Journal of Financial Markets 4 (2001) 209–229

Journal of FINANCIAL MARKETS

www.elsevier.nl/locate/econbase

Market microstructure and securities values: Evidence from the Paris Bourse ☆

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Abstract

We study a sample of Paris Bourse stocks that were transferred between call trading and continuous trading. Consistent with the results of Amihud et al. (J. Financial Econom. 45 (1997) 365), we find that frequently-traded stocks that are transferred from call trading to continuous trading experience, on average, liquidity improvements that are positively associated with price appreciation. We also find that infrequently-traded stocks that are transferred from continuous trading to call trading experience price and liquidity declines. Our results suggest that continuous markets offer better liquidity for frequently-traded stocks, but call markets do not offer better liquidity for infrequently-traded stocks. Our results support the Amihud and Mendelson (J. Financial Econom. 17 (1986) 223) assertion that there is a direct link between market microstructure and firm value. © 2001 Elsevier Science B.V. All rights reserved.

JEL classification: G12; G14; G15

Keywords: Market microstructure; Liquidity; Trading systems

☆We wish to thank Marianne Demarchi of the Paris Bourse for her assistance and Kumar Venkataraman for his generosity. We thank Saul Bronfeld, Cynthia Campbell, Ian Domowitz, Ananth Madhavan, Harold Mulherin, Dror Shalit, Avi Wohl, Bruce Lehmann (the editor), and an anonymous referee for helpful comments and suggestions.

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PII: S1386-4181(00)00022-7

1. Introduction

Equity markets have many dimensions on which to compete for order flow. These include the choice between a quote-driven system and an order-driven system, the choice of the number of market makers/specialists for each security, the choice of the minimum price variation (tick size), the choice of the priority rules for order execution, and the choice of the market clearing frequency. In recent years, leading international equity markets have made major investments to improve their trading mechanisms along one or more of these dimensions. The Toronto Stock Exchange moved to decimal pricing. US stock exchanges have changed the minimum tick size from $1/8 to $1/16 and plan to move to decimal pricing. The Paris Bourse and other stock exchanges have converted their trading systems from call markets to ones that allow selected stocks to trade continuously.

Two important and related questions for both academics and practitioners are: (1) which changes in trading mechanisms improve market quality? and (2) do improvements in market trading mechanisms create value? The link between market microstructure and firm value is an important and recent addition to the finance literature. Amihud and Mendelson (1986) first proposed that risk-adjusted returns on stocks are increasing in their illiquidity. They show that improved liquidity increases securities values because rational investors discount securities more heavily in the presence of higher trading costs, holding other things equal. Market microstructure is also relevant to recent developments in asset pricing. Brennan and Subrahmanyam (1996) show that liquidity measures should be included in factor pricing models.[1] Our paper provides evidence on these issues by examining the value and liquidity effects of a change in the market clearing frequency for selected stocks on the Paris Bourse.

The choice of market clearing frequency comes down to a choice between a call market and a continuous market. In a call market, investors' orders are accumulated (batched) for simultaneous execution at a single transaction price at a pre-determined time. In a continuous market, investors' orders are submitted for immediate execution leading to a sequence of bilateral transactions that may occur at different prices.

Periodically, the Paris Bourse transfers stocks from a twice-daily call auction ("Fixing") to continuous trading ("Continuous"), or vice versa, based on their evaluation of the stock's trading activity. Frequently-traded stocks in the Fixing category are transferred to the Continuous category, and infrequently-traded stocks in the Continuous category are transferred to the Fixing category. Unlike a change in exchange listing, where the decision is made by the firm's manage-

[1] Also see Brennan et al. (1998) and Datar et al. (1998).

ment, this pure microstructure event is not controlled by the firm. The announcements from the Paris Bourse explain that the transfers are being made "pour raisons purement techniques" (for purely technical reasons) and not based upon any private information about the firm's future prospects. Therefore, any liquidity change around the transfer is due to a change in the clearing frequency, and any associated price change around the transfer reflects the value of this change in the trading mechanism. This paper investigates the liquidity and value effects of these stock transfers on the Paris Bourse.

Assuming that investors trade in markets that offer the best liquidity, the fact that we observe that the world's leading equity markets are moving the vast majority of their trading from call to continuous suggests that continuous trading offers the best liquidity for most securities, most of the time. However, even as more equity markets are becoming more continuous, call auction procedures are still used on several of them. The New York Stock Exchange and many other continuous markets open with a call auction. Some markets have experimented with closing continuous sessions with a call auction.[2] Other markets, including the Tokyo Stock Exchange, hold a midday call auction in between morning and afternoon continuous trading sessions. The Paris Bourse and other markets operate a continuous market for frequently-traded securities and a call market for infrequently-traded securities. This suggests that there may be certain securities for which call auctions offer better liquidity than continuous trading.

The implications of several theoretical market microstructure models are consistent with this observation.[3] Continuous markets offer immediacy and lower information costs. However, call markets offer greater stability in the presence of severe asymmetric information (e.g., for the trading of low volume stocks) and more protection for uninformed limit order traders from being "picked off" by informed traders.

Several empirical papers have studied the choice of market clearing frequency. One group of studies examines price discovery for stocks that trade in different market clearing mechanisms throughout the trading day.[4]

Our paper is most closely related to the previous studies that examine the choice between call and continuous markets as the primary market mechanism. Easley et al. (1996) show that the probability of information-based trading on the NYSE is higher for low-volume stocks. Therefore, the degree of asymmetric information and hence the transaction costs are higher for less liquid stocks. As

[2] See Thomas (1998).

[3] See Garbade and Silber (1979), Mendelson (1982, 1987), Madhavan (1992), Glosten and Milgrom (1985), and Ho et al. (1985).

[4] Amihud et al. (1990), Amihud and Mendelson (1991), and Kehr et al. (1998) study the Milan, Tokyo, and Frankfurt Stock Exchanges, respectively.

a consequence, the incentives for uninformed investors to forego immediacy for the sake of lower transaction costs are higher for less active stocks. They suggest the use of different trading mechanisms for active and inactive stocks. While active stocks should trade continuously throughout the trading day, inactive stocks should trade periodically through call auctions. Easley et al. state that their findings suggest that "switching the trading of illiquid stocks to such a call market, as has been recently done on the Paris Bourse, should result in an improvement of overall trader welfare".

Amihud, Mendelson, and Lauterbach (1997) (hereafter AML) is the first study to examine the value and liquidity effects of transferring a stock from a call market to a continuous market. They analyze 120 stocks on the Tel Aviv Stock Exchange that were transferred gradually during 1987–1994 from a daily call auction to continuous trading sessions. They find a 5.5% cumulative abnormal return around the transfer date. They also find that there are associated liquidity improvements due to the improved trading method. The evidence suggests that a continuous trading environment is a superior trading venue for relatively active stocks.

In a follow-up paper, Lauterbach (1999) studies 97 stocks on the Tel Aviv Stock Exchange that were transferred back to a daily call auction from continuous trading. He finds that most of the firms experience a decrease in both stock price and liquidity. In 1998, the Tel Aviv Stock Exchange discontinued the use of the daily call auction in favor of a continuous computerized market. Kalay et al. (2000) study a sample of 749 stocks on the Tel Aviv Stock Exchange during the transition and find a significant increase in the relative trading volume of stocks following their transfer to continuous trading. They also find that stocks that remained in call auctions experienced dramatic reductions in their relative volume when similar stocks were transferred to continuous trading. Kalay et al. conclude that the new continuous trading mechanism is clearly superior to the old call market.

This paper extends the work of AML and Kalay et al. in two ways. First, it examines a similar microstructure event on a different market. Specifically, this paper examines frequently-traded stocks that are transferred from the "Fixing" category to the "Continuous" category on the Paris Bourse. Second, this paper also examines the exact opposite microstructure event – a transfer of infrequently-traded stocks from "Continuous" trading to "Fixing" trading.

The remainder of the paper is organized as follows. Section 2 describes the Paris Bourse market structure. It includes descriptions of the continuous trading category, the call auction trading category, and the trading category transfer procedures. Section 3 describes the Paris Bourse BDM database, and presents the sample of transferred firms. Section 4 presents the methodology by summarizing the three sets of empirical tests that are conducted. The empirical results are presented in Section 5. Section 6 concludes the paper.

2. The Paris Bourse market structure

The French equity market, the Société des Bourses Française (Paris Bourse), is an order-driven market. It uses a centralized computer limit order book system, the Cotation Assistée Continu (CAC) system, closely patterned after the Toronto Computer Assisted Trading System, for displaying and processing orders.

Managers apply for the listing of their firm's securities on the Paris Bourse under one of two *trading compartments* – the Official List or the Second Market. Each trading compartment has its own qualitative and quantitative listing requirements based on standards, such as the degree of financial statement disclosure and the percentage of equity offered to the public. The Official List has the more rigid listing requirements. Firms that are initially listed on the Second Market may apply for a switch to the Official List after they meet the minimum requirements.

In addition to the two trading compartments, stocks are placed in one of two *trading categories*. In contrast to the trading compartment decision, the firm's management does not make the trading category decision. The Paris Bourse assigns new listings to a trading category based on expected trading activity. Trading activity is defined by the Paris Bourse as the mean and median daily number of trades, mean and median daily value of shares traded (in French Francs), and mean number of daily orders submitted into the CAC system. Securities with relatively high trading activity are traded on a continuous basis in the "Continuous" trading category. Securities with relatively low trading activity are traded in twice daily batch auctions in the "Fixing" trading category. The approximately 700 common stocks traded on the Paris Bourse are roughly evenly divided between the "Continuous" and "Fixing" categories.

The primary market mechanism for securities in the "Continuous" category is a continuous market that proceeds after a two-stage opening procedure. The first stage is the pre-opening phase from 8:30 a.m. to 10:00 a.m., where orders are accumulated in the centralized order book without any transactions taking place. The second stage is the market opening at 10:00 a.m., with a batch auction at the theoretical equilibrium price computed at the end of the pre-opening phase. The continuous market operates from 10:00 a.m. to 5:00 p.m. During this time, limit orders are placed on the CAC by member firms on a continuous basis, where they are given price priority and then time priority. When a new order to buy (sell) matches an existing order to sell (buy) on the centralized book, one or more transactions are immediately executed according to price and time priority, and the computerized order book is instantaneously updated.[5]

[5] Pagano and Röell (1993) and Biais et al. (1995) study the microstructure of the Paris Bourse.

For securities in the "Fixing" category, orders are managed through an orderbook that operates continuously from 8:30 a.m. to 4:00 p.m., but are matched just twice daily (11:30 a.m. and at 4:00 p.m.) using the same batch auction procedure as the market opening for the continuously traded stocks.

The Paris Bourse periodically transfers stocks from batch trading to continuous trading, or vice versa, based upon trading activity. Infrequently-traded "Continuous" stocks are transferred to the Fixing category, while frequently-traded "Fixing" stocks are transferred to the Continuous category. Sometimes the Paris Bourse transfers a stock from one trading category to another for reasons other than trading activity. If a "Fixing" stock is included in the SBF120 Index, then it is immediately transferred to the Continuous trading category. If a "Continuous" stock is a target for a takeover, then it is transferred to the Fixing trading category after the date of the takeover agreement until the effective date of the takeover.

3. Data description

The Paris Bourse publishes the Base de Données de Marché (BDM) database. This database contains reference information on each of the securities traded on the Paris Bourse, as well as all transactions, and the highest bids and lowest offers for each stock on the orderbook at a given time. Stocks that are transferred from one trading category to another during the sample period of 1995–1999 are identified using this database. This sample period is chosen due to data availability.

The Paris Bourse officially announces every trading category transfer in an "Avis". The Avis contains the announcement date, effective date, and reason for the transfer. Of the 276 total category transfers of French stocks, 142 were related to index inclusions or corporate actions (takeovers, mergers, etc.), while 134 were transferred purely because of their trading activity. The finance literature is replete with studies demonstrating the dramatic price and volume effects of mergers and index inclusions. Since the objective of this study is to examine the effects from a pure microstructure event, transfers related to corporate events are removed from the analysis.

Table 1 contains the list of 134 firms that were transferred from one trading category to another for purely trading activity reasons. Panel A contains the list of the 86 firms that were transferred from "Fixing" to "Continuous". Panel B contains the list of the 48 firms that were transferred from "Continuous" to "Fixing".

4. Methodology

This paper follows the methodology presented in AML. We also use their notation. Three separate sets of empirical tests are conducted. Each test is

Table 1
Sample firms

Firms trading on the Paris Bourse that were transferred from either Fixing-to-Continuous trading or from Continuous-to-Fixing trading during January 1995–December 1999.

Firm name	Announcement date	Transfer date
Panel A: *Fixing-to-Continuous firms* ($N = 86$)		
GRP.VALFOND FRF100	950127	950201
MECATHERM	950619	950621
CEGEDIM	950629	950703
ADA	951020	951102
CAOUTCHOUCS PADANG	951020	951102
CFPI	951020	951102
CHANGE BOURSE	951020	951102
CRCAM MORBIHAN CCI	951020	951102
CRCAM P.CALAIS CCI	951020	951102
DAUPHIN	951020	951102
INFOGRAMES ENTERT.	951020	951102
LANDANGER CAMUS	951020	951102
MATUSSIERE FOREST	951020	951102
SAGA	951020	951102
SIDERGIE	951020	951102
ONET	951226	960102
REASSURANCES FSE	960222	960301
DISTRIBORG GROUPE	960307	960311
CONSORTIUM INTL	960312	960315
MEDASYS DIGITAL	960403	960409
HIT	960522	960603
ELEC.MADAGASCAR	960726	960729
IMS INTL METAL SCE	961007	961009
PRODUITS CHIM.AUX.	961016	961017
COM 1	961028	961104
EURO.TELESECU.CET	961028	961104
IMMOB.BATIBAIL	961028	961104
INFOR.ET REALITE	961028	961104
INFRA +	961028	961104
MANUTAN	961028	961104
NOMAI	961028	961104
SABATE	961028	961104
STEDIM	961028	961104
WAELES	961028	961104
JEAN CLAUDE DARMON	970211	970217
AIRFEU	970220	970303
LVL MEDICAL GROUPE	970326	970401
SASA INDUSTRIE	970516	970602
HBS TECHNOLOGIE	970527	970602
JET MULTIMEDIA	970630	970701
GROUPE DECAN	970708	970715
LAFUMA	970723	970728
LEON DE BRUXELLES	970923	971001

Table 1 (*continued*)

Firm name	Announcement date	Transfer date
DUC	971017	971103
INTER PARFUMS	971219	980102
BENETEAU	971229	980102
CEA-INDUSTRIE CIP	980121	980202
CONTINENT.ENTREPR.	980121	980202
DU PAREIL AU MEME	980121	980202
EXPAND	980121	980202
GEA GRENOBL.ELECT.	980121	980202
GRANDE PAROISSE	980121	980202
HUREL-DUBOIS	980121	980202
ING.CION INFOR.	980121	980202
SIRAGA	980121	980202
WALTER	980121	980202
VRANKEN MONOPOLE	980414	980416
GEODIS	980420	980422
ORGASYNTH	980429	980504
REP	980507	980512
AVIATION LATECOERE	980715	980717
SYLIS	980807	980811
TRANSICIEL	980810	980812
IEC PROFES.MEDIA	981229	990104
TELEFLEX LIONEL-DU	990318	990401
GTI GLE TRSP.IND.	990318	990401
ALBATROS INVEST.	990318	990401
PLAST.VAL DE LOIRE	990318	990401
BOIZEL CHANOINE	990318	990401
DANE ELEC MEMORY	990318	990401
GROUPE FOCAL	990318	990401
BRIT AIR	990318	990401
AES LABO.GROUPE	990318	990401
GIORGIO FEDON SICO	990318	990401
ALTEN	990428	990503
TRIGANO	990512	990517
TOUAX	990610	990614
VIKING	990628	990701
FINUCHEM	990728	990802
SOLERI	990728	990802
ALAIN MANOUKIAN	990825	990901
AUBAY TECHNOLOGY	990927	991001
PINGUELY HAULOTTE	990927	991001
GLE BUREAUT.INFOR.	990927	991001
TONN.FRANCOIS FRES	991125	991201
CEN.RECH.IND.TECHN	991125	991201
Panel B: Continuous-to-Fixing firms ($N = 48$)		
ALAIN MANOUKIAN	951020	951102
CAUMARTIN PART.	951020	951102
CONCORDE-ASS.RISQ.	951020	951102

Table 1 (*continued*)

Firm name	Announcement date	Transfer date
DEVANLAY	951020	951102
ELYSEE INV.	951020	951102
EXPAND	951020	951102
FOURMI IMMOBILIERE	951020	951102
FRANKOPARIS	951020	951102
ICC	951020	951102
INS.PART.BOIS MEUB	951020	951102
INSTALLUX	951020	951102
MECADYNE	951020	951102
MECELEC	951020	951102
PACKAGING C.G.P.	951020	951102
PARFINANCE	951020	951102
ROSARIO STE FIN.DE	951020	951102
ROULEAU-GUICHARD	951020	951102
SDR PICARDIE	951020	951102
ACMER	961028	961104
AGACHE(FINANCIERE)	961028	961104
CENTREST	961028	961104
CERMEX	961028	961104
GTI GLE TRSP.IND.	961028	961104
INDUSTRIE(CENT.)	961028	961104
REYDEL INDUSTRIES	961028	961104
SODECCO	961028	961104
SODERO	961028	961104
CAOUTCHOUCS PADANG	980121	980202
CRCAM LOIRE AT.CCI	980121	980202
IPO(INST.PART.O.)	980121	980202
MINES KALI THERESE	980121	980202
POCHET	980121	980202
SABETON	980121	980202
SAGA	980121	980202
SCAC DELMAS VIELJ.	980121	980202
WAELES	980121	980202
PAUL PREDAULT	990318	990401
BAINS MER	990318	990401
ARBEL	990318	990401
IMMOB.HOTELIERE	990318	990401
GEL 2000	990318	990401
BROSSE DUPONT	990318	990401
NSC GROUPE	990318	990401
MAXI LIVRES PROFR.	990318	990401
SEDIVER EURO.ISOL.	990318	990401
INFRA +	990318	990401
SIRAGA	990318	990401
BNPI	991028	991102

conducted separately for the sample of firms that are transferred from "Fixing" to "Continuous" and for the sample of firms that are transferred from "Continuous" to "Fixing".

The first set of tests is conducted to examine the price effects of transferring from one trading category to another. The announcement day is denoted by "A" and the transfer day is denoted by "T". The event window extends from 10 days before the announcement day ($A-10$) until 30 days after the transfer day ($T+30$). Starting from day $A-10$ allows for possible leaks about proposed transfers from the member firms whose opinions regarding the transfer are solicited by the Paris Bourse prior to the formal announcement in an "Avis".[6] The long post-event period allows for an examination of whether any effect on firm value is permanent.

Table 1 indicates that the events are clustered in time, which suggests that some modifications of standard event study methodology may be appropriate. Brown and Warner (1985) suggest a risk-adjusted methodology.

Abnormal returns are calculated for each stock n on each day t in the event window as

$$AR_{nt} = R_{nt} - (\alpha_n + \beta_n RM_t),$$

where R_{nt} is the return on stock n on day t and RM_t is the daily return on the value-weighted SBF120 Index. Returns are calculated as the logarithms of daily closing price changes adjusted for dividends. None of the sample firms experienced stock splits or other confounding distribution events during their event window.[7] The α and β coefficients for each firm are estimated from the market model:

$$R_{nt} = \alpha_n + \beta_n RM_t + \varepsilon_{nt}.$$

The market model is estimated over days $T+31$ to $T+160$. Because the Continuous-to-Fixing stocks are thinly traded, the Scholes and Williams (1977) method of estimating α and β is used for both subsamples.[8] Post-event data is used for estimation to avoid an ex-post selection bias.[9] Firms with less than 40 observations in the estimation period, yielding unreliable market model parameter estimates, are excluded from the analysis.

[6] We thank Marianne Demarchi of the Paris Bourse for providing the Avis and answering questions regarding the transfer procedures.

[7] Stock distribution events are listed in Paris Bourse BDM Database. The Adjustment Coefficients file contains a record for each distribution event (dividends, stock splits, subscription allotment rights, etc.). The Number of Listed Shares file contains a record for each modification of the number of listed shares.

[8] We thank an anonymous referee for this suggestion.

[9] See Brown et al. (1995).

Cumulative abnormal returns are calculated as

$$CAR_{ns} = \sum_{t=A-10}^{s} AR_{nt},$$

for each stock n on each event day s. Average cumulative abnormal returns (CAR_s) are obtained for each sample by averaging CAR_{ns} across all stocks in that sample.

As previously mentioned, the Paris Bourse usually transfers stocks in batches. The *CAR*s of individual stocks in the same transfer batch may not be independent, which means that the variance and associated t-statistics may be biased. To overcome this potential problem, we combine stocks transferred in the same batch into portfolios. Fixing-to-Continuous firms were transferred in 41 separate batches, while Continuous-to-Fixing firms were transferred in 5 separate batches. Portfolio cumulative abnormal returns are calculated for each transfer portfolio i on each event day s as

$$CAR_{is} = \sum_{t=A-10}^{s} AR_{it},$$

where AR_{it} is the equally-weighted return on transfer portfolio i on event day t. Average portfolio cumulative abnormal returns (CAR_s) and associated t-statistics are obtained for each sample by averaging CAR_{is} across all transfer portfolios in that sample. Weighted average portfolio cumulative abnormal returns and associated t-statistics are calculated through weighting by the number of stocks in each transfer portfolio.

We conduct a second set of tests using non-parametric tests of changes in liquidity and market efficiency, between the pre-event and post-event periods. The two liquidity measures that we examine are trading activity and market depth. Market efficiency is measured using the market model return residuals.

To test the change in trading activity from a trading category transfer, the change in average daily relative volume (DV) is examined:

$$DV_j = \log(V_j/VM)_{AFTER} - \log(V_j/VM)_{BEFORE},$$

where V_j is the average daily trading volume (in French francs) of stock j and VM is the average daily trading volume (in French francs) of the market. The choice of our trading activity measure is motivated by two reasons. First, AML measure trading activity as volume in monetary units relative to the market volume. Second, the Paris Bourse uses volume in monetary units as one measure of trading activity when making category listing and transfer decisions.[10] The

[10] As a robustness check, we tried various trading activity measures such as share volume relative to the market, unadjusted share and French franc volume, and turnover. All of the results from the various measures of trading activity are qualitatively and quantitatively similar to those reported in the tables.

pre-event period (*BEFORE*) is defined as day $A-150$ through day $A-31$ and the post-event period is defined (*AFTER*) is defined as day $T+31$ through day $T+150$. An increase (decrease) in relative volume is associated with an increase (decrease) in liquidity.

To test the change in market depth from a trading category transfer, the relative change in the liquidity ratio (*DLR*) is examined:

$$DLR_j = \log(LR_{j,AFTER}/LR_{j,\,BEFORE}),$$

where the liquidity ratio (*LR*) is defined as

$$LR_j = \sum_t V_{jt} / \sum_t |R_{jt}|,$$

where V_{jt} is the volume of stock j on day t and R_{jt} is the return of stock j on day t. The liquidity ratio measures the trading volume associated with a unit change in the stock price. We use a market depth measure constructed with daily data because the common liquidity measures that use intraday quote and/or transaction data cannot be applied in this study. Quoted spreads, effective spreads, and price impacts for twice-daily simultaneous batch auctions are not directly comparable to smaller, irregularly-spaced sequential continuous transactions. The depth of the limit order book can not be calculated because the database does not include order cancellations for prices that are away from the inside bid and ask. The liquidity ratio is a well-established proxy for market depth. Originally developed by Amivest Corporation as a liquidity measure for its monthly investment advisory newsletter, the liquidity ratio has been used in several empirical market microstructure research studies.[11] A high liquidity ratio suggests that a large number of shares can be traded with little price movement. An increase (decrease) in the liquidity ratio is associated with an increase (decrease) in market depth or liquidity.

To test the change in market efficiency from a trading category transfer, two measures of the change in the dispersion of the returns of individual stocks around the market return are examined.

For each event day s, the relative return dispersion (*RRD*) is calculated as

$$RRD_s = (1/J) \sum_{j=1}^{J} \varepsilon_{js}^2,$$

where the residuals ε for each stock j are calculated using a market model estimated separately for the pre-event and post-event periods and averaged across the total number of stocks J in each sample. The mean *RRD* over the 120 days in the pre-event period is compared to the mean *RRD* in the post-event period.

[11] For example, see Cooper et al. (1985), Khan and Baker (1993), and AML.

To test the relative change in market efficiency across stocks, the change in the variance of the market model residuals ($DVARE$) is calculated for each stock j as

$$DVARE_j = \log(VARE_{j,\,AFTER}) - \log(VARE_{j,\,BEFORE}),$$

where $VARE$ is the variance of the market model return residuals for each stock j. Low measures of RRD and $VARE$ suggest fewer pricing errors. A decrease (increase) in the amount of pricing errors is associated with an increase (decrease) in market efficiency.

Finally, the third set of empirical tests examines whether the price change for a particular transfer stock is positively related to an improvement in market quality. The following cross-sectional regression model is estimated:

$$CAR_j = \alpha_j + \delta\, DMQ_j + \kappa_j,$$

where CAR_j is the cumulative abnormal return on stock j from day $A - 10$ to day $T + 30$ and DMQ is the change in market quality as measured by liquidity (DV or DLR) or efficiency ($DVARE$). If price increases (decreases) due to trading category changes are related to market quality improvements (declines), then we should see positive δ coefficient for the liquidity variables and a negative δ coefficient for the efficiency variable. The models are estimated using generalized method of moments (GMM). GMM yields consistent parameter estimates and corrects the t-statistics for possible heteroskedasticity and serial correlation.[12,13]

To test whether the liquidity and efficiency market quality variables are positively related, the following cross-sectional regression model is estimated:

$$DV_j = \gamma_j + \lambda\, DVARE_j + \mu_j,$$

where DV_j is the change in relative volume for stock j and $DVARE_j$ is the change in market efficiency. As AML point out, DLR cannot be used as a liquidity measure for this test because it is constructed from the same return data as $DVARE$, possibly causing a spurious result.

5. Empirical results

This section presents the results of the three sets of empirical results. The cumulative abnormal return results are presented first, followed by the liquidity and efficiency results. Cross-sectional tests are presented last.

[12] Both the White (1980) and Breusch-Pagan (1979) tests reject the null hypothesis of no heteroskedasticity. The regression model was also estimated with standard errors corrected by White's (1980) method and the results are quantitatively similar to the GMM results.

[13] The Durbin Watson test rejects the null hypothesis of no autocorrelation. Our GMM results report the heteroskedasticity and autocorrelation consistent (HAC) standard errors using the quadratic spectral kernel recommended by Andrews (1991).

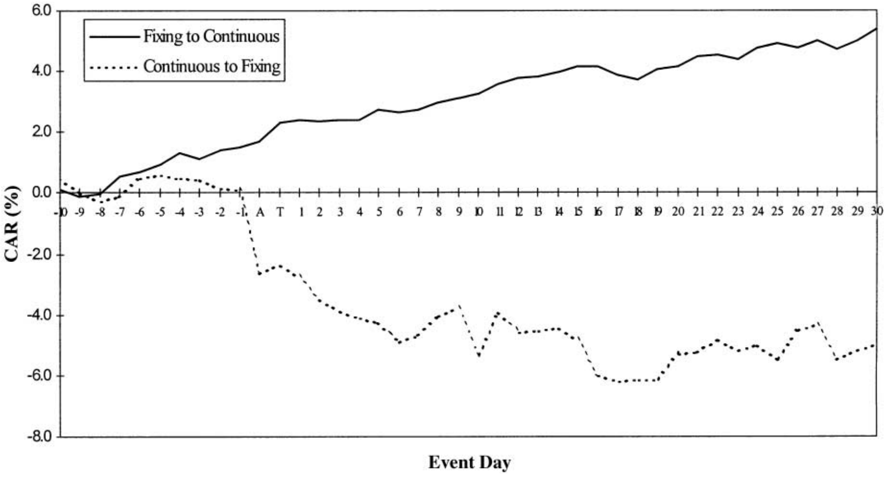

Fig. 1. Cumulative abnormal returns (*CAR*) for firms moving from Fixing-to-Continuous and Continuous-to-Fixing trading on the Paris Bourse from 1995 through 1999. Event day "A to $T - 1$" aggregates the time period from the day of the announcement by the Paris Bourse of the stocks selected for transfer through the day before the transfer (the number of days in this period varies.) "T" is the transfer day. The *CAR* for each stock was established over the period $A - 10$ through $T + 30$. A market model with the SBF120 index as the market return was used to estimate the abnormal returns. Returns were calculated as the logarithm of relative price changes. (The market model was established over days $T + 31$ through $T + 160$.)

5.1. Cumulative abnormal returns

Fig. 1 presents the cumulative abnormal return results. It shows that Fixing-to-Continuous firms, on average, experience positive cumulative abnormal returns of approximately 5.4% over the event window and that Continuous-to-Fixing firms, on average, experience negative cumulative abnormal returns of approximately -5%.

The estimated cumulative abnormal returns may underestimate the full effect of the transfers in both directions for two reasons. First, because the Paris Bourse selects stocks for transfer based upon their prior trading activity, market participants could identify stocks that are likely transfer candidates well before the official announcement date. Second, our methodology of starting the event window at ten days prior to the formal announcement date to allow for possible leaks of information may be providing noisy estimates of price impacts.

Table 2 shows the cumulative abnormal returns for each sample for each day along with the associated t-statistics and statistical significance levels (one-tailed tests). The Fixing-to-Continuous firms experience statistically significant positive cumulative abnormal returns over the event window. The 5.40% *CAR* is very similar to the 5.52% *CAR* found by AML for transfers to continuous

Table 2
Cumulative abnormal returns

Cumulative abnormal returns (CAR) for 84 firms moving from Fixing-to-Continuous and 41 firms moving from Continuous-to-Fixing trading on the Paris Bourse from 1995 through 1999. Event day "A to $T-1$" aggregates the time period from the day of the announcement by the Paris Bourse of the stocks selected for transfer through the day before the transfer (the number of days in this period varies.) "T" is the transfer day. The CAR for each stock was established over the period $A-10$ through $T+30$. A market model with the SBF120 index as the market return was used to estimate the abnormal returns. Returns were calculated as the logarithm of relative price changes. (The market model was estimated over days $T+31$ through $T+160$.)

	Fixing-to-Continuous firms		Continuous-to-Fixing firms	
Day	CAR	t-Statistic	CAR	t-Statistic
$A-10$	0.13	0.46	0.49	1.17
$A-9$	− 0.10	− 0.22	0.01	0.02
$A-8$	− 0.03	− 0.07	− 0.26	− 0.32
$A-7$	0.55	0.92	− 0.14	− 0.16
$A-6$	0.69	1.11	0.48	0.50
$A-5$	0.93	1.31[a]	0.57	0.58
$A-4$	1.30	1.58[a]	0.49	0.42
$A-3$	1.13	1.26	0.46	0.37
$A-2$	1.40	1.47[a]	0.14	0.11
$A-1$	1.51	1.53[a]	0.13	0.09
A to $T-1$	1.70	1.32[a]	− 2.66	− 1.62[a]
T	2.29	1.67[b]	− 2.34	− 1.46[a]
$T+1$	2.38	1.73[b]	− 2.71	− 1.59[a]
$T+2$	2.35	1.72[b]	− 3.48	− 2.03[b]
$T+3$	2.40	1.70[b]	− 3.86	− 2.19[b]
$T+4$	2.40	1.57[a]	− 4.11	− 2.22[b]
$T+5$	2.73	1.63[a]	− 4.27	− 2.11[b]
$T+6$	2.63	1.61[a]	− 4.91	− 2.46[c]
$T+7$	2.72	1.59[a]	− 4.67	− 2.29[b]
$T+8$	2.98	1.73[b]	− 4.06	− 1.90[b]
$T+9$	3.10	1.71[b]	− 3.78	− 1.87[b]
$T+10$	3.23	1.72[b]	− 5.33	− 2.28[b]
$T+11$	3.60	1.86[b]	− 3.94	− 1.87[b]
$T+12$	3.78	1.94[b]	− 4.56	− 2.06[b]
$T+13$	3.81	1.88[b]	− 4.54	− 2.03[b]
$T+14$	3.96	1.94[b]	− 4.44	− 2.05[b]
$T+15$	4.15	1.88[b]	− 4.82	− 2.24[b]
$T+16$	4.13	1.81[b]	− 6.02	− 2.45[c]
$T+17$	3.85	1.70[b]	− 6.21	− 2.55[c]
$T+18$	3.70	1.59[a]	− 6.17	− 2.51[c]
$T+19$	4.06	1.70[b]	− 6.16	− 2.50[c]
$T+20$	4.13	1.64[a]	− 5.29	− 2.27[b]
$T+21$	4.47	1.72[b]	− 5.23	− 1.92[b]
$T+22$	4.55	1.76[b]	− 4.82	− 1.95[b]
$T+23$	4.41	1.75[b]	− 5.19	− 2.09[b]
$T+24$	4.78	1.88[b]	− 4.99	− 2.04[b]

Table 2 (*continued*)

Day	Fixing-to-Continuous firms		Continuous-to-Fixing firms	
	CAR	*t*-Statistic	*CAR*	*t*-Statistic
$T + 25$	4.91	1.88[b]	− 5.48	− 2.05[b]
$T + 26$	4.76	1.78[b]	− 4.54	− 1.80[b]
$T + 27$	5.01	1.81[b]	− 4.35	− 1.69[b]
$T + 28$	4.72	1.67[b]	− 5.47	− 2.00[b]
$T + 29$	5.01	1.76[b]	− 5.18	− 1.88[b]
$T + 30$	5.40	1.88[b]	− 4.99	− 1.75[b]

[a]Significant at the 10% level (one-tailed test).
[b]Significant at the 5% level (one-tailed test).
[c]Significant at the 1% level (one-tailed test).

trading on the Tel Aviv Stock Exchange. Fifty-seven percent of the 84 firms had positive *CAR*s. The average portfolio *CAR* for the Fixing-to-Continuous firms is 7.75%, which is significant at the 5% level. Twenty-six of the 41 portfolios (63%) had positive *CAR*s.

The Continuous-to-Fixing firms experience statistically significant negative cumulative abnormal returns of − 4.99% over the event period. Sixty percent of the 40 firms had negative returns. The average portfolio *CAR* for the Continuous-to-Fixing firms is − 7.35%, which is significant at the 5% level. Four of the five portfolios had negative returns.

The overall cumulative abnormal return results show that Fixing-to-Continuous firms experience, on average, value increases around the transfer. Continuous-to-Fixing firms experience value decreases.

5.2. Liquidity and efficiency

5.2.1. Volume

One measure of liquidity is daily trading activity. The average daily relative volume across all Fixing-to-Continuous firms is 0.0054% (median = 0.0047%) in the pre-event period and 0.0082% (median = 0.0073%) in the post-event period. The increase in the mean relative volume from the pre-event to the post-event period across all Fixing-to-Continuous firms is significant at the 1% level, with an associated *t*-statistic of 6.25.

The average relative volume across all Continuous-to-Fixing firms is 0.0034 (median = 0.0021%) in the pre-event period and 0.0026% (median = 0.0017%) in the post-event period. The decrease in the mean relative volume from the pre-event to the post-event period across all Continuous-to-Fixing firms is statistically insignificant with an associated *t*-statistic of 0.93.

We calculate $DV = \log(\textit{post-event mean relative volume}) - \log(\textit{pre-event mean relative volume})$ for each sample and test whether DV is significantly different from zero. DV is positive for 63% (47/75) of the Fixing-to-Continuous firms. The mean is 0.13 ($t = 2.38$), and the median is 0.12. The DV for Continuous-to-Fixing firms is negative for 63% (26/41) of the transferred stocks. The mean is -0.12 ($t = -1.74$), and the median is -0.11.

The overall volume results show that Fixing-to-Continuous firms experience, on average, significant increases in trading activity after the transfer. Continuous-to-Fixing firms experience, on average, marginally significant trading activity decreases after the transfer.

5.2.2. Market depth

We calculate $DLR = \log(\textit{post-event mean market depth/pre-event mean market depth})$ for each sample and test whether DLR is significantly different from zero. The DLR for Fixing-to-Continuous firms is positive for 73% (54/74) of the transferred stocks with sufficient data. The mean change in the liquidity ratio is 0.23 ($t = 4.30$), and the median is 0.24. The DLR for Continuous-to-Fixing firms is negative for 56% (22/39) of the transferred stocks with sufficient data. The mean change is -0.21 ($t = -2.24$), and the median is -0.17.

The market depth results show that Fixing-to-Continuous firms experience a significant increase in market depth after the transfer. Continuous-to-Fixing firms experience a significant decrease in market depth.

5.2.3. Market efficiency

We calculate RRD and $DVARE$ for each sample and test whether the change in these measures of pricing errors from the pre-event period to the post-event period are significantly different from zero. The average relative return dispersion (RRD) across all Fixing-to-Continuous firms is 7.06 (median = 6.29) in the pre-event period and 5.41 (median = 5.20) in the post-event period. The decrease in the mean RRD from the pre-event to the post-event period across all Fixing-to-Continuous firms is significant at better than 1%, with an associated t-statistic of -5.15.

The average relative return dispersion (RRD) across all Continuous-to-Fixing firms is 8.74 (median = 7.12) in the pre-event period and 12.61 (median = 9.06) in the post-event period. The increase in the mean RRD from the pre-event to the post-event period across all Continuous-to-Fixing firms is significant at better than 1%, with an associated t-statistic of 3.18.

The $DVARE$ for Fixing-to-Continuous firms is negative for 69% (51/74) of the transferred stocks with sufficient data. The mean change is -0.13 ($t = -4.99$), and the median change is -0.17. The $DVARE$ for Continuous-to-Fixing firms is positive for 59% (23/39) of the transferred stocks with sufficient data. The mean change is 0.11 ($t = 1.80$), and the median change is 0.08.

Table 3
Cross-sectional tests

This table contains simple regression models of cumulative abnormal returns (CAR) and changes in market quality. DV is the change in relative volume, DLR is the change in market depth, and $DVARE$ is the change in market efficiency. The regressions are estimated using generalized method of moments (GMM) to account for possible heteroskedasticity. The numbers in parentheses are p-values for a one-tailed test.

Independent variable	Model 1: DV	Model 2: DLR	Model 3: $DVARE$
Panel A: *Fixing-to-Continuous*			
α	0.36	− 3.42	− 0.26
	(0.43)	(0.03)	(0.46)
δ	7.14	9.42	− 5.88
	(0.02)	(< 0.01)	(0.17)
Number of observations	75	74	74
Adjusted R^2	0.11	0.22	0.01
Panel B: *Continuous-to-Fixing*			
α	− 9.96	− 9.92	− 9.44
	(< 0.01)	(< 0.01)	(< 0.01)
δ	0.10	0.12	− 2.02
	(0.48)	(0.47)	(0.16)
Number of observations	38	38	38
Adjusted R^2	0.01	0.01	0.01
Panel C: *Combined*			
α	− 2.48	− 3.47	− 3.03
	(0.08)	(0.02)	(0.04)
δ	5.98	6.01	− 5.84
	(< 0.01)	(< 0.01)	(0.01)
Number of observations	113	112	112
Adjusted R^2	0.09	0.15	0.04

The market efficiency results show that Fixing-to-Continuous firms experience a significant decrease in pricing errors after the transfer. Continuous-to-Fixing firms experience a significant increase in pricing errors.

5.3. Cross-sectional tests

Table 3 presents the results of the cross-sectional regression $CAR_j = \alpha_j + \delta\, DMQ_j + \kappa_j$. Model 1 defines DMQ as the change in relative trading volume (DV). Model 2 defines DMQ as the change in the liquidity ratio (DLR). Model 3 defines DMQ as the change in efficiency ($DVARE$). In all three models, the estimated δ coefficients have the predicted signs, positive for the liquidity variables and negative for the efficiency variable. However, the coefficients for the liquidity variables are only statistically significant for the Fixing-to-Continuous sample and the combined sample. The coefficients for the efficiency variable are only statistically significant for the combined sample.

We estimate the cross-sectional regression model $DV_j = \gamma_j + \lambda DVARE_j + \mu_j$ to examine the interaction between changes in liquidity and efficiency due to a trading category transfer. The estimated λ coefficients are -0.07 ($t = -0.29$) for the Fixing-to-Continuous sample, -0.27 ($t = -2.18$) for the Continuous-to-Fixing sample, and -0.29 ($t = -2.36$) for the combined sample. The interpretation of the negative λ coefficient is that changes in liquidity are negatively associated with changes in return noise. In other words, liquidity improvements (declines) are related to greater (less) pricing efficiency.

AML point out that the estimated δ and λ coefficients are possibly biased downward toward zero because all three proxies for DMQ are noisy estimates of market quality for transferred stocks. In addition, the small sample sizes may be contributing to a lack of power in the individual sample tests. Even so, the overall cross-sectional regression results suggest that Paris Bourse stocks that are transferred between the "Fixing" to the "Continuous" trading categories experience value effects that are positively related to the market quality effects from the transfer, and that the liquidity and efficiency market quality effects are also positively related.

6. Conclusions

We find that frequently-traded stocks on the Paris Bourse that are transferred from a twice daily batch auction to continuous trading experience, on average, positive price increases. It is unlikely that the price appreciation is the result of new information about the firms since the Paris Bourse justifies the transfers purely on the basis of past trading activity. We also find that the price increases are associated with market quality improvements, as measured by both liquidity and efficiency. These results are consistent with the findings that Amihud et al. (1997), Lauterbach (1999) and Kalay et al. (2000) obtain for stocks on the Tel Aviv Stock Exchange that are transferred from a daily call auction to continuous trading sessions.

Our study also allows us to investigate the antipodal microstructure event. We find that infrequently-traded Paris Bourse stocks that are transferred from continuous trading to twice daily batch auctions, experience price and market quality declines. These results are inconsistent with the prediction of Easley et al. (1996) that these transfers should result in an improvement of overall trader welfare. Alternatively, the lack of improvement in trading characteristics is consistent with inappropriate transfers by the Paris Bourse.

Our results provide further evidence that improvements in the trading mechanisms enhance liquidity and increase firm value à la Amihud and Mendelson (1986) and provide a justification for the inclusion of liquidity measures in factor pricing models such as Brennan and Subrahmanyam (1996). Our results contradict the assertion that call markets unambiguously offer better liquidity than continuous markets for infrequently traded stocks.

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