Does an Electronic Stock Exchange Need an Upstairs Market?*

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Abstract

We examine block trades on the Paris Bourse to test several theoretical predictions regarding upstairs trading, and exploit cross-sectional variation in "crossing rules" on the Paris Bourse to provide evidence on their relevance. Paris provides an excellent setting to test the implications of upstairs intermediation models, because its electronic limit order market closely resembles the downstairs markets envisioned by theorists.

We present direct evidence in support of Grossman's (1992) prediction that upstairs brokers lower execution costs by tapping into pools of unexpressed liquidity, as actual execution costs upstairs are less than one third as large as would be anticipated if block trades were executed against displayed liquidity in the downstairs market. Consistent with prior analyses, the Paris data also supports the Seppi (1990) hypothesis that upstairs brokers certify trades as uninformed.

We find that participants in stocks with less restrictive crossing rules agree to outside-the-quote executions for more difficult trades and at times when downstairs liquidity is lacking. These likely represent trades that could not have been otherwise completed, suggesting that market quality can be enhanced by allowing participants more flexibility to execute blocks at prices outside the quotes, a consideration particularly relevant to U.S. markets in the wake of decimalization.

1. Introduction

Glosten (1994) emphasizes the efficiencies that result from consolidating financial market trading in a centralized electronic limit order book. A computerized market has relatively low operating costs, the book's price and time priority rules provide incentives for liquidity providers to bid aggressively for market orders, and the consolidation of trading ensures that each order is exposed to all other displayed orders. Despite these efficiencies, virtually every stock market (including those featuring an electronic limit order book) is accompanied by a parallel "upstairs" market, where larger traders employ the services of brokerage firms to locate counterparties and negotiate trade terms. This paper provides empirical description of the upstairs market and tests of theoretical models of upstairs trading using data from the Paris Bourse. The Bourse is particularly well suited to this endeavor because the downstairs market in Paris is an electronic limit order mechanism very similar to that envisioned by theoreticians, and because of cross-sectional variation in the "crossing rules" that govern upstairs executions.[1]

Theoretical analyses of upstairs trading focus on two issues that are of particular importance to larger traders: order exposure and trades' information content. Prices are likely to move adversely if the existence of a large unexecuted order becomes widely know, as other traders may "front run" the order or simply infer information about future price movements from its presence. A large limit order, in particular, provides free trading options and risks being "picked off" if market conditions change. Grossman (1992) argues that the trading preferences of many large investors are not expressed publicly, and that a role of the upstairs broker is as a repository of information on large investors' hidden or unexpressed trading interests. Given that some trading interest is not publicly expressed, a large market order sent to the downstairs market will "walk the book", bypassing unexpressed liquidity and increasing execution costs. In contrast, an upstairs broker who receives a large customer order can tap the pool of unexpressed trading interest, while minimizing the degree to which the customer's order is exposed.

A second branch of research on upstairs markets considers the role of upstairs brokers in certifying trades' information content. Easley and O'Hara (1987) demonstrate that an investor trading on

private information regarding security values will prefer to trade larger quantities. Their model implies

that liquidity providers will charge more to complete larger orders. Large traders who transact for

liquidity rather than informational motives therefore have incentives to identify themselves as such.

Seppi (1990) describes mechanisms by which an upstairs broker can distinguish between informed and

uninformed traders. This allows the broker to screen informed traders from the upstairs market, lowering

adverse selection costs for large liquidity traders.

This paper extends our understanding of the role of upstairs markets, focusing in particular on the

Paris Bourse, where the upstairs market competes with an electronic limit order market. The Paris market

is well suited for studying upstairs trading, particularly as compared to the New York Stock Exchange.

Theoretical analyses of upstairs trading typically compare the benefits of a negotiated upstairs market

with a pure auction mechanism in the downstairs market. The NYSE floor is more complex, and may

replicate some benefits of upstairs trading. In particular, NYSE floor brokers can "work" client orders

without fully revealing them. Chakravarty (2001) argues that NYSE specialists and floor brokers can

sometimes deduce the identity of trade initiators, thereby lowering the risk of adverse selection.[2] Further,

the NYSE specialist, being positioned at the center of a trading "crowd" on the exchange floor, has

information on unexpressed trading interests on the floor.[3] While these features likely increase the appeal

of the NYSE trading floor to investors, they interfere with clean tests of upstairs trading models.

Two recent papers, Smith, Turnbull and White (2001) and Booth, Lin, Martikainen, and Tse

(2001) also study upstairs trading when the downstairs market is electronic. The former studies the

Toronto Stock Exchange (TSE) and focuses on the empirical properties of trades routed upstairs, while

the latter studies the Helsinki Stock Exchange, and focuses on issues related to price discovery. Booth,

Lin, Martikainen, and Tse document that prices are mainly discovered in the downstairs market, while

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[1] See Biais, Hillion, and Spatt (1995) for description of the Paris limit order market.
[2] Benveniste, Marcus and Wilhelm (1992) argue that the long-standing professional relationships between the floor traders and specialists result in information exchange, which can mitigate adverse selection costs.
[3] In addition, Venkataraman (2001) suggests that the trading rules in a floor-based market structure allow large traders to selectively participate in block trades and better control the risk of order exposure. Hence, large traders are more likely to express their demands in the downstairs market in a floor-based market structure.

upstairs prices consist of the downstairs component plus a transitory factor.[4]

Our paper is distinguished from these studies and earlier work partly because the downstairs market in Paris more closely resembles that envisioned in the theory papers, but mainly because we test a broad set of hypotheses that the prior papers could or did not.[5] Notably, we present the first empirical evidence regarding Grossman's (1992) prediction that the upstairs broker lowers execution cost by tapping into pools of unexpressed liquidity. Prior empirical work has focused mainly on Seppi's (1990) prediction regarding the informational role of the block broker, while the Grossman prediction remained untested due to the lack of an empirical proxy for expressed liquidity beyond the inside quotes. We are able to use the unique Weighted Average Spread (WAS) measure provided by the Paris Bourse to measure expressed liquidity and thereby extend the understanding of the role of block brokers. We also provide the first empirical test of the Burdett and O'Hara (1987) implication that the extent of downstairs price leakage prior to an upstairs trade will increase with the number of counterparties contacted and time taken for facilitation.

Further, we are able to exploit variation in the "crossing rules" that were in effect on the Paris Bourse during our sample period to present evidence on their relevance. Upstairs trades in most Paris Bourse stocks must be executed at prices at or within the best bid-offer (BBO) quotes in the downstairs market at the time of the trade. However, for a subset of liquid stocks (called *eligible stocks*), the Paris Bourse allows block trades to be executed at prices away from the BBO. The possibility of allowing outside-the-quote executions may open the upstairs market in a broader set of circumstances. We examine the factors that govern when the option to complete trades outside the quotes is used, and the quality of these executions. An investigation of the effect of different crossing rules is particularly useful in the wake market decimalization in the United States. The NYSE generally requires upstairs trades to be executed at prices that match or improve on the downstairs quotes. This requirement has become more

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[4] This finding might be interpreted as an affirmative answer to a variation of the question posed in the title of this paper: "Does an Upstairs Market Need an Electronic Stock Exchange?"

restrictive in the wake of decimalization, which has substantially tightened bid-ask spreads.

We investigate the popular view that an automated execution system is inherently less expensive than a trading mechanism with human intermediation. To do so, we implement econometric techniques that control for self-selection bias in traders' choice between upstairs and electronic trading, and measure the inherent cost of completing trades in each market. The results indicate that a randomly selected order would incur higher execution costs in the upstairs market than in the electronic market. Finally, we provide a methodological enhancement by defining a block trade on the basis of share price and normal trading activity, in contrast to the traditional approach of defining a block trade as any trade larger than 10,000 shares, independent of share price or normal trading activity.

We analyze 92,170 block trades in a broad cross-section of 225 Paris stocks. The upstairs market at the Paris Bourse is an important source of liquidity for large transactions, as almost 67% of the block trading volume is facilitated upstairs. The option to complete upstairs trades in eligible stocks at prices outside the quotes is exercised for larger trades, when the downstairs spread is unusually narrow, and when there is relatively little depth in the limit order book. This suggests that more flexible crossing rules allow some trades to be completed that otherwise would not.

Overall trading costs for those block trades completed upstairs are lower than for block trades completed downstairs, despite the fact that selectivity-adjusted estimates indicate higher fixed costs in the upstairs market. This reflects the strong support in the Paris data for the Seppi (1990) prediction that upstairs brokers screen on the basis of information content: upstairs trades contain less information than downstairs trades, despite being larger. This result complements that provided by Smith, Turnbull, and White (2001) for the Toronto Stock Exchange. We also find strong support for the notion that traders strategically choose across the upstairs and downstairs markets to minimize expected execution costs. We find more limited support for the Keim and Madhavan (1996) hypotheses that upstairs trade execution costs are concave in trade size and positively related to the cost of finding counterparties, and strong

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[5] Even the electronic market at the TSE differs from a pure auction market, due to the presence of a designated market maker. The liquid stocks at the Paris Bourse that we study do not have a designated market maker. The Paris

support for the Burdett and O'Hara (1987) prediction that buyer-initiated trades are more costly and less welcome in the upstairs market.

Execution costs for upstairs trades are much lower than would be expected if the trade were simply executed against the expressed liquidity downstairs, which provides direct evidence if favor of the Grossman (1992) prediction that upstairs brokers are able to tap into unexpressed trading interest. However, the finding that the unconditional (selectivity-bias-adjusted) liquidity cost in the upstairs market exceeds that in the downstairs market supports the popular perception that the upstairs market represents a trading mechanism that is inherently more expensive than the electronic market.

Some upstairs trades in stocks listed on the Paris Bourse are completed in London rather than Paris, and are not included in our database. Jacquillat and Gresse (1995) estimated the London market share of French stocks at 8.4% in 1993, while Demarchi and Foucault (1999) report similar numbers for 1998. As a consequence, our results understate the importance of upstairs trading for Paris-listed stocks.[6]

This paper is organized as follows. Section 2 describes market structure at the Paris Bourse and the testable predictions of theoretical models of upstairs trading, while Section 3 describes the sample. Section 4 investigates the effect of varying crossing-rules at the Paris Bourse. In Section 5 we present empirical evidence regarding trading costs in the upstairs and downstairs market. Section 6 presents evidence on the execution cost of a typical order in both markets, after controlling for selection bias in the data. Section 7 summarizes results and discusses policy implications for electronic stock exchanges.

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market therefore is a closer approximation to the downstairs markets considered in upstairs theory papers

[6] Pagano (1997) argues that the reported trading volumes in the London dealer market and the French auction market are not directly comparable, noting (page 6) "A direct customer trade with a London exchange member generates a "cascade" of inter-dealer transactions, by which the dealer rebalances his inventories – an effect not present in an auction market when two customers' orders are crossed". Inventory rebalancing trades are likely to be particularly important for block transactions that leave dealers with large inventory imbalances. In contrast to the evidence reported by Jacquillat and Gresse (1995) and Demarchi and Foucault (1999), Friederich and Tonks (2001) report that the London market share of liquid French firms averaged between 40% and 50% during the 1990s.

2. Market Structure and Testable Predictions on Block Trading at the Paris Bourse

A. Upstairs Market Structure

This discussion of the upstairs market in Paris is based on conversations with officials of the Paris Bourse, and the manual titled "The organization and operation of the regulated market operated by SBF-Paris Bourse," dated March 30th, 1998, which is published by SBF-Paris Bourse. Appendix A provides more detail as to rules in effect on the Bourse during our sample period.

In a typical Paris upstairs transaction, an institutional investor (block initiator) submits a large order to a member firm (upstairs broker) with whom the block initiator ordinarily has a long-standing relationship. The broker generally has discretion to (a) send the order to the downstairs market to execute against standing limit orders, (b) act as a dealer (i.e., principal) and execute the block against his own inventory, or (c) act as a broker (i.e., agent), and search for counterparties.

The upstairs broker deals with numerous institutional investors on a daily basis, and typically has some information on their current holdings and latent trading interest. The block broker contacts potential counterparties and negotiates the transaction price. The identity of the block initiator is not revealed during the search process, though counterparties are informed of the block size. All upstairs transactions are reported immediately to the Paris Bourse, which publishes a majority of the transactions with no delay. Block trades in which a member firm acts a dealer may be made public with delay to enable the member firm to reverse its position. It is important to note that, although some principal trades are made public with a delay, the Base de Donnees de Marche (BDM) database that we use indicates actual trade times. Upon publication of the transaction by the system the public learns the details of the transaction, except whether the member firm acted as a dealer or a broker.

B. The Benefits and Costs of Upstairs Trading

Theoretical papers model the benefits and costs of upstairs intermediation. Grossman (1992) suggests that upstairs brokers have knowledge on the states of nature that are likely to induce customers to trade. One such state would be the opportunity to trade with a block initiator who wishes to trade for liquidity rather than information-based reasons. Seppi (1990) focuses on this idea, suggesting that the

upstairs broker screens informed traders from the upstairs market.[7] Liquidity providers can therefore

charge a smaller information premium, which lowers the execution cost. Grossman also emphasizes that

potential block traders may prefer to not quantify or publicly reveal their trading interest. The upstairs

broker has information on the unexpressed trading interests of these customers, and accessing this

unexpressed demand increases the effective liquidity of the upstairs market, thus reducing execution costs

to the block initiator.

The insights provided by Seppi and Grossman are related, but distinct. The ability of the upstairs

broker to tap into pools of unexpressed liquidity can reduce the cost of trading for any order, informed or

not, implying that the Grossman reasoning could be empirically supported even if the Seppi hypothesis

were not. However, the hypotheses are not competing, in the sense that they could both be correct, a

conclusion supported by our empirical results.

Though the benefits of trading in the upstairs market could be significant, the search process in

the upstairs market is costly. In Keim and Madhavan (1996), the cost of upstairs facilitation is an

increasing function of the number of counterparties located. In Burdett and O'Hara (1987), a cost of

upstairs trading is information leakage in the downstairs market. In Grossman (1992), a cost of upstairs

trading is the extra volatility (price uncertainty) of trading in a decentralized market. Each block trader

can select the upstairs or downstairs market based on expected costs and benefits.

C. Testable Predictions on Block Trading

The theoretical analyses of block trading provide several testable implications. These are stated

in terms of both trades' information content; observed empirically as permanent (on average) price

changes around trades, and in terms of the liquidity costs of trading; observed empirically as execution

prices that are inferior (on average) to the post-trade value of the stock.

The liquidity effect, or temporary price impact, of a block trade measures compensation provided

to the counterparties for providing liquidity. Keim and Madhavan (1996) predict the temporary price

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[7] For example, the broker may require the trader to make a "no bagging" commitment to not trade again for a
specified interval. This commitment is not costly to a liquidity trader who has revealed their full trading program,

effect to be an increasing and concave function of trade size. The concavity arises because the block

broker, at the margin, chooses between searching for more counterparties or making a concession on the

block price. This implies that the search function of an upstairs broker is particularly useful for locating

counterparties to large transactions, and for less liquid and more volatile stocks. Grossman (1992)

suggests that the upstairs broker has information on the hidden or unexpressed trading interests of large

investors that allows him to lower execution costs of block transactions upstairs, relative to the expressed

(or displayed) liquidity in the downstairs market.

The prediction that larger (block) orders are more likely to be initiated by informed traders

(Easley and O'Hara (1987)) provides uninformed block traders with incentives to distinguish themselves

from informed traders. Seppi (1990) suggests that the upstairs market improve on the terms of trade

faced by uninformed traders by screening informed traders from the upstairs market. Therefore, the

certification role of the upstairs broker implies that (a) orders routed to the upstairs market have less

likelihood of being initiated by an informed trader, and (b) the incentives to use the upstairs market

increase with order size.

These analyses support the following testable hypotheses:

Hypothesis I: Grossman (1992) predicts that execution cost for an upstairs trade will be lower than

the cost of completing a similar trade against the displayed liquidity in the downstairs market.

Hypothesis II: Proposition 1 in Keim and Madhavan (1996) implies that the absolute temporary effect

is an increasing and strictly concave function of trade size.

Hypothesis III: Proposition 2 in Keim and Madhavan (1996) implies that, for given order size, the

temporary price component is positively related to the cost of locating counterparties and the variance

of the risky asset's return, and the relationship will be stronger for larger order sizes.

Hypothesis IV: Seppi (1990) predicts that the permanent price effects of block trades routed to the

upstairs market will be less than that of similar trades sent to the downstairs market.

Hypothesis V: Proposition 4 of Keim and Madhavan (1996) predicts that the permanent price effects

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but can be costly to a strategic informed trader.

(price increase for buys and decrease for sells) of upstairs trades will an increasing and concave

function of order size.

Hypothesis VI: The Burdett and O'Hara's (1987) analysis implies that the extent of downstairs price

leakage will increase with the number of counterparties contacted and time taken for facilitation.

We provide empirical tests of Hypotheses I through VI. In addition, we provide evidence regarding the importance of variation in crossing rules and on the inherent cost of executing trades in the upstairs and electronic markets.

3. Sample Selection and the Distribution of Block Trading Volume

A. Sample Selection

As our objective is to investigate the significance of an upstairs market across a broad cross-section of firms, we focus on firms comprising the SBF-250 Index at the beginning of our April 1997 to March 1998 sample period. SBF250 represents all sectors of the French economy and includes all component firms of the CAC40 and SBF-120 indexes. Trade and quote data are obtained from the BDM database made available by the Paris Bourse.[8] To remain in the sample, a firm must (a) trade in the continuous (not batch) downstairs auction market, so that downstairs prices are available to calculate trades' price effects (deletes 13 firms), (b) trade common equity with voting rights (deletes 5 firms), and (c) have normal trade and quote data during the sample period (deletes 7 firms)[9]. The remaining 225 stocks are further divided into liquidity quintiles based on the average daily trading volume during the sample period.

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[8] We use a series of filters to delete trades and quotes that have a high likelihood of reflecting errors. Trades are omitted if (a) trade price is non-positive (b) involves a price change (since the prior trade) greater than absolute value of 25% (c) occurs on a day when change in overnight price is greater than 15% (d) occurs on the day of stock split. Quotes are deleted if (a) bid or ask is non-positive (b) bid-ask spread is negative (c) change in bid or ask price is greater than absolute value of 10% (d) bid or ask depth is non-positive.

[9] These 7 firms have large quoted depth on only one side of the market for many months, and subsequently delist. During this period, trades only occur on the deeper side of the market. It is possible that professional market makers may be providing price support for these stocks before delisting occurs. Inclusion of these firms would bias results.

Ideally, analyses of upstairs markets would be conducted using order level data on the entire trading programs of all institutional investors. In practice, however, publicly available datasets (e.g., NYSE's TAQ, SBF-Paris Bourse's BDM, TSE's Order and Trade) have broad coverage, but do not provide data on the orders that underlie trades or on trading intentions. We follow Madhavan and Cheng (1997), Smith, Turnbull, and White (2001) and Booth, Lin, Martikainen and Tse (2001) in using trades as the basic unit of observation.[10] In Paris, a large marketable order to buy (sell) can exhaust the depth on the inside quote and walk up (down) the limit order book. Such a large order is reported as multiple trades occurring at the same time in the BDM database. Following Biais, Hillion, and Spatt (1995), Piwowar (1997), and Venkataraman (2001), we classify these simultaneous trades as one large trade. The size of the trade is calculated as the size-weighted average of the simultaneously reported trades, and the transactions price is calculated as the size weighted average of the simultaneous trade prices.

We analyze large transactions that occur during regular market trading hours, for three reasons. First, the theoretical models of the upstairs market focus on liquidity provision for large orders. Second, to understand the factors that affect the choice between the two markets, we need to restrict our analysis to transactions executed when both markets are open. Third, the price effects of block trades can most readily be measured when the downstairs market is open.

B. Definition of a block trade

The empirical literature typically follows the NYSE definition, and considers a transaction of greater than 10,000 shares to be a block trade. In our view, however, the definition of a large, or block, trade should vary depending on share price and typical liquidity in the stock, as measured by average trading volume and typical quote or limit order depths. Share price variation is particularly relevant for this study. Figure 1 reports on the distribution of share prices for NYSE (all common stocks) and Paris (the 225 stocks in this study). On April 1, 1997, the average stock price at the Paris Bourse is FF800 (or

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[10] A notable exception is Keim and Madhavan (1996), who use a non-public dataset obtained from Dimensional Fund Advisors (DFA) that includes orders. However, their dataset reflects orders by only a single institutional trader, who specializes in small-capitalization stocks. It is difficult to know the extent to which analyses based on proprietary datasets that reflect a small slice of overall trading can be generalized beyond the specific sample.

U.S. $142), compared to $41 on the NYSE. Also, stock prices are more widely dispersed at the Paris Bourse than the NYSE.[11] Since traders are likely to be concerned about the dollar (or franc) size of the transaction, it is reasonable to suggest that the block size in shares at the Paris Bourse should be smaller than the NYSE on average, and should vary across stocks.

The Paris Bourse defines a "normal block size" (NBS) for those stocks that are eligible for special block trading rules, including 80 stocks in our sample. We use the Bourse definition of NBS for these 80 stocks. We also compute a normal block size (NBS) for the remaining sample stocks, using a method similar to the Bourse, as follows. First, for firm "i", we calculate the average market price, average daily trading volume in the downstairs market, and the average depth on the inside quotes in the limit order book for month "m". We define block size as $NBS_{i,m} = MAX [NBS_1, NBS_2, NBS_3]$, where $NBS_1 = 7.5 *$ (average depth of the inside quotes in the limit order book), $NBS_2 = 2.5 \%$ of average daily downstairs trading volume, and $NBS_3 = FF\ 500,000\ /$ average price. The NBS for a calendar quarter is the average value of $NBS_{i,m}$ for the preceding quarter.[12]

We define as block transactions those with size greater than or equal to the computed NBS of the firm. In our view, researchers who study block trading in diverse international markets will be better served by defining a stock-specific block size measure along the lines of the one used here, as opposed to using a uniform definition such as 10,000 shares. In the present sample, the average block size is 1.45 million French francs, or about $290,000. Computed block sizes vary substantially across liquidity quintiles, from an average 0.5 million francs for the least liquid to 4.3 million francs for the most liquid.

C. Descriptive Statistic on Paris Block Trading

Table 1 presents sample summary statistics. Sample firms are classified into liquidity quintiles. The average stock price and market capitalization of the sample on April 1, 1997, is FF 799 and FF 13,544

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[11] See Angel (1997) for additional description of diverse stock price distributions across world markets.
[12] As a check, we compare computed measures of NBS with the block sizes provided by the Paris Bourse for the 80 sample stocks that are eligible for special block trading rules, and find a correlation of 0.86. The Bourse ensures that any change in trading activity is permanent before announcing a change in block size. In the same spirit, we minimize the effect of temporary abnormal trading activity by identifying stocks where the absolute change in NBS from one quarter to the next is greater than 100% (14 observations). If the change is due to a stock split, then we

million respectively. Average market capitalization increases monotonically from FF 1,614 million for the least liquid quintile to FF 48,670 million for the most liquid quintile.

The sample includes 92,170 block trades. Of these, 31,088 (33.7%) were facilitated in the upstairs market. The average size of a block trade in the upstairs market is FF 11.5 million, compared to FF 2.9 million for block trades in the downstairs market. The substantial difference between mean and median trade sizes indicates that some trades in both markets are very large. As expected, the number of trades, the average trade size, and trading volume tend to increase across liquidity quintiles.

The upstairs market at the Paris Bourse is a significant source of liquidity for large transactions, with almost 67% of cumulative block trading volume facilitated upstairs. By comparison, Hasbrouck, Sofianos and Sosebee (1993) report that 27% of block volume in all NYSE-listed stocks is facilitated upstairs, while Madhavan and Cheng (1997) find that 20% of the block volume in the DJIA index stocks is facilitated in the upstairs market. The greater percentage of block volume facilitated upstairs at the Paris Bourse as compared to the NYSE is consistent with the conjecture that the upstairs market will play a more significant role at an electronic stock exchange than when the downstairs market includes a trading floor.[13]

Results in Panel A of Table 2 indicate that large trades are more likely to be facilitated in the upstairs market. Here, we classify block trades as small if (NBS ≤trade size< 2*NBS), medium if (2*NBS ≤trades size< 5*NBS), and large if (trade size ≥ 5*NBS). For small block trades, only 20% of the trades and cumulative trading volume is facilitated in the upstairs market. However, for large block trades, almost 80% of the trades and 87% of cumulative block volume is facilitated upstairs. Finding that large trades are more likely to be routed upstairs in Paris is broadly consistent with the results reported by

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change the NBS on the day on which the split is effective (3 occasions). If the increase in NBS is due to abnormal trading behavior in a single month, then we retain the NBS from the previous quarter (8 occasions).
[13] In a result not reported in the Tables, we find blocks are bought and sold with similar frequency in Paris. This finding contrasts with results for the U.S. market, (e.g., Kraus and Stoll (1972), Chan and Lakonishok (1995)) where blocks are sold with a higher frequency.

Smith, Turnbull, and White (2001) for the Toronto Stock Exchange.[14]

Results in Panel B of Table 2 indicate that firms with less liquidity in the downstairs market have a higher level of upstairs participation. In this analysis, trades are first classified into trade size (in FF) quintiles. We calculate the upstairs participation rate for each firm, and report the median upstairs participation rate by size quintile. Results indicate that within a trade size quintile, the upstairs participation rate increases for less liquid firms. For example, in trade size quintile 3, the upstairs participation rate increases from 19.9% for firms in the most liquid quintile to 57.1% for firms in the least liquid quintile.

4. Crossing Rules and Execution Costs

We next evaluate the effect of variation in crossing rules on execution costs. An exchange's crossing (or interaction) rules stipulate the allowable price range for upstairs trades, and whether downstairs orders that offer superior prices for smaller quantities will be allowed to participate in the transaction. At the NYSE, for example, upstairs trades must typically be completed at prices at or within the downstairs BBO, and downstairs participants are allowed to take a portion of the block.[15] At the TSE, upstairs trades need to be executed at or within the best bid-offer (BBO) quotes in the downstairs market at the *time the order is received* by the upstairs broker. As Smith, Turnbull and White (2001) note, this obligation leads upstairs market makers in Toronto to submit most orders immediately to the downstairs markets.

While the same crossing rules apply to all stocks at the NYSE and TSE, the crossing rules in effect at the Paris Bourse during our sample period varied depending on liquidity. For the majority of

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[14] Although the key result is similar, we view our finding as more robust. Smith, Turnbull and White use a logit regression on all trades in all firms. By limiting our analysis to block transactions, we ensure that internalization of small orders by member firms do not affect our results. Also, we calculate upstairs participation rates for trade size categories within a firm. This approach controls for other firm characteristics that could be correlated with trade size.

[15] NYSE rule 127 does allow for blocks to be completed at prices outside the downstairs BBO after "exploring crowd interest". However, this process is costly, and Hasbrouck, Sofianos, and Sosebee (1993) report that less than one half of one percent of NYSE share volume occurs under Rule 127. Madhavan and Cheng (1997) note that

stocks listed on the Paris Bourse, upstairs trades need to be completed at or within the BBO quotes in the downstairs market at the time of the trade.[16]   However, for a subset of liquid stocks (called *eligible stocks*), the Paris Bourse allowed block trades to be executed at prices away from the BBO at the time of the trade. However, trades in eligible stocks must still be completed within the "weighted average spread" computed by the Paris Bourse, as discussed below. Appendix A provides more detail regarding crossing rules on the Paris Bourse. We exploit the existence of variation in crossing rules to present evidence on their relevance.

Panel A in Table 3 reports locations of transaction prices for upstairs trades relative to the bid-ask quotes at the time of the cross. For each firm, we calculate the percentage of buyer- and seller-initiated trades that are executed: (a) outside the relevant quote, (b) at the quote, and (c) between the quote and the midpoint. For *eligible* firms (N=80) and *non-eligible* firms (N=145) in our sample, Panel A reports the median percentage of trades executed and the median trade size, in each location category. Also reported is the average quoted depth, inside spread, the average total execution cost, and, for *eligible* firms, the weighted average spread in the downstairs market at the time of the trade. The execution cost measure reported compares the block transaction price with the quote mid-point at the time of the trade, and is similar to the effective spread measure in the literature (e.g., Huang and Stoll (1996)). The weighted average bid (ask) is computed by the Bourse for eligible stocks, and gives the weighted average price of executing a market sell (buy) order of order size equal to the NBS against the limit order book. Hence, it takes depth away from the inside quotes into account and is an empirical measure of the displayed block liquidity in the book.[17]

For *eligible* firms, about 10% of upstairs trades occur outside the quotes, and these trades pay

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NYSE crossing rules provide incentives for upstairs NYSE participants to complete the negotiated transaction as a "clean cross" on a regional stock exchange rather than the NYSE floor.

[16] The Bourse does allow an exception for very large blocks (called *structural blocks*), which can be executed at prices away from the quotes, provided the trade size exceeds an amount as determined by an *SBF-Paris Bourse Instruction.*

[17] The Bourse allows for hidden limit orders, which are not displayed in the book, but are executable against market orders (see Harris (1996) for details). As a consequence, the downstairs market allows traders to access committed but unexpressed liquidity. In contrast, the role of the upstairs broker is to access uncommitted and unexpressed liquidity.

execution costs that are about 40 to 50 basis points higher than for upstairs trades executed at or within

the quotes.[18] However, trades completed outside the quotes are larger than average, and occur when

downstairs spreads and depths are unusually small. For example, buyer-initiated trades completed above

the ask price occur when the downstairs spread is 0.13% and the quoted depth is 11% of the NBS,

compared to a spread of 0.27% and depth that is 16% of NBS when buyer initiated trades are completed

below the ask price. These statistics are consistent with the reasoning that those block trades completed

outside the quotes would not otherwise have been completed at all.

Panel B of Table 3 presents additional information on liquidity in the limit order book around the

time upstairs trades are crossed. For all stocks and across all trade sizes, quoted spreads are wider at the

time of the trade than 30 minutes before the trade. This result is consistent with the reasoning expressed

by Biais, Hillion, and Spatt (1995) that block traders respond to crossing rule constraints by submitting

market orders that clear out limit orders and widen the downstairs spread, so that they can then cross

upstairs trades at desired price. Note, though, that the increase in spreads at the time of the trade is larger

(about fifteen basis points on average) for non-eligible firms than for eligible firms (about four basis

points on average). This result is consistent with the reasoning that more flexible crossing rules reduce

incentives to manipulate downstairs spreads.

A key result that can be observed on Panel B of Table 3 is that average execution costs for

upstairs trades in *eligible* stocks, including those in the large block category, are significantly lower than

the weighted average spreads at the time of the trade. Recall that the weighted average spread is

calculated as the cost that would be incurred if a trade equal to the normal block size were to execute

against displayed liquidity in the limit order book. The block trades we examine are larger than the

normal block size by definition. Hence the weighted average spread is a downward biased measure of the

cost that would have been incurred if the block trade had been executed against the publicly displayed

liquidity. Observing that actual upstairs execution costs are close to the quoted spreads and significantly

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[18] Only a miniscule proportion of upstairs trades in *non-eligible* firms are executed away from the inside
quotes.

less than the weighted average spread therefore provides direct support for the Grossman (1992) prediction (Hypothesis I) that block facilitators are able to tap into pools of unexpressed liquidity to provide better upstairs executions relative to the displayed liquidity in the downstairs market.

The point estimates reported on Table 3 indicate that the effect on trading costs of being able to tap into unexpressed liquidity is large. Actual execution costs in the upstairs market are on average only about a third as large as weighted average spreads. More specifically, trading costs average 21 (23) basis points for buyer (seller) initiated trades, compared to weighted average spreads of 73 (85) basis points at the time of buyer (seller) initiated trades.

We next turn to an analysis of the decision to execute a trade in an eligible stock outside the quotes. We consider all 23,634 upstairs trades in eligible stocks. For these trades, we estimate a pooled time-series cross-sectional probit model with firm-specific indicator variables. The dependent variable equals one if the trade is completed outside the quote and zero otherwise. Explanatory variables include: the quoted spread at the time of the trade, trade size relative to the NBS, a buy order dummy, a first hour of trade dummy, a last hour of trade dummy, and a measure of the imbalance in the downstairs market, defined as in Handa, Schwartz, and Tiwari (1998) as Imb_t = (weighted average quote on the same side – quote midpoint)/weighted average spread. The imbalance variable takes a value closer to zero (one) when there is more (less) downstairs trading interest on the side of the initiating order.

Block initiators are likely to be more receptive to executions outside the quotes when downstairs liquidity is lacking, implying a positive coefficient estimate on the imbalance measure and a negative coefficient on the spread width. Larger trades and buy orders are generally more difficult to facilitate, so we also anticipate a positive coefficients on these variables. If traders wait to observe market conditions after the open we anticipate a negative coefficient on the first hour of trading indicator. Finally, if traders place a premium on completing the transaction before the market close we anticipate a positive coefficient on the last hour of trading indicator.

Results of estimating the probit model are reported below (the a superscript indicates statistical significance at the .01 level):

Probit Analysis of the Decision to Execute Away from the Inside Quotes
Dependent Variable = 1 if the upstairs trade is executed away from the inside quotes, and 0 otherwise

Constant	Bid-ask spread	Order Imbalance	Trade Size/ NBS	Buy Order Dummy	First Hour Dummy	Last Hour Dummy
-1.452 [a]	-1.233 [a]	0.841 [a]	0.007 [a]	0.014	-0.453 [a]	-0.145 [a]

Each coefficient estimate is of the anticipated sign, with the exception of the last hour indicator, and all are statistically significant except the buy order dummy. Market participants are more likely to agree to having a block trade executed at a price outside the quotes when the inside spread is narrow, when there is relatively little liquidity in the downstairs book on the side of the initiated trade, for large trades, and for buy orders. They are less likely to complete block trades outside the quotes during the first and last hours of trading. This last result may reflect the possibility of trading during after-hours crossing sessions. On balance, these results are consistent with market participants agreeing to outside the quote executions for more difficult trades completed during more difficult market conditions, and with the notion that these trades might not have been completed at all in the absence of the option to take the price outside the quotes.

As noted above, the NYSE effectively requires all upstairs trades to be completed at prices at or within the best downstairs quotes. The recent (January 2001) reduction in the NYSE tick size to one cent has narrowed the inside bid-ask spread and reduced the depth of the NYSE quotes (see, for example, Bessembinder (2001)). In short, decimalization has made the requirement to complete upstairs-facilitated trades at or within the quotes more restrictive. Our analysis of cross-sectional variation in crossing rules suggests that market quality could be improved by allowing upstairs initiators to agree to prices outside the quotes. Consistent with this view, the Euronext market (which was created by the September 2000

merger of the Paris, Brussels, and Amsterdam stock markets) now allows block trades in all stocks to be executed outside the quotes.[19]

5. Trading costs in the upstairs and downstairs markets

We next present evidence on trading costs for a broad cross-section of stocks in the broker facilitated upstairs and electronic downstairs markets at the Paris Bourse. Comparisons of upstairs and downstairs trading costs have been presented for narrow cross-sections of stocks in prior papers. These include Madhavan and Cheng (1997), who focus on the 30 liquid DJIA index firms and Booth, Lin, Martikainen, and Tse (2001), who study only the 20 most active Helsinki stocks. Smith, Turnbull, and White (2001) analyze all firms listed on the TSE, but do not differentiate based on firm's liquidity.

A. Empirical measures of price effects

Kraus and Stoll (1972) first delineated measures of temporary and permanent price changes around a block trade, and their interpretation as liquidity costs and informational effects, respectively.[20] Figure 2 provides a graphical representation of the price effects of a block buy order. The temporary component ($\tau(Q)$) represents compensation to liquidity providers (i.e., counterparties), and can be measured by the price *reversal* after the block trade: $\tau(Q) = \ln(P_b) - \ln(P_1)$, where P_b is the block trade price and P_1 is a measure post-trade value.[21]

The permanent component ($P(Q)$) can be divided into post-trade impact and pre-trade leakage. The post-trade impact ($\pi(Q)$) represents the change in the market's perception of a security's value after the announcement of the block trade: $\pi(Q) = \ln(P_1) - \ln(P_0)$, where P_0 is the pre-trade value of the security,

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proxied by the last quote midpoint before the announcement of the block trade. The leakage effect ($L(Q)$) represents price movements in the downstairs market while the block is being facilitated (or "shopped") in the upstairs market; $L(Q) = \ln(P_0) - \ln(P_d)$, where P_d is the security value when the upstairs broker initiates the search process.[22, 23] The total execution cost ($T(Q)$) to the block initiator is the sum of the liquidity and information effects, i.e., $T(Q) = P(Q) + \tau(Q) = \ln(P_b) - \ln(P_d)$. All measures are expected to be positive for a block buy and negative for a block sell. We adjust each measure for overall market movements by subtracting the SBF120 index's market return from the stock's return.

B. Price effects in the upstairs and downstairs market

Table 4 presents execution costs measures for seller- and buyer-initiated block trades. Our discussion focuses on results obtained when using quotes three days prior as the pre-trade benchmark. Results using the one-day prior benchmark are similar. For seller-initiated trades (Panel A), the average execution cost is 59.4 basis points (bp) in the upstairs market and 73.7 bp in the downstairs market. Separating total trading costs into permanent and temporary price effects reveals that the information content of an upstairs trade is significantly lower than that of a downstairs trade, in each liquidity quintile. On average, a seller-initiated trade permanently lowers prices by 11 bp in the upstairs market and 57 bp in the downstairs market. However, compensation to counterparties (measured by the temporary price effect) is larger in the upstairs market (48.4 bp) than in the downstairs market (16.7 bp). In both markets, average trading costs are lower for stocks with higher liquidity.

For a buyer-initiated trade (Panel B), the benefit of facilitating a trade in the upstairs market is significantly larger. Average execution costs are 65.9 bp in the upstairs market compared to 119.2 bp in the downstairs market. Execution costs in the upstairs market are lower by at least 50 bp in each liquidity quintile, except quintile 4. The cost advantage in the upstairs market for buy orders again originates from

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[22] We consider three proxies for P_d: (a) the mid-point of the quotes 30 minutes before the trade, (b) the mid-point of the closing quotes the day before the block trade (t_{-1}), and (c) the mid-point of the closing quotes three days before the block trade. We report results using (b) and (c). Demarchi and Thomas (1996) survey the member firms at the Paris Bourse and find that most block orders are facilitated within a day.

a lower adverse selection component. The permanent price effect is significantly lower in the upstairs market (64.2 bp) relative to the downstairs market (156.8 bp), and this finding holds across liquidity quintiles.[24]

To summarize, a block trade initiator incurs lower trading costs in the upstairs market than in the downstairs market. This result holds across most liquidity quintiles, and the execution cost advantage of the upstairs market is significantly larger for a buyer-initiated trade.[25] An analysis of the components of execution cost provides strong support of the certification role of the upstairs broker (Seppi (1990). While trades in both markets contain information, the adverse selection component of execution cost is significantly lower in the upstairs market relative to the downstairs market. Liquidity-motivated traders are able to use the services of an upstairs broker to obtain lower trading costs. In addition, counterparties may also prefer to provide liquidity in the upstairs market, as the lower risk of adverse selection provides greater compensation to them even while providing lower execution costs to block initiators.

The results obtained here concerning the lower information content of upstairs block trades can be contrasted with those of Madhavan and Cheng (1997). Their results indicate only slightly lower information content for upstairs NYSE trades, and in some subsamples their results indicate larger information content for upstairs trades. The lack of strong support for the certification hypothesis in NYSE data, contrasted with the strong support in the Paris data presented here and in the TSE data analyzed by Smith, Turnbull, and White (2001), support the contention that theories of upstairs trading can best be tested when the downstairs market is an electronic stock exchange.

C. Regression analysis of the price effects

We next analyze the systematic determinants of variation in the price impacts of block trades.

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[23] Although the measure L(Q) has traditionally (e.g. Keim and Madhavan (1996) been interpreted as measuring pre-trade information leakage, an alternate perspective is that L(Q) could be positive because traders following momentum strategies will buy after price increases, and vice versa.

[24] Counterparties to upstairs block buys receive insignificant compensation for their services, while counterparties to block buys in the downstairs market lose money on average (-37.6 bp), as the stock price tends to increase after a block buy. The possibility that counterparties take losses on block transactions is addressed by Burdett and O'Hara (1987). They note that the counterparty might be an active risk averse investor with a desire to transact, who would prefer the certainty of a small loss to the uncertain cost of demanding liquidity in the market.

Hypotheses II and V, which are due to Kiem and Madhavan (1996), concern relations between permanent and temporary price impacts, respectively, and trade size. In their model, tradeoffs between search costs and price concessions depend on the probability of locating a counterparty. Since this probability is likely to differ across firms, we test these hypotheses using time series data. The following regression is estimated for each firm, and we report the mean and median values of regression coefficients across the sample of firms:

Model 1: $|Y(Q)| = \beta_0 + \beta_1 * Q + \beta_2 * Q^2 + \beta_3 * I + \varepsilon$; for each stock (1)

where Q is the trade size normalized by the NBS, I is a dummy variable which equals 1 for a buyer-initiated trade, and 0 otherwise, and $|Y(Q)|$ is equal to $|\tau(Q)|$ for results reported on Panel A of Table 5, and $|P(Q)|$ in Panel B of Table 5. The Keim and Madhavan analysis predicts $\beta_1 > 0$ and $\beta_2 < 0$. This analysis is restricted to a sub-sample of 132 firms that have at least 30 upstairs trades during the sample period.

Results in Panel A of Table 5 provide weak evidence of a concave relationship between temporary price effect of upstairs trades and trade size, as implied by Hypothesis II. The coefficients are of the predicted sign i.e., positive on the trade size variable and negative on the squared trade size variable. However, the coefficient on the squared trade size variable is statistically insignificant. The coefficient on the buy/sell dummy variable indicates that counterparties earn lower compensation for participating in buyer-initiated trades.

Results in Panel B of Table 5 provide little support for the notion of a positive concave relationship between absolute permanent price effect of upstairs trades and trade size (Hypothesis V). The coefficients on trade size and squared trade size are statistically insignificant. These results are, however, consistent with the Seppi (1990) conjecture that larger order size does not increase the likelihood that the trade is informed, given that the non-anonymous trade initiator has signaled the trade to be uninformed. Finally, consistent with Burdett and O'Hara (1987), buyer-initiated trades in the upstairs market contain more information than seller-initiated trades.

Table 6 presents the results of testing Hypotheses III and VI, which concern relations between the temporary and leakage price effects of upstairs trades and firm characteristics such as stock volatility and liquidity. Conditional on trade size, the cost of locating counterparties is likely to be higher for firms with less liquidity. Hence, these hypotheses have testable implications across a cross-section of firms, after controlling for the effect of trade size. Keim and Madhavan (1996) suggest that short sale constraints and the difficulty in locating traders with large holdings of a particular asset will result in larger temporary price effects for block buys. To test these hypotheses, we first classify trades into quintiles based on their size in francs. Next, for each trade size quintile, we calculate the average temporary and leakage price effect for each stock, and estimate the following cross-sectional regression:

Model 2: $|Y_i| = \beta_0 + \beta_1 * Liquidity_i + \beta_2 * Volatility_i + \beta_3 * I + \varepsilon_i ,$ (2)

Where $|Y_i|$ is the average temporary price effect in Panel A and the leakage price effect in Panel B for block trades in stock "i", volatility is the variance of the daily quote-midpoint stock returns, liquidity is measured as the stock mean of (price * NBS / 1,000,000), and I is a dummy variable which equals 1 for a buyer-initiated trade, and is 0 otherwise.

Consistent with Hypothesis III, we find evidence of an inverse relationship between temporary price effects and firm liquidity (Panel A of Table 6). However, we find the relationship to be statistically significant in the larger trade size quintiles only. These results support the Keim and Madhavan (1996) prediction that the upstairs broker will be forced to provide larger price concessions while filling larger orders in illiquid stocks. Also, counterparties earn lower compensation for participating in buyer-initiated trades. Results in Panel B of Table 6 provide weak evidence of a relationship between leakage effects and firm characteristics such as liquidity and volatility, as implied by Hypothesis VI. The coefficient estimate on liquidity is of the predicted sign for all size quintiles except the third, but is statistically significant only for quintile two. As predicted by Burdett and O'Hara (1987) leakage effects prior to upstairs trades are larger for buyer-initiated than for seller-initiated trades.

6. Transaction costs and self-selection of trading venue

The preceding sections of this paper reported on execution costs for those trades routed to the upstairs and downstairs markets. Since trade initiators presumably select the market they expect to provide the lowest cost execution for their trade, the observed execution cost measures must be interpreted as conditional on self-selection of venue. In this section we present an analysis of unconditional execution costs, i.e. costs for orders selected at random, to measure the inherent cost of completing trades in the upstairs market and in the electronic limit order market. This analysis allows us to investigate the validity of the perception that execution costs will be lower in an electronic market, and to validate empirically the intuition that traders do strategically select the market to route their order. To do so, we implement econometric techniques to control for self-selection bias. The technique to correct for self-selection of trading venue involves two stages (refer to Maddala (1983) for a general discussion, and Madhavan and Cheng (1997) for a similar implementation that uses data from the NYSE trading floor). In the first stage, the block initiator's choice process is modeled as a structured Probit. In the second stage, the expected liquidity effects of random orders in each market are estimated after correcting for the selection bias.

A. Determinants of the Choice of the Trading Venue

The block initiator is anticipated to route his order to the market with the lowest expected execution cost. This will depend in part on liquidity in the limit order book. As empirical proxies for liquidity we use the bid-ask spread and a measure of order imbalance (as defined in Section 4). Other variables that likely affect the choice of the trading venue are the block size (normalized by the NBS), return volatility, and the (inverse) stock price. A dummy variable that denotes buyer-initiated trades is also included.

The choice of the market to complete the block order is modeled as a structured probit, where the dependent variable is an indicator variable that equals 1 for an upstairs trade and 0 for a downstairs trade. We expect that a block initiator will more likely route his order to the upstairs market for larger order

sizes, during periods of wider downstairs spreads, during larger order imbalances, and when volatility is lower. If buyer-initiated trades are more likely to be initiated by an informed trader, as implied by Burdett and O'hara (1984) and Saar (2001), then the probability of an upstairs execution will be lower for a buyer-initiated trade.

To control for firm-specific effects and allow valid inference, we estimate the first-stage probit and the second-stage regressions simultaneously, using maximum likelihood estimation (MLE), on a firm-by-firm basis. This approach differs from Madhavan and Cheng (1997), who perform the analysis after pooling all trades in the DJIA firms. Panel A of Table 7 reports median coefficient estimates from the Probit model for the 115 firms with more than 30 block trades where the MLE routine converged. All average coefficient estimates are of the predicted sign and are statistically significant. The likelihood of routing a trade to the upstairs market is higher: (a) during periods of wider spreads, larger order imbalance, and lower volatility, (b) for larger orders, and (c) for a seller-initiated trade.

B. The Endogenous Switching Regression Model

Trading costs in the two markets can be modeled as:

$$E\left[\tau_i^u \mid U_i = 1\right] = \beta_u * X_i + \sigma_u * \left[\phi\left(\gamma * Z_i\right) / \Phi\left(\gamma * Z_i\right)\right] \tag{3}$$

$$E\left[\tau_i^d \mid U_i = 0\right] = \beta_d * X_i + \sigma_d * \left[-\phi\left(\gamma * Z_i\right) / \left(1 - \Phi\left(\gamma * Z_i\right)\right)\right] \tag{4}$$

where $\phi(.)$ denotes the standard normal density function, $\Phi(.)$ denotes the cumulative standard normal distribution, Z's represent explanatory variables affecting choice of venue, γ's represent coefficient estimates from the probit model, and X's represent the variables affecting expected liquidity costs. If traders strategically select their execution market, then liquidity costs conditional on selection of a market will be lower than the unconditional liquidity costs. That is, we expect $\sigma_u < 0$ and $\sigma_d > 0$.

Since theory suggests that order size affects execution costs in both markets, we include order size (Q_i) (normalized by the NBS) as an explanatory variable. The asymmetric effects of buyer versus seller-initiated orders are again captured by an indicator variable that equals one for buyer-initiated trades. Also, we include the product of the buyer-initiated indicator variable and order size to allow for

differences in marginal effects of order size across buyer- and seller-initiated trades. The slope coefficients in (3) and (4) estimate the marginal effects of characteristics of *random orders* in each market.

The results of the regression analysis are presented in Panel B of Table 7. The dependent variable is the liquidity effect, $\tau(Q)$, in basis points. As predicted by theory, the estimate of σ_u is significantly negative while the estimate of σ_d is significantly positive, empirically confirming that traders strategically select the market that provides lower execution costs.

The intercept term in the upstairs market regression is statistically and economically significant (34.5 basis points), and the difference between the intercepts in the upstairs and downstairs market is positive. This result is consistent with the reasoning that the upstairs market has a higher fixed cost, reflecting the need for screening, search, and negotiation. Somewhat surprisingly, the marginal effect of order size on execution costs is not statistically significant in either market. In the upstairs market this likely reflects that trader reputation, rather than order size, is the determinant of execution costs.

The parameter estimates from Table 7 can be used to estimate the difference in expected liquidity effects orders in the upstairs and downstairs market as:

$$E\,[Y_i^u - Y_i^d] = (\beta_u - \beta_d) * X_i \qquad\qquad (5)$$

We evaluate (5) based on an order with average characteristics for each firm. In Panel C of Table 7 we report cross-sectional median estimates indicating that, for a random seller (buyer) initiated order, liquidity costs are lower in the downstairs markets by 41 (64) basis points. Estimates of this cost differential are little altered when we evaluate (5) for larger or smaller trade sizes, because coefficient estimates on trade size are close to zero.

This analysis confirms that traders self-select to the market that will provide the better execution cost for their trades, and indicates that the liquidity cost of executing a typical block order is lower in the downstairs market than in the upstairs market. This provides support for those who argue that an electronic trading process is inherently less expensive than a trading process with human intervention.

Glosten (1994), for example, argues that the electronic limit order book is "inevitable", unless alternative market structures can provide tangible benefits to overcome their greater costs. Based on the estimates obtained here, the Paris upstairs market is a viable alternative for those traders who gain at least 41 (64) basis points by reacting strategically to time variation in relative liquidity across the upstairs and downstairs markets, or by credibly signaling that their sell (buy) orders do not reflect private information.

7. Conclusions and Discussion

This paper investigates the role of an upstairs market operating in parallel with an electronic stock exchange, using data on 92,170 block trades completed at the Paris Bourse. The answer to the question posed in the title of this paper is clearly "yes". Despite the inherently lower costs of the electronic downstairs market, the upstairs market is efficient for many large traders. Previous work in the literature has attributed the efficiencies to the certification role of upstairs brokers as described by Seppi (1990). While our analysis confirms the importance of block broker certification, we also provide strong empirical evidence in support of Grossman's (1992) hypothesis that upstairs brokers are able to tap pools of unexpressed liquidity, which also attributes to upstairs efficiencies.

We argue that Paris provides an excellent setting to test the implications of upstairs intermediation models, because its electronic limit order market closely resembles the downstairs markets envisioned by theorists. We find strong support for the predictions that: (1) upstairs brokers lower the risk of adverse selection by certifying block orders as uninformed, (2) upstairs brokers are able to tap into pools of "hidden" or "unexpressed" liquidity, (3) traders strategically choose across the upstairs and downstairs markets to minimize expected execution costs, (4) trades are more likely to be routed upstairs if they are large, or are in stocks with less overall trading activity, and (5) buyer-initiated trades are less welcome and pay higher costs in the upstairs markets. We find weaker empirical support for the predictions that (1) permanent and temporary price effects of upstairs block trades are concave in order size, (2) temporary price effects are greater for trades in less-liquid stocks, and (3) pre-trade leakage is greater for buyer-initiated upstairs trades and trades in less liquid stocks.

We investigate the effect of variations in crossing rules at the Paris Bourse on execution costs. For the subset of stocks with less restrictive crossing rules (*eligible* stocks), we find that market participants agree to outside-the-quote execution mainly for more difficult trades and at times when downstairs liquidity is lacking. These outside the quote executions likely represent trades that could likely not have been otherwise completed, suggesting that market quality can be enhanced by allowing participants more flexibility to execute blocks at prices outside the quotes. We also find evidence suggesting that more flexible crossing rules reduce incentives to manipulate the downstairs spread that otherwise constrain upstairs prices. Consistent with this reasoning, the Euronext market has recently adopted rules that allow large block trades in all Paris stocks to be executed outside the quotes. These findings are particularly relevant to U.S. markets since quoted spreads and depths have decreased substantially in the wake of decimalization.

Overall execution costs for Paris block trades completed in the upstairs market are lower than for those completed in the downstairs market, a result that holds across firms with different liquidity characteristics. However, results of estimating a self-selection econometric model indicates higher costs for the upstairs market for randomly selected trades. This supports the common perception that electronic trading is inherently less expensive than a trading process with human intermediation. The estimates indicate that intermediated upstairs trading is an efficient choice only for those who can obtain significant cost savings by responding to time variation in the relative liquidity of the upstairs and downstairs markets, or by signaling that their trades are not information motivated.

If the upstairs market offers significant advantages to certain types of block traders, then there are important implications for the design of the next generation of electronic stock markets. The upstairs market in Paris completes two thirds of block trading volume, compared to 20% on the NYSE. A likely explanation is that the NYSE floor allows large traders to execute customized strategies through a floor broker, while avoiding the risks of order exposure. If orders submitted to electronic markets do not allow block initiators to limit order exposure and trade strategically, then order flow is likely to migrate to alternative trading venues such as the upstairs market.

If an objective of a stock exchange is to consolidate order flow in a centralized market, then the next generation of electronic trading systems should include more features to meet the needs of large traders. For example, if investors have difficulty in managing order exposure in an electronic exchange, then a wider range of order types that include state contingent exposure and execution algorithms can be made available. In short, to avoid losing orders to competing venues, the electronic exchanges need to allow a greater degree of strategic interaction among orders, to replicate some benefits of trading floors and upstairs markets.

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Appendix A: Trading Rules at the Paris Bourse

The trading rules described below were in effect in Paris during our sample period and are outlined in the manual titled "The organization and operation of the regulated market operated by SBF-Paris Bourse," dated March 30th, 1998, which is published by SBF-Paris Bourse. We also held extensive discussions with exchange officials for additional clarifications on the trading rules and the BDM dataset.

A.1. Crossing Rules

During our sample period, the Paris Bourse had two distinct sets of rules for block trading. Upstairs trades in most Paris Bourse stocks must be executed at prices at or within the best bid-offer (BBO) quotes in the downstairs market at the time of the trade (Article N.4.1.17 and N.4.2.6). However, the Paris Bourse classified certain stocks as being *eligible* for the special rules of block trading (Article N.4.2.8). For these *eligible* stocks, the Bourse specified a standard block size (NBS) and continuously disseminated the weighted average spread (WAS). The weighted average bid (ask) gives the weighted average price of executing a market sell (buy) order of order size equal to the NBS against displayed liquidity in the limit order book.

An upstairs trade in an eligible stock with size greater than the NBS can be executed at prices at or within the WAS (Article N.4.2.9, N.4.2.10, and N.4.2.13). During our sample period, upstairs trades in the *non-eligible* stocks cannot trade through the book.

A.2. Reporting Rules

An upstairs trade could involve a member firm as a dealer (principal) or broker (cross-trade). All upstairs trades have to be reported immediately to the Paris Bourse (Article N.4.2.15). Cross-trades and ordinary principal trades are published with no delay (Article N.4.2.17). Principal block trades that are less than five times the NBS are published at the end of a two-hour period commenced upon notification. Structural block trades that are at least five times larger than the standard block size are published at the opening of the next trading session.

The BDM dataset provides the time at which an upstairs trade is reported to the exchange, and not the time at which an upstairs trade is publicly published. While the data set does not distinguish between principal and cross-trades, the exchange officials told us that the majority of upstairs trades are cross-trades and are published with no delay. However, to account for delayed reporting, we use the mid-point of closing quotes on the next trading day to calculate our measures of trades' permanent and temporary price impacts.

Figure 1: Distribution of Stock Prices in the NYSE and the Paris Bourse

The figure presents the graphical distribution of the share prices for all common stocks at the NYSE and the 225 sample stocks at the Paris Bourse on April 1, 1997.

Stock Prices in the NYSE and Paris Bourse
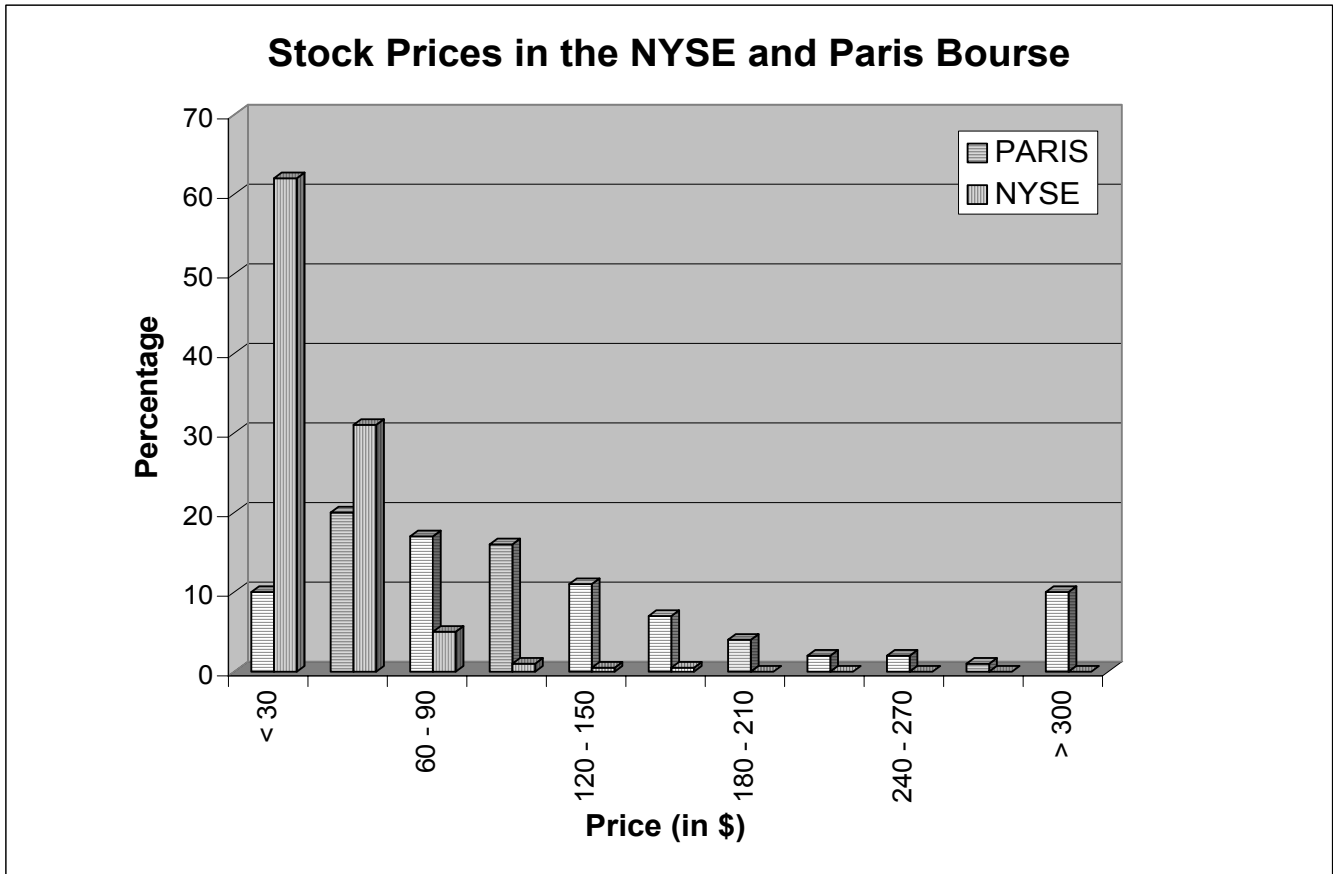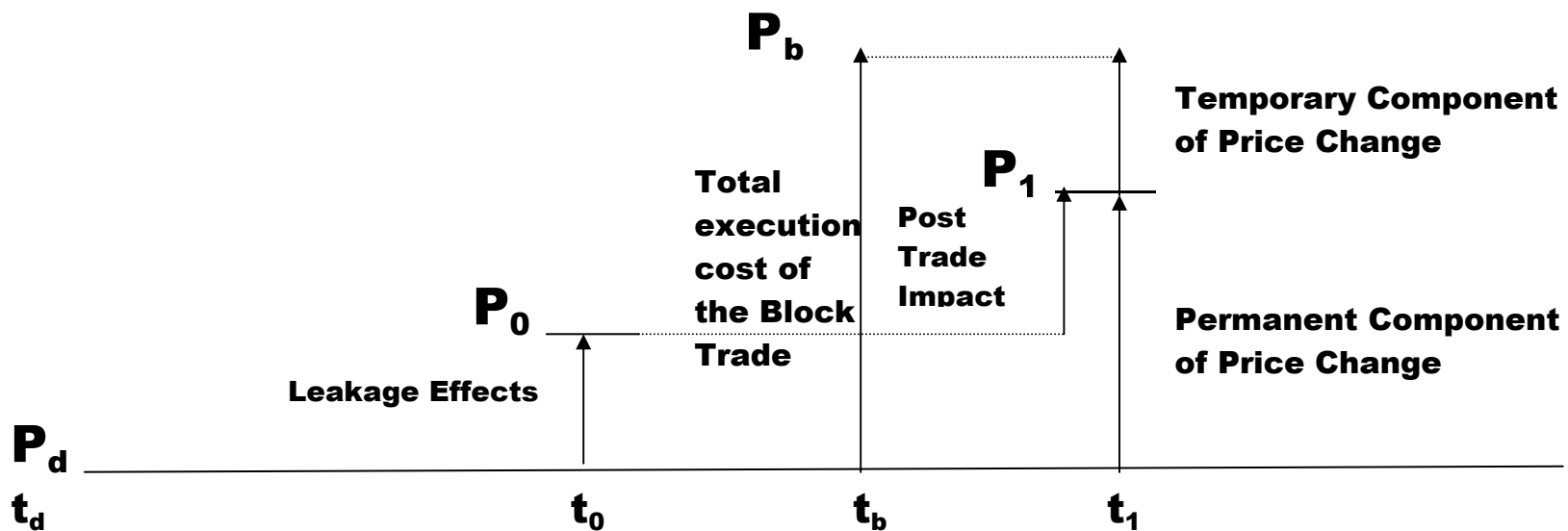
Figure 2: Liquidity and information effects of a block buy

The figure provides a graphical representation of the expected price effects of a block buy. The facilitation process is initiated at time=t_d in the upstairs market. The leakage of information of the block size may move the security value in the downstairs market. The security value just before the block trade (time=t_0) is P_0. The block of size=Q is executed in the upstairs market at (time=t_b) at price=P_b. The liquidity effect of the block results in a price reversal and moves prices to P_1.

- Temporary component of price change $\tau(Q)$: $\ln(P_b) - \ln(P_1)$

- Post-trade impact $\pi(Q)$: $\ln(P_1) - \ln(P_0)$

- Leakage effect $L(Q)$: $\ln(P_0) - \ln(P_d)$

- Permanent component of price change $P(Q)$: $\ln(P_1) - \ln(P_d)$

- Total execution cost of the block trade $T(Q)$: $\ln(P_b) - \ln(P_d)$

Table 1: Sample Summary Statistics and the Distribution of Block Trading Volume

The Paris Bourse sample consists of the component firms of the SBF-250 Index that trade common stock in the continuous auction market on April 1, 1997. The sample period is from April 1997 to March 1998 and the data source is the BDM-database. The firms are classified into quintiles based on their liquidity, which is measured by average (Price * NBS) during the sample period, where NBS is a proxy for the block size of each firm. Only block trades executed during regular market hours are included in the analysis. Reported are the average market price and market capitalization of the sample of firms on April 1, 1997. For upstairs and downstairs block trades, the table reports the total number of trades, the mean and median trade size, the cumulative trading volume and the percentage of the trades and cumulative trading volume executed in the upstairs market during the entire sample period.

	Stock Price (in FF)	Market Size (in FF ml)	Number of trades		Trade size (in FF)		Cumulative Volume	
			N	%age	Mean	Median	(in FF million)	(%age of all volume)
Full Sample	799	13,554						
Downstairs			61,082		2,871,875	1,835,000	175,420	
Upstairs			31,088	33.7%	11,491,550	5,047,500	357,249	67.1%
Most Liquid	800	48,670						
Downstairs			26,342		4,414,975	3,055,000	116,300	
Upstairs			20,323	43.6%	14,709,025	7,452,000	298,931	72.0%
Quintile 4	1,184	8,903						
Downstairs			17,741		2,063,000	1,487,500	36,600	
Upstairs			5,617	24.0%	6,036,575	2,542,500	33,907	48.1%
Quintile 3	1,016	5,334						
Downstairs			11,680		1,401,825	988,575	16,373	
Upstairs			2,967	20.3%	5,436,975	1,800,000	16,132	49.6%
Quintile 2	604	3,252						
Downstairs			3,795		1,192,025	856,350	4,524	
Upstairs			1,453	27.7%	3,921,725	1,542,000	5,698	55.7%
Least Liquid	391	1,614						
Downstairs			1,524		1,065,700	734,200	1,624	
Upstairs			728	32.3%	3,544,550	1,269,450	2,580	61.4%

Table 2: Firm Liquidity, Trade Size and Upstairs Participation Rates

The table presents the average upstairs market participation rate for 225 firms at the Paris Bourse for the period April 1997 to March 1998. The firms are classified into quintiles based on their liquidity, which is measured by average (Price * NBS) during the sample period, where NBS is a proxy for the block size for the firm, and is unique for each firm. In Panel A, trades are classified as (a) small if (NBS≤Trade size<2*NBS) (b) medium if (2*NBS≤Trade size<5*NBS) (c) large if (trade size≥5*NBS). Reported are the median percentage of trades and cumulative trading volume executed in the upstairs market in trade size categories. In Panel B, trades are also classified into trade size (in FF) quintiles, producing a 5X5 classification. Reported is the median percentage of trades executed in the upstairs market, for each classification.

Panel A: Trade Size and Upstairs Participation Rates

Trade size	Number of trades			Cumulative trading volume		
	Small	Medium	Large	Small	Medium	Large
Full Sample	18.5%	42.6%	80.0%	19.7%	45.2%	87.3%
Most Liquid	30.7%	66.3%	90.9%	35.2%	70.9%	96.2%
Quintile 4	13.7%	35.0%	72.4%	14.5%	37.3%	77.3%
Quintile 3	15.9%	35.8%	69.4%	16.8%	37.5%	80.1%
Quintile 2	14.9%	40.0%	80.0%	16.3%	37.8%	86.7%
Least Liquid	21.9%	52.4%	88.9%	25.5%	53.0%	90.0%

Panel B: Firm Liquidity and Upstairs Participation Rates

Liquidity Quintiles	Overall	Trade Size (FF) Quintiles				
		Small	2	3	4	Large
Most Liquid	41.7%	0.0%	13.1%	19.9%	34.4%	74.4%
Quintile 4	22.2%	9.8%	14.5%	27.3%	47.7%	77.7%
Quintile 3	28.1%	11.9%	24.7%	37.1%	61.5%	86.8%
Quintile 2	32.2%	15.6%	32.0%	50.0%	75.0%	100.0%
Least Liquid	38.6%	26.3%	50.0%	57.1%	100.0%	100.0%

Table 3: Crossing Rules and Execution Costs

Panel A reports the locations of transaction prices for upstairs trades relative to the bid-ask quotes at the time of the cross for *eligible* and *non-eligible* stocks. The Paris Bourse allows block trades in *eligible* stocks to be executed at prices away from the BBO at the time of the trade. For both firm-types, reported are the cross-sectional median percentage of trades executed and the median trade size, in each location category. For a buyer (seller) initiated trade, location categories are (a) above (below) the ask (bid) price, (b) at the ask (bid) price and (c) between the ask (bid) price and quote-midpoint. For *eligible firms,* the average quoted spreads (%), quoted depth, and weighted average spread at the time of the upstairs trade, and execution cost (%) are also reported. Panel B reports the trade size, quoted spreads (%), quoted depth, weighted average spreads (%) and execution cost (%) of upstairs trades in eligible and non-eligible stocks, by trade size category. Trades are classified as (a) small if (NBS≤Trade size<2*NBS) (b) medium if (2*NBS≤Trade size<5*NBS) (c) large if (trade size≥5*NBS), where NBS is a proxy for the block size of the firm and is unique for each firm.

Panel A: Location of the upstairs transaction relative to the quotes								
	Cross-sectional Medians of Firm-Specific Means are reported							
	ELIGIBLE FIRMS (N=80) N = 23,637 trades						NON ELIGIBLE FIRMS (N=145) N = 4,474 trades	
	Percentage of Trades Executed	Quoted Spread (%)	Quoted Depth /NMS	Weighted Average Spread (%)	Execution Cost Upstairs (%)	Trade Size /NMS	Percentage of Trades Executed	Trade Size /NMS
Seller-initiated trades								
Below the bid price	9.3%	0.141	0.121	0.721	0.690	5.4	0.0%	21.6
At the bid price	51.8%	0.175	0.170	0.621	0.175	3.5	42.3%	4.1
Above the Bid	40.2%	0.263	0.154	0.766	0.113	3.5	57.1%	3.9
Buyer-initiated trades								
Above the ask price	10.4%	0.125	0.107	0.624	0.582	3.9	0.0%	170.7
At the ask price	53.5%	0.177	0.181	0.586	0.177	3.5	42.9%	3.4
Below the Ask	35.0%	0.269	0.159	0.745	0.117	3.6	58.3%	3.8

Table 3 (continued)

Panel B: Liquidity in the downstairs market during an upstairs transaction

	Trade size / NMS	Quoted Spreads (%)		Quoted Depth / NMS		Weighted Average Spreads (%)	Execution Cost Upstairs (%)
		At the time of the trade	30 min before the trade	At the time of the trade	30 min before the trade		
I. Eligible firms							
Seller-initiated trades							
Small block trade	1.3	0.236	0.190	0.305	0.351	1.158	0.213
Medium block trade	2.9	0.229	0.185	0.699	0.521	0.776	0.211
Large block trade	15.5	0.232	0.199	1.397	1.331	0.729	0.341
Overall	4.9	0.232	0.191	0.819	0.753	0.851	0.230
Buyer-initiated trades							
Small block trade	1.3	0.216	0.177	0.219	0.220	0.723	0.191
Medium block trade	2.9	0.224	0.192	0.228	0.238	0.738	0.204
Large block trade	17.2	0.233	0.187	0.375	0.291	0.742	0.267
Overall	5.2	0.225	0.185	0.247	0.236	0.732	0.214
II. Non eligible firms							
Seller-initiated trades							
Small block trade	1.4	0.613	0.519	0.194	0.161		0.375
Medium block trade	3.1	0.620	0.500	0.174	0.157		0.402
Large block trade	23.7	0.728	0.538	0.201	0.170		0.572
Overall	7.9	0.679	0.536	0.187	0.157		0.474
Buyer-initiated trades							
Small block trade	1.4	0.660	0.469	0.157	0.137		0.398
Medium block trade	3.0	0.693	0.525	0.158	0.132		0.370
Large block trade	16.7	0.661	0.554	0.161	0.123		0.425
Overall	7.4	0.681	0.519	0.158	0.132		0.436

Table 4: Price Effects of Seller-initiated and Buyer-initiated Block Trades

The table presents the average components of price effects of seller- and buyer-initiated trades in the upstairs and the downstairs market for 225 firms at the Paris Bourse for the period April 1997 to March 1998. All price effects are adjusted for market movements in the SBF120 index. The adjustment is made by subtracting the relevant market index return from the stock's return. The trades are classified into market buys and sells using the Lee and Ready (1991) algorithm. The firms are classified into quintiles based on their liquidity, which is measured by average (Price * NBS) during the sample period, where NBS is a proxy for the block size of each firm. The price effects are stated in percentage basis points.

		Leakage Price Effect (L_{-3})	Leakage Price Effect (L_{-1})	Post Trade Impact (P_{+1})	Permanent Effect ($P_{-3,+1}$)	Temporary Effect (T_{+1})	Total Trading Cost (PE_{-1})	Total Trading Cost (PE_{-3})
Panel A: Price Effects of Seller-Initiated Block Trades								
Overall	Downstairs	-26.9 [b]	-5.3	-30.1 [a]	-57.0	-16.7 [a]	-52.1 [a]	-73.7 [a]
	Upstairs	-20.6 [b]	-3.7	9.6	-11.0	-48.4 [a]	-42.5 [a]	-59.4 [a]
Most Liquid	Downstairs	-36.1 [c]	-22.9 [b]	1.1	-35.0 [b]	-21.1 [a]	-42.9 [a]	-56.1 [a]
	Upstairs	1.6	-7.3 [c]	0.8	2.4	-21.2 [a]	-27.7 [b]	-18.8 [c]
Quintile 4	Downstairs	-6.4	-7.6	-22.1 [b]	-28.5 [b]	-14.7 [c]	-44.4 [a]	-43.2 [a]
	Upstairs	-5.2	7.3	-6.2	-11.4	-21.6 [b]	-20.5 [c]	-33.0 [b]
Quintile 3	Downstairs	-43.5 [b]	0.0	-36.8 [a]	-80.3 [a]	-9.2	-46.0 [a]	-89.5 [a]
	Upstairs	-53.8 [a]	-9.2	14.4	-39.4 [a]	-56.5 [a]	-51.3 [a]	-95.9 [a]
Quintile 2	Downstairs	-13.2	13.0	-33.6 [b]	-46.8 [b]	-24.7 [c]	-45.3 [a]	-71.5 [a]
	Upstairs	0.0	0.0	31.5 [b]	31.5 [b]	-84.5 [a]	-53.0 [a]	-53.0 [a]
Least Liquid	Downstairs	-36.0	-8.2	-63.3 [a]	-99.3 [a]	-14.5	-86.0 [a]	-113.8 [a]
	Upstairs	-47.5	-9.4	9.4	-38.1 [c]	-62.3 [c]	-62.3 [a]	-100.4 [a]
Panel B: Price Effects of Buyer-Initiated Block Trades								
Overall	Downstairs	70.4 [a]	41.2 [a]	86.4 [a]	156.8 [a]	-37.6 [a]	90.0 [a]	119.2 [a]
	Upstairs	30.3 [a]	20.1 [a]	33.9 [a]	64.2 [a]	1.7	55.7 [a]	65.9 [a]
Most Liquid	Downstairs	83.6 [a]	51.7 [a]	44.9 [a]	128.5 [a]	-24.6 [a]	72.0 [a]	103.9 [a]
	Upstairs	33.0 [a]	16.5 [a]	1.7	34.7 [b]	17.8 [a]	36.0 [a]	52.5 [a]
Quintile 4	Downstairs	61.1 [b]	37.5 [a]	68.5 [a]	129.6 [a]	-30.0 [a]	76.0 [a]	99.6 [a]
	Upstairs	48.4 [a]	29.6 [a]	19.9 [b]	68.3 [a]	16.7	66.2 [a]	85.0 [a]
Quintile 3	Downstairs	54.1 [b]	41.8 [a]	72.7 [a]	126.8 [a]	-24.1 [b]	90.4 [a]	102.7 [a]
	Upstairs	33.4 [b]	27.8 [a]	27.7 [b]	61.1 [a]	3.4	58.9 [a]	64.5 [a]
Quintile 2	Downstairs	107.9 [b]	54.4 [a]	92.9 [a]	200.8 [a]	-29.5 [b]	117.8 [a]	171.3 [a]
	Upstairs	15.6	20.7	38.7 [b]	54.3 [a]	5.7	65.1 [a]	60.0 [a]
Least Liquid	Downstairs	42.6	18.2	163.2 [a]	205.8 [a]	-85.8 [a]	95.6 [a]	120.0 [a]
	Upstairs	19.4	4.3	88.4 [a]	107.8 [a]	-39.9	52.8 [a]	67.9 [a]

a signifies: p-value < 0.01; b signifies: 0.01 £ p-value < 0.05; c signifies: 0.05 £ p-value < 0.10

Table 5: Regression Analysis of Price Effects in the Upstairs Market and Trade Size

The table presents mean and median values of the coefficients from a regression of temporary and permanent price effects in the upstairs market on trade size. The regression coefficients are computed for the 132 firms at the Paris Bourse that have at least 30 upstairs trades for the period April 1997 to March 1998. All price effects are adjusted for market movements in the SBF120 index. The price effects are stated in percentage basis points. The trades are classified into market buys and sells using the Lee and Ready (1991) algorithm. The following regression test proposition 1 and 4 in Keim and Madhavan (1996).

Panel A: $|\tau(Q)| = \beta_0 + \beta_1 * Q + \beta_2 * Q^2 + \beta_3 * I + \varepsilon$; for each stock

where $|\tau(Q)|$ = Absolute value of temporary price effect (after correcting for market drift)

Panel B: $|P(Q)| = \beta_0 + \beta_1 * Q + \beta_2 * Q^2 + \beta_3 * I + \varepsilon$; for each stock

where $|P(Q)|$ = Absolute value of permanent price effect (after correcting for market drift)

and Q = Trade Size/(NBS*100), I = 1 for a block buy, and I = 0 for a block sell

Reported is the p-value of the mean and the p-value of the rank statistic under the null hypothesis that the population median coefficient is zero. Also reported is the median adjusted R^2 for the regression models.

N = 132 FIRMS	Intercept	Size/NBS	(Size/NBS)^2	Dummy	Median Adj R^2
Panel A: Temporary Price Effects and Trade Size					
Mean	0.221	5.842	-22.566	-0.342	0.014
p-value	(0.000)	(0.010)	(0.184)	(0.000)	
Median	0.256	1.379	-0.241	-0.221	
p-value (sign test)	(0.000)	(0.029)	(0.258)	(0.002)	
Panel B: Permanent Price Effect and Trade Size					
Mean	0.177	-1.198	-16.56	0.416	0.02
p-value	(0.136)	(0.768)	(0.582)	(0.013)	
Median	0.167	-1.269	0.649	0.453	
p-value (sign test)	(0.045)	(0.139)	(0.258)	(0.018)	

Table 6: Regression Analysis of Price Effects in the Upstairs Market and Firm Characteristics

Reported are coefficients from a regression of temporary and leakage price effect measures in the upstairs market on firm characteristics such as stock volatility and liquidity. Trades are classified into quintiles based on their trade size (in FF), and regression coefficients are reported for each quintile. All price effects are adjusted for market movements in the SBF120 index. The adjustment is made by subtracting the relevant market index return from the stock's return. The price effects are stated in percentage basis points. For each firm, daily volatility is the variance of returns using the closing quote midpoints, while liquidity is proxied by the NBS of the firm (divided by 1,000,000). The dummy coefficient equals 1 for a buy order, and 0 otherwise. Trades are classified into buys and sells using the Lee and Ready (1991) algorithm. The p-values are reported in parenthesis.

Trade Size Quintiles	*Panel A: Temporary Price Impact and Firm Characteristics*					*Panel B: Leakage Price Impact and Firm Characteristics*				
	Intercept	Daily Volatility	Liquidity (Price * NBS)	Buy Order Dummy	Adj R^2	Intercept	Daily Volatility	Liquidity (Price * NBS)	Buy Order Dummy	Adj R^2
Large Trades	0.3852	2.1494	-0.0276	-0.1392	0.0073	0.0643	37.9554	-0.0061	0.1132	0.0012
	(0.00)	(0.90)	(0.00)	(0.00)		(0.40)	(0.15)	(0.53)	(0.00)	
Quintile 4	0.3186	5.1197	-0.0196	-0.0401	0.0006	0.1632	38.158	-0.0147	0.1282	0.0015
	(0.00)	(0.76)	(0.05)	(0.15)		(0.04)	(0.15)	(0.35)	(0.00)	
Quintile 3	0.2967	13.3174	-0.0411	-0.0265	0.0006	0.1761	34.6636	0.0159	0.1456	0.0017
	(0.00)	(0.50)	(0.03)	(0.35)		(0.05)	(0.25)	(0.59)	(0.00)	
Quintile 2	0.1946	-8.8544	-0.034	-0.065	0.0005	0.5463	28.5205	-0.1581	0.1793	0.0031
	(0.00)	(0.56)	(0.40)	(0.04)		(0.00)	(0.23)	(0.01)	(0.00)	
Small Trades	0.1704	-4.588	-0.0018	-0.2176	0.0075	0.3826	-0.6777	-0.0687	0.0556	-0.0003
	(0.04)	(0.87)	(0.98)	(0.00)		(0.00)	(0.98)	(0.57)	(0.28)	

Table 7: Liquidity Effects of a Random Trade After Controlling for Selection Bias

Panel A presents the results of the probit model estimating the likelihood of executing an order in the upstairs market. The dependent variable is a dummy variable that equals 1 for an upstairs trade, and 0 otherwise. The explanatory variables are liquidity characteristics such as bid-ask spread and order imbalance at the time of order execution and order characteristics such as size of the order and whether it is a buyer or seller-initiated. The trades are classified into market buys and sells using the Lee and Ready (1991) algorithm. Panel B presents the coefficient estimates of the endogenous switching regression model of the liquidity effects of block trades. The following models are estimated simultaneously using a maximum likelihood estimator approach

$$E\,[Y_i^u \mid U_i = 1\,] = \beta_u * X_i + \sigma_u * [\,\phi\,(\gamma * Z_i)\,/\,\Phi\,(\gamma * Z_i)\,]; \text{ and}$$

$$E\,[Y_i^d \mid U_i = 0\,] = \beta_d * X_i + \sigma_d * [\,-\,\phi\,(\gamma * Z_i)\,/\,(1 - \Phi\,(\gamma * Z_i))\,]\,;$$

where $X_{i,t} = (1, Q_{i,t}/NBS_i, DMKTORD_t, DMKTORD*Q_{i,t}/NBS_i)$. Q_t is order size, NBS_i is the normal block size of the security, DMKTORD equals 1 for a buyer-initiated trade and 0 otherwise, and $\gamma * Z_I$ denotes the estimated value of the continuous response variable based on the structural probit estimates. Panel C presents the liquidity effects of a random buyer and seller initiated trade in both markets.

Panel A: Probit Analysis of the Choice of the Trading Venue							
	Constant	Bid-ask spread	Order Imbalance	Buy Order	Order Size/ NBS	Volatility (Hourly)	Price (Inverse)
	-0.743	0.488 [a]	0.395 [a]	-0.199 [a]	0.281 [a]	-1021.51 [a]	-24.43

Panel B: Selectivity Adjusted Analysis of Liquidity Effect in Both Markets					
	Constant	Order Size/ NBS (Q)	Buy Order	Buy Order * Q	Covariance (Sigma)
Temporary Price Effect					
Upstairs Market	34.59 [a]	-0.07	-1.68	-1.49	-15.28 [c]
Downstairs Market	0.65	0.84	-25.69 [a]	-0.09	37.20 [b]
Upstairs - Downstairs	31.56 [a]	-2.19	27.28	0.04	-47.84 [b]

Panel C: Execution Cost of a Random Order (in basis points)		
	Sell Order	Buy Order
Temporary Price Effect		
Upstairs - Downstairs	41.27 [b]	63.63 [a]

a signifies: p-value < 0.01; b signifies: 0.01 £ p-value < 0.05; c signifies: 0.05 £ p-value < 0.10