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Packaging Liquidity: Blind Auctions and Transaction Efficiencies

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Abstract

The costs of implementing investment strategies represent a significant drag on the performance of mutual funds and other institutional investors. It is the responsibility of institutional investors, and in the interests of the individual investors they represent, to seek market mechanisms that mitigate trading costs. We investigate an example of one such liquidity provision mechanism whereby liquidity demanders auction a set of trades as a package directly to potential liquidity providers. A critical feature of the auction is that the identities of the securities in the package are not revealed to the bidder. We demonstrate that this mechanism provides a transactions cost savings relative to more traditional trading mechanisms for the liquidity demander as well as an efficient way for liquidity suppliers to obtain order flow. We argue that the cost savings afforded this new mechanism are due to the potential for low cost crosses with the bidder's existing inventory positions and through the longer trading horizon, and superior trading ability, of the bidders. This research suggests that the ability to innovate via new liquidity provision mechanisms can provide market participants with transaction cost savings that cannot be easily duplicated on more traditional exchanges.

I. Introduction

The costs of implementing investment strategies represent a significant drag on the performance of mutual funds and other institutional investors. It is the responsibility of institutional investors, and in the interests of the individual investors they represent, to seek market mechanisms that mitigate trading costs.

We analyze one example (of potentially many other trading mechanisms) within a general class of "blind" auctions of a package of transactions, where innovations in liquidity provision can benefit market participants with transaction

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efficiencies that are not easily duplicated on more traditional exchanges. In this class of blind auctions, a liquidity demander (asset manager) auctions a portfolio of trades directly to a set of liquidity providers (brokers). While some of the procedural details vary across auctions, two key features are common to all auctions of this type. First, many trades are pooled together into a portfolio, or package, and, second, the bidders have only aggregated information concerning the individual trades in the package. That is, the identities of the individual securities in the package are not revealed to the bidders.[1] The liquidity demander has the option to accept the lowest bid or to reject all bids.

Chapman (2000) reports there are approximately 40 asset managers who regularly solicit bids on packages with six brokers actively bidding. Discussions with bidders in our sample corroborate this characterization as well as provide some further detail about the market. Of the six bidders, four are large and very active while the remaining two are somewhat smaller. One of the active bidders reported trading approximately $30 billion through the blind auction mechanism during 2002.[2] Independent discussions with that broker and three additional brokers in our sample yielded an estimated total market size of $250–$300 billion for 2002. As a comparison, the amount of volume facilitated in the NYSE's upstairs market was $1.27 trillion in 2001.[3] Thus, the blind auction mechanism is not substantially different in size when compared to other important alternative trading mechanisms.

We examine the transactions associated with 83 packages of equity trades with a combined value of $7.32 billion that were auctioned by a single asset manager (the liquidity demander) over the period July 1998 to July 2000.[4] Our results suggest that trading the packages via the blind auction mechanism resulted in trading costs that were 62 basis points lower than a benchmark estimate of trade costs that accounts for the difficulty of executing the individual trades (e.g., the size of the individual trades, the liquidity of the market for the stock, and the exchange on which the stock trades). This amounts to a 48% reduction in transaction costs relative to trading via traditional trading venues. At the same time, liquidity suppliers (bidders) are able to obtain order flow cheaply. The results suggest that the liquidity demander's cost savings from this liquidity provision mechanism hinge upon the liquidity providers (bidders) possessing both inventory positions with which they can cross many of the trades within the package and a longer trading horizon. To a lesser extent, our results are also consistent with the cost savings being generated from liquidity providers' (bidders) superior trading ability.

The remainder of the paper is organized as follows. Section II outlines our model and describes the advantages of packaging and auctioning securities. Section III provides the details of a typical package auction and the supporting data

[1]This is in contrast to basket, or program, trading where the exact composition of the portfolio (e.g., the S&P 500) is known and the trades are all in one direction.

[2]Of the amount traded, the bidder revealed that approximately 20% is priced off the previous day's close as in our study with the remainder priced using some function of the closing price on the day of the auction. See footnote 7 for further discussion of these alternatives.

[3]Values are taken from the *Factbook 2001* published by the NYSE.

[4]The data are obtained from Aronson+Johnson+Ortiz LP, an active quantitative investment management firm that manages small- to mid-cap growth stocks. We thank them for providing their proprietary trading data for this study.

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used in the study. Section IV compares the costs of trading a package with estimates of the benchmark cost of trading the securities individually. In addition, we use trade and quote-level data to examine hypotheses regarding the source of the lower cost of the package trades. Section V analyzes the strategies of the bidders as well as the strategy of the fund manager. Specifically, we highlight differences in how liquidity providers formulate their bids, as well as the decision of the fund manager to accept or reject the lowest bid. Section VI concludes.

II. A Model of Blind (Principal Bid) Auctions

A. The Manager's Problem

Consider an asset manager whose investment decision process generates a list of securities transactions. Such a list might result from the periodic execution of a proprietary quantitative model that determines the investable universe for the portfolio or from periodic meetings of an investment committee. The list of transactions might also result from a liquidity shock, such as a cash inflow or redemption. Note that the composition of trades on the list can consist of buys, sells, or a mixture of buys and sells. One option available to the manager is to execute the list of transactions individually on the in-house trade desk (this may include utilizing any of a number of traditional mechanisms such as agency trading or the upstairs market). However, this is potentially expensive if the objective is to trade the securities quickly because transaction costs for liquidity demanders increase with the degree of immediacy desired.

Alternatively, the manager can sell the list to a broker for execution. When the broker agrees to assume ownership of the package and execute the trades, execution risk is transferred from the asset manager to the broker. In the arrangement between the broker and asset manager examined here, this transfer is achieved by the broker assuming ownership of the bundle of stock positions and guaranteeing to the manager the closing price at day $t - 1$ for each individual stock in the package. Thus, the manager is guaranteed "execution" of the package at yesterday's closing prices, and the execution risk associated with liquidating the package of trades now resides with the broker.

In placing a package up for bid, the manager's optimization problem is to minimize transaction costs by choosing between the low bid presented him in the auction and the expected transaction costs resulting from execution by the manager using his standard trading mechanisms. Thus, from the manager's perspective, the benefit of packaging trades is the elimination of execution (price) risk and the potential for lower costs of trading.

B. The Brokers' Problem

Consider a set of brokers who each have a stochastic book of pending transactions, where each broker only knows the composition of his own book. The books are stochastic with respect to the stocks that are represented, the amounts to be traded, and the direction of the trades. Each broker is presented with the opportunity to bid on a package of trades that would deliver a large amount of

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order flow to the broker and provide the potential for many pending trades to be completed. Brokers submit a bid or commission fee they are willing to receive for assuming the execution risk of the package and providing liquidity. Each bid, which is a function of the individual broker's expected costs of trading the package components, is presumably high enough to cover his own costs of liquidating the package (plus some profit) but lower than the manager's expected cost of executing the individual trades in-house. Thus, from the broker's perspective, the benefit of bidding on a package arises from the ability to inexpensively acquire bulk order flow.[5] The broker's optimization problem is to maximize profits, which are a function of the brokers' cost of trading, by choosing a bid that is low enough to win the auction but high enough to generate profits from the trades.

Why might the broker's expected costs of trading a package be lower than the manager's expected costs?

Hypothesis 1. The broker may have a large book of pending transactions (or may soon have from successful bids on other packages), and these transactions may represent the other side of many of the manager's trades already in place, resulting in the potential for low cost crosses.

Hypothesis 2. The broker may not be constrained by the immediacy facing the manager and, as a result, has a trading horizon that is longer than the asset manager's, permitting patient, lower cost trading.

Hypothesis 3. The broker possibly has greater trading expertise than the manager as a result of the benefits from economies of scale afforded by a larger trading operation.

The last two hypotheses are broker-specific and are not related to the characteristics of the package and its components. The first hypothesis is jointly related to both the composition of the broker's book and the composition of the package. It is this aspect of the package that can sufficiently lower the broker's cost so that he can submit a low enough bid (below the manager's expected cost) to be successful, yet be high enough (above his own expected costs) to be profitable. Obviously, the larger the percentage of the package that can be crossed with existing positions on the broker's book, the lower the cost to the broker of executing the trades and the higher his overall profit.

C. Conditions for Equilibrium

First, and perhaps obviously, the use of a competitive auction will ensure a competitive and fair price for the transaction services being demanded. Second, a double blind auction is used because of information asymmetries arising from proprietary information that neither party to the transaction wants to reveal to the other. The auction is double blind in the following sense: i) the broker does not know the identities of the individual securities in the package, and is provided only with limited information (e.g., sector and market cap distributions and

[5] An additional advantage of a successful bid on a package of trades is that the broker can induce a large quantity of order flow by adjusting a single commission fee, which is preferable to adjusting the separate commissions for individually brokered transactions on many stocks.

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percentage of Nasdaq stocks) concerning the degree of intersection between the package and his book; and ii) the manager does not know the composition of the broker's book and the potential for crosses with trades contained in the package and, therefore, has limited information about the broker's cost of executing the trades in the package. From the manager's perspective, the package of trades is the output of the manager's proprietary model; minimizing the dissemination of that information is important and valuable to the manager. If the auction were not blind, each bidder, irrespective of their bid, would know the forthcoming trades of either the manager or the winning bidder and would be able to front-run those trades. Thus, the losing bidders could extract trading profits at the expense of the higher trading costs for the manager or the winning bidder. The same arguments can be applied to the revelation of the bidder's existing book of trades. The double blind feature ensures the confidentiality of information from both sides of the transaction.

Also relevant here is the "no trade" principle of Milgrom and Stokey (1982) that too much information may cause markets to break down. On one hand, if the bidders know the components of the package, they can extract the entire cost of the manager trading the securities on his own, effectively shutting down the mechanism. On the other hand, if the manager knows the trading costs of bidders, she can extract the entire surplus from their bids, again shutting down the market. Rothschild and Stiglitz (1977) provide another example of this problem in the context of the insurance market.

III. The Blind Auction Mechanism and Supporting Data

A. A Description of the Auction Process

In the blind auction mechanism, the manager puts the package of transactions up for bid in a sealed bid auction. The "price" submitted by the bidders participating in the auction is the commission fee, stated in average cents per share, they will charge to assume ownership of the package.[6] Thus, the *lowest* submitted commission fee wins the auction. While technically the bidders are unaware of the identities of the other bidders, given that the set of active bidders is small, bidders probably have some idea who they are bidding against.

To give some feel for the heterogeneity of the trades within a package, Panel A of Table 1 provides sample information for the individual trades in a package that was auctioned on October 29, 1999. The package shown is smaller, in terms of number of names and total value, than the typical package in our sample, but was chosen to illustrate the potential for uncertainty regarding the degree of trade difficulty associated with the transactions contained in these packages. First, most

[6]Other package trading mechanisms guarantee different pricing functions for the component stocks. For example, some auctions that we have been made aware of guarantee the weighted average transaction price throughout the auction day instead of yesterday's closing price, thereby reducing the price risk to the broker and lowering the fee charged the manager. Our example represents the most difficult case from the bidder's perspective. Thus, transaction cost savings in our setting would lend strong support for the trading efficiency of this general class of mechanisms that includes auctions with less risky pricing rules.

of the stocks are small and illiquid, with many residing in the smallest half of market capitalization for NYSE stocks. Second, the quantity of shares to be traded is large, in most cases representing a significant fraction of typical daily dollar trading volume and, in two extreme cases, represents 43% and 126% of each stock's average daily dollar trading volume (see the *VolRatio* variable). As mentioned previously, this information on the package composition is not revealed to the brokers bidding on the package.

TABLE 1

Package Components and Aggregate Statistics for the October 29, 1999 Package

Panel A. Package Components

Ticker	Buy/Sell	Shares	*VolRatio*	Ticker	Buy/Sell	Shares	*VolRatio*
ADPT	S	2,700	0.52	FNV	S	41,300	12.87
AFG	B	72,100	126.42	GTW	S	8,200	0.50
BSC	S	4,900	0.94	HIG	S	33,300	6.30
CCR	S	4,800	0.81	LEH	S	10,700	1.70
CDD	S	27,500	15.92	LRCX	S	12,200	6.45
CI	B	19,000	2.87	MGG	B	3,700	3.19
CLE	S	106,700	22.99	NSI	B	45,000	42.53
CMH	S	35,250	8.87	ODP	B	97,600	2.71
CP	B	8,900	2.33	OK	S	17,850	12.40
CTX	S	20,000	5.66	OSSI	B	28,200	6.07
DLJ	S	21,600	4.43	PCAR	B	8,300	6.41
EAT	B	9,700	3.12	S	B	37,900	1.62
ENI	B	9,000	3.78	SEG	B	98,000	4.46
ETR	B	9,800	1.68	UB	S	17,800	7.67
FHS	B	2,6000	3.42	WLL	B	5,500	2.31

Panel B. Aggregate Package Statistics

Number of stocks	30
Total no. of shares	843,000
Average closing price	$37.13
Total value of pkg. ($ mill.)	$24.73
% of stocks that are Nasdaq	13.3
% of stocks that are buys	50
Median mkt. cap. ($ bill.) of stocks in pkg.	$3.878
Mean price inverse for stocks in pkg. (%)	3.75
Mean shares traded per stock	28,117
Mean (*VolRatio*) for stocks in pkg. (%)	10.68
Skewness (*VolRatio*) for stocks in pkg. (%)	4.55

Panel A contains a list of the individual securities that were auctioned as a package on October 29, 1999, and reports whether the individual security transaction was a buy or a sell, the desired number of shares to be traded, and a relative measure of trade size, *VolRatio*, which is defined as [(Number of Shares Traded∗Price)/(Average Daily Dollar Trade Volume over the previous 12 months)]∗100. Panel B presents some of the summary characteristics for the October 29, 1999 package that were provided to the bidders for their use in preparing bids for the package.

Nevertheless, some of the uncertainty regarding the trade difficulty of the package is resolved prior to the bidding because information regarding the *characteristics* of the package is provided to potential bidders on the morning of the auction. The characteristics include: i) the number of stocks in the package; ii) the total number of shares to be traded; iii) the total package value (number of shares multiplied by yesterday's closing price); iv) the percentage of buys; v) the percentage of Nasdaq stocks; vi) the average correlation of the component securities with the S&P 500; vii) the distribution of market capitalization for the component securities; viii) the distribution of *VolRatio* = [(Number of Shares Traded∗Price)/(Average Daily Dollar Trade Volume over the previous 12 months)] ∗100; ix) the distribution of quoted spreads within the package; and x) the allocation of the component securities across economic sectors.

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Panel B of Table 1 displays some summary statistics for the characteristics of the October 29, 1999 package. The information in Panel B is not as detailed as the distributional summary statistics given to the bidders. For example, we do not report on the industry membership and bid-ask spread quotes for the stocks in the package, information that is provided to the bidders. Nevertheless, Panel B does give some appreciation for the incomplete picture the brokers have when formulating their bids. What the potential bidders might infer from this somewhat fuzzy snapshot is that the package is not particularly large ($24.73 million in total value), is equally distributed across buys and sells, and contains a substantial percentage of small-cap stocks, most of them being non-Nasdaq stocks, many of which trade in relatively illiquid markets. What this incomplete picture *does not* tell the bidders is that there are a number of extremely difficult trades that represent significant fractions of typical daily dollar trading volume. The information given the bidders does not provide any clues about potential trouble stocks that may be distressed or otherwise going through difficult times. Note that although the picture is incomplete, all the bidders are provided with this same fuzzy image.[7]

The information regarding the above characteristics is submitted to the potential bidders by 8:00AM ET on the morning of the auction. Each participating bidder returns a (sealed) bid by 9:00AM ET that same day. The bid represents a cents-per-share commission fee that the broker will charge the asset manager to guarantee execution at yesterday's closing prices for the trades in the package. The asset manager collects all bids and makes a decision by 9:15AM ET (before the market opens) to either accept the lowest bid or reject all bids (and execute the trades using his standard trading technique). Each bidder is notified and informed whether their bid is accepted or rejected. In the case of rejection of all bids, the asset manager shares no information on the submitted bids, the outcome of the auction (i.e., was a bid accepted?), the identities of the bidders, or the identity of the desired transactions with the bidders. In the case of a winning bid, the list of desired transactions (specifying the identity of the stocks, the direction of the trades (buy or sell), and number of shares) is transferred immediately to the winning broker. However, neither the outcome of the auction nor the list of desired transactions is revealed to the losing bidders.

If a bid is accepted, the asset manager wires the net proceeds (purchases minus sales) plus the commission (i.e., the amount of the winning bid) to the winning bidder. In addition, the winning bidder takes possession of shares (in the case of a sale) and transfers shares to the asset manager (in the case of a purchase). Two logistical issues are worth noting. First, the executed package is typically reported in London or Tokyo, thereby camouflaging the transaction. Second, individual trades within the package are cleared using the standard $T + 3$ procedure. Thus, the winning bidder has three days to deliver the necessary shares to accommodate the manager's purchases.

[7]While there is an incentive on the part of the manager to package some extremely difficult trades, two items mitigate this. First, most package trading arrangements contain a *force majeure* clause that automatically eliminates from the package individual trades that experienced a 5% price move from the previous day close to the open on the morning of the auction. Second, the manager's reputation as a trustworthy counterparty would be jeopardized, and the set of subsequent bidders reduced, by attempting to hide difficult trades in the package.

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B. The Package Data

Our data contain the auction details and the contents of 83 packages of equity trades with a combined value of $7.32 billion that were auctioned over the period July 1998 through July 2000. We have details for every stock included in each package: the ticker symbol; a buy-sell indication; the number of shares to be traded; the exchange on which the stock trades; the average daily dollar trading volume over the previous 12 months; the closing price on the day before the auction; and market capitalization. Regarding auction information, we have the identities and bids of all the bidders for each auctioned package, as well as the decision by the asset manager to either accept the lowest bid or pass on all bids.

Table 2 provides summary characteristics separately for the completed and passed packages. Out of 83 packages, a winning bid is accepted for 48 packages with a combined value of $4.27 billion ("completed" packages), while 35 packages with a combined value of $3.05 billion have no bid accepted ("passed" packages). The packages range from 30 to 396 stocks of which 5% to 50% are Nasdaq stocks. The percentage of buy orders is in general near 50%, although the percentage ranges from 15% to 100%. In comparing the completed vs. passed packages, the samples are similar in terms of the total value of the package, the percentage of component stocks that are Nasdaq, and the market capitalization of the component stocks. However, the completed packages tend to contain more stocks on average (163) than do the passed packages (98), while the passed packages contain a much larger trade volume per stock in the package (35,743 shares) than do the completed packages (20,651 shares).

TABLE 2

Characteristics of Common Stock Package Trades, Reported Separately for Completed and Passed Packages

	Mean	Std. Dev.	Min	25th	Median	75th	Max
Panel A. Completed Packages ($N = 48$)							
Total value of securities in pkg. ($ mill.)	88.97	73.33	16.36	39.03	58.08	122.36	323.25
Number of stocks in pkg.	163	101	30	82	129	243	396
% of stocks that are Nasdaq	23.3	7.6	6.8	19.1	24.2	28.2	37.4
% of stocks that are buys	50.8	14.0	15.8	44.1	50.0	53.3	100.0
Mean shares traded per stock	20,651	12,910	3,289	11,743	18,526	27,890	66,655
Mean (*VolRatio*) for stocks in pkg. (%)	10.81	6.24	1.00	5.66	10.40	14.36	26.69
Mean mkt. cap. ($ mill.) of stocks in pkg.	13,358.5	11,275.1	1,403.2	6,086.4	9,583.6	13,065.2	40,442.6
Mean price inverse of stocks in pkg. (%)	3.79	0.82	2.05	3.27	3.88	4.30	5.80
Panel B. Passed Packages ($N = 35$)							
Total value of securities in pkg. ($ mill.)	87.26	50.11	26.97	45.82	86.85	114.03	231.31
No. of stocks in pkg.	98	41	38	74	93	115	220
% of stocks that are Nasdaq	26.4	11.7	4.5	15.7	26.4	33.8	48.6
% of stocks that are buys	46.7	6.6	31.9	41.6	45.6	51.6	59.6
Mean shares traded per stock	35,743	20,076	11,444	19,052	30,170	48,571	80,992
Mean (*VolRatio*) for stocks in pkg. (%)	15.21	9.89	4.18	8.03	12.33	19.63	45.29
Mean mkt. cap. ($ mill.) of stocks in pkg.	11,534.2	10,596.9	1,890.4	4,513.1	7,000.8	14,587.3	38,330.0
Mean price inverse of stocks in pkg. (%)	4.06	0.98	2.74	3.00	4.16	4.90	6.29

Panel A contains statistics for auctioned packages for which a bid was accepted and the package contents were transferred to the bidder. Panel B contains statistics for those packages for which the low bid was rejected and the securities in the package were individually traded by the asset manager. *VolRatio* is defined as [(Number of Shares Traded∗Price)/(Average Daily Dollar Trade Volume over the previous 12 months)]∗100. Total value of the packages is $4.27 billion in Panel A and $3.05 billion in Panel B. All packages were auctioned during the period July 1998 to July 2000.

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The summary statistics in Table 2 also indicate that the packages are populated with very large and difficult trades, as revealed through *VolRatio*, the ratio of dollar volume traded to the average daily dollar trading volume measured over the prior 12 months. Further, the passed packages contain, on average, more difficult trades than the completed packages. The average trade size of the stocks in the completed packages represents 10.81% of the average daily dollar volume, while the corresponding number for the passed packages is 15.21%. The large difference in trade difficulty between the completed and passed packages suggests that the manager's decision to pass on packages is perhaps related to relatively higher bids associated with the presence of more difficult trades in those packages. Indeed, for one of the passed packages, the average dollar trade size of the component trades represented 45.3% of their respective average daily dollar volume. And for eight of the 35 passed packages, the average dollar trade size exceeded 50% of average daily dollar volume for more than 10% of the stocks in the package.

IV. Evidence on Packaging as a Low Cost Trading Mechanism

A. Estimated Benchmark Costs of Trading the Package Components Individually

While we have the manager's realized trading costs for the passed packages, the manager's costs of executing the individual trades within the package are not observed for the successfully auctioned packages since the trades are not executed by the manager. To proxy both for the absent realized costs for the traded packages as well as to develop a general pricing model for package trades, we construct a benchmark for the costs of executing the individual trades contained in the packages. To construct the benchmark, we first estimate a model of trade costs developed by Keim and Madhavan (1997). Their model shows that equity trade costs for institutional money managers are a function of trade venue (NYSE, Nasdaq), trade size, market capitalization, and the inverse of price (a proxy for the proportional bid-ask spread). We use updated parameter estimates of their model for the combined periods April 1996 to March 1997 (just prior to the sample period for our packages) and calendar year 2000 (concurrent with the latter part of our sample period and after the tick size reduction).[8] The estimated parameters of the model for a sample of U.S. equity trades for 33 institutional money managers follow (*t*-statistics are in parentheses).

[8]The Nasdaq Order Handling Rules were phased in from January 20, 1997, through October 1997. In addition, the tick size reduction from 1/8th to 1/16th occurred on June 2, 1997, for Nasdaq and June 24, 1997, for the NYSE. Our benchmark estimates make use of data both before and after the Rule changes to account for the possibility that institutional trade costs may have been affected by these regulatory changes (see Jones and Lipson (2001)). A previous version of the paper uses benchmark estimates based only on the 1996–1997 institutional trade data (because many of the packages in our sample occurred before 2000). These previous results are qualitatively the same as those reported in this version of the paper.

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Buys:

$$\begin{aligned} Cost_i \;=\; & \underset{(5.56)}{0.2690} + \underset{(7.74)}{0.3489}\, D_i^{OTC} + \underset{(12.74)}{0.5274}\, TradeSize_i + \underset{(23.38)}{17.2316}(1/P_i) \\ & - \underset{(-10.09)}{0.1152}\, ln(Mcap_i) \quad \text{Adj. } R^2 = 0.022 \\ & \qquad\qquad\qquad\qquad\qquad\qquad (N = 82{,}313) \end{aligned}$$

Sells:

$$\begin{aligned} Cost_i \;=\; & \underset{(19.80)}{0.7093} + \underset{(16.98)}{0.8691}\, D_i^{OTC} + \underset{(25.42)}{1.2102}\, TradeSize_i + \underset{(5.35)}{0.3408}(1/P_i) \\ & - \underset{(-13.68)}{0.1558}\, ln(Mcap_i) \quad \text{Adj. } R^2 = 0.024, \\ & \qquad\qquad\qquad\qquad\qquad\qquad (N = 71{,}087) \end{aligned}$$

where *Cost* is the total cost of the trade (including both price impact and commissions), D^{OTC} equals one for a Nasdaq stock and zero otherwise, *TradeSize* is the number of shares traded as a percent of the total shares outstanding, *P* is the stock price, and *Mcap* is the market capitalization of the stock in $ billions. As in Keim and Madhavan (1997), trade costs for this updated sample of institutional trades are significantly related to the independent variables for both buys and sells: costs are higher for Nasdaq stocks than for exchange-traded stocks, are positively related to trade size and the bid-ask spread, and are inversely related to market capitalization.

We use these parameter estimates in conjunction with the corresponding characteristics for the individual components of the packages to compute predicted values of the costs associated with execution of individual trades having those characteristics by a representative institution. For example, the predicted cost of buying 50,000 shares of a Nasdaq stock with a market cap of $1 billion and a price of $25 is 1.31%. Think of these predicted values as the costs incurred by the asset manager (liquidity demander) had she actually executed the trades individually.

Once the predicted costs for the individual trades are computed as described above, we then aggregate by computing the volume-weighted trade cost for each package. This volume-weighted trade cost is a benchmark for the cost of trading this package of securities, in the specified quantities, by a *typical institutional investor*. For example, the estimate for the benchmark cost of the package trade of October 29, 1999 (described in Table 1) is 1.17%. Across all 83 packages in our sample, the average estimated benchmark cost of trading the package components individually is 1.556% (averaged over the individual components within a package, then across packages) with a standard deviation of 0.655%. The median estimated benchmark cost across packages is 1.549%, with a minimum (maximum) of 0.398% (3.642%). What remains to be seen is how these estimated benchmark costs of trading the stocks individually compare with both the costs to the liquidity demander associated with auctioning the securities in package form and the trade costs realized by the manager when the auction bids are rejected.

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B. The Determinants of Brokers' Bids

While it is possible to estimate the trade costs of individual trades of the liquidity demander, it is not possible to assess the costs incurred by the brokers when trading the package securities because we do not have information on the percentage of trades within the package that can be crossed with existing positions in the broker's book. At one extreme, all the trades in the package could be crossed, and the broker's cost of providing liquidity would be zero. In this case, the broker's profit from assuming the responsibility of executing the package equals the commission charged. At the other extreme, all the trades in the package would have to be executed immediately in the market and, therefore, have costs equivalent to the asset manager's expected costs. In this case, the broker suffers an expected loss equal to the asset manager's expected costs minus the broker's commission. Because some positive percentage of the trades will likely be crossed with existing positions in the broker's book, the broker's expected profits (and costs) will lie between these two extremes.

What determines the costs for the trades that the broker actually executes? The broker faces the same trade-specific costs that are defined in previous research. These costs are related to the size of the trade (i.e., the volume of shares traded), the liquidity of the venue in which the stock trades (Nasdaq vs. NYSE), and the bid-ask spread. However, in the context of a package of trades and because of the sequence of events in the blind auction process, there are additional factors that are important. First, there is a diversification effect related to the number of stocks in the package. The greater the number of stocks in a package, the greater the possibility that subsequent adverse price movements will offset each other (Axelson (1999) examines this effect in the context of bundling securities for sale; see also Gorton and Pennacchi (1993)), thereby lowering the total cost of executing the individual trades in the package. Second, the relative numbers of buy and sell transactions in the package will affect the probability of crosses with the broker's existing inventory of positions. Other things equal, a broker with a surplus of existing buy (sell) transactions would submit a lower (i.e., more aggressive) bid for a package that contained predominantly sell (buy) transactions. For packages that contain similar numbers of buys and sells, this effect will be negligible. Finally, because in our specific blind auction the broker is guaranteeing yesterday's closing price in an auction that takes place the following morning, the overnight behavior of markets will affect the prices at which the broker will be able to liquidate the positions in the package. Further, the magnitude of this effect will be a function of the composition of buys and sells within the package. For example, a package that contains predominantly buys will elicit a higher (less aggressive) bid if the overnight market return is positive, other things equal, because the expected higher opening prices for stocks will result in higher expected execution values. The opposite will occur for a package of predominantly sells. For packages that contain similar numbers of buys and sells, this effect will be negligible.

To provide some confirmation of the determinants of the broker's expected costs of executing the trades contained in the packages, we estimate a model that includes the factors discussed above. We include the following factors to capture

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the main costs and benefits of assuming ownership of the package: the number of stocks in the package; the total number of shares to be traded; the skewness of *VolRatio* (defined as the ratio of the dollar value of the trade to the average daily dollar trading volume over the prior 12 months); the percentage of stocks in the package that trade on Nasdaq; and the average of the inverse of the stock price (a proxy for the proportional bid-ask spread). To capture the buy/sell concentration effect as well as the behavior of the overnight market, we use the following two variables—the number of buys as a percentage of the total number of trades in the package, and the overnight return on the S&P 500 futures from Globex. Note that in our sample the number of buys expressed as a percentage of the total number of trades in the package is tightly distributed around 50% (half of our sample of packages have a value for the percentage buys that lies between 42% and 53%, and 90% of the packages lie between 35% and 65%). Because of the lack of packages that are predominantly buys or sells, we expect that neither the buy/sell concentration effect nor the overnight market effect described in the previous paragraph will be easily detected in our sample. Indeed, neither of these variables, nor an interaction term, was significant when included in the model, so we do not include them in the specification below. The regression estimated for all 83 packages in our sample yields the following results[9] (*t*-statistics are in parentheses),

$$\begin{aligned} Bid_i \;=\; & -\underset{(2.69)}{0.307} - \underset{(5.01)}{0.001}\, NumStocks_i + \underset{(7.02)}{0.008}\, NumShr_i \\ & + \underset{(1.09)}{0.017}\, TrSkew_i + \underset{(5.31)}{0.015}\, Nasdaq_i + \underset{(5.63)}{0.172}\,(1/P_i) \\ & N = 83; \quad \text{Adj. } R^2 = 0.721, \end{aligned}$$

where Bid_i is the low bid for package i stated as a percent of the value of the package and reported in percentage terms; $NumStocks_i$ is the number of stocks in package i; $NumShr_i$ is the mean number of shares traded for stocks in package i, in thousands of shares; $TrSkew_i$ is the estimated skewness of the distribution of *VolRatio* for stocks in the package i; $Nasdaq_i$ is the percentage of stocks in package i that trade on Nasdaq (in %); and $1/P_i$ is the mean of the ratio of 1.0/price for the stocks in package i.

The regression results provide a clear characterization of the bidder's concerns regarding execution costs when submitting a bid. First, bids are lower (more aggressive), the larger the number of stocks that are being traded. This is consistent with the idea that the larger the number of stocks in a package, the greater the diversification effect in execution risk. In contrast, bids are higher (less aggressive) as the total share volume within a package increases, reflecting larger and, therefore, more difficult trades for a given number of stocks within a package. Also, bids are increasing in the degree of skewness in the distribution of trade size. These results are symptomatic of the bidder's concern that a small number of individual trades in the package might be extremely difficult to execute, perhaps representing substantial fractions of typical daily trading volume. For such

[9]The regression is also estimated using the average bid as the dependent variable, which yielded quantitatively and qualitatively similar results.

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packages, the cost of these few extremely difficult trades may represent a significant portion of the overall cost of trading the entire package. Lastly, bidders submit higher (less aggressive) bids, the higher the proportion of Nasdaq stocks and the lower the average price level. Huang and Stoll (1996) and Keim and Madhavan (1997) show that institutional trade costs are higher for Nasdaq stocks than for NYSE stocks. Similarly, Harris (1994) points out that given a common fixed minimum tick size, the bid-ask spread represents a larger percentage of the stock price the lower a stock's price level. Therefore, all else equal, low priced stocks tend to be more costly to transact. While the R^2 of the regression is high, the unexplained portion (representing 26% of the variation in bids) is not trivial and is likely attributable to the proportion of trades in the package that can be crossed in the broker's book. We will turn to this in Section V.

C. A Comparison of Package (Bid) Costs and Benchmark Trade Costs

Table 3 and Figure 1 compare the low (winning) bid, stated as a percent of total package value, the benchmark cost, estimated according to the model discussed in Section IV.A, and the asset manager's realized trading costs for the passed packages.[10] To highlight the differences in the costs for the completed and the passed samples, the left side of Figure 1 presents results for the completed packages while the right side presents the passed packages. Within each graph, the package costs are listed in chronological order. There are several important observations. First, all three series are highly correlated. Fluctuations in the low bids across packages have correlations with the estimated benchmark trade costs and the realized trade costs of 0.82 and 0.63, respectively. In addition, for the passed packages, the estimated benchmark trade costs have a correlation with the manager's realized trade costs of 0.63.

Second, trade costs—both estimated benchmark costs and package low bids—are higher for the passed packages than for the completed packages. The average low bid on the passed packages (1.11%) is significantly higher than the average winning bid on the completed packages (0.67%) with a *t*-value of 8.14. Similarly, the average estimate of individual trade cost for the passed packages (1.92%) is significantly higher than for the completed packages (1.29%) with a *t*-value of 4.93. These findings confirm the inferences drawn in Section III.B from the package characteristics in Table 2: to wit, the stocks in the passed packages are more difficult to trade than the completed packages, resulting in higher bids that have, on average, a greater likelihood of being rejected.

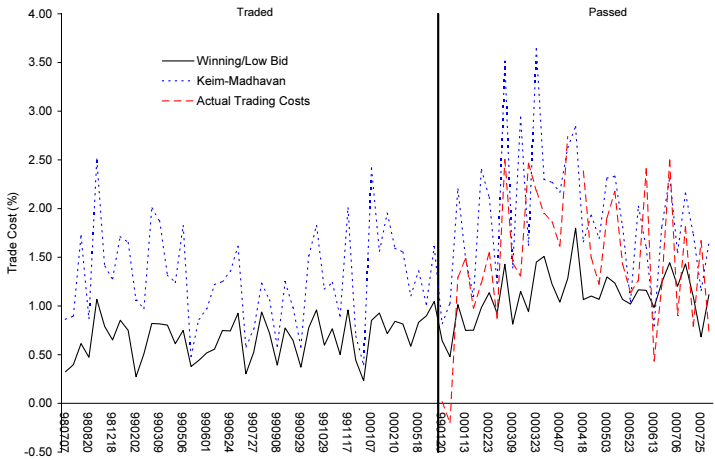
Third, the bids are lower than both the estimated benchmark trade costs and the manager's realized trade costs for almost every package. Over the entire sample, the average benchmark trade cost is 1.56% in contrast to 0.70% for the average low bid, and the difference is significant ($t = 14.76$). This difference is larger for the passed packages (0.82%, $t = 9.26$) than for the traded packages (0.62%, $t = 12.63$). For the passed packages, the average benchmark trade cost and realized trade costs are 1.92% and 1.49%, respectively. Both figures are

[10]The manager's realized trading costs are calculated by volume weighting the percent change of the trade prices to the previous day's closing price.

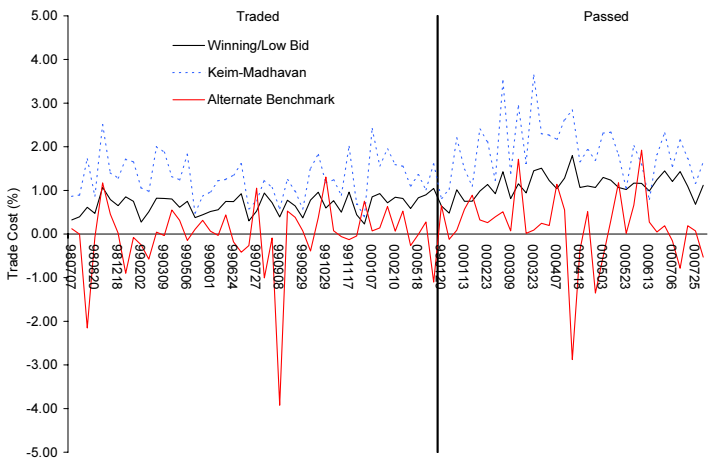
FIGURE 1

A Comparison of Trade Costs to Auction Bids

Graph A. Keim-Madhavan Estimate of Trade Cost, Winning/Low Package Bid, and Realized Trade Costs



Graph B. Winning/Low Package Bid, Keim-Madhavan Benchmark, and Alternate Benchmark–Opening Trade



The benchmark trade cost estimate is generated using the Keim-Madhavan (1997) trade cost model with updated data for the combined periods April 1996–1997 and calendar year 2000 (see Section IV.A for details). The winning/low package bid represents the winning bid in the case of a completed package and the lowest bid in the case of a passed package. The realized trade costs are the costs the manager actually incurred trading the components of the passed packages. The data in the completed (passed) portions of Graphs A and B are listed in chronological order.

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statistically significantly higher than the average low bid of 1.106%.[11] An important implication of these last findings is that for the packages for which a winning bid is accepted, the manager saves, on average, an economically significant 62 basis points by auctioning the package, measured relative to the estimated benchmark cost. By the same token, for the 38 packages in the passed sample, the manager suffers 82 basis points of foregone savings if measured against the benchmark and 39 basis points of foregone savings if measured against his own realized trade costs. Of course the foregone savings are a function of the ex post *actual* transactions costs incurred by the manager, which are distinct from the manager's *expectations* of transactions costs before the trades are executed. The discrepancy between actual and expected is likely a function of the difficulty in assessing the trading ability of his internal desk, the changing liquidity profile within the market, and errors in estimating the execution risk associated with different packages. The issue of learning about the estimation errors from the manager's accumulated experience with these auctions is important in understanding this discrepancy. Although addressing the issue of learning is beyond the scope of the analysis in this paper, Section V.C contains an analysis of the manager's decision.

As an alternate benchmark for the individual trade costs, we also compute the costs assuming the bidder traded all package components at the opening trade on the day of the auction. This is an admittedly unrealistic assumption because it assumes the bidder can execute large trades at the opening price and without any price concession. We know that many of these trades represent substantial fractions of average daily volume and require large price concessions in order to satisfy such demands for immediacy. Nonetheless, it does provide a "lower bound" to the costs of trading the package individually. Graph B of Figure 1 overlays the alternate benchmark. The mean of the alternate benchmark is 0.05%. Notice that the bid lies between the Keim-Madhavan benchmark and the lower bound estimate (alternate). The alternate benchmark as well as the manager's own realized trade costs provide support for the reasonableness and accuracy of the Keim-Madhavan benchmark, which incorporates price concession costs, as well as our claim that package trading provides cost savings to both the manager and the bidders.

D. Basis for Cost Savings

Given the significant overall cost savings of auctioning a package of securities transactions relative to trading the individual securities internally, we examine Hypotheses 1, 2, and 3 from Section II.B concerning this efficiency gain. Using individual security trade and quote-level data from the NYSE TAQ database, we argue that the cost savings are due primarily to three advantages that the bidders (liquidity providers) have over the asset manager. First and most importantly, Hy-

[11] There are some caveats to the realized trading cost figures. On one hand, the manager did not always complete the full number of shares for each component. The manager failed to complete the total number of shares for 17 of the 35 passed packages while seven packages had less than 95% of the original shares executed. On the other hand, the manager sometimes executed more than the volume specified in the package. The first effect biases the costs downward, while the second effect likely biases the costs upward.

TABLE 3

Mean Low Bids and Estimated Benchmark Costs for Package Trades

	Packages			
	All (N = 83)	Completed (N = 48)	Passed (N = 35)	t(Passed−Completed)
Estimated benchmark trade cost (%)	1.556 (0.655)	1.290 (0.486)	1.922 (0.684)	4.93
Winning (or low) bid (% of total pkg. value)	0.855 (0.321)	0.672 (0.217)	1.106 (0.269)	8.14
Manager's realized trade cost (%)			1.494 (0.706)	
Benchmark cost−bid	0.702 (0.431)	0.618 (0.339)	0.817 (0.515)	2.12
t (Benchmark cost−bid)	14.76	12.63	9.26	

Table 3 reports average values for the winning (or low) auction bids and for estimates of a benchmark cost of trading the securities in the package by a typical institutional trader, and the manager's realized trading costs. Standard deviations are in parentheses. The package trades were auctioned during the period July 1998 to July 2000. The benchmark cost is a volume-weighted average of the individual cost estimates for all the securities in the package. To obtain estimates of trade cost (commissions+impact) for each of the individual securities in the package, we use the following estimation of a model proposed by Keim and Madhavan (1997),

$$\textit{Buys}: \quad Cost_i = \underset{(5.56)}{0.2690} + \underset{(7.74)}{0.3489}\, D_i^{OTC} + \underset{(12.74)}{0.5274}\, TradeSize_i + \underset{(23.38)}{17.2316}(1/P_i) - \underset{(-10.09)}{0.1152}\, ln(Mcap_i) \quad \text{Adj. } R^2 = 0.022 \ (N = 82{,}313)$$

$$\textit{Sells}: \quad Cost_i = \underset{(19.80)}{0.7093} + \underset{(16.98)}{0.8691}\, D_i^{OTC} + \underset{(25.42)}{1.2102}\, TradeSize_i + \underset{(5.35)}{0.3408}(1/P_i) - \underset{(-13.68)}{0.1558}\, ln(Mcap_i) \quad \text{Adj. } R^2 = 0.024, \ (N = 71{,}087)$$

where $Cost_i$ is one way total trade cost (price impact+broker commissions) in percent; D_i^{OTC} equals 1 if traded security i is Nasdaq, 0 otherwise; $TradeSize_i$ equals number of shares traded/shares outstanding in percent; $Pinv_i$ is the inverse of the closing price of security i on the day before the trade; and $Mcap_i$ equals price of security i∗shares outstanding, stated in billions of dollars. We use updated parameter estimates of the Keim and Madhavan (1997) model over the combined periods April 1996 to March 1997 and the calendar year 2000 for the U.S. equity trades of 33 institutional managers. These parameter estimates are used in conjunction with the corresponding characteristics of the individual components of the package to obtain an estimate of the cost of executing an individual trade having those characteristics by a representative institution.

pothesis 1 states that bidders hold potentially extensive inventories of offsetting transactions that can be used to cross a large portion of the individual package trades. Again, crossing trades presents zero costs to the bidders and is likely to represent the majority of the cost differential between the manager and bidders. Hypothesis 2 states that the bidders have less demand for immediacy than the manager when disposing of the acquired position, resulting in a longer trading horizon. We do not have evidence on how much longer their trading horizon might be, however, anecdotal evidence suggests that liquidity providers may take several days, and possibly weeks, to complete a large trade, whereas the manager's horizon is typically two or three days at most. Hypothesis 3 argues that on average the bidders are likely to be better traders than the traders on the manager's internal trading desk. These efficiencies in trading are likely to come from economies of scale associated with a large trading operation and/or the proximity and linkages to exchanges (potentially owning seats on particular exchanges or being designated market makers).

To investigate these three hypotheses further, we extract the trade and quote data from the TAQ database for each of the stocks within each package. For

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each individual stock symbol, we collect all trades and quotes for the nine-day period beginning three days before the auction date and ending five days after the auction date. In preparing the trade and quote data to be used in calculating the variables of interest, we conduct the standard adjustments. First, the national best bid and offer (NBBO) is calculated over the nine-day window for each stock. Second, trades are adjusted using the Lee and Ready (1991) five-second rule and are designated as buyer- or seller-initiated using the Lee and Ready classification scheme. In particular, trades are designated as buyer- (seller-) initiated if the trade price is above (below) the current NBBO midpoint. For trades at the NBBO midpoint, the initiator is determined by whether the last transaction price change was an uptick (buy) or downtick (sell).

Using the trade and quote data, we construct three variables that are relevant for Hypotheses 1–3: i) cumulative market-adjusted returns, ii) net dollar trading volume in the direction of the package trade, and iii) a trading efficiency measure. We discuss the construction of each in turn.

To construct cumulative market-adjusted returns, we compute daily returns for each stock using end-of-day quote midpoints, then the return of the Russell 2000 value index over the corresponding day is subtracted to obtain a measure of market-adjusted movement for each stock. We use the Russell 2000 value index to match the small-cap value characteristics of the stocks in our sample (which are dictated by the investment style of the asset manager). Having normalized the market-adjusted return of each stock to one the day before the auction, we cumulate the market-adjusted return for six days beginning on the auction day. We construct a weighted average separately for buys and sells and for three categories of size for the package trades, where the weights are the dollar volume of the package trade. The three size groups are: small trades, including trades that make up less than 50% of that stock's average daily dollar volume; medium trades, including trades between 50% and 100% of average daily dollar volume; and large trades, including trades larger than the average dollar volume traded in one day.

Our dollar trading volume variable is based on the difference between trading volume in the direction of the package trade vs. trading volume against the direction of the package trade. For each half-hour period, we sum separately the buyer- and seller-initiated dollar trading volume associated with each stock in the package. Given the substantial differences in trading volume across stocks in the sample, we normalize the dollar trading volume by dividing the buyer- and seller-initiated dollar trading volume by the average daily dollar trading volume for that stock (measured over the prior 12 months). We then assign a trade direction to the volume series associated with each particular trade within the package. Specifically, if a stock is to be purchased (sold) within a package, then the buyer-initiated (seller-initiated) volume is designated as volume *with* the package trade and the seller-initiated (buyer-initiated) volume is designated as volume *against* the package trade. For both series, volume with and against the package trade, we construct a weighted average (again the weights are the dollar volume of the package trade) where stocks are allocated to a category according to the stock's trade size (small, medium, and large). Finally, we cumulate the difference between the volume with the package trade and the volume against the package trade. By cumulating the difference between the volume with and the volume against the

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trade, we have a measure of the net volume in the direction of the package trade for each half-hour period over the window.

Our third variable measures where trade prices are executed relative to the NBBO at the time of the trade. For each buyer-initiated trade, we calculate the ratio of the trade price to the existing national best ask quote, while for each seller-initiated trade we calculate the ratio of the existing national best bid quote to the trade price. This ratio, which we refer to as our trading efficiency variable, provides a measure of where the transaction price occurs relative to the corresponding NBBO quote. Ratio values less than one denote trade prices within the NBBO spread that contain price improvement, while values greater than one denote trade prices outside the NBBO spread that contain price concessions. Like the trading volume variable, we assign a trade direction to the buyer- and seller-initiated trading efficiency series based on the direction of the associated trade within the package. This results in a trading efficiency measure with the trade and a trading efficiency measure against the trade. Similar to the net volume variable, we compute a weighted average of the trading efficiency measures separately for the three trade size categories (small, medium, and large).

Using these data, we examine Hypotheses 1–3 by investigating the extent to which the manager or the bidders leave "footprints" of their trading activity in the period surrounding the auction. Hypothesis 1 asks whether the cost differential between trading the securities as a package and trading the securities individually is due to the bidders' ability to cross a portion of the package trades with their own inventory, as opposed to the manager trading each individual security using his standard trading technique. Provided the bidder is able to cross some of the trades within the package and consequently avoid the market altogether, we should observe, on average, a smaller trading impact associated with the stocks in the completed packages relative to the passed packages. Moreover, this difference is likely to be greatest for the most difficult (largest) trades. Figure 2 compares the cumulative market-adjusted return, or price impact, surrounding the auction date for the passed packages (Graph A) and the completed packages (Graph B). Other things equal, the larger the percentage of the package's stocks that are not traded the larger the positive (negative) slope associated with the cumulated price impact for buys (sells). Also, the larger the volume to be traded, the steeper the slope should be. Consistent with our hypothesis, the cumulative trading impact of the passed packages (Graph A) is substantially larger than the trading impact of the completed packages (Graph B) for virtually all trade sizes. Moreover, a large fraction of the trading impact appears within two trading days of the auction. Significance tests show that the passed packages have statistically higher trading impacts at the 10% level within both parametric and non-parametric tests for day zero and one on the buyside and days one and two on the sellside. [12] Also, the larger is the trade, the greater is the price impact both for buy and sell trades as well as for passed and completed packages.

Hypothesis 2 states that the manager demands more immediacy than the bidders. We argue that the patience of the bidders is likely to manifest itself as a long

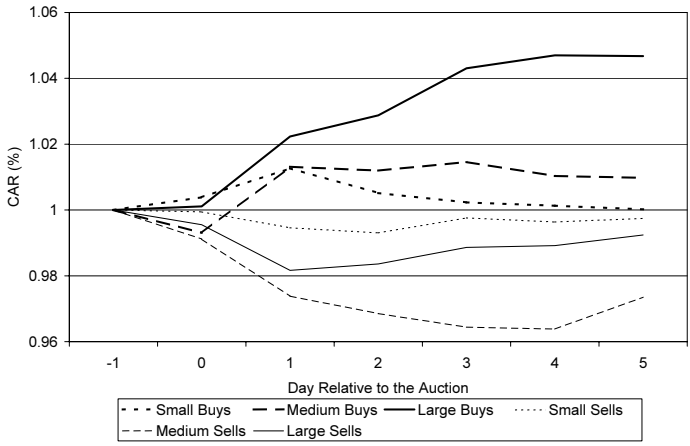
[12] We compare the traded and passed package trades statistically using a standard *t*-test as well as a Wilcoxon rank sum test applied to all package trades as well as to trade size categories.

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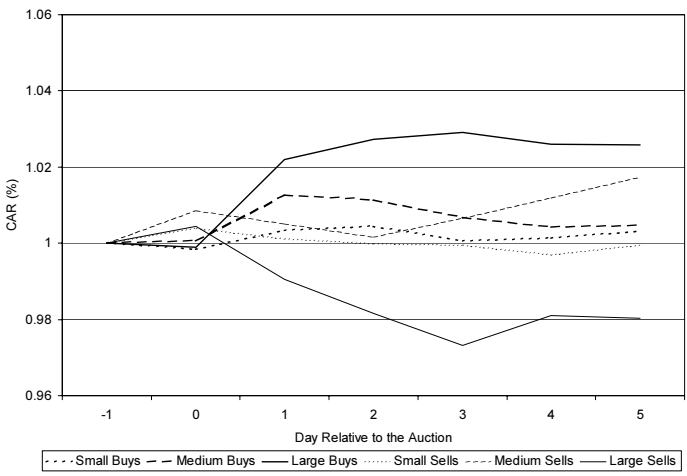
FIGURE 2

Cumulative Market-Adjusted Returns for Passed and Completed Packages

Graph A. Passed Packages



Graph B. Completed Packages



Market-adjusted returns are constructed by subtracting the daily Russell 2000 value index return from the daily return of each stock in a package and then cumulated for six days starting on the auction day. Aggregate statistics are calculated using a weighted average of abnormal returns, where the weights are the dollar volume of the package trades. Small, medium, and large trades represent less than one-half, between one-half and one, and more than one day's worth, respectively, of average daily dollar trading volume.

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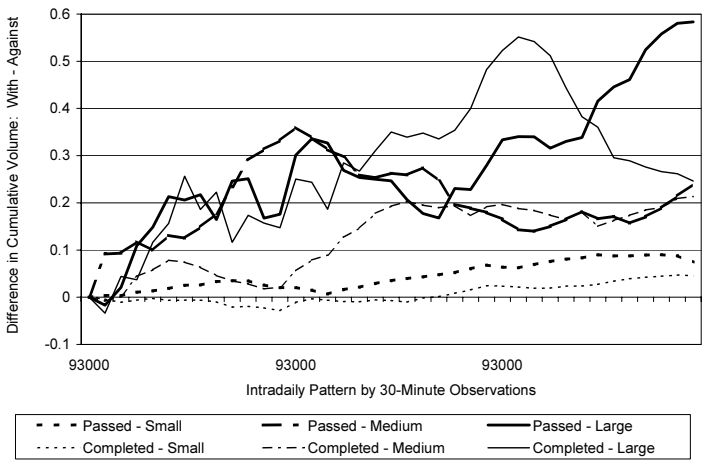
investment horizon, since bidders have the ability to spread trades over a longer time. One way to investigate this is to analyze the difference between the cumulative trading volume in the direction of the package trade and the cumulative trading volume against the trade. This difference in cumulative trading volume expresses the "excess" trading volume that accumulates in the direction that the manager, and potentially the bidders, may be trading. Under the hypothesis that the bidders have a longer investment horizon, the bidder's net trading volume in the direction of the trade should be positive, but less than the manager's net trading volume in the direction of the trade. Figure 3 compares the net trading volume in the direction of the trade for passed and completed packages broken out by trade size over the auction day, the subsequent day, and days two through five aggregated together. Notice that, in general, the net cumulative volume measures are all positive, suggesting that there is more volume cumulating in the direction of the manager's trade than against. Consistent with our hypothesis, the net cumulative volume measures for the passed package trades are higher than the net cumulative volume measures for the completed packages trades, particularly for the small- and medium-size trades for the two trading days following the auction. While there appears to be less of a clear difference between the net cumulative volume measures for the large trades, the auction day results are consistent with our intuition. Statistically, the differences between the passed and traded cumulative volumes only show up the day of the auction. Furthermore, the differences across packages are significant at the 1% level for the non-parametric test but not significantly different for the parametric test. These results provide some evidence consistent with the bidders being able to work the trades over a longer horizon thereby incurring smaller transaction costs because of low immediacy demands.

Hypothesis 3 suggests that bidders are, on average, more facile traders. Despite the fact that trading expertise is extremely difficult to quantify given the complexity of the notion of a "good" trade and the many ways of measuring performance, we focus on one aspect of trading performance, namely the transaction price relative to the quoted bid-ask spread (NBBO). On one hand, the ability of a trader to execute trades inside the quoted spread suggests an ability to capture price improvement for his trade and thereby reduce the costs of immediacy. On the other hand, transacting at prices that exceed the quoted prices suggests the trader is paying a price concession, in addition to the quoted spread, to execute the order immediately or to trade in size. Thus, the ability of a trader to routinely trade inside the spread, despite trading large quantities, would be consistent with trading expertise. We measure the trading expertise of the manager and the bidders by comparing the trading efficiency variable in the direction of the package trades. If the manager's trading efficiency ratio is higher than the bidder's trading efficiency ratio, it implies that the bidders are more adept at realizing price improvement and/or avoiding price concessions for their trades as compared to the manager.

Figure 4 compares the difference in the trading efficiency measures between passed and completed packages broken out by trade size over the auction day, the subsequent day, and days two through five aggregated together. The results show that the trading efficiency measure for the completed package trades remains at or below one with few exceptions (one notable exception are small trades early

FIGURE 3

Cumulative Net Volume in the Direction of the Package Trades



Dollar volume is summed at 30-minute intervals and normalized by average daily dollar volume over the past 12 months, signed using Lee and Ready (1991) and then cumulated by initiator. Each series represents the weighted average of the difference between the cumulative volume in the direction of the package trade and the cumulative volume against the package trade, where the weights are the dollar volume of the package trades. Small, medium, and large trades represent less than one-half, between one-half and one, and more than one day's worth, respectively, of average daily dollar trading volume.

on the day of the auction). This suggests that the bidders are trading at or inside the quoted spread, typically avoiding price concessions when they trade. In contrast, there are sustained periods where the trading efficiency measures for the passed package trades are *above* one, most notable of these are the largest trades during the auction day. Significance tests show that the differences across passed and traded packages are significant at the 1% level for both parametric and non-parametric tests for days one and two. Consistent with our hypothesis, the trades the manager executes himself (passed trades) are more likely to carry with them larger transaction costs because he is executing larger trades and suffering price concessions. And as expected, the largest trades generate the highest price concessions for the manager.

V. Strategies within the Blind Auction: Bidder Behavior and Manager Decisions

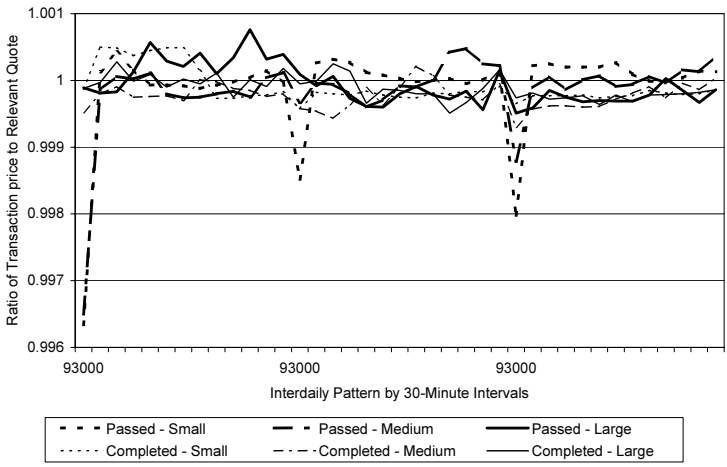
A. Bidder Behavior

In addition to information on the characteristics of the securities contained in the packages, we also have the individual bids (in cents per share) submitted by all competing brokers in the auctions for the packages. The number of brokers participating in an individual auction ranges from three to six. However, there

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FIGURE 4

Trading Efficiency Measure in the Direction of the Package Trade



For each trade, the ratio of the trade price to the quoted ask, in the case of a buyer-initiated trade, or the ratio of the quoted bid to the trade price, in the case of a seller-initiated trade is calculated. Weighted averages of these ratios are calculated at 30-minute intervals where the weights are dollar volume of the package trade. The initiator is determined using the Lee and Ready (1991) algorithm. Small, medium, and large trades represent less than one-half, between one-half and one, and more than one day's worth, respectively, of average daily dollar trading volume.

were four brokers that participated regularly throughout the sample period, so the analysis we present will focus exclusively on those four brokers.[13]

Table 4 contains summary statistics on package characteristics and broker bidding behavior reported separately by broker and by whether the broker's bid was a winning or a losing bid. Panel A reports mean characteristics of bids and packages when the broker submitted a losing bid in an auction for a package, and Panel B reports the same statistics for packages where the broker submitted the winning bid (i.e., the asset manager accepted the low bid) or the best bid (the asset manager passed on the low bid) in an auction. Panels A and B in Table 4 report the following separately for each broker: the bid, stated both in cents per share and as a percentage of the total value of the package; the differences between the broker's bid and the winning (or lowest) bid, the second-best bid, and the high bid; the difference between the broker's bid and the estimated benchmark trade cost, as described in Section IV.A; and the mean values of the package characteristics described in Section III.B.

Turning first to Panel B, which contains the results associated with the brokers' winning bids, a relationship is evident between the degree of trading difficulty of a package and the broker who submitted a winning bid. For example, Broker A tended to submit relatively high bids for the least difficult packages—those packages with the smallest total value and that contained the largest cap (most liquid) stocks, stocks with trade volumes that represent a small percentage

[13]The number of bids submitted by the three brokers that we exclude from the analysis range from three to seven, and none are winning bids.

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TABLE 4

Bidding by Brokers on Blind Packages

	Broker			
	A	B	C	D
Panel A. Mean Characteristics of Bids and Packages when Broker Submitted Losing Bid				
No. of bids	60	43	56	35
Broker's losing bid (cents/share)	31.6	32.1	28.6	25.2
Broker's losing bid (%)	1.14	1.15	1.02	0.83
Winning or best bid (%)	−0.30*	−0.27*	−0.22*	−0.18*
Second-best bid (%)	−0.17*	−0.15*	−0.08*	−0.08*
Worst bid (%)	0.10*	0.13*	0.16*	0.18*
Benchmark cost (%)	0.37*	0.45*	0.48*	0.40*
Mean of total pkg. value ($ mill.)	94.4	93.9	82.8	75.8
Mean no. of stocks in pkg.	139	129	145	145
Mean percentage Nasdaq stocks	24.1	25.5	23.9	22.1
Mean percentage of buys	49.4	47.9	49.8	50.9
Mean shares traded per stock	28,393	28,606	24,411	20,321
Mean (*VolRatio*) (%)	12.74	13.44	11.75	9.73
Mean mkt. cap. ($ bill.) of stocks in pkg.	12.5	10.9	13.6	16.1
Panel B. Characteristics of Bids and Packages when Broker Submitted Winning or Low Bid				
No. of bids	7	39	25	12
Broker's winning or best bid (cents/share)	25.1	22.1	27.5	19.6
Broker's winning or best bid (%)	0.79	0.83	0.99	0.70
Second-best bid (%)	0.06**	0.15**	0.10**	0.20**
Worst bid (%)	0.34**	0.36**	0.36**	0.50**
Benchmark cost (%)	0.49**	0.72**	0.69**	0.81**
Mean of total pkg. value ($ mill.)	51.5	81.8	101.4	120.9
Mean no. of stocks in pkg.	76	145	116	200
Mean percentage Nasdaq stocks	22.9	23.9	26.5	23.7
Mean percentage of buys	51.5	50.3	47.8	46.5
Mean shares traded per stock	22,973	24,872	33,081	23,671
Mean (*VolRatio*) (%)	8.15	11.96	14.32	14.36
Mean mkt. cap. ($ bill.) of stocks in pkg.	18.8	13.8	10.9	8.4

Table 4 presents summary statistics specific to each broker's losing bids (Panel A) and winning bids (Panel B). The top portion of each panel contains average values of each broker's losing (Panel A) and winning (Panel B) bids, reported both in cents per share and as a percentage of total package value. Also reported in the top portion of each panel are average values of the corresponding winning bids, second-best bids, worst bids, and benchmark costs (as defined in Table 3) for the auctioned packages, all stated relative to the broker's bid (in %). *VolRatio* is defined as [(Number of Shares Traded∗Price)/(Average Daily Dollar Trade Volume over the previous 12 months)]∗100. The results are based on 83 packages auctioned during the period July 1998 to July 2000.

*indicates that the value is significantly different from the broker's losing bid at the 0.05 level; **indicates that the value is significantly different from the broker's winning bid at the 0.05 level.

of average daily volume, the lowest percentage of Nasdaq stocks, and a low share volume for the component stocks. These are packages for which the estimated benchmark execution cost (1.27%) is relatively low. Consistent with this profile is a conservative bidding strategy in which Broker A tended to win by just edging out the others in tight bidding. Broker A's average winning bid is just six basis points below the second-best bid, and only 49 basis points below the estimated benchmark cost of individually executing all the implied transactions in the package.

At the other extreme, Broker D submitted the lowest bids for the most difficult packages: those packages with the largest total value and that contained the smallest cap (least liquid) stocks, stocks with trade volumes that represent a large percentage of average daily volume, the highest percentage of Nasdaq stocks, and a high share volume for the component stocks. The estimated benchmark execution cost for these packages is 1.51%. In pursuing these more difficult packages, Broker D is following a more aggressive bidding strategy in which the average

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winning bid is 20 basis points below the second-best bid and a substantial 81 basis points below the estimated benchmark cost of individually executing all the implied transactions in the package. One might interpret this as evidence of the winner's curse, but remember that it is quite possible that Broker D might have been able to cross many of these transactions with existing trades in its book, resulting in a low average cost of disposing of the package contents. Although we do not have direct evidence on this, we examine this possibility indirectly in Section V.B.

Brokers B and C appear to be following moderately aggressive bidding strategies that might be described as more balanced than Broker D, winning with relatively high bids for packages of moderate to difficult trade characteristics. The estimated benchmark execution cost for these packages ranges from 1.53% to 1.67%. Brokers B and C submitted bids that are 10 to 15 basis points below the second-best bid and approximately 70 basis points below the estimated benchmark cost of individually executing all the implied transactions in the package.

The evidence in Panel A of Table 4 regarding the losing bids tends to reinforce the assessment of the bidding strategies sketched above. For instance, Broker A's conservative strategy is evident in the level of the losing bid relative to both the winning bid and the benchmark cost. When Broker A loses, his bid is significantly higher, by 30 basis points, than the winning (or best) bid, and is 37 basis points below the benchmark cost, not much lower than when he submitted the winning bid. At the other extreme, Broker D appears to submit fairly aggressive bids even when he loses, the bids being only 18 basis points higher, on average, than the winning bid. Interestingly, Broker D's losing bids are only 40 basis points lower than the benchmark cost for those packages, in direct contrast to the 81-basis-point difference for his winning bids, further highlighting the aggressive nature of his bidding strategy in auctions that he wins.

B. The Determinants of Bidder Behavior

The above results regarding the relation between bidding strategy and package characteristics prompt the question: Do specific package characteristics factor into the bid calculation differently across brokers? For example, one broker might attach more importance to the presence of extremely large trades in a package than another broker, perhaps because of a relatively weaker trade desk. Or one broker might attach more significance to the concentration of Nasdaq stocks within a package than to the number of names in a package because they have less access to a Nasdaq market making operations and are less concerned that they be able to cross the trades internally. To examine these issues, we estimate the empirical model of the determinants of package bids that was developed in Section IV.B separately for each of the four brokers in our sample, [14]

$$Bid_i = a_0 + a_1 NumStocks_i + a_2 NumShr_i + a_3 TrSkew_i + a_4 Nasdaq_i + a_5(1/P_i).$$

[14] We also estimated the models in this section with two additional variables that are described in Section IV.B—the number of buys as a percentage of the total number of trades in the package, and the overnight return on the S&P 500 futures from Globex. For the same reasons described in that section, the coefficients on the two variables are insignificant in each broker-specific model, so we do not report the models that include those variables.

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The resulting bidding functions, estimated across both winning and losing bids, are reported in Table 5.

TABLE 5

Individual Bidding Functions for Package Auctions

	Broker			
	A	B	C	D
Intercept	−0.6370 (−3.39)	−0.4595 (−2.64)	-0.1074 (−0.90)	0.0331 (0.22)
No. of stocks in pkg.	−0.0003 (−0.88)	−0.0013 (−3.52)	−0.0013 (−5.05)	−0.0009 (−2.82)
Mean shares traded for stocks in pkg.	0.0114 (5.99)	0.0108 (5.94)	0.0054 (4.28)	0.0039 (1.70)
Trade size skewness	0.0174 (0.63)	0.0325 (1.36)	0.0092 (0.56)	0.0099 (0.47)
% of stocks in pkg. that trade on Nasdaq	0.0058 (1.36)	0.0200 (4.61)	0.0040 (1.27)	0.0127 (3.11)
Price inverse (proxy for bid-ask spread)	0.3297 (7.13)	0.1899 (4.11)	0.2640 (7.68)	0.1351 (3.51)
Adj. R^2	0.66	0.62	0.67	0.48
No. of obs.	67	82	81	47

Table 5 reports estimates of the following model separately for each of the four brokers who bid on the packages in our sample, $Bid_i = a_0 + a_1 NumStocks_i + a_2 NumShr_i + a_3 TrSkew_i + a_4 Nasdaq_i + a_5 1/P_i + e_i$, where Bid_i is the broker's bid for package i stated as a percent of the value of the package and reported in percentage terms; $NumStocks_i$ is the number of stocks in package i; $NumShr_i$ is the mean number of shares traded for stocks in package i, in thousands of shares; $TrSkew_i$ is the estimated skewness of the distribution of *VolRatio* for stocks in the package i; $Nasdaq_i$ is the percentage of stocks in package i that trade on Nasdaq (in %); and $1/P_i$ is the mean of the ratio of 1.0/price for the stocks in package i. *VolRatio* is defined as [(Number of Shares Traded∗Price)/(Average Daily Dollar Trade Volume over the previous 12 months)]∗100. The results are drawn for a total sample of 83 packages auctioned over the period July 1998 to July 2000. t-values are reported in parentheses.

The regression estimates in Table 5 show that the influence of the package characteristics on the magnitude of the submitted bids varies across brokers. The package characteristics that appear to have the largest and most significant impact on bid levels are the average of the price inverses of the stocks within the package, a proxy for the average bid-ask spread, and total shares in the package. The coefficients on price inverse and total shares are positive and significant for each of the broker regressions. As discussed earlier, both these characteristics result in higher expected trade costs for a package and, therefore, higher bids. Regarding the other characteristics, there are some differences across the brokers with respect to the extent they condition their bids on these variables. For example, Broker A's bids are not significantly related to the number of stocks in the package, the presence of excessively large trades in the package (as measured by skewness of the distribution of trade size within the package), or to the percentage of Nasdaq stocks in the portfolio. Indeed, the skewness coefficient, although insignificant, comes in negatively. These results might be evidence of a very simple bidding strategy, or evidence that Broker A expects to be able to cross many of the trades with existing positions in its portfolio so that the expected costs of executing the trades in the package are not relevant.[15]

[15]We also estimate a version of the Table 5 regression where, in addition to the original variables, each explanatory variable is interacted with a dummy variable that takes on the value one if the bid is a winning (or best) bid and zero otherwise. The coefficients on the variables that are interacted with the dummy variable measure the difference in a variable's influence on the broker's bidding strategy

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C. The Manager's Decision to Accept or Reject the Low Bid

Another interesting aspect of the auction process is the decision by the asset manager to either accept the lowest bid, or pass and execute the individual trades himself. In general, the cost savings afforded a typical manager through the auction mechanism is the difference between the lowest bid and the benchmark cost. This measure of cost savings is positive and significant for both completed and passed packages and, interestingly, is larger for the passed packages (see Table 3). Reinforcing this result, the realized trade costs of the specific manager within this study are also higher than the low bid for 80% of the passed packages. Given these findings, it would be useful to better understand the manager's decision process regarding the acceptance of bids.

We investigate the manager's decision by estimating a probit model of the choice to accept or reject the low bid. The dependent variable equals one when the asset manager accepts the lowest bid (completed package) and zero otherwise (passed package). The explanatory variables reflect the information revealed to the manager via the distribution of bids. Specifically, we use the low bid, the difference between the low bid and the second-lowest bid, and the range of the bids (difference between the highest and lowest bid). In addition, we include the benchmark cost that we estimated for each package.

Table 6 presents four models to analyze the manager's decision. In each model, the coefficient estimates can be interpreted as the impact of the variable on the probability of accepting the low bid. Model 1 confirms the standard intuition that the lower (more aggressive) the low bid the higher the probability that the manager will accept the bid. Model 2 investigates how the difference between the benchmark cost and the low bid influences the choice. The coefficient suggests that the more difficult the package (the higher the benchmark cost) the more likely the manager will pass on the low bid. This result can be interpreted as the manager imposing a reservation bid above which the manager passes, irrespective of the cost of executing the individual trades. Model 3 incorporates more information about the distribution of the bids. We include the lowest bid, the difference between the lowest and second-lowest bid as well as the range of the bids. As before, the lower the winning bid the more likely the manager will accept the bid. In addition, the larger the range of the bids, the more likely the manager will accept. This result is consistent with a manager choosing to trade a package when the winning bid is unusually aggressive relative to the other bids (presumably because of some bidder-specific advantage such as an extensive inventory). Model 4 incorporates all four explanatory variables as well as dummy variables for each bidder to control for the identity of the bidders. None of the bidder dummy variables is significant. Consistent with the previous models, the low bid loads negatively, the bid range loads positively and the benchmark cost is insignificant. Thus, the manager appears not to condition on the identity of the bidders, and after controlling for the low bid and the range of the bids, the level of

depending on whether the broker submits the lowest bid vs. when the broker's bid is not the lowest. The results are both quantitatively and qualitatively similar to those presented in Table 5, however, few of the coefficients on these additional variables are significant.

the benchmark cost does not figure into his decision on whether to accept or pass on the package.[16]

TABLE 6

Probit Model of Asset Manager's Decision to Trade or Pass

	Model			
	1	2	3	4[a]
Intercept	4.15* (0.80)	0.69* (0.28)	3.90* (0.90)	3.65* (1.03)
Low bid	−4.53* (0.89)		−5.40* (1.10)	−6.09* (1.37)
Difference between low bid and second-lowest bid			−1.64 (1.89)	−2.21 (2.35)
Bid range			3.43* (1.22)	3.50* (1.43)
Difference between benchmark cost and low bid		−0.70 (0.34)		0.29 (0.71)

Table 6 presents the results of a probit analysis of the decision to accept the lowest submitted bid or reject all bids. The dependent variable takes on the value one if the package is completed and zero otherwise.

[a]Model 4 was also estimated using dummy variables for the individual bidders. No coefficient was significant at the 5% level; *indicates values significant at the 1% level. Standard errors are in parentheses.

VI. Conclusion

The equity market landscape is replete with different trading mechanisms designed to provide liquidity to market participants. Given the vast array of trading mechanisms available, the question of which one is best is an obvious question with not such an obvious answer. We explore an example of an alternative liquidity provision mechanism whereby a liquidity demander auctions a package of trades to potential liquidity suppliers through a blind auction. The auction mechanism results in a transaction efficiency gain—our findings suggest that auctioning packages provide a 62-basis-point transaction cost savings for liquidity demanders, as well as an efficient method for liquidity suppliers to acquire order flow. We present evidence that the transaction cost savings are attributable to the liquidity supplier's ability to execute the component trades of the package at lower cost than the asset manager because of the liquidity supplier's i) ability to cross portions of the package with his own inventory, ii) longer trading horizon, and iii) greater trading expertise.

Our results have both regulatory and practitioner implications. On the regulatory side, the results suggest that the push for a consolidated, one size fits all model of liquidity provision implicitly ignores the disparate needs of liquidity demanders with respect to the execution of their trades. Those needs might best be served using different trading venues with different mechanisms. Our study of the package auction process demonstrates that an alternative liquidity provision mechanism can, in fact, provide cost savings relative to traditional liquidity

[16]We also estimated the probit model with the overnight return on the S&P 500 futures from Globex; however, the estimated coefficient was consistently insignificant for all model specifications and therefore not reported.

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provision mechanisms. In a larger sense, the findings highlight the importance of being able to innovate via new liquidity provision mechanisms that provide trading advantages not easily duplicated on more traditional exchanges.

From the practitioner perspective, the significant reduction in institutional trading costs demonstrated here has important implications for the investment performance of professionally managed funds because the large trading costs incurred by institutions are a major contributor to the poor performance widely documented in the literature. In addition, a blind auction of package trades represents an attractive liquidity provision mechanism for institutional traders given a number of recent developments that have added to the overall costs of transacting. First, recent reductions in the minimum tick size have resulted in significantly diminished quoted depth as well as displayed limit order depth. This change has likely increased transaction costs for institutional market participants who trade in large volume (Goldstein and Kavajecz (2000)). Second, the dispersion of depth across many competing trading venues has increased the search cost of finding liquidity providers for individual securities, particularly small-cap stocks. For these reasons, the package auction is an attractive alternative. In particular, auction bids are unconstrained by minimum tick sizes. Moreover, diminished cumulative depth coupled with its fragmentation among competing exchanges makes having liquidity providers come to the institution, instead of conducting a counterparty search, another advantageous feature.

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