THE UPSTAIRS MARKET FOR LARGE-BLOCK TRANSACTIONS: ANALYSIS AND MEASUREMENT OF PRICE EFFECTS

by

Donald B. Keim
Ananth Madhavan

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RODNEY L. WHITE CENTER FOR FINANCIAL RESEARCH
The Wharton School
University of Pennsylvania
Philadelphia, PA 19104-6367

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Donald B. Keim
and
Ananth Madhavan*

The Wharton School
University of Pennsylvania
Philadelphia, PA 19104-6367

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Abstract

This paper analyzes the effect on equity prices of large-block transactions negotiated 'upstairs.' We develop a model of the upstairs market which yields testable hypotheses. We investigate these hypotheses with unique data for 5,625 block trades in 1985-1992. Unlike previous studies, all the trades in our data are negotiated upstairs and are identified as either buyer- or seller-initiated. This information is critical because many block trades examined in the previous literature occur downstairs. We find that price movements up to four weeks prior to the trade date are significantly related to trade size, consistent with information leakage as the block is "shopped" upstairs. This suggests that permanent price impacts measured relative to the price on the day preceding the block trade can severely underestimate the information contained in the block trade. The temporary price impact has a concave response to order size, which is consistent with our prediction of more intensive search in the upstairs market as trade size increases. Since our sample consists of mostly small market capitalization stocks, our estimated price impacts are substantially larger than found in previous studies. We also find that the price responses for buyer- and seller-initiated trades are asymmetric.

1 Introduction

In recent years, large (block) transactions have accounted for a substantial fraction of the volume of trading in common stocks.[1] Many of these block transactions are negotiated in the so-called 'upstairs' market and are then brought 'downstairs' to the floor for execution. Markets resembling the upstairs mechanism exist for other assets and in other countries. Yet, despite its importance there are relatively few theoretical or empirical analyses of the process by which large-block trades are negotiated upstairs.[2] This paper analyzes the operation of the upstairs market and the effects of upstairs-negotiated block trades on stock prices.

The upstairs market is of interest not only because of its size but also because it operates quite differently from the 'downstairs' (auction-dealer) market that is currently the primary focus of academic research. Unlike the downstairs market, the upstairs market operates as a search-brokerage mechanism where an initiator contacts intermediaries or block traders who then search for contraparties to the trade. In addition, the negotiation process in the upstairs market takes time, so that information about the motives for trading may leak to the downstairs market and result in significant pre-trade movements. Further, the transitory price concession demanded by liquidity providers to accomodate a large trade may be less in the upstairs market than in the downstairs market because the block trader finds contraparties to cushion the price impact. These differences between the upstairs and downstairs markets may be associated with significant differences in price formation, but have largely been ignored in the theoretical literature.

From an empirical perspective, our knowledge of the upstairs market is also incomplete. Although several previous papers have examined the price impacts associated with large-

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[1] A block trade is defined traditionally as a trade of 10,000 or more shares. While this definition is an imperfect measure of size, it does provide an indication of the relative importance of block trading. Block trades of 10,000 shares or more amounted to almost 51 percent of New York Stock Exchange (NYSE) share volume in 1992; in 1965 the corresponding figure was just 3 percent.

[2] Burdett and O'Hara (1987), Seppi (1990), and Grossman (1991) provide theoretical analyses of block trading. Scholes (1972), Kraus and Stoll (1972), Mikkelson and Partch (1985), Holthausen, Leftwich, and Mayers (1987), Ball and Finn (1989), and Choe, McInish, and Wood (1991) provide empirical evidence on the price impacts of large-block trades, some of which were arranged upstairs.

block transactions, their data are of limited use for an analysis of the upstairs market for several reasons. First, the block trades used in previous studies are identified by their size, not by the mechanism where they originate, and consist of a mixture of upstairs and downstairs trades. Indeed, the majority of block trades occur in the downstairs market; only 27 percent of NYSE block volume in 1992 was negotiated upstairs by member firms.[3] This can result in sample selection bias because block trades in active markets are more likely to reflect downstairs trades than block trades in inactive markets.[4] Another problem arises because the trades examined in previous studies may represent only parts of larger orders that are broken-up for easier execution in the downstairs market. Order fragmentation can potentially bias the measured price impacts associated with upstairs-negotiated trades. Finally, the data used in previous studies often do not identify a block trade as buyer- or seller-initiated and this has to be inferred indirectly from tick tests based on the direction of the price movement. Again, this procedure may result in biases because some trades (perhaps those of greatest interest) may be incorrectly classified.[5]

This paper's objective is to increase our understanding of the effects of large transactions negotiated in the upstairs market on the prices of common stocks. We develop a model of the upstairs market that incorporates the key feature of this mechanism, i.e., the search-brokerage nature of trading, in a framework where optimizing agents endogenously form their beliefs and strategies. The model yields testable hypotheses that formalize and extend previously articulated predictions about the price effects associated with a block trade.

We investigate these hypotheses with unique data on block trades. Our data differ from those used in previous empirical examinations of block trades in several important respects. First, there is no ambiguity about the market in which these block trades were

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[3] New York Stock Exchange (1993). Note that most previous studies of block trading use only NYSE stocks.

[4] For active stocks it is not unusual for downstairs market makers to accommodate trades well in excess of 10,000 shares from inventory. See, e.g., Madhavan and Smidt (1992) and Hasbrouck and Sofianos (1992) who find that NYSE specialists frequently take large positions for their own accounts.

[5] In our sample, the use of the tick test would result in the misclassification of 6.5% of the seller-initiated trades and 20.1% of the buyer-initiated trades, and these errors would significantly alter our conclusions.

initiated; all the trades in our sample were negotiated in the upstairs market. Thus, our data do not suffer from sample selection biases of the type noted above. Second, the block trades in our sample are not fragmented, so there are no difficulties in interpreting the price impacts associated with these trades. Third, the data employed here identify the trade as either buyer- or seller-initiated so that there is no possibility of systematic errors from incorrect inferences about trade initiation. Finally, whereas previous studies of price effects of block transactions in the U.S. markets generally examine only block trades on the NYSE, the blocks examined here are from the NYSE, AMEX and NASDAQ NMS. Our block trades are for stocks that reside in the bottom half of market capitalization on the NYSE; thus, the results document block price effects for less liquid stocks than previous studies.

The empirical results provide support for the model's predictions about price movements around upstairs-facilitated trades. Consistent with the model, we find that price movements up to four weeks prior to the trade date are significantly related to trade size. Intuitively, the upstairs market operates as a search-brokerage mechanism and there is an information leakage as the block is "shopped" prior to the trade date. Thus, the standard measure of the permanent price impact, estimated using trade-day price movements, can seriously understate the information contained in the block trade. This may explain why in the previous literature the permanent impacts measured on the block trade day are not related to trade size. Indeed, using the traditional definition we find that permanent impacts are significant but unrelated to trade size.

The temporary price impact (which captures the price-pressure effect of the trade) has a concave response to order size. This is consistent with our model, where a block trader will search for contraparties until the marginal search cost is equated with the marginal benefits in terms of a diminished temporary price impact (due to greater risk bearing capacity), bounding the impact. We also find significant asymmetries in the price impacts of buyer- versus seller-initiated trades. These asymmetries may reflect differences in the initiator's motivation for trade; buyer-initiated trades may be more likely to originate from traders with private information. Finally, the temporary price impacts of block trades, especially for seller-initiated trades which make up the bulk of our sample, are substantially larger than found in previous studies, probably due to the relative illiquidity of the markets in which our sample of smaller stocks trade.

The paper proceeds as follows. Section 2 develops a theoretical model of the upstairs market; Section 3 describes the data and provides summary results for our sample of block trades; Section 4 reports our results and the corresponding implications for assessing the implicit costs of trading; and Section 5 summarizes the paper.

2 A Model of the Upstairs Market for Block Trades

2.1 The Basic Framework

We begin our analysis with a theoretical examination of the operation of the upstairs market. We model the upstairs market as a search-brokerage mechanism and describe the optimal behavior of its participants. In the model, agents beliefs and strategies are endogenously determined. The model provides a natural framework to organize our subsequent empirical analyses and yields testable hypotheses regarding the price effects associated with an upstairs- facilitated trade. These predictions are consistent with previous empirical research and suggest new directions for further analysis. In addition, a formal description of this important market mechanism is of independent interest.

Consider a risky security whose full-information value at time T in the future, denoted by $\tilde{v}$, is distributed normally with mean μ. Our analysis focuses on the price path of the security around an upstairs-negotiated transaction that occurs at calendar time t_b. Let t_d represent the day when the block trading process is initiated, t_0 represent the day preceding the block, t_1 represent the day immediately after the block, where $t_d < t_0 < t_b < t_1 < T$. Associated with trading at times t_d, t_0, t_b, and t_1 are the prices p_d, p_0, p_b, and p_1 respectively. Note that only the block transaction price p_b represents a trade in the upstairs market; all other prices represent 'downstairs' dealer-auction market prices. Downstairs market prices equal the expected value of the stock given the public information at that time and are determined by an auction mechanism with atomistic traders.

Public information is assumed to evolve through time as follows. At the decision date t_d, the block trade is not public so that p_d is the unconditional expectation of the liquidation value, i.e., $p_d = E_{t_d}[\tilde{v}] = \mu$. The intermediate or pre-trade downstairs price p_0 may differ from μ because information about the size of the block trade that has become public through "leakage" in the upstairs market. This information is valuable because there is a possibility the trade is initiated by a trader with private information about the liquidation value of the asset, as we show below. When the block trade is arranged at time t_b, the block traders and contraparties are assumed to condition their beliefs on the size of the trade, so that for one of these agents, $E_{t_b}[\tilde{v}] = E[\tilde{v}|Q]$. At date t_1 after the trade is public, the post-trade price is equal to the expectation of the asset's value conditioned on order size, i.e., $p_1 = E_{t_1}[\tilde{v}] = E[\tilde{v}|Q]$.

It is useful at this stage to distinguish between the *permanent* and *temporary* components of the price changes around a block trade. These distinctions, first used by Kraus and Stoll (1972), are commonly used in the empirical literature on block trading. The permanent component represents the change in the market's perception of the security's value due to the block transaction. In previous empirical work, the permanent component is defined as the difference between the stock's price before and after the block, i.e., by $p_1 - p_0$. We argue below that this definition may understate the true revision in beliefs as a result of the trade. Intuitively, the inevitable leakage of information about order size as the trade is negotiated in the upstairs market may be reflected in the pretrade price. Our approach is to define a new measure of a permanent impact with reference to the price at the time the trade was initiated. Accordingly, we define the permanent impact as

$$\pi = p_1 - p_d. \tag{1}$$

The temporary component represents the transitory price movement necessary to provide the liquidity to absorb the block. We define the temporary component, τ, as the deviation between the block price and the price following the block where:

$$\tau = p_b - p_1. \tag{2}$$

The total price impact associated with the block trade is the sum of the two components, i.e., $p_b - p_d = \pi + \tau$. Our objective is to obtain closed-form solutions for the two price components. This is difficult because the price components are determined endogenously; the revision in beliefs and the price pressure effects depend on the optimal behavior of the initiator, which in turn is conditioned on expectations of the price effects of the trade.

2.2 Upstairs Market Participants

There are three types of agents in the model: a trader who initiates the block trade, a block trader (or upstairs market maker) who facilitates the trade by locating potential contraparties to take the opposite side of the block transaction, and the contraparty traders themselves. Traders maximize their utility given their conjectures regarding the strategic behavior of other agents and their beliefs about the value of the security. In equilibrium, agents' conjectures regarding strategies are correct and their predictions of the asset's value are based on rational expectations.

We examine the trading sequence in reverse order, analyzing first the contraparty traders who eventually take the opposite side of the block, and then considering the block trader's choice of the number of contra-parties to locate, and finally closing the model by analyzing the strategy of the initiator of the trade.

2.2.1 Potential Traders

Let Q represent the number of shares the initiator wishes to trade, where $Q > 0$ is interpreted as a buy order and $Q < 0$ is a sell order. The trade size chosen by the initiator is determined endogenously, and we describe the optimization problem below. The initiator contacts a block trader who locates potential traders. A representative potential trader (indexed by i) has a mean-variance utility function over final period wealth of the form

$$E[\widetilde{W}_i] - \left(\frac{\rho}{2}\right)\sigma^2[\widetilde{W}_i] \tag{3}$$

where $\widetilde{W}_i$ is the (random) wealth at time T, ρ_i is trader i's coefficient of absolute risk aversion, and $E[\cdot]$ and $\sigma^2[\cdot]$ represent the mean and variance operators, given the trader's information at time t_b. Wealth $\widetilde{W}_i$ is a random variable given by

$$\widetilde{W}_i = (\tilde{v} - p_b)q_i + c_{0i} \ . \tag{4}$$

where $\tilde{v}$ is the final-period value of the risky asset, q_i is the number of shares of the risky security traded by i, with the sign convention that purchases are positive and sales are negative, c_{0i} is trader i's initial cash holding, and p_b is the price at which the shares are traded.

We assume that the contraparties know the total size of the order. The assumption that order size is inferred by potential traders is consistent with the absence of anonymity in the upstairs market. Alternatively, this assumption can be motivated by reputational considerations including the block trader's desire to maintain long-term relationships with potential customers. For simplicity, we assume traders have homogeneous expectations and consider a representative contraparty.[6] Thus, the contraparty's expectation of asset value is equal (on average) to the post-trade price, p_1. The solution to the expected utility maximization problem (described in detail in the appendix) yields a demand function for the representative contraparty, denoted by $q_i(p_b; Q)$. The demand function depends on Q because the contraparty's expectation of asset value is conditioned on the signal conveyed by the initiator's order size.

2.2.2 The Block Trader

We assume the block trader is a competitive broker who does not hold inventory but facilitates the trade by locating contraparties to take the opposite side.[7] The brokerage

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[6] It is straightforward to extend the model to incorporate heterogeneous expectations without altering our conclusions.

[7] Many block traders do not take principal positions, possibly reflecting capital constraints, inventory holding costs, or agency problems. Our model can be extended to allow the block trader to act as a

function involves costly search, and the block trader charges commissions to offset these costs. Increasing the number of traders participating in the block transaction increases search costs and hence the initiator's commission fees, but decreases the price impact faced by the initiator since the block is absorbed by more contra-parties. A competitive block trader chooses the number of searches to minimize the total expected execution costs, which consist of the total price impact and the direct commission costs, of the initiator. At the optimal number of searches, the marginal cost of locating an additional trader must equal the expected marginal benefit in terms of a better price on the entire amount of the trade.

Burdett and O'Hara (1987) provide a model of the block market based on sequential search. Our model differs from theirs in important respects. In Burdett and O'Hara (1987), marginal search costs are interpreted as the marginal permanent price impact from revealing the impending trade to an increasingly large group of traders. More intensive searches increase the probability of execution, but result in larger permanent impacts. By contrast, the transaction price in our model reflects the trade size irrespective of when this information is revealed. Indeed, if it were possible for a block trader to deceive counter-parties about the trade size by limiting the number of searches, he or she would soon develop a reputation for such actions. Potential contraparties with rational expectations would make inferences about the true size of the order from the portion they observe or simply deal with other block traders. Thus, we do not treat the permanent price impact as an economic cost.[8]

Let $\phi(n)$ represent the total costs of locating n potential contraparty traders. Search costs represent the direct costs of finding a potential trader as well as the costs associated with the eventual physical distribution of the securities and the potential reputational costs if the trade turns out to be informationally motivated. (As noted above, the marginal permanent impact of an additional search is not a component of this cost function as this

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dealer who positions part of the block by treating the block trader as another contraparty.

[8] As in Burdett and O'Hara (1987), we assume that increasing the number of counter-parties does increase the speed at which the news of the block becomes public information. We discuss the implications of this assumption in detail below.

is a pecuniary cost.) In what follows, we consider cost functions of the form $\phi(n) = \delta n^{\gamma}$, where to assure an interior solution we assume that $\delta > 0$ and $\gamma \geq 1$. The constant δ is inversely related to the probability of locating willing contraparties; γ reflects the returns to the search process, with higher values implying diminishing returns to search.

Suppose the block trader contacts n contraparties to absorb the block. The equilibrium price of the block solves the equation

$$\sum_{i=1}^{n} q_i(p_b; Q) + Q = 0, \tag{5}$$

where $q_i(p_b; Q)$ is the potential trader's demand function. Let $p_b(Q; n)$ denote the block price solving this equation as a function of order size, Q, given the number of contraparties, n.

A competitive block broker facilitates the upstairs trade in such a way as to maximize the net revenue of the initiator. More intensive search decreases the overall price impact by increasing the number of contraparties but also increases commission costs. As shown in the appendix, this trade-off implicitly defines the optimal search intensity as a function of order size Q, denoted by $n(Q)$, and a corresponding commission schedule denoted by $c(Q)$. Thus, the block price, p_b can be expressed as a function of order size alone, i.e., $p_b(Q) = p_b(Q; n(Q))$. We can handle the case where the block trader can act as a broker-dealer by positioning a part of the block by treating the block trader as a contraparty that can be contacted at zero cost; this benefits the initiator by reducing execution costs but does not affect the main elements of the analysis. Finally, we must close the model by describing the initiator's choice of order size.

2.2.3 The Initiator

Given the strategies adopted by the traders and the block broker, the initiator (indexed as agent 0) faces a price schedule that is a function of trade size, denoted by $p_b(Q)$. Like contraparties, the initiator has a utility function of the form given by equation (3). The initiator, however, observes a private signal regarding the value of the risky asset at time T. Let y denote the realization of this signal, where we assume that y is drawn from a normal distribution with mean equal to the realized liquidation value, v. Then, using the properties of the normal distribution, the expected value of the security from the initiator's viewpoint is $E_0[\tilde{v}|y] \equiv \mu_0 = (1 - w_0)\mu + w_0 y$, where $w_0 \in (0, 1)$, i.e., the expectation is a weighted average of the prior mean and the signal.[9] The initiator's trade also reflects portfolio hedging motives. Let x denote the initiator's (unobservable) holdings of the risky asset, where (unconditionally) x is distributed normally with a mean normalized to zero. Thus, the initiator's order reflects a mix of information and liquidity motivations for trade.

An initiator with rational expectations recognizes the effect of trade size on the block price (through both permanent and temporary impacts) and commission costs. Let $\widetilde{W}_0$ denote the future wealth of the initiator, where $\widetilde{W}_0 = \tilde{v}(Q + x) - (p_b(Q) + c(Q))Q$. Substituting this into equation (3) and simplifying, the initiator's maximization problem is

$$\max_Q \mu_0(Q + x) - (p_b(Q) + c(Q))Q - \left(\frac{\rho}{2}\right) \sigma_0^2 (Q + x)^2 \tag{6}$$

where σ_0^2 denotes the conditional variance of the asset's value. The solution to the maximization problem yields an expression for order size as a function of information and asset holdings for a given the conjectured functional $p_b(Q)$.

2.3 Equilibrium Price Paths

We are now in a position to examine the equilibrium price movements around an upstairs-negotiated block trade. Recall that the total price impact of the trade is the sum of the temporary price effect (which represents the price pressure associated with the block trade) and the permanent effect (which represents the revision in public beliefs as a result of the block.) Equilibrium requires that the initiator's choice of order size be based on rational expectations about the total impact of the trade, and that the trade price in

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[9] The weight placed on the signal, w_0, is the ratio of the variance of prior distribution to the sum of the variance of the prior and the variance of the private information signal. See, e.g., DeGroot (1970).

turn be consistent with outsider's beliefs about the optimal behavior of the initiator. In other words, we search for functional forms for the temporary and permanent impacts that are consistent with the rational beliefs and actions of all optimizing agents in the model. In the appendix, we show that equilibrium exists if the degree of information asymmetry is not too severe. Formally, we require that the liquidity motive for trading (measured by the variance of the initiator's endowment x) be sufficiently large relative to the information motive for trade (represented by the precision of the initiator's private information signal.) If this condition is satisfied, we obtain closed-form solutions for the temporary and permanent components.

The following result characterizes the temporary price effects of a block trade.

Proposition 1 *In equilibrium, the temporary price component of an upstairs-negotiated block trade is*

$$\tau(Q) = K_1 \mathrm{sign}(Q)|Q|^{\frac{\gamma-1}{\gamma+1}} \tag{7}$$

where $K_1 > 0$ *is a constant.*

The proposition yields a complete representation of the temporary impact. As expected, the temporary impact is positive for buys and negative for sells, but the proposition also demonstrates that the absolute equilibrium temporary impact is an increasing and strictly concave function of trade size. (The only exception occurs when marginal search costs are constant, so that the number of contraparties located is proportional to trade size and the price impact is a constant.) Intuitively, larger orders are associated with greater price impacts, so that block traders can increase the traders' net revenue by searching more actively for contraparties. The optimal number of traders increases with order size, and the temporary impact increases with order size at a *decreasing rate* because additional contraparties reduce the price impact on the entire amount of the trade. The concavity of the relation arises from the search-brokerage aspect of the upstairs market; this mechanism mitigates the price impact of the trade by intensifying the search for contraparties as trade size increases, even if there are strongly diminishing marginal returns to search.

The following result provides comparative statics results on the temporary impact:

Proposition 2 *For a given order size, the temporary price component is positively related to the cost of locating contra-parties,* β*, the degree of risk aversion,* ρ*, and the variance of the risky asset's return,* σ_v^2*.*

Proposition 2 is important for our subsequent empirical analysis of the empirical determinants of the temporary impact. The proposition shows that the temporary impact, adjusted for trade size, will be larger for trades arranged through brokers with high search costs or for securities where uncertainty is large. Our data allows us to distinguish trades executed in the upstairs market through exchange-member brokers from those executed by third-market (non-exchange member) brokers who specialize in block transactions. As third-market brokers may have lower search-brokerage costs, the temporary effects associated with transactions executed through third-market brokers may be less than that of exchange members, particularly for larger trades where locating contraparties is essential to minimizing the price impact of the trade.

The proposition may also help shed some light on the stylized fact that the great majority of block trades are sells. The model admits the possibility that the costs of locating contraparties for buyer-initiated trades are larger than for seller-initiated trades. This case is realistic because of short-sale constraints and the difficulty in locating traders who have large holdings of a particular asset. If this is indeed the case, the price effects of buyer and seller-initiated transactions may be asymmetric, possibly explaining some previous empirical findings.

The temporary impact is an implicit trading cost for the initiator, who must also bear explicit commission costs. Commission costs in our model are endogenously determined. The following proposition characterizes these costs.

Proposition 3 *Commission costs are a function of order size*

$$c(Q) = K_2|Q|^{\frac{2\gamma}{\gamma+1}} \tag{8}$$

where $K_2 > 0$ *is a constant that is positively related to search costs, risk aversion, and the variability of the asset's return.*

The proposition shows that commission costs are an increasing function of trade size. The relation is linear if $\gamma = 1$ and convex if $\gamma > 1$.[10] The commission per share is positively related to search costs, risk aversion, and the variability of the asset's return. Higher search costs directly imply higher commissions, while greater price volatility or risk aversion increases the necessary level of search intensity and hence higher costs.

Proposition 3 has an important implication for empirical studies of execution costs because it implies a systematic relation between explicit (i.e., commissions) and implicit (i.e., price impact) costs. This relation is not intuitive. For example, it is natural to hypothesize that there is a trade-off between commissions paid and the resulting price impact of the trade; a trader can pay high commissions to obtain better execution and hence lower implicit costs in the form of reduced price impact. Indeed, such a trade-off drives our theoretical model of the upstairs market. However, the *equilibrium* relation between commissions and price impact need not be negative. To see this, observe from Propositions 1 and 3 that when $\gamma > 1$, larger orders result in larger commissions per share and higher temporary impacts. In this case, the sample correlation between these variables is positive, not negative as one might expect.[11]

The total price impact is the sum of the permanent and temporary impacts. The following proposition characterizes the permanent price impact of the trade.

Proposition 4 *The equilibrium permanent impact measured relative to the decision price is a nonlinear function of order size. For buys, the relation is*

$$\pi(Q) = \lambda_1 Q + \lambda_2 Q^{\frac{\gamma-1}{\gamma+1}} + \lambda_3 Q^{\frac{2\gamma}{\gamma+1}} \tag{9}$$

The relation for sells is defined correspondingly. Equilibrium exists if the unconditional variance of the initiator's asset holdings is sufficiently large.

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[10] Commission costs also reflect costs other than search costs. If there are substantial fixed costs associated with negotiating an upstairs trade, commission costs may decline with size on a per share basis.

[11] When $\gamma = 1$, both commissions per share and the temporary price impact are constants independent of size.

The proposition implies that the permanent component, measured relative to the decision date, is an increasing (decreasing) function of buy (sell) trade size. The functional relation is nonlinear when there are diminishing marginal returns to locating contraparties, and in this case the absolute permanent impact is a convex function of order size beyond a certain level. The permanent impact is a linear function of trade size only in the special case with constant marginal search costs. Propositions 1 and 4 provide a complete description of the price impact of an upstairs trade; except in the special case with constant returns to search, this relation is a nonlinear function of order size. The nonlinearity in the permanent impact, which reflects the revision in beliefs, is induced by the nonlinearity of the temporary impact. In turn, the nonlinearity in the temporary impact arises from the microstructure of the upstairs, search-brokerage market.

The price functionals described are equilibrium responses when the degree of information asymmetry is not unduly severe, i.e., when there are sufficient non-informational motives for trade. As noted above, this requires that the variance of the initiator's initial stockholdings be sufficiently large in relation to the precision of the private information signal. This is a familiar requirement in trading models.[12]

Proposition 4 has some additional implications for empirical studies which measure the permanent impact relative to the pre-trade price instead of the decision price. As the process of negotiating an upstairs trade it time consuming, information on the impending block trade may leak to the market between times t_d and t_b, affecting p_0 and hence biasing the traditional estimate of the permanent impact. To investigate this intuition more formally, suppose outside agents receive noisy signals about the size of the block trade before time t_0. On the basis of these signals, suppose that public information concerning the size of the impending block is summarized by a distribution function, denoted by $F(\cdot)$. Using our definition of the permanent impact, $E[\tilde{v}|Q] = \pi(Q) + p_d$, so that $p_0 = E_{t_0}[\tilde{v}] = \int \pi(z)dF(z) + \mu$. Let π^0 denote the usual measure of the permanent

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[12] See also Glosten (1989) and Madhavan (1992).

impact so that

$$\pi^0 = p_1 - p_0 = \pi(Q) - \int \pi(z)dF(z)$$

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This representation shows that π^0 generally does not reflect the true revision in beliefs, unless the block is completely unanticipated. Indeed, the permanent effect measured by π^0 can yield estimates that are exactly the opposite of the true revision in beliefs for large trades. To see this, suppose that there are diminishing returns to search and prior distribution about block size is unbiased (i.e., $\int zdF(z) = Q$) with support in the convex region of the price functional. Using Jensen's inequality, the permanent impact defined relative to the pre-trade price in the case where the public's expectations of block size are unbiased will be positive (negative) for sell (buy) orders above a certain size, the reverse of the actual revision in beliefs. Thus, the permanent impact measured relative to the pre-trade date may be a severely biased estimate of revision in beliefs induced by the block trade. The extent of this mismeasurement is an empirical question, one we address below.

In the remainder of the paper, we investigate the hypotheses suggested by Propositions 1–4 using data on block transactions arranged in the upstairs market.

3 Empirical Evidence on Upstairs Trade

3.1 The Data

The data file used is constructed from the trading history of a passive investment management firm, Dimensional Fund Advisors, Inc. (DFA). The file contains trade dates, trade prices, number of shares traded and commissions paid for all upstairs-negotiated trades in which the firm participated during the period July 1985 to December 1992. The firm selectively takes the opposite side of large trades initiated by others in the upstairs market, trading stocks that are on their buy or sell list. In this respect, the firm is a contraparty, not a block trader, in the terms of our model. DFA's buy list consists of all stocks that reside in the smallest half of market capitalization. The cutoff is determined by the median market capitalization for stocks trading on the NYSE, but the list also includes AMEX and OTC National Market System (NMS) stocks that fall into this category. The trades are not time-stamped (within the day), although given the normal volume of trading in these shares the block transactions are easily identifiable on intra-day transactions tapes. The sample used here consists of 4,688 seller-initiated blocks and 937 buyer-initiated blocks.

It is worth emphasizing the unique aspects of these data. First, unlike previous studies all the trades in our sample were negotiated in the upstairs market. Second, the firm has a policy of taking the entire amount of the block, so that order fragmentation is not an issue. However, this policy does require the firm to pay or receive the potential prices offered by other traders who would breakup the block to reduce the impact. Essentially, DFA must match the competitively determined price schedule (based on multiparty search) derived above to obtain the trade. Paying such a premium may make sense for this firm because it follows such a simple trading strategy and can selectively time its trades. Third, the data employed here identify the trade as either buyer- or seller-initiated so that there is no possibility of systematic errors from incorrect inferences about trade initiation. Finally, whereas previous studies of price effects of block transactions in the U.S. markets generally examine only block trades on the NYSE, the blocks examined here are from the NYSE, AMEX and NASDAQ NMS.

To examine the price effects associated with our sample of block trades, we use closing prices from the CRSP daily stock files to compute the temporary and permanent impacts. Since infrequent trading is prevalent in our sample of small stocks (our trades are sometimes the only trade of the day), the use of closing prices instead of intraday pre- and post-block prices will not likely influence our computed price impacts adversely. Additionally, nearly 15 percent of our block trades are reported as the closing price on the CRSP file for that day. For this reason, we measure the temporary and permanent impacts using the closing price of the trading day after the block.[13] Specifically, the temporary price

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[13] There is also the possibility of bid-ask bias as suggested by Blume and Stambaugh (1983), which would tend to reduce the measured price impact. However, when impacts are defined in level form, there

impact is defined as -$\ln(P_{t+1}/P_{trade})$ where P_{t+1} is the closing price on the day following the block, P_{trade} is the negotiated trade price, and date t is the block trade date. The permanent price impact is defined as $\ln(P_{t+1}/P_{t-n})$ where P_{t-n} is the closing price on the nth trading day before the trade date. All non-trade-date price movements are adjusted for market movements. The equal-weighted CRSP NYSE-AMEX market index is used to adjust the NYSE and AMEX stock trades, and the CRSP NASDAQ index is used to adjust the NASDAQ stock trades.

Recall that the block price effects described in propositions 1 and 4 are stated in dollar price changes. Our predictions regarding the effects of trade size on the price effects are unaffected by using a definition in returns form. However, the predictions relating to prices require more care. The permanent and temporary components are hypothesized to be decreasing functions of price when they are defined in absolute terms. Therefore, defining them in return form (dividing by price) does not alter our hypotheses about the effects of price levels on these effects.

Before describing our results, we must address a potential difficulty: the empirical hypotheses suggested by the model relate to a particular stock whereas our empirical analysis is cross-sectional. In our case, however, this does not represent a serious problem. First, the stocks in our sample are relatively homogeneous since they are all smaller NYSE stocks or comparably sized AMEX or OTC-NMS stocks. Second, the model's predictions are tested in such a way as to minimize the distortions created by differences among stocks in market capitalization and trading activity, for example, by scaling trade size by the number of outstanding shares. Third, we performed tests for sub-samples of the data sorted by size and price, and verified that our results held in general.

3.2 Summary Results: Seller-Initiated Trades

Tables 1 and 2 contain summary statistics for the sample of block trades used here. Table 1 reports results for the seller-initiated blocks, table 2 for the buyer-initiated blocks.

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is no systematic bid-ask bias. Since our results also hold for price changes, the potential biases appear to be small.

The tables contain estimated means (standard errors) of temporary and permanent price impacts for the sample. Also included are the sample medians for the trade price, market capitalization, number of shares in the block, and the number of shares in the block expressed as a percent of the total number of shares outstanding, as well as the number of blocks.

Panel A of Table 1 reports summary statistics measured within each sample year. Panel B reports statistics separately for listed (NYSE and AMEX) and NASDAQ trades, and also across all markets for the entire period. Consistent with previous research, there appears to be a large 'temporary' price effect (-2.84 percent) associated with the block trade. This block-day price change is more dramatic than documented previously because of the illiquid markets in which the stocks in our study trade. The median price of the blocks here is \$8.38 for firms with a median market capitalization of \$77 million. Some blocks are smaller than 10,000 shares, the definition applied by the NYSE in classifying block transactions. We include all trades of at least 5,000 shares, since a trade of this magnitude in a very thinly-traded stock may represent an extremely large trade.

There is not much year-to-year variation in the estimated temporary impacts, although there does appear to be a tendency for the blocks in 1985 and 1986 to display smaller temporary price effects – about 1.0 to 1.5 percent compared to almost 3.0 percent in the last six years in our sample. The results for the separate markets, reported in panel B, tell basically the same story. Interestingly, the NASDAQ blocks display larger temporary effects (-3.28 percent) than the NYSE and AMEX blocks (-1.86 percent), although the market capitalizations of the NASDAQ firms in our sample are generally smaller and the size of the NASDAQ blocks are larger when computed as a percentage of total outstanding shares. We estimate regressions below that test for differences across markets while controlling for price and trade size.

To detect the possible influence of information leakage prior to the trade on the measurement of the permanent impact, we report three estimates of the permanent price impact that incorporate different amounts of pre-trade price movement. Recall that the permanent price impact for trade i is defined as $\ln(P_{i,t+1}/P_{i,t-n})$, where $P_{i,t-n}$ is the closing price for stock i on the nth trading day before the trade date, and that all non-trade-date price movements are adjusted for market movements by subtracting the market return over the same interval from the return for stock i. We report the trade-date permanent impact which incorporates no pre-trade information (identified in the table as covering the period t-1 to t+1), a permanent impact that incorporates one week of pre-trade price movements (t-6 to t+1), and one that incorporates four weeks of pre-trade price movements (t-22 to t+1).

The estimates of the trade-date permanent impact are negative and significant, -1.50 percent when averaged over all markets and years, but substantially smaller than the corresponding temporary impact. These findings are consistent with previous research. In contrast to the results for the temporary impacts, the permanent impacts are larger for NYSE and AMEX trades (-1.86 percent) than for the NASDAQ trades (-1.37 percent), suggesting that the listed block trades in our sample tend to be more informationally motivated than the NASDAQ trades.

Our estimates of the one-week and four-week permanent impacts are consistent with the notion that information about the trade leaks to the market and is incorporated into the price prior to the trade. Adjusted for market movements, the one-week permanent impact is -4.32 percent and the four-week permanent impact is -7.40 percent. These estimates are both statistically and economically significant. The downward movement in price before the block suggests that the permanent price effects computed in previous studies, using only prices on the day of the block trade, may reflect a *lower bound* on the actual permanent effects associated with the transaction. In many cases, blocks are unsuccessfully 'shopped' for several weeks prior to the actual trade date, permitting the market to incorporate the information associated with the block prior to the actual transaction. However, such information leakage may be less of a problem for the larger, more liquid stocks examined in most previous studies.

An alternative explanation for the the pre-trade price movement is that traders, on average, place buy (sell) orders following positive (negative) returns. Nelling (1992) uses our data described above, and additional information on how long each block was "shopped" (i.e., when the initiator first announced an intention to trade by submitting indications to an electronic bulletin board), to distinguish these hypotheses. Nelling finds strong support for the hypothesis that the pre-trade price movement reflects leakage in the upstairs market. Indirect support for the leakage hypothesis is provided by Keim and Madhavan (1993), who find no evidence that institutional trades are motivated by past price movements.

These findings for the temporary and permanent price effects are illustrated graphically in figure 1 which contains the average price behavior for the seller-initiated blocks for the two months surrounding the block trade date. To compute the series, we first computed market-adjusted daily returns for each block-firm's stock for the two months surrounding the block day. Value-weighted market-adjusted returns were then computed across all stocks for each day in the two-month period, and a wealth series was created by initially 'investing' $1 and recording the day-by-day movements in this wealth index. The spike on the block day (the temporary price effect) is an obvious departure from the downward trend that these stocks experience in the month prior to the block trade. After the block trade, there is no obvious trend in the returns of the seller-initiated blocks.

Finally, we note that for this sample, the use of the tick test to identify trades as seller-initiated transactions (i.e., by comparing the block price to the previous day's closing price) would result in 220 seller-initiated trades (about 6.5% of the sample) not being correctly classified.

3.3 Summary Results: Buyer-Initiated Trades

Table 2 reports summary statistics for the sample of buyer- initiated blocks for the entire sample and separately for each year and by exchange. The table provides an interesting contrast with table 1 for the sample of seller-initiated trades. First, there are far fewer buyer-initiated trades than seller-initiated trades. Buyer-initiated trades constitute approximately 20% of the total sample; these proportions are very similar to the proportions reported in other studies of large trades. Second, the buyer-initiated blocks in table 2 tend to be for stocks with larger prices and market capitalization than those in table 1 since the firm's sell list will tend to contain larger stocks that are exiting the small capitalization universe. Third, the permanent price effects are in the hypothesized direction, but the estimates that incorporate longer pre-trade periods tend to be smaller in magnitude than the permanent effects for the seller- initiated trades in table 1. Finally, only after 1990 is the temporary impact of the right sign for this sample of buyer- initiated blocks[14]; but the magnitudes of the temporary impacts are very small and statistically insignificant.

The asymmetry in the temporary components of buyer- versus seller- initiated trades is puzzling. However, this result appears to be pervasive in the literature on block price impacts. Similar results are found in Kraus and Stoll (1972), Scholes (1972), Ball and Finn (1983), Holthausen, Leftwich and Mayers (1987), and Chan and Lakonishok (1993). Although this result appears to be fairly robust, part of this asymmetry for our data may be explained by the fact that the passive trading strategy of the management firm is common knowledge and presents an option to informationally motivated buyers. An initiator with private information knows that the firm is willing to sell stocks for liquidity reasons once the capitalization of these stocks exceeds the bottom half of NYSE capitalization. The asymmetry may also arise because of differences in the information content of a buyer- versus a seller-initiated trade. Again, the fact that the temporary impacts had the wrong sign in the early years of our sample is consistent with the idea that the firm incorrectly assessed the probabilities of dealing with agents with private information in selling stock. Thus, while DFA may sell to buying initiators at a price above the last trading price, the price continues to rise following the trade; equivalently, the price set for the trade is too low relative to the market's expectation of the trade price because the firm is eager to sell for liquidity reasons. Thus, the temporary impact is subsumed into the permanent impact for buyer- initiated transactions. The persistent upward post-block

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[14] Table 2 does not report the temporary impact for those quintiles in which the temporary impact is less than zero.

price movement for nearly three weeks for the buyer-initiated blocks documented in figure 2 reinforces the notion that the buyers may have been informationally motivated.

The direction of the temporary impacts suggests the use of the tick test to identify trades as buyer-initiated transactions may produce serious biases; indeed, we find that 170 buyer-initiated trades (about 20.1% of the sample) would be not be correctly classified with this methodology.[15]

4 The Determinants of Block Price Effects

4.1 Descriptive Statistics

To measure the determinants of block price effects, we first simply divide the sample of blocks according to block size measured by number of shares traded as a percent of the total number of shares outstanding. Separately for the buys and sells, trades are sorted on trade size and divided into quintiles. Average temporary and permanent impacts are computed for each quintile. Table 3A reports results for seller-initiated blocks and Table 3B reports the buyer-initiated blocks.

The findings for the seller-initiated blocks in Table 3A show that the temporary price impacts are positively related to the size of the block. Proposition 1 predicts that the absolute value of the temporary effect is positively related to trade size, so this finding confirms the model and is also consistent with previous research. Proposition 4 predicts no particular relation between the permanent effect, as measured relative to the previous trade date, and the size of the trade. We find no obvious relation between the trade-day permanent impact (t-1 to t+1) and trade size for the seller-initiated blocks. This finding is consistent with most results in the literature.[16]

Proposition 4 also implies that measurement of the permanent component on the block date may understate the information effect if the block was extensively 'shopped'

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[15] Holthausen, Leftwich, and Mayers (1990) examine a subset of their sample of trades to verify the accuracy of their tick classification scheme and find that the tick test correctly classifies only 53% of their trades; Robinson and White (1991) and Chan and Lakonishok (1993) using data that identifies buyer- and seller-initiated transactions report very similar results.

[16] The exception is Kraus and Stoll (1972).

prior to actual execution. If that were true, then information is revealed in the pre-block price behavior, and the permanent effect measured relative to the decision price is an increasing function of trade size. Since we don't know precisely when the initiators made the decision to sell the blocks in our sample, we report two additional estimates of the permanent impact: one that incorporates one week of pre-trade price movements (t-6 to t+1) and one that incorporates four weeks of pre-trade price movements (t-22 to t+1). While we don't observe much of a relation between the one-week permanent impact and trade size, the four-week permanent impacts are strongly related to trade size, suggesting that the larger is the block, the greater is the tendency for the information component to be incorporated into price prior to actual execution of the block.[17] In a cross-sectional regression of the pre-trade price change on the stock price and trade size (measured as a percentage of outstanding shares), the coefficient on trade size is -0.0112 with a t-value of -3.77. Intuitively, the very fact that a block trade is impending conveys information to the market (the so-called 'over-hang'), and the larger the block, the greater the information contained in that signal. Consistent with this conjecture, Nelling (1992) finds strong support for the hypothesis that the relation between trade size and pre-trade returns reflects leakage in the upstairs market.

The results for the buyer-initiated blocks, given in Table 3B, are less clear. As discussed above in table 2, we find no evidence of significant temporary impacts for the buyer-initiated blocks and, as a result, no relation between trade size and temporary impacts. Although the trade-day permanent impacts appear to be strongly related to trade size, the one-week and four-week permanent impacts exhibit no such relation. Apparently for the buyer-initiated trades, there is less information leakage about the impending trade *prior* to the trade so that a significant relation between the permanent impact and trade size remains at the time of the trade. One explanation may be that block purchases, since they involve negotiations primarily with large current stockholders, occur under conditions of greater secrecy than block sales. Although there is evidence of significant pre-trade price

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[17] We find that a permanent impact that incorporates two weeks of pre-trade price movements is significantly related to trade size.

movement in table 3B, it is not significantly related to trade size. The temporary impacts for buyer-initiated trades indicate that, in general, the post-trade price was at or above the block price.[18] In addition, there is evidence of a significant relation between post-trade market-adjusted price movements and trade size, suggesting that much information contained in the trade was not incorporated into the price until after the trade, and that this post-trade "information component" is related to trade size. As we noted above, this finding can be explained if DFA under-estimated the signal content of buyer-initiated trades or was willing to sell stock at a lower premium than expected by the market because of its passive trading strategy. In the case of seller-initiated blocks, however, the firm selects among a large number of stocks that fall into its trading universe.

4.2 Regression Results

In this subsection we estimate regressions for the temporary and permanent impacts to confirm the summary measures reported in table 3. We begin by estimating the following regression for the temporary impacts:

$$\tau_i = \beta_0 + \beta_1 D_i^{OTC} + \beta_2 PINV_i + \beta_3 q_i + \beta_4 q_i^2 + \beta_5 q_i^3 + \beta_6 D_i^{3rd} + \epsilon_i \tag{10}$$

where D_i^{OTC} is a dummy variable that equals one if block trade i is an OTC stock and zero otherwise, $PINV_i$ is the inverse of the trade price, q_i is the (absolute) number of shares traded divided by the number of shares outstanding, and D_i^{3rd} equals one if block trade i was done by a 3rd market broker and zero otherwise.

The regression equation (10) is motivated by our model. The coefficient β_1 allows us to test for systematic differences in the price impacts of listed versus NASDAQ transactions. The coefficient β_2 captures the effect of price on the temporary component. With price acting as a proxy for market value or liquidity, the effect should be negative. Proposition 1 predicts that the absolute value of the temporary impact is an increasing and concave

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[18] We again do not report in the table the temporary impact for those quintiles in which the temporary impact is greater than zero.

function of trade size. By including trade size and higher powers of trade size , we can examine this hypothesis in a general way. In the case of a seller-initiated trade, for example, we expect $\beta_3 < 0$, $\beta_4 > 0$, and $\beta_5 < 0$.

Table 4A reports estimates of equation (10). The first regression in panel A is for seller-initiated transactions, which comprise almost 80% of our sample. The coefficient of the NASDAQ dummy variable, β_1, is significantly negative, suggesting that temporary costs are higher (for seller-initiated transactions, the temporary impact is negative) for non-listed stock trades. The results show that there is a significant inverse relation between the temporary impact and the price level. This finding is consistent with our hypotheses since higher priced stocks tend to be associated with larger market capitalizations, making it easier and cheaper to find a counter-party for the trade. Further, more information may be available for higher priced stocks, implying counter-parties take larger opposing positions, reducing the temporary impact.

Turning to the effect of trade size, we find that the magnitude of the temporary impact is significantly related to trade size, as shown by negative and significant estimate of β_3. Additionally, β_4 is significantly positive, consistent with the prediction of Proposition 1 in which the relation between temporary impacts and trade size is nonlinear. Although β_5 is negative as predicted, it is insignificant. The bounded concave relation implied by the regression estimates in Table 4A is graphically depicted in Figure 3 for the relevant range of trade size for our sample. Finally, the coefficient on the third-market broker variable is insignificant, indicating that the magnitude of the temporary impact is not affected by the choice of the broker.

The second regression in panel A contains results for the temporary impacts for buyer-initiated trades. Unlike the sample of seller-initiated blocks, the coefficients on both the NASDAQ and price variables are insignificantly different from zero for the buyer-initiated temporary impacts. The coefficient on the third-market broker variable is also insignificantly different from zero. Finally, the coefficients on the trade size variables are significantly different from zero, but are exactly the reverse in sign of our predictions. Larger trade sizes appear to reduce the temporary price impact. There are two possible explanations for this finding. First, the finding is possibly due to our confounding the identity of the initiator for these trades. Participants in the upstairs market know the identity and trading strategy of the investment management firm from whom we obtained these data. Consequently, when a stock moves out of the firm's trading universe, other traders know the firm has liquidity motivations for selling and submit buy orders. In this case, although a trade may be classified as buyer-initiated, the trade was really triggered by the firm's own trading strategy. The negative temporary impacts for buyer-initiated trades may be explained by this argument, which also provides an explanation for the seemingly anomalous findings of table 4A. Indeed, blocks of the same size may have very different price impacts if outsiders can infer part of the motivations for trade. For example, a large order placed by a pension fund that frequently rebalances its portfolio may have small price effects.[19] Second, as noted earlier, this finding is also consistent with the firm incorrectly assessing the probability that a buyer-initiated trade was informationally motivated. That is, the estimated relation may be confounding the temporary and permanent components of the trade impact.[20]

Figure 1 suggests that using the date t-1 price to proxy for p_0 in computing the permanent impact may seriously understate the magnitude of this component, because the market impounds information conveyed by the impending block well before the trade. Accordingly, in our test of the information component of the trade, we measure the permanent impact using the price that prevailed 22 days before the block was traded. Table 4B contains results from estimating the following equation,

$$\pi_i = \beta_0 + \beta_1 D_i^{OTC} + \beta_2 PINV_i + \beta_3 q_i + \beta_4 q_i^2 + \beta_5 q_i^3 + \beta_6 D_i^{3rd} + \beta_7 R_i^{Post} + \epsilon_i \tag{11}$$

where the dependent variable is the permanent impact defined as $\ln(P_{t+1}/P_{t-22})$ and R_i^{Post} is equal to $\ln(P_{t+21}/P_{t+2})$, where P_{t+n} is the closing price on the nth trading day before

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[19] Forster and George (1991) show that anonymity plays a critical role in determining market liquidity.

[20] When we estimate the regression for buyer-initiated temporary impacts using only those impacts with the correct sign, the coefficients on all trades size variables are insignificantly different from zero.

or after the trade date. Recall that all non-trade-date price movements are adjusted for market movements.

The results in panel B show that the magnitude of the seller-initiated permanent impact is significantly greater for exchange-listed stocks (see also figure 1) and inversely related to the price of the security. We find evidence that larger trade sizes imply higher permanent impacts for the seller-initiated trades, and this effect is linear as shown by the insignificant coefficients β_4 and β_5.[21] The coefficient on the third-market broker variable β_6 is statistically insignificant. Interestingly, the coefficient on the post-trade return variable is negative and significant, indicating that a significant portion of the negative pre-trade price movement for some trades is reversed after the trade. This finding suggests that some of the pre-trade price movement reflects price pressure effects that are temporary in nature.

The estimates for the permanent impact regression for the buyer-initiated trades indicates that permanent effects are significantly larger for NASDAQ trades, but the remaining cofficients are all insignificantly different from zero. The lack of statistical significance of trade size is consistent with the 'buyer-initiated' trades being perceived as largely liquidity motivated.[22]

To summarize, the results for seller-initiated trades provide strong support for our conjectures. The results for buyer-initiated trades, however, are not so strong, possibly because there are far fewer buys than sells or because of systematic differences in the pricing of buyer-initiated versus seller-initiated trades. The implications of our results for large upstairs trades may be useful for empirical studies of price impacts in dealer markets. Specifically, researchers need to be careful about assumptions of linearity of the

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[21] When the permanent impact was measured using the previous day's price as the base, the regression provided little explanatory power; further, the magnitude of the impact was not related to trade size. This finding is consistent with our earlier claim that studies of price impacts that ignore the effect of the pre-trade 'overhang' may seriously understate the permanent impacts of the trade.

[22] It is possible that the magnitude of the permanent impact depends on whether the trade is buyer- or seller-initiated. For example, many block traders keep detailed records of the stock holdings of large investors. Thus, the block trader may be more likely to ascribe liquidity motives to a sell order from an initiator whose total stockholdings are large relative to the order. With buy orders, it may be more difficult to discern liquidity motives for trade, especially if the initiator has no current stockholdings.

relation between temporary impact and trade size when the range of trade size under study includes very large trades that were likely to have been negotiated in the upstairs market.[23]

4.3 Analysis of Commissions

The analysis so far has focused on the price impacts associated with large-block trades. These impacts provide a measure of implicit trading costs. In this section, we turn to the analysis of explicit trading costs. Our data contain the commissions paid on the trades in our sample. For the test below, we use only commission data for NYSE and AMEX transactions in which commission per share was greater than zero. (For some exchange transactions where commission data were not available, commissions were erroneously recorded as zero.) We also excluded obvious data errors where the per share commission was unreasonably large.

After applying the filters described above, our sample contained 407 seller-initiated transactions and 184 buyer-initiated transactions. Explicit transactions costs are far from negligible in this sample. The average per share commission cost is $0.07 for buyer-initiated trades and $0.08 for seller-initiated trades. The similarity in the per-share commission costs for buyer- versus seller-initiated transactions is interesting because it suggests that differences in the costs of locating counter-parties cannot explain the asymmetries in the price impacts for our sample. Rather, the differences in the price impacts between block buys and sells probably reflects differences in the motivations of the trade originators. The mean commission fee paid was $2,511 for the seller-initiated transactions in the sample. For the buyer- initiated transactions, the corresponding figure was $3,493.

Proposition 3 implies that commissions are an increasing function of the number of shares traded. The functional form depends on the costs of placing the security with

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[23] For example, Hausman, Lo, and MacKinlay (1992) use an ordered probit model to analyze intraday price movements. They report that in order to achieve a reasonable fit for their model they had to truncate large trades in addition to taking a logarithmic transformation of order size. Other researchers, e.g., Glosten and Harris (1988), have noted that the estimated effect of quantity on price is lower than expected.

counter- parties. As is often the case in practice, these costs may increase for higher priced securities, suggesting that commissions may also depend on the price level of the security. Cost factors may also lead to differences between the commissions charged by third-market brokers and those charged by member brokers. To test these hypotheses, we estimate the following regression for buyer- and seller-initiated transactions:

$$ln(C_i) = \beta_0 + \beta_1 ln(Q_i) + \beta_2 PINV_i + \beta_3 D_i^{3rd} + \epsilon_i \tag{12}$$

where, for trade i, $ln(C_i)$ is the natural log of the commission paid (in dollars), $ln(Q_i)$ is the natural log of the (absolute) number of shares traded, $PINV_i$ is the inverse of the stock price, and D_i^{3rd} equals one if block trade i was done by a 3rd market broker and zero otherwise.

The estimated coefficients are shown in the table below (where the numbers in parentheses are heteroscedasticity-consistent standard errors):

β_0	β_1	β_2	β_3	$\bar{R}^2$
Seller-Initiated Trades				
4.3679	1.0775	−1.9287	0.0238	0.792
(0.1159)	(0.0362)	(0.2985)	(0.0443)	
Buyer-Initiated Trades				
4.7950	0.9601	−1.4869	−0.0161	0.987
(0.0257)	(0.0088)	(0.1964)	(0.0142)	

The coefficient on $ln(Q_i)$ provides an estimate of $\frac{2\gamma}{\gamma+1}$ from Proposition 3. For seller-initiated transactions, the estimated coefficient is significantly greater than one, implying diminishing returns to search. Interestingly, for buyer-initiated transactions we estimate a coefficient significantly less than one. Of course, these relations may include fixed costs and other direct costs of execution that are not related to search. Such costs will not be related to trade size in the same way as search costs. We also find significant price effects for both buyer- and seller-initiated transactions – commissions are higher for higher priced securities. Finally, the third-market dummy variables are insignificant for the buyer- and seller-initiated transactions.

5 Conclusions

A significant fraction of large-block trades in U.S. equities is accomplished through the so-called upstairs market. Understanding the operation of this market is important for both theoretical and practical reasons. From a theoretical perspective, the upstairs market is a search-brokerage mechanism that is very different from the downstairs auction-dealer market where most transactions are executed. However, despite its importance, the upstairs market has largely been overlooked by previous theoretical studies which have focused almost exclusively on the downstairs market. From an empirical viewpoint, previous studies of large (block) transactions identify trades by their size, not by the mechanism in which they originate. As most block trades occur in the downstairs market, the failure to distinguish trades in the upstairs market limits our understanding of this mechanism. This problem is compounded by the fact that the data used in previous studies generally do not identify a trade as buyer- or seller-initiated, and the trades examined may be parts of still larger orders. Given these deficiencies, even basic empirical questions about the upstairs market remain unanswered. This paper analyzes, both theoretically and empirically, the effect of large-block transactions arranged in the upstairs market on the prices of common stocks.

We develop a model of the upstairs market which provides theoretical representations of the price effects around an upstairs trade. We investigate the model's predictions with unique data obtained from a trader of small, illiquid stocks in the upstairs market. The data cover 5,625 block trades during the period 1985 to 1992. Unlike previous studies, all the trades in our database are negotiated upstairs and are identified as buyer- or seller-initiated. As a result, we view our findings as a more accurate characterization of the operation of the upstairs market and its effect on the costs of trading large blocks of stock.

We find that the temporary price impact for seller-initiated trades is positively and significantly related to trade size, and negatively related to price. The impacts for NASDAQ trades are significantly larger than the impacts for comparable trades on the NYSE or AMEX. There is also evidence that the temporary price impact of block trades is bounded for large trades, as predicted by the model. This finding suggests that we exercise care in modeling the relation between price impact and trade size when trades include large-block trades that were likely to have been negotiated in the upstairs market. We also find significant pre-trade (net-of-market) price movements that are related to the size of the trade. We attribute these price movements to the search-brokerage nature of the upstairs market, where information contained in the trade may be leaked to the market before the actual consummation of the trade. Thus, the standard measure of the permanent price impact, estimated using trade-day price movements, probably provides a lower bound for information actually contained in a block trade.

We also find significant differences in the price impacts for buyer-initiated versus seller-initiated block trades. These differences are particularly important for the relation bwteen price impacts and order size, and in the magnitude and behavior of the components of the total price impact. We find little difference in the price impacts between exchange-member and non- exchange-member (third market) brokers. Finally, commission costs are non-trivial and are related to order size in the predicted manner.

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Appendix

Proof of Proposition 1:

Substituting equation (4) into equation (3), and maximizing utility with respect to q_i, we derive the demand function for the representative contraparty

$$q_i(p_b; Q) = \frac{E_{t_b}[\tilde{v}|Q] - p_b}{\rho\sigma_v^2}. \tag{A.1}$$

Suppose the block trader locates n contraparties. The equilibrium block price satisfies

$$-Q = \sum_i q_i(p_b; Q).$$

Using equation (A.1) and solving, we can express the equilibrium block price as a function of Q, given n, which we denote by:

$$p_b(Q; n) = E_{t_b}[\tilde{v}|Q] + \frac{\alpha Q}{n} \tag{A.2}$$

where $\alpha = \rho\sigma_v^2$. The size of the trade becomes public at time t_1, so that the post-trade price in the downstairs market p_1 (which equals the expected value of the security given the size of the trade) is equal to the conditional expectation of the representative contraparty who observes the trade size, i.e., $p_1 = E_{t_1}[\tilde{v}] = E_{t_b}[\tilde{v}|Q]$. Using equations (A.2) and (2), the temporary effect can be expressed as

$$\tau = p_b - p_1 = \frac{\alpha Q}{n}. \tag{A.3}$$

The number of contraparties is selected by the block trader. A competitive block trader arranges the trade to maximize the trading revenue (or minimize the cost) for a block sale (buy). Formally, the block trader chooses the search intensity n to solve the following maximization problem

$$\max_n -Q p_b(Q; n) - \phi(n). \tag{A.4}$$

Equating expected marginal revenues and costs (and ignoring integer constraints[24]), the optimal number of traders identified through the search process solves

$$\frac{\alpha Q^2}{n^2} - \gamma\delta n^{\gamma-1} = 0. \tag{A.5}$$

This equation implies that the optimal number of contacts as a function of trade size,

$$n(Q) = \zeta|Q|^{\frac{2}{\gamma+1}}. \tag{A.6}$$

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[24] Treating n as a continuous variable simplifies the exposition considerably, and may be more in keeping with reality where several contraparties are contacted (although very few may respond) by the block trader.

where $\zeta = (\frac{\alpha}{\gamma\delta})^{\frac{1}{\gamma+1}}$. Equation (A.6) defines the number of contraparties, n, as a function of trade size, $|Q|$. Then, substituting equation (A.6) into equation (A.3) yields equation (7) where

$$K_1 = \alpha^{\frac{\gamma}{\gamma+1}}(\gamma\delta)^{\frac{1}{\gamma+1}}. \tag{A.7}$$

Note that when $\gamma > 1$, $\tau(|Q|)$ is an increasing (decreasing) and concave (convex) function of trade size for buys (sells.) When $\gamma = 1$, the temporary impact is a constant independent of size. ■

Proof of Proposition 2:

Fix order size, Q, and consider equation (A.7). As K_1 is increasing in δ and α, it follows that the temporary impact is increasing with the cost of search, degree of risk aversion, and the conditional variance of the asset's liquidation value. ■

Proof of Proposition 3:

Denote by $c(Q)$ the total commission costs as a function of trade size. As n is a function of trade size, $|Q|$, the commission costs are also a function of size

$$c(Q) = \phi(n(Q)) = K_2|Q|^b \tag{A.8}$$

where $K_2 = \delta^{\frac{1}{\gamma+1}}(\alpha/\gamma)^{\frac{\gamma}{\gamma+1}}$ and $b = \frac{2\gamma}{\gamma+1}$. For a given order size, K_2 is increasing in α and δ, i.e., commissions increase with cost of search, degree of risk aversion, and the conditional variance of the asset's liquidation value. ■

Proof of Proposition 4:

The block price can be expressed as the sum of the temporary component, τ, and the post-trade price, p_1, so that $p_b(Q) = p_1(Q) + \tau(Q)$. Recall that the contraparty's information set is equal to the set of public information following the trade. Thus, the post-trade price is equal to the contraparty's expectation of asset value conditioned on size, i.e., $p_1 = E_{t_1}[\tilde{v}] = E_{t_b}[\tilde{v}|Q]$. Let $g(Q) = \tau(Q) + p_1(Q) + c(Q)$. Then, the initiator's optimal order quantity solves

$$\mu_0 - Qg'(Q) - g(Q) - \rho\sigma_0^2(Q + x) = 0. \tag{A.9}$$

At the optimal order quantity, the second order condition is

$$-2g'(Q) - Qg''(Q) - \rho\sigma_0^2 < 0. \tag{A.10}$$

As the block trader and contraparties observe Q but not y or x, they cannot infer completely the private signal of the initiator. However, from order size, they can form the statistic s where

$$s = \frac{Qg'(Q) + g(Q) + \rho\sigma_0^2 Q - (1 - w_0)\mu}{w_0}. \tag{A.11}$$

Using equation (A.9), it is clear that s is distributed normally with a mean equal to the realization of the initiator's private information signal, y, and a variance proportional to the unconditional variance of the initiator's asset holdings, x. Formally, the signal has the form $s = y + kx$, where $k = -\rho\sigma_0^2/w_0$ is a constant. Suppose the expected value of the asset given the order size can be expressed in the form

$$E[\tilde{v}|Q] = p_1(Q) = (1 - w)\mu + ws = \mu + w(s - \mu) \tag{A.12}$$

where w is the weight placed on the signal conveyed by the initiator's order. Note that as the variance of the signal s is a constant, the weight is a constant determined by the signal to noise ratio. Using equations (A.9) and (A.12), the post-trade price is a function of order size solving the following differential equation

$$p_1(Q) = \mu + \frac{w}{w_0}\left(Q(\tau'(Q) + c'(Q) + p_1'(Q)) + \tau(Q) + c(Q) + p_1(Q) + \rho\sigma_0^2 Q - (1 - w_0)\mu\right). \tag{A.13}$$

The equilibrium price functional must satisfy equation (A.13) subject to the initial condition $p_1(0) = \mu$, i.e., that there is no information revelation without trade.

Consider a block buy; the case for a sell is symmetric. Recall that $\tau(Q) = K_1 Q^a$ and $c(Q) = K_2 Q^b$, where K_1 and K_2 are positive constants, $a = \frac{\gamma-1}{\gamma+1}$, and $b = a + 1 = \frac{2\gamma}{\gamma+1}$. Equation (A.13) can be expressed in the form:

$$p_1(Q) = \mu + B[2K_1 Q^a + 2K_2 Q^b + Qp_1'(Q) + CQ + D] \tag{A.14}$$

where $B = w/w_0$, $C = \rho\sigma_0^2$ and $D = -(1 - w_0)\mu$. Observe that $B < 1$. Intuitively, for a contraparty s is a noisy signal of y which in turn is a noisy signal of v, so the variance of s is greater than the variance of y. Accordingly, the initiator places more weight on the direct signal than the contraparty places on the indirect signal conveyed by order size.

The following price functional solves equation (A.13):

$$p_1(Q) = \mu + \lambda_1 Q + \lambda_2 Q^a + \lambda_3 Q^b \tag{A.15}$$

in the case where $\gamma > 1$, where $\lambda_1 = \frac{BC}{1-B}$, $\lambda_2 = \frac{2BK_1}{1-aB}$, $\lambda_3 = \frac{2BK_2}{1-bB}$. As $0 \geq a \leq 1$ and $0 \geq B \leq 1$, the constants λ_1 and λ_2 in the pricing equation are positive. To ensure the second order conditions are satisfied we need $\lambda_3 > 0$ or $B > b$. Recall that $B = w/w_0$. The ratio of weights, B, depends on the ratio of the variance of the initiator's signal to the variance of the noisy signal conveyed by order size to contraparties. The latter depends on the variance of the initiator's holdings, i.e., the variance of x. The larger this variance, the greater the variance of s, and hence the higher B. Existence requires that the variance of x be large relative to the variance of the private information, i.e., that the degree of information asymmetry not be too severe relative to the liquidity motivations for trade. This is a familiar requirement in such models. If this condition is satisfied, the pricing equation is well defined and the permanent impact is increasing in order size. For sufficiently large orders (i.e., for $Q > \frac{(1-a)\lambda_2}{(a+1)\lambda_3}$), the price functional is a convex function of order size.

When $\gamma = 1$ (i.e., constant marginal search costs), τ is a constant and $c(Q)$ is linear. It is straightforward to verify that for a buy order, $p_1(Q) = \mu + \tau + \lambda Q$ where $\lambda > 0$ is a constant. The price response for sell orders is determined in a similar manner. ■

Table 1

Summary Statistics for Seller-Initiated Block Trades for NYSE, AMEX and NASDAQ NMS Stocks for the Period July 1985 to December 1992

The table provides summary information on upstairs-negotiated block trades. The temporary price impact is defined as $-\ln(P_{t+1}/P_{\text{trade}})$ where P_{t+1} is the closing price on the day following the block, P_{trade} is the negotiated trade price, and date t is the block trade date. The permanent price impact is defined as $\ln(P_{t+1}/P_{t-n})$ where P_{t-n} is the closing price on the nth day before the trade date. All non-trade-date price movements are adjusted for market movements. The equal-weighted CRSP NYSE-AMEX market index is used to adjust the NYSE and AMEX stock trades, and the CRSP NASDAQ index is used to adjust the NASDAQ stock trades. These impacts are stated in percent, and standard errors are reported in parentheses. Also reported are the median values for share price, market capitalization (millions of dollars), number of shares traded (thousands of shares), and trade size ((number of shares traded/total shares outstanding) * 100) for the traded stocks in the particular (sub)sample.

	Temporary Impact	Permanent Impact Measured over the Period:			Number of Blocks	Median Price	Median Market Cap ($ mill)	Median No. of Shares Traded ('000s)	Median Trade Size (%)
		($t-1$ to $t+1$)	($t-6$ to $t+1$)	($t-22$ to $t+1$)					
A. All Markets									
1985	−1.05 (0.36)	−1.99 (0.41)	−4.45 (0.56)	−8.42 (0.96)	118	$ 7.50	$ 46	16	0.32
1986	−1.50 (0.19)	−1.72 (0.22)	−3.94 (0.34)	−6.53 (0.63)	384	10.38	67	15	0.22
1987	−2.95 (0.19)	−1.46 (0.23)	−4.50 (0.33)	−8.77 (0.57)	652	8.50	58	23	0.37
1988	−2.99 (0.18)	−1.26 (0.15)	−4.09 (0.22)	−6.67 (0.40)	982	6.88	48	30	0.42
1989	−2.94 (0.18)	−1.66 (0.16)	−4.43 (0.24)	−8.02 (0.43)	773	8.00	55	33	0.50
1990	−2.71 (0.23)	−1.82 (0.22)	−4.66 (0.31)	−7.52 (0.69)	590	9.13	146	44	0.27
1991	−2.67 (0.22)	−1.18 (0.23)	−3.70 (0.37)	−6.05 (0.58)	508	9.63	153	50	0.31
1992	−3.73 (0.24)	−1.47 (0.19)	−4.77 (0.30)	−7.64 (0.52)	681	8.50	135	54	0.34
B. All Years									
All Markets	−2.84 (0.08)	−1.50 (0.07)	−4.32 (0.11)	−7.40 (0.20)	4688	$ 8.38	$ 77	33	0.34
NYSE & AMEX	−1.86 (0.12)	−1.80 (0.12)	−4.69 (0.18)	−8.19 (0.35)	1441	9.88	124	36	0.30
NASDAQ/NMS	−3.28 (0.10)	−1.37 (0.09)	−4.17 (0.14)	−7.05 (0.24)	3247	7.63	64	30	0.38

Table 2

Summary Statistics for Buyer-Initiated Block Trades for NYSE, AMEX and NASDAQ NMS Stocks for the Period July 1985 to December 1992

The table provides summary information on upstairs-negotiated block trades. The temporary price impact is defined as $-\ln(P_{t+1}/P_{\text{trade}})$ where P_{t+1} is the closing price on the day following the block, P_{trade} is the negotiated trade price, and date t is the block trade date. The permanent price impact is defined as $\ln(P_{t+1}/P_{t-n})$ where P_{t-n} is the closing price on the nth day before the trade date. All non-trade-date price movements are adjusted for market movements. The equal-weighted CRSP NYSE-AMEX market index is used to adjust the NYSE and AMEX stock trades, and the CRSP NASDAQ index is used to adjust the NASDAQ stock trades. These impacts are stated in percent, and standard errors are reported in parentheses. Also reported are the median values for share price, market capitalization (millions of dollars), number of shares traded (thousands of shares), and trade size ((number of shares traded/total shares outstanding) * 100) for the traded stocks in the particular (sub)sample.

	Temporary Impact[1]	Permanent Impact Measured over the Period:			Number of Blocks	Median Price	Median Market Cap ($ mill)	Median No. of Shares Traded ('000s)	Median Trade Size (%)
		($t-1$ to $t+1$)	($t-6$ to $t+1$)	($t-22$ to $t+1$)					
A. All Markets									
1985	—	1.86 (0.52)	3.28 (1.09)	7.64 (1.35)	35	$25.00	$189	21	0.19
1986	—	1.83 (0.32)	2.72 (0.61)	5.26 (1.16)	90	25.25	244	18	0.16
1987	—	1.59 (0.33)	2.56 (0.53)	3.43 (0.87)	139	22.50	234	34	0.32
1988	—	1.85 (0.72)	3.50 (0.94)	3.02 (1.40)	42	19.38	164	40	0.37
1989	—	1.45 (0.23)	2.93 (0.42)	3.91 (0.69)	153	23.00	217	29	0.22
1990	—	2.20 (0.25)	3.58 (0.64)	6.48 (1.14)	220	19.00	305	20	0.12
1991	0.23 (0.30)	0.89 (0.37)	1.22 (0.69)	0.23 (0.99)	78	23.63	376	18	0.12
1992	0.10 (0.22)	1.09 (0.28)	2.50 (0.57)	5.44 (1.06)	180	21.38	340	20	0.13
B. All Years									
All Markets	—	1.60 (0.12)	2.82 (0.24)	4.66 (0.41)	937	$22.13	$278	24	0.16
NYSE & AMEX	—	1.52 (0.14)	2.57 (0.30)	3.38 (0.47)	582	22.38	253	25	0.17
NASDAQ/NMS	—	1.73 (0.20)	3.24 (0.39)	6.76 (0.77)	355	19.88	302	20	0.13

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[1] We do not report the average temporary impact for the buyer-initiated trades when it is less than zero.

Table 3

The Relation between Percentage Price Changes and Block Size

The table presents mean temporary, permanent and post-block percentage price changes for upstairs-negotiated block trades for NYSE, AMEX and NASDAQ stocks for the period July 1985 to December 1992. The temporary price impact is defined as $-\ln(P_{t+1}/P_{\text{trade}})$, where P_{t+1} is the closing price on the day following the block, P_{trade} is the negotiated block price, and date t is the block trade date. The permanent price impact is defined as $\ln(P_{t+1}/P_{t-n})$ where P_{t-n} is the closing price on the nth day before the trade date. All non-trade-date price movements are adjusted for market movements. The equal-weighted CRSP NYSE-AMEX market index is used to adjust the NYSE and AMEX stock trades, and the CRSP NASDAQ index is used to adjust the NASDAQ stock trades. These impacts are stated in percent, and standard errors are reported in parentheses. Block size is defined as the number of shares traded stated as a percentage of the total number of shares outstanding.

Trade Size[1]	Temporary Impact[2]	Permanent Impact Measured over the Period:			Post-Block Price Change
		(t−1 to t+1)	(t−6 to t+1)	(t−22 to t+1)	(t+2 to t+21)
A. Seller-Initiated Blocks					
0.01–0.15	−1.48	−1.56	−3.58	−3.72	0.19
	(0.13)	(0.14)	(0.29)	(0.70)	(0.41)
0.15–0.27	−2.21	−1.51	−4.38	−5.99	−1.02
	(0.14)	(0.15)	(0.22)	(0.54)	(0.43)
0.27–0.46	−2.76	−1.28	−3.91	−6.84	−1.15
	(0.15)	(0.16)	(0.23)	(0.45)	(0.43)
0.46–0.82	−3.31	−1.54	−4.67	−7.97	−1.90
	(0.17)	(0.17)	(0.26)	(0.43)	(0.44)
0.82–7.86	−4.57	−1.64	−4.78	−9.08	−1.76
	(0.20)	(0.19)	(0.28)	(0.47)	(0.46)
B. Buyer-Initiated Blocks					
0.01–0.07	0.23	1.22	2.70	4.96	−1.89
	(0.19)	(0.26)	(0.45)	(1.36)	(1.48)
0.07–0.13	0.28	1.19	2.47	5.04	−2.18
	(0.19)	(0.22)	(0.41)	(0.93)	(1.28)
0.13–0.19	—	1.85	2.99	6.18	0.32
		(0.29)	(0.54)	(1.05)	(0.87)
0.19–0.35	—	1.94	3.26	6.46	0.48
		(0.26)	(0.70)	(1.30)	(0.85)
0.35–5.48	—	1.77	2.78	3.26	1.68
		(0.27)	(0.50)	(0.70)	(0.79)

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[1] Each classification category represents a quintile based on a sort of the data based on trade size. Each category contains 937 observations in panel A and 187 observations in panel B.

[2] We do not report the average temporary impact for the buyer-initiated trades when it is less than zero.

Table 4

The Determinants of the Price Impacts for Block Trades

The parameter estimates in the table are for the following model[a] estimated over the period July 1985 to December 1992:

$$y_i = \beta_0 + \beta_1 D_i^{\mathrm{OTC}} + \beta_2 \mathrm{PINV}_i + \beta_3 q_i + \beta_4 q_i^2 + \beta_5 q_i^3 + \beta_6 D_i^{\mathrm{3rd}} + \beta_7 R_i^{\mathrm{Post}} + e_i \, .$$

β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	Adjusted R-Squared
A. Temporary Impact ($y_i = \tau_i$)[b]								
Seller-Initiated								
0.0081	−0.0081	−0.1354	−0.0201	0.0041	−0.0003	−0.0022	—	.163
(0.0021)[c]	(0.0016)	(0.0126)	(0.0037)	(0.0019)	(0.0002)	(0.0016)		
Buyer-Initiated								
0.0012	0.0007	0.0420	−0.0252	0.0156	−0.0023	−0.0019	—	.009
(0.0029)	(0.0021)	(0.0341)	(0.0072)	(0.0046)	(0.0008)	(0.0021)		
B. Permanent Impact ($y_i = \pi_i$)[b]								
Seller-Initiated								
−0.0590	0.0167	−0.0928	−0.0230	0.0019	0.0003	−0.0029	−0.0471	.020
(0.0052)	(0.0044)	(0.0182)	(0.0101)	(0.0051)	(0.0006)	(0.0042)	(0.0135)	
Buyer-Initiated								
0.0299	0.0366	−0.0967	0.0187	−0.0182	0.0030	0.0117	−0.0142	.014
(0.0113)	(0.0096)	(0.1055)	(0.0268)	(0.0158)	(0.0025)	(0.0087)	(0.0208)	

[a] The variables in the model are:

$\tau_i = -\ln(P_{i,t+1}/P_{i,\mathrm{trade}})$

$\pi_i = \ln(P_{i,t+1}/P_{i,t-22})$

$D_i^{\mathrm{OTC}} = 1$ if block trade i is a NASDAQ stock

$= 0$ otherwise

$\mathrm{PINV}_i = 1/P_{ib}$

$q_i = [(\text{number of shares traded})/(\text{total shares outstanding})]\cdot 100$ (absolute value)

$D_i^{\mathrm{3rd}} = 1$ if block trade i was done by a 3rd market broker

$= 0$ otherwise

$R_i^{\mathrm{Post}} = \ln(P_{i,t+21}/P_{i,t+2})$

[b] All non-trade-date price movements are adjusted for market movements. The equal-weighted CRSP NYSE-AMEX market index is used to adjust the NYSE and AMEX stock trades, and the CRSP NASDAQ index is used to adjust the NASDAQ stock trades.

[c] The numbers in parentheses are heteroscedasticity-consistent standard errors.

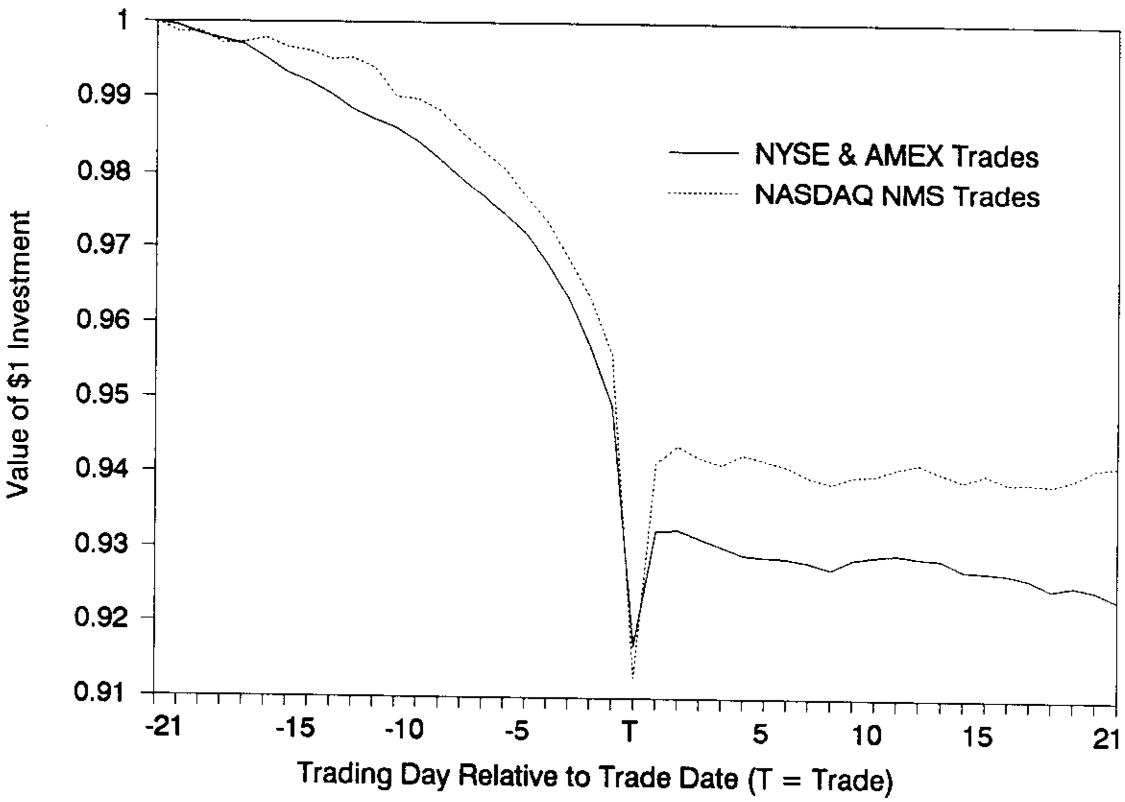

Fig. 1. Price behavior associated with seller-initiated blocks for two months (42 trading days) surrounding the trade day, for the period July 1985 to December 1992.

The series represents the average price behavior for our combined sample of NYSE, AMEX and OTC block trades. We compute the series using the following steps: (1) allign the daily returns for each of the block firms around the block trade day; (2) compute a value weighted return r_t^{vw}, across all firms, for each day t; (3) Create a wealth series, with initial value $V_{-22} = 1$, as

$$V_t = V_{t-1}\,(1+r_t^{vw}).$$

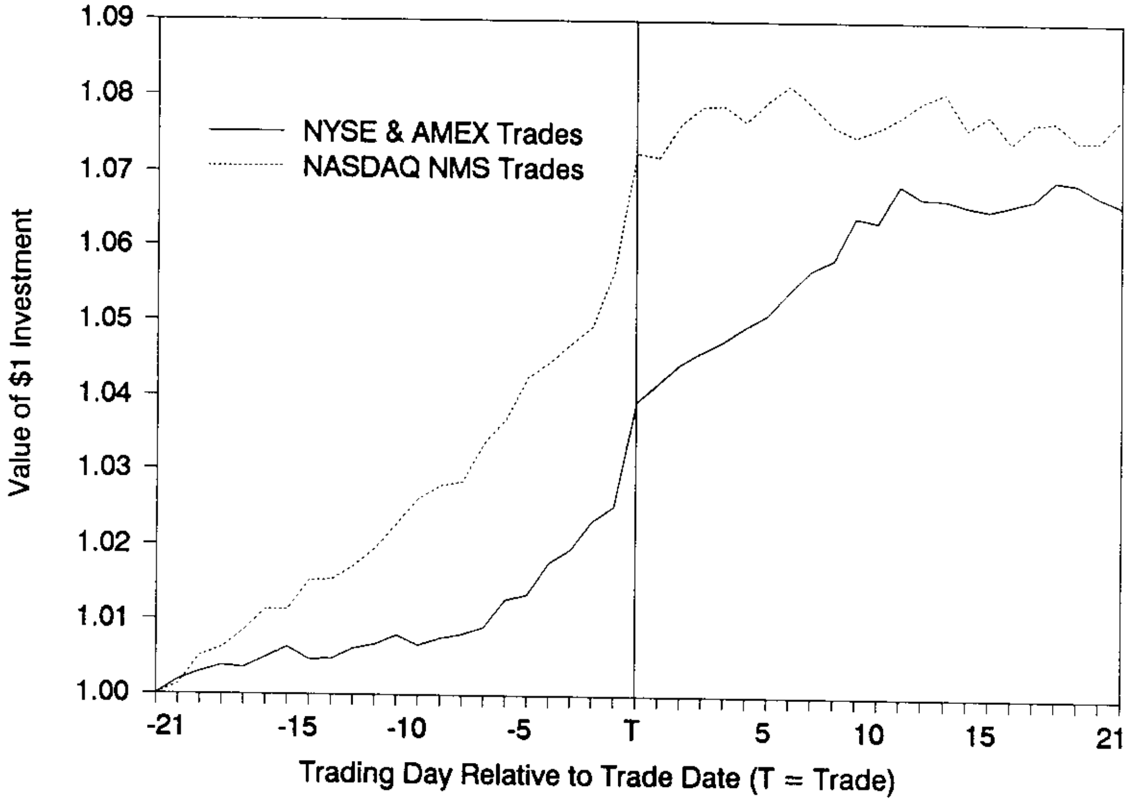

Fig. 2. Price behavior associated with buyer-initiated blocks for two months (42 trading days) surrounding the trade day, for the period July 1985 to December 1992.

The series represents the average price behavior for our combined sample of NYSE, AMEX and OTC block trades. We compute the series using the following steps: (1) allign the daily returns for each of the block firms around the block trade day; (2) compute a value weighted return r_t^{vw}, across all firms, for each day *t*; (3) Create a wealth series, with initial value $V_{-22} = 1$, as

$$V_t = V_{t-1}\,(1+r_t^{vw}).$$

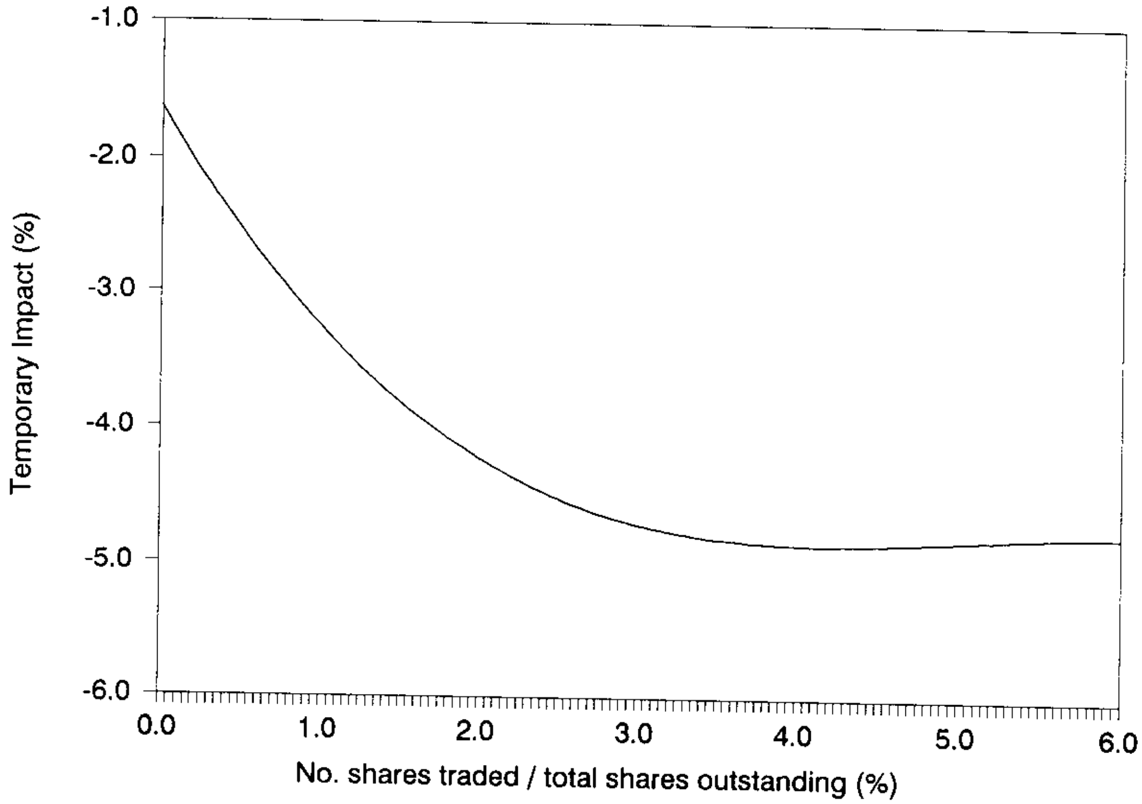

Fig. 3. Relation between temporary price impacts of seller-initiated blocks and trade size, defined as the number of shares traded divided by the total shares outstanding, stated in percent. (July 1985 to December 1992)

The plot is generated using the estimated coefficients from equation (10) over the relevant range of trade size for our sample of block trades, for NASDAQ block trades ($D^{OTC} = 1$) arranged by exchange-member brokers ($D^{3rd} = 0$). The median share price for our sample ($8.375) is used in the calculations.