., a Nasdaq market maker purchasing order flow, to examine the claim that customers receive a portion of order-flow payments in the form of lower commissions, to document the total amount of market-making revenue, and to determine the split of revenue between the broker and dealer functions. Starting with the universe of low-commission brokers, we find only one not receiving market-making revenue through payment for order flow or internalization. That broker, Trade Fast, acts as our benchmark. We compare the estimated net cost of trading (liquidity cost plus commission) through Trade Fast to the net cost of trading through brokers selling Knight order flow. Several brokers selling order flow offer lower net trading costs than Trade Fast, which is consistent with the claim that brokers

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[16] It is possible that the additional orders received from CB2 provide Knight with economies of scale in technology, clearing costs, or other considerations that offset this apparent negative net revenue.

accepting order flow inducements share these revenues with customers through lower commissions. We believe that this evidence suggests that trading through brokers accepting payment for order flow is not unambiguously harmful to investors relative to trading through brokers not accepting such order-routing inducements.

We find that Knight's gross realized market-making revenue is about $0.057 per share for market orders in Nasdaq-100 securities. During our sample period, Knight paid $0.025 per share for order flow. In addition, Knight shared its net profits with a consortium of brokers. This suggests that, for market orders, market-making revenue is split roughly evenly between the dealer and the broker. It is important to note that this revenue figure is for market orders with which Knight interacts. It does not apply to limit orders sent to Knight for execution (which we expect to be less profitable to Knight than market orders) or to market orders interacting with a limit order held by Knight (for which Knight earns no market making revenue). Thus, the $0.032 is likely to be an upper bound on net revenue for Knight's overall order flow.

One must exercise caution in extrapolating these results. We examine a single market maker over a three-month period. Knight had a reputation as an aggressive purchaser of order flow, paying one of the highest per share figures. This may allow Knight-affiliated brokers to lower commissions more than brokers associated with other market makers offering order-flow inducements. We deliberately selected a time period prior to many of the changes that recently have occurred in the Nasdaq market in order to allow payment for order flow to have the greatest effect. Nasdaq's Order Handling Rules and the move to pricing securities in increments of $0.0625 has significantly decreased dealer revenues and order flow payments (see Los Angeles

Times [1998]).[17] Finally, we ask only whether investors are necessarily worse off using brokers

accepting order-flow inducements than with brokers not accepting these payments. This takes the

existence of payment for order flow as given. Given the existence of payment for order flow, we

believe we have achieved our objective of providing a counter-example to the commonly-held

belief that dealing with a broker selling order flow is not in the investor's best interests.

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[17] Although we would be interested in investigating the effect of the order handling rules and smaller minimum tick size on how dealer revenue is shared, we do not have the data required to do so.

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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
Order Flow Received by Knight Securities L.P. Between October and December 1996

Panel A: All Nasdaq securities.

Broker[1]	Number of Orders	% Market Orders	% Limit Orders	% Marketable Limit Orders[2]
CB1	126,596	35.02%	64.98%	12.88%
CB2	80,608	35.83%	64.17%	8.98%
CB3	58,926	38.23%	61.77%	13.11%
CB4	55,051	35.61%	64.39%	13.64%
CB5	18,743	66.05%	33.97%	6.65%
CB6	23,029	51.11%	48.89%	13.73%
CB7	31,895	30.02%	69.88%	18.53%
CB8	23,346	39.63%	60.37%	23.42%
CB9	12,088	47.53%	52.47%	24.35%
CB10	10,467	37.39%	62.61%	17.85%
Total	**538,501**	**38.28%**	**61.72%**	**15.07%**

Panel B: Nasdaq-100 securities.

Broker[1]	Number of Orders	% Market Orders	% Limit Orders	% Marketable Limit Orders
CB1	57,471	38.98%	61.02%	12.60%
CB2	28,800	40.74%	59.24%	9.76%
CB3	25,672	41.09%	58.91%	13.29%
CB4	17,042	38.88%	61.12%	13.01%
CB5	10,037	71.22%	28.78%	5.19%
CB6	10,248	54.66%	45.34%	12.72%
CB7	16,227	31.19%	68.81%	17.94%
CB8	11,178	42.11%	57.89%	22.20%
CB9	5,093	51.44%	48.56%	23.04%
CB10	5,368	42.18%	57.82%	16.11%
Total	**223,812**	**42.05%**	**57.95%**	**14.80%**

[1] Brokers are numbered in descending order based on the quantity of market orders routed to Knight by the brokerage firm from October through December 1996. CB1 corresponds to the broker routing the most market orders to Knight during the period. All percentages are based on total orders. The column labeled % market orders and the column labeled % limit orders total to 100%.

[2] Marketable limit orders are limit orders that are immediately executable at contemporaneous quotes.

**Distribution Limit Orders in Nasdaq-100 Securities
Received by Knight During the Fourth Quarter of 1996**
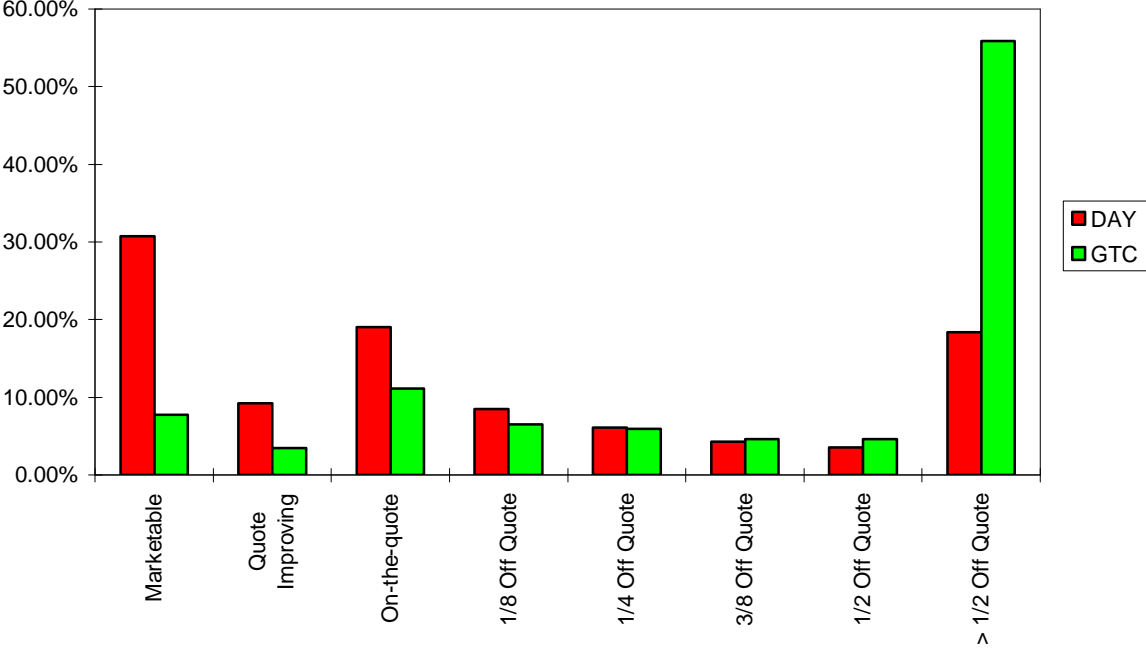
Figure 1

Notes: Limit orders with a limit price not divisible by $0.125 are rounded (made less marketable) for classification. 129,790 limit orders are received by Knight during the fourth quarter of 1996.

Table 3

Descriptive Statistics on Price and Size of Market Orders in Nasdaq-100 Securities Received by Knight between October and December 1996

Broker[1]	VWAP[2]	Mean order size (shares)	1 to 99 Shares	100 to 499 Shares	500 to 999 Shares	1000 Shares	1001+ Shares
CB1	$47.39	209.00	22.62%	66.87%	6.71%	2.66%	1.13%
CB2	52.18	447.00	14.81	50.92	14.48	15.01	4.78
CB3	49.07	414.00	14.77	56.24	13.73	10.45	4.82
CB4	42.55	402.00	17.07	56.01	12.48	8.99	5.45
CB5	71.84	203.00	43.06	45.73	6.44	2.95	1.82
CB6	39.68	353.00	17.86	62.66	9.68	5.57	4.23
CB7	65.22	811.00	5.87	43.76	13.75	16.04	20.58
CB8	53.21	257.00	22.75	59.27	10.69	5.93	1.36
CB9	50.58	350.00	21.15	54.89	11.30	8.44	4.24
CB10	51.85	483.00	21.82	50.75	12.63	7.11	7.69
All Firms	52.05	377.00	19.39	56.73	11.20	7.97	4.72

[1] Columns 4 through 8 total to 1.00 on each row.

[2] VWAP = volume weighted average price per share.

Table 4

Our Sample of On-Line, Deep Discount, and Discount Brokers

Broker	Appear in Brokerage Ranking by				Issues in which Broker Directly Receives Dealer Revenue[5]
	Barrons[1]	Online Invest. Services[2]	Smart Money[3]	AAII 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 4 (continued)

Broker	Appear in Brokerage Ranking by				Issues in which Broker Directly Receives Dealer Revenue
	Barrons	Online Invest. Services	Smart Money	AAII 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 *AAII Journal*.

[5] Dealer revenue may come in the form of payment for order flow or internalization.

Table 5

Brokerage Commissions

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 Securities	$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 5 (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 6

Liquidity Premia for Market Orders in Nasdaq-100 Securities routed to Knight During the Fourth Quarter of 1996

Panel A: Liquidity Premia[2] for market orders submitted in 1/8 point markets.

Corresponding Broker	Order Size					
	Odd Lots	100 to 499	500 to 999	1000	1001 to 2499	2500 to 5000
CB1	$0.0653 130/134	$0.0720 1,418/1,492	$0.0773 479/518	$0.0768 375/397	$0.0791 206/225	$0.0841 110/140
CB2	$0.0626 41/42	$0.0674 651/700	$0.0657 564/601	$0.0706 1,125/1,239	$0.0654 457/499	$0.1125 228/340
CB3	$0.0667 37/39	$0.0638 626/660	$0.0711 457/489	$0.0702 633/672	$0.0702 313/335	$0.1213 237/382
CB4	$0.0706 22/23	$0.0663 360/377	$0.0659 268/283	$0.0745 355/369	$0.0843 247/256	$0.0989 159/227
CB5	$0.0665 79/82	$0.0724 361/380	$0.0691 173/180	$0.0762 136/146	$0.0733 121/129	$0.0858 64/86
CB6	$0.0627[3] 24/24[4]	$0.0629 344/357	$0.0624 175/181	$0.0546 174/185	$0.0717 166/180	$0.0594 113/122
CB7	$0.0788 7/8	$0.0643 258/277	$0.0676 226/243	$0.0704 495/525	$0.0658 853/893	$0.0837 423/507
CB8	$0.0737 27/28	$0.0756 293/310	$0.0811 155/162	$0.0721 169/192	$0.0725 59/65	$0.1423 11/24
CB9	$0.0714 12/12	$0.0654 154/159	$0.0664 87/90	$0.0688 124/130	$0.0649 84/89	$0.1038 17/28
CB10	$0.0637 14/14	$0.0658 132/139	$0.0673 101/105	$0.0665 106/110	$0.0620 120/128	$0.0893 117/139
ALL	**$0.0664 445/461**	**$0.0684 5,475/5,775**	**$0.0698 3,398/3,610**	**$0.0704 4,518/4,857**	**$0.0702 3,275/3,528**	**$0.0996 1,694/2,356**
P^2 Test for LP differences over order size	3829[5] 40[6] 0.001[7]					
P^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 6 (continued)
Panel B: Liquidity Premia for market orders submitted in 1/4 point markets.

Corresponding Broker	Order Size					
	Odd Lots	**100 to 499**	**500 to 999**	**1000**	**1001 to 2499**	**2500 to 5000**
CB1	$0.1228 61/63	$0.1209 651/717	$0.1263 212/251	$0.1207 128/148	$0.1165 61/71	$0.1412 30/45
CB2	$0.1265 23/24	$0.1116 291/339	$0.1137 219/267	$0.1093 309/389	$0.1129 152/198	$0.1580 69/92
CB3	$0.1187 20/21	$0.1195 294/323	$0.1151 224/250	$0.1267 270/309	$0.1241 121/147	$0.1618 97/145
CB4	$0.1256 18/18	$0.1247 213/233	$0.1214 122/134	$0.1179 145/161	$0.1192 151/163	$0.1387 50/78
CB5	$0.1184 20/21	$0.1168 134/148	$0.1092 53/61	$0.1087 39/46	$0.1012 17/26	$0.1250 8/8
CB6	$0.1226 14/14	$0.1158 168/184	$0.1263 101/105	$0.1078 89/98	$0.1208 68/74	$0.1250 65/65
CB7	$0.1123 3/3	$0.1137 98/112	$0.1189 103/113	$0.1312 182/210	$0.1272 460/500	$0.1430 142/172
CB8	$0.1197 11/11	$0.1258 129/139	$0.1132 66/75	$0.1129 47/55	$0.1620 15/19	no orders
CB9	$0.1214 9/9	$0.1184 79/84	$0.1209 60/62	$0.1070 62/73	$0.0730 35/44	$0.1419 20/25
CB10	$0.1204 5/5	$0.1202 53/59	$0.1168 37/40	$0.1573 36/40	$0.1204 37/43	$0.1316 52/66
ALL	**$0.1223 212/221**	**$0.1190 2,571/2,840**	**$0.1182 1,538/1,725**	**$0.1181 1,663/1,926**	**$0.1227 1,453/1,663**	**$0.1455 618/850**
P^2 Test for LP differences over order sizes	1522 40 0.001					
P^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 securities priced below $10, orders entered when the market is closed, orders received in locked or crossed markets, and orders lacking a valid quote when or 330 seconds after the minute in which an order is executed.

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

[3] Share-weighted LP.

[4] Orders with an LP of the half-spread in the numerator and total orders in the denominator ('000 omitted).

[5] Chi-Square test statistic.

[6] Degrees of freedom.

[7] p-value.

Table 7
Per Share Net Trading Costs for Market Order Traders
Whose Brokers Route Orders to Knight

Panel A: Per Share Net Trading Costs in 1/8 Spread Markets.[1]

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 1/4 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] Per Share Net Trading Costs (NTC) = LP + lowest per share brokerage commission available from broker. The LP are obtained from Table 5 and the brokerage commissions are obtained from Table 4.

Table 8

Distribution of Market-Order Per Share Net Trading Costs for Trade Fast[1]

Spread Width	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

[1] We assume traders placing market orders in Nasdaq-listed securities via Trade Fast during the fourth quarter of 1996 pay liquidity premia equal to the quoted half-spread.

[2] During the fourth quarter of 1996, quoted prices for Nasdaq 100 stocks were SOES accessible for orders for up to 1000 shares. Orders for more than 1000 shares cannot be executed via SOES and can be executed away from the inside quote when there is insufficient size at that quote.

Table 9

Realized Liquidity Premia for Market Orders in Nasdaq-100 Securities
Routed to Knight During the Fourth Quarter of 1996

Panel A: Realized Liquidity Premia[2] for market orders submitted in 1/8 point markets.

Corresponding Broker	Order Size					
	Odd Lots	**100 to 499**	**500 to 999**	**1000**	**1001 to 2499**	**2500 to 5000**
CB1	$0.0672 52/134	$0.0472 691/1,492	$0.0300 235/518	$0.0288 197/397	$0.0333 103/225	$0.0748 52/140
CB2	$0.0598 19/42	$0.0394 285/700	$0.0348 208/601	-$0.0081 343/1,239	$0.0187 152/499	$0.0383 118/340
CB3	$0.0643 15/39	$0.0595 292/660	$0.0665 206/489	$0.0499 301/672	$0.0240 133/335	$0.0437 113/382
CB4	$0.0793 10/23	$0.0484 170/377	$0.0663 130/283	$0.0530 146/369	$0.0412 143/256	$0.0928 71/227
CB5	$0.0746 29/82	$0.0696 157/380	$0.0606 76/180	-$0.0355 50/146	$0.0158 36/129	$0.0376 26/86
CB6	$0.0548[3] 13/24[4]	$0.0600 209/357	$0.0578 112/181	$0.0407 94/185	$0.0541 84/180	$0.0710 49/122
CB7	$0.0908 2/8	$0.0555 87/277	$0.0496 75/243	$0.0110 143/525	$0.0478 287/893	$0.0481 226/507
CB8	$0.0771 11/28	$0.0742 135/310	$0.0461 72/162	-$0.0333 63/192	-$0.0073 28/65	$0.0091 8/24
CB9	$0.0520 4/12	$0.0560 64/159	$0.0762 41/90	$0.0091 48/130	-$0.0025 32/89	$0.1208 13/28
CB10	$0.0602 5/14	$0.0590 62/139	$0.0717 52/105	$0.0335 55/110	$0.1135 64/128	$0.0908 46/139
ALL	**$0.0668** **182/461**	**$0.0546** **2,609/5,775**	**$0.0454** **1,544/3,610**	**$0.0167** **1,787/4,857**	**$0.0316** **1,345/3,528**	**$0.0620** **848/2,356**
F Test for RLP differences over order size	536[5] 40[6] 0.001[7]					
F 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 9 (continued)
Panel B: Realized Liquidity Premia for market orders submitted in 1/4 point markets.

Corresponding Broker	Order Size					
	Odd Lots	**100 to 499**	**500 to 999**	**1000**	**1001 to 2499**	**2500 to 5000**
CB1	$0.1168 26/63	$0.1132 304/717	$0.1162 94/241	$0.0827 60/148	$0.1052 26/71	$0.0714 23/45
CB2	$0.1230 11/24	$0.0949 125/339	$0.0837 84/267	$0.0468 101/389	$0.0644 43/198	$0.1574 22/92
CB3	$0.1144 8/21	$0.1112 133/323	$0.0945 81/250	$0.0931 113/309	$0.0453 43/147	$0.1269 39/145
CB4	$0.1208 10/18	$0.1110 116/233	$0.1060 56/134	$0.1113 72/161	$0.0667 62/163	$0.0312 18/78
CB5	$0.1213 8/21	$0.1004 65/148	$0.0920 19/61	$0.1019 13/45	$0.1214 4/26	$0.2109 0/8
CB6	$0.1066 7/14	$0.1191 96/184	$0.1090 61/105	$0.0848 45/98	$0.0827 41/74	$0.0560 20/65
CB7	$0.0725 1/3	$0.0970 41/112	$0.0961 44/113	$0.1014 61/210	$0.0960 189/500	$0.1254 67/172
CB8	$0.1207 4/11	$0.1251 66/139	$0.0533 30/75	$0.0458 7/55	-$0.019 5/19	no orders
CB9	$0.1311 4/9	$0.1215 39/84	$0.045 34/62	$0.0471 22/73	$0.0057 5/44	$0.1924 10/25
CB10	$0.1195 2/5	$0.1363 25/59	$0.1048 17/40	$0.1339 20/40	$0.1185 17/43	$0.1628 29/66
ALL	**$0.1174 96/221**	**$0.1107 1,255/2,840**	**$0.0953 685/1,725**	**$0.0764 655/1,926**	**$0.0710 573/1,663**	**$0.1000 262/850**
P Test RLP differences over order sizes	279 40 0.001					
P 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 received in locked or crossed markets, and orders lacking a valid quote when or 330 seconds after the minute in which an order executes.

[2] Difference between an order's execution price and the bid-ask spread's midpoint 330 seconds after order execution time.

[3] Share-weighted RLP.

[4] Orders with an RLP of the half-spread in the numerator and total orders in the denominator ('000 omitted).

[5] Chi-Square test statistic.

[6] Degrees of freedom.

[7] p-value.