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Market Microstructure and Securities Values: Evidence from the Tel Aviv Stock Exchange

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MARKET MICROSTRUCTURE AND SECURITIES VALUES:

Evidence from the Tel Aviv Stock Exchange

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MARKET MICROSTRUCTURE AND SECURITIES VALUES:
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Abstract

This paper examines the value effects of improvements in the trading mechanism. Stocks on the Tel Aviv Stock Exchange were transferred gradually from a daily call auction to a mechanism where the call auction was followed by iterated continuous trading sessions. This event was associated with a positive and permanent price appreciation. The cumulative average market-adjusted return over a period that started five days prior to the announcement and ended 30 days after the stocks started trading by the new method was approximately 5.5%. In addition, we find positive liquidity externalities (spillovers) across related stocks, and improvements in the value discovery process due to the improved trading method. Finally, there was a positive association between liquidity gains and price appreciation. Our results suggest that improvements in market microstructure are valuable.

1. Introduction

Many securities markets around the world are making major investments to improve their trading technology. The London Stock Exchange is phasing in an automated order-driven trading system to improve liquidity and reduce trading costs[1]. Other European stock exchanges (e.g., the French, Italian, Spanish and Swedish markets) have converted their trading systems from the traditional call market to computer-based continuous trading alternatives. The stock exchanges of Toronto, Montreal, Vancouver and Alberta have recently changed their trading systems to support decimal pricing "in a bid to increase liquidity."[2] In the U.S., the Securities and Exchange Commission has introduced new rules requiring market-makers to incorporate in their public quotes both customer limit orders and orders they quote on electronic communication networks such as Instinet and Selectnet. These rules are intended to improve liquidity through increased market transparency and enhanced quality of execution.[3] Further, emerging markets are evaluating and implementing new trading systems, and are making considerable investments in improving their microstructure.

A question of interest for both financial economists and practitioners is whether investments in improving the market microstructure have positive value. The answer relates to the *raison d'etre* of market microstructure research, and it can quantify the benefits of improving trading mechanisms. This paper examines the value of an improvement in the market

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[1]See London Stock Exchange (1996). The current plan is to implement the system for the FTSE-100 stocks while preserving the traditional quote-driven system for large-block trades.

[2]Source: Reuters Canadian Financial Markets Report, April 15, 1996. The change allows quotes in 5-cent increments for stocks priced above $5 Canadian Dollars and 1-cent increments for lower-priced stocks.

[3]See, Securities and Exchange Commission Release No. 34-37619, RIN 3235-AG66, Order Execution Obligations - Final Rules, August 29, 1996. These reforms were partly triggered by the studies of Christie and Schultz (1994) and Christie, Harris and Schultz (1994), who presented evidence that market makers implicitly colluded to maintain high bid-ask spreads,

microstructure for selected stocks on the Tel Aviv Stock Exchange (TASE). In April 1987, the TASE introduced a new trading method, stating:

> *"The objective of the new method is to create an efficient and well-functioning market for trading securities."* (TASE (1987)).

The TASE transferred stocks to the new trading method gradually, periodically selecting stocks on the basis of their "marketability." Before the transfer, the selected stocks were traded once a day in a call auction. After the transfer, these stocks traded in repeated continuous trading sessions following an opening daily call auction. Continuous trading after the call auction is expected to improve value discovery and trading efficiency and increase stock liquidity.[4] If improvements in market microstructure are valuable, the prices of stocks selected for trading under the new method should increase upon the announcement of the change in their trading mechanism.

Improved liquidity is expected to increase securities values because rational investors discount securities more heavily in the presence of higher trading costs (holding other things equal). This hypothesis, due to Amihud and Mendelson (hereinafter, A-M) (1986), was empirically supported by the evidence. Cross-sectionally, risk-adjusted returns on stocks and bonds were found to be increasing in their illiquidity, measured by the bid-ask spread (A-M (1986, 1989a, 1991a), Kamara (1994), Eleswarapu (1995)) or the price impact of trades (Brennan and Subrahmanyam (1996)), or decreasing in their liquidity, measured by volume or turnover ratio (Datar *et al.* (1996), Haugen and Baker (1996)). Silber (1991) found that on average, restricted stocks that are not allowed to trade on public exchanges are lower in value by 33.75% compared with identical publicly-traded stocks. Amihud, Mendelson and Wood (1990) found

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and Huang and Stoll (1996), who showed that NASDAQ spreads exceeded NYSE benchmarks.

[4]See Amihud, Mendelson and Murgia (1990). Indeed, a TASE study (Tamari and Resnik (1990)) and Lauterbach and Ungar (1992) documented improvements in market microstructure-

that during the October 19, 1987 stock market crash, price declines were greater for stocks whose liquidity suffered most, and price recovery was greater for stocks whose liquidity subsequently improved.

We therefore expect that stocks transferred to the improved trading mechanism should increase in value. The TASE's board of directors announced a list of stocks to be transferred to the new trading method every few months, and the actual transfer took place a day or more afterwards. We estimated the market-adjusted price changes of the transferred stocks over a test period that begins five days before the TASE announcement and ends 30 days after these stocks started trading by the new method. The cumulative abnormal return on the transferred stocks over the test period averaged about 5.5%.[5] This suggests a significant value gain, especially compared with the moderate cost of the improvement. In December 1995, the market value of the 100 securities traded under the new method was about $26 billion. Assuming that the new trading mechanism gave rise to a permanent price increase of 5.5%, its introduction contributed at least $1.35 billion to the market value of securities traded on the TASE. The cost of this system was estimated at less than $10 million, including the cost incurred by the brokers and banks using the system.[6] Comparing these costs with the subsequent stock price appreciation demonstrates the value of investments in improving the market microstructure.

The value of the new trading method exceeded the price appreciation of the transferred stocks since trading is characterized by *liquidity externalities* or spillover effects: when the prices

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related characteristics (volume and volatility) under the new trading method.

[5]This value gain is smaller than in Silber (1991) because the transferred stocks were already publicly traded (in fact, they were the most liquid stocks) before their trading method was improved. In contrast, restricted stocks are illiquid for a long period of time (their holders cannot trade them in a public market for two years after being issued, and their subsequent liquidation is constrained to be gradual). Thus, the liquidity differential between restricted and publicly-traded stocks is far greater than the liquidity gains for the stocks in our study; the difference in value between them is correspondingly greater.

[6]This estimate was provided by Mr. Sam Bronfeld, the CEO of the TASE.

of two securities are correlated, an improvement in the liquidity of one should improve the liquidity of the other (A-M (1988b, 1990, 1991c)). This results in part from the fact that improved value discovery for one security facilitates value discovery for the other (correlated) security. We test this effect using data on "twin stocks," i.e., two different classes of stock of the same company of which only one (the "primary stock") was transferred to the new trading method while the other (the "secondary stock") was not. Liquidity externalities would imply that the price of the secondary stock should increase upon the transfer announcement of the primary stock, but by a smaller magnitude. Our results support this hypothesis.

Our study is related to research on the effects of exchange listing of stocks traded over the counter, which alters their market microstructure environment. This is presumably done with the expectation that listing would improve liquidity and value (Cooper *et al* (1985), A-M (1986, 1988a)). Indeed, Christie and Huang (1994) found that exchange listings of NASDAQ stocks were associated with sharp declines in trading costs, especially for the less liquid stocks, which were both economically and statistically significant. Grammatikos and Papaioannou (1986), Sanger and McConnell (1986) and Kadlec and McConnell (1994) found that listing announcements led to price increases which were positively associated with liquidity improvements.

Our paper differs from these studies. Exchange listing is a *voluntary, endogenously-determined* decision of a firm, reflecting some optimization by management, and it can be associated with its private information. Companies are not obliged to list and in fact hundreds of large, listing-eligible companies choose to remain unlisted. Thus, listing reflects an inherent self-selection: observed are only those cases where management expected listing to be beneficial. It is therefore impossible to examine the general effect of changing the market microstructure on securities values.

In contrast, the event studied here is *exogenous* to the firm: the transfer decision was made by the TASE's board of directors, not by the firm's management. The TASE's decision was based on the stock's marketability at the time of the decision and not on any private information about the firm's prospects. Therefore, the price appreciation reflects the value of improved market microstructure rather than any perceived firm-generated information, and there is no self-selection bias. This should not be construed as a criticism of studies on the effects of exchange listing. Rather, we point out that these studies have different objectives and hence they were not designed to examine the issue under study here.

Our study is also related to studies that examined the effects of the announcement of adding stocks to the S&P 500 Index. Harris and Gurel (1986) and Shleifer (1986) found a temporary price increase which, they claimed, reflected a buying pressure by index funds which must invest in these stocks. For the more recent period, Shleifer (1986) and Lynch and Mendenhall (1996) found a permanent price appreciation, explained by the growing importance of index funds.

Our results cannot be attributed to the demand by index funds because in Israel such funds are relatively unimportant.[7] And while these funds were introduced only in the last two years of our sample period, we found that the price appreciation was the same in the earlier and later transfers to the new trading method. Thus, the demand of index funds cannot explain our results. Instead, we suggest that in both our study and in those on the S&P 500, the price appreciation is due to the improved liquidity, following A-M (1986). This hypothesis was recently tested and supported by Edmeister and Pirie (1995). Our results on liquidity externalities can also explain Dhillon and Johnson's (1991) findings that for firms whose stocks were selected for the S&P 500, other traded securities appreciated. They attributed this finding to favorable information;

[7]On December 1995, funds that invested in V-Method stocks constituted only 1.3% of the

however, the selection for the S&P 500 list is not based on private information. By our results, the inclusion of a stock in the S&P 500 Index enhances its liquidity and generates liquidity externality which favorably affects the other securities of the same firm.

In what follows, Section 2 describes trading mechanisms on the TASE and the market microstructure change that took place when the new trading system was introduced. Section 3 presents our empirical results. We show in Section 3.2 that the value effects due to the new trading mechanism are positive, persistent and significant. In Section 3.3 we introduce liquidity externalities and examine their impact. In Section 3.4 we demonstrate how the new trading mechanism affected the liquidity and efficiency of the transferred stocks, and Section 4 offers a brief summary of our results and their implications.

2. Trading Mechanisms on the Tel Aviv Stock Exchange

The Tel Aviv Stock Exchange (TASE) is the only securities market in Israel. As of June 1995, it had 672 listed stocks in addition to other corporate securities (warrants and bonds) and government bonds (TASE (1995)). The market value of the stocks listed on the TASE was about one half of Israel's annual GNP. The stock market became more important in the last decade due to the economic growth which followed the 1985 anti-inflation program, the liberalization of the Israeli capital market and the intensified privatization of government-owned firms.

In 1987, the TASE made a fundamental change in its trading system, introducing a new method that enabled continuous trading facilitated by a number of daily trading sessions. We describe below the traditional call method of trading, the new Variable Price trading mechanism

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market value of these stocks. Some were confined to a subset of these stocks.

and the process of transferring stocks from the old to the new method.

2.1. The Call Method (C-Method)

Prior to 1987, all stocks listed on the TASE were traded once a day in a call auction (hereafter, the C-Method). Until 1991, the auction was conducted by a human auctioneer. Investors' limit and market orders were sent to the TASE before the opening or were retained by the brokers. Stocks were called in a predetermined sequence by an auctioneer, who first announced the stock's excess demand (positive or negative) at the previous day's closing price and then changed the price based on the direction of excess demand, proceeding at fixed price increments. As the announced price changed, the excess demand decreased (in absolute value) until an equilibrium was reached.[8]

The auction process of the C-Method was computerized in 1991. Traders route orders to the TASE which electronically communicates the excess demand at the previous day's closing price. Traders observe the excess demand and have a short time interval during which they can send additional "offsetting orders" which can be only buy (sell) orders when the excess demand is positive (negative, respectively). Afterwards, the new excess demand (which reflects the offsetting orders) is announced, and traders can submit offsetting orders again. Following this round, the system computes the new equilibrium prices that are announced simultaneously for all stocks.

There are a number of problems with the C-Method. First, an investor who submits an order for a particular stock does not know its clearing price nor the prices of related stocks.

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[8]If an equilibrium could not be reached at a daily price increase of 10%, the stock was announced as "buyers only" and the price was set at +5% without executing any order. After two days of "buyers only," the price was allowed to move without bound. Price declines were treated analogously.

Once the price information for all stocks is broadcast after the call transaction, investors may want to adjust their trades for a particular stock. However, under the C-Method, such adjustments must be postponed to the following business day. Second, investors are reluctant to place large orders that could result in significant price impacts. Instead, they may break large orders into smaller ones and trade them over a number of days, thereby bearing the costs of illiquidity, delay and risk. The C-Method can also result in partial executions that may require additional trading on the following day. Finally, traders bear significant inventory risk when taking a position in a security because it can only be unwound on the following day. This diminishes the willingness of traders to provide liquidity by acting as market makers and absorb temporary demand or supply shocks. These shortcomings of the C-Method are particularly important in a thin and highly volatile market such as the TASE.

2.2. The Variable Price Method (V-Method)

In 1987, the TASE started experimenting with a new method of trading securities, the "Variable Price Method" (V-Method). The TASE engaged in a process of learning by doing and changed the V-Method during its initial period of operation. The following describes the method in its final form since December 6, 1987.

Under the V-method, trading is opened by a call auction similar to the C-Method described above. Continuous trading then commences through a series of sequential trading sessions in an arena which resembles a trading pit. In each session, stocks are announced in a predetermined order, and traders in the arena can execute bilateral trades continuously, until the demand for trading is satisfied (usually within 1-3 minutes). At first, there was a single arena in which all V-Method trades occurred. Due to the increase in the number of stocks traded under this method, there are now three trading arenas operating simultaneously. On a typical day, there are 3-5 rounds of continuous trading, and each stock is traded a number of times in each round.[9]

The V-Method was designed to increase liquidity and efficiency. Traders' ability to execute multiple transactions within the day mitigates the price impacts of large orders. Traders can also correct pricing errors after observing the prices of the same and similar stocks and obtaining additional market information. Such correction of pricing errors in response to market-wide information takes place in exchanges that open with a call auction followed by continuous trading; see Amihud, Mendelson and Murgia (1990) for the Milan Stock Exchange and A-M (1991b) for the Tokyo Stock Exchange. The V-Method thus facilitates the convergence of prices to new information and contributes to a smoother value discovery process. Finally, the ability to take a position and unwind it during the same day reduces the risk of carrying unwanted inventory. This increases traders' willingness to absorb temporary demand shocks into their inventory and increases liquidity (A-M (1980), Ho and Stoll (1981)).

Indeed, stocks transferred from the C-Method to the V-Method enjoyed an improvement in efficiency and liquidity and a decline in volatility (see Section 3.4 below). By the first half of 1995, trading in V-Method securities accounted for 73% of the total equity trading volume on the TASE (including convertibles). About 40% of the volume in V-Method securities was traded at the opening call auction, and 60% -- in the subsequent rounds of continuous trading (TASE (1995)).

A large proportion of trades still takes place at the open, partly because of a required minimum order size of $3,000 ($5,000 during part of our sample period) in the continuous trading sessions, although brokers may combine small orders with the same limit price into a larger order. Also, on the opening transaction all orders are executed at a single price, while in the continuous trading that follows there may be a difference between the buying and selling

[9] In 1994, the mean daily number of transactions in the continuous trading session was 24.4

prices, resulting in higher cost of trading (A-M (1985)). For some traders, the concentration of trading at the opening enhances liquidity (Mendelson (1985), Admati and Pfleiderer (1988)), and some are unwilling to delay their trades. As a result, both the opening call and the continuous trading sessions attract significant volume. Thus, the V-Method makes alternative trading methods available on the same stock exchange (as proposed by A-M (1985, 1988b)), and investors can choose between them.

2.3. Transfer Procedure

Stocks were phased into the new V-Method gradually. A TASE executive committee periodically selected groups of securities for transfer and made a recommendation to the TASE board of directors. Subsequently (usually within 5 trading days), the TASE board of directors publicly announced the list of securities to be transferred. The announcement day in our study is the day of the board's announcement. The actual transfer took place a few days following the announcement. The V-Method was designed for stocks with "high marketability" (TASE (1988)), and this constituted the main selection criterion.[10] The number of securities traded under the V-Method grew gradually and it is now one hundred.

3. Methodology and Empirical Results

Our main hypothesis is that the improved market microstructure under the V-Method had a positive effect on the prices of stocks transferred from the C-Method. We tested this hypothesis by conducting an event study of the transferred stocks. The transfer of stocks to the

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per stock, and the median was 17.1 (calculated from data in TASE (1994)).

[10]Christie and Huang (1994) showed, however, that when stocks were transferred from NASDAQ to U.S. stock exchanges, the greatest liquidity benefits accrued to the less

V-Method is virtually *a pure microstructure event.* The decision is made by the TASE based on "marketability" criteria, and the affected firm has no say in the matter. Hence, the transfer does not reflect any optimizing decision by the firm's management that can be expected to improve the stock value, nor does it reveal any private information about the firm. Consequently, any price effect of the TASE transfer decision can be attributed entirely to the change in the trading mechanism.

3.1. The Data

Stocks were transferred from the C-method to the V-method in groups, a few stocks at a time. We study all 120 stock transfers that occurred between December 6, 1987, when the TASE implemented the final and current form of the V-Method, and the end of 1994. The 120 stocks were transferred in 17 batches; the average number of stocks in each transfer was 7 and the median was 6. Part of the 120 transferred stocks were dropped at various times; the net effect of these additions and deletions is that 100 securities are currently traded under the V-Method.

Data on the stocks transferred, the TASE announcement dates and the subsequent transfer dates was obtained from "This Month in the TASE," an official TASE publication. We designated as the announcement day the date of the transfer decision by TASE's board of directors. The decision was announced immediately after the market's closing, and thus affected stock prices on the following day. The transfer date was announced as part of the board's decision; it was between one and seven business days after the announcement day (the median was 3 days). We denote the announcement day by "A" and the transfer day by "T". Daily closing prices (adjusted for cash and stock dividends) were obtained from the Israeli financial data services firm Tochna Lainyan and from the database of the Faculty of Management at Tel

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marketable stocks.

Aviv University.

3.2. Cumulative Abnormal Returns

We first present descriptive event-study data documenting the Cumulative Abnormal Returns (CAR) (cf. Brown and Warner (1980)). The event window is from 5 days before the announcement until 30 days after the transfer. We start from day A-5 to account for possible leaks of the TASE executive committee's recommendation regarding the list of stocks to be transferred, and allow for a long post-event period to examine whether the effect on stock prices was permanent.

We estimated the market model regressions

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

where R_{nt} is the return on stock n on day t and RM_t is the daily return on the value-weighted TASE index (returns are the logarithms of the relative price changes, presented in percentage points), α_n and β_n are constant coefficients, and ε_{nt} are the residuals. The market model is estimated over days T+31 to T+160,[11] in order to avoid an ex-post selection bias.[12] We then calculated the abnormal returns $AR_{nt} = R_{nt} - (\alpha_n + \beta_n RM_t)$ for each day t in the event window, days A-5 through T+30, and the cumulative abnormal returns $CAR_{nS} = \Sigma^{S}_{t=A-5} AR_{nt}$, S = A-5, A-4, ..., T+30. Then, we averaged the CAR_{nS} across all stocks to obtain CAR_S. The days between the announcement A and the last day before the transfer, T-1, which varied, were

[11]The last transfer event had data available only through day T+103.

[12]Copeland and Mayers (1982) estimated the market model using post-ranking data in their study of the Value-Line enigma to avoid such a problem. Brown *et al* (1995) discuss biases in event-study results where parameters are estimated from pre-event data while the test is conditional on ex-post information. In their study of the effect of listing, Kadlec and McConnell (1995) used post-listing data to estimate the market model. Here, the selection criteria of the TASE may induce a bias in the estimated market-model parameters if we use pre-event data to estimate the model. The TASE is more likely to select stocks that reached high volume and capitalization, which implies that they performed unusually well prior to their

combined.[13]

INSERT FIGURE 1 HERE

As shown in Figure 1, the average cumulative abnormal return, CAR_S, rises slightly during days A-5 to A-1, possibly reflecting news leaks or market anticipation.[14] It then rises sharply at the announcement and through day T, where CAR_T = 6.80%. The average CAR then declines slightly and hovers between +5% and +6% through the end of the event window. These results show that the transfer of stocks into the V-Method generated a *permanent* price increase of about 5% on average. However, this value may *underestimate* the full effect of the transfer to the V-Method. Because the selection criterion was based on "high marketability," the market could partially anticipate which stocks were likely candidates for transfer to the V-Method,[15] and their prices could have risen well before the announcement.

For explicitly testing the effect of the transfers to the V-Method, the ordinary event-study test procedure may be inappropriate. Because stocks were transferred in batches, the returns of stocks in the same batch could be cross-sectionally dependent, thereby biasing the variance estimates. We therefore carried out the event study tests for *portfolios* of stocks transferred in the same batch ("transfer portfolios"). Each of the 17 transfer events i, i=1,2,...,17 is identified

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selection.

[13]A similar methodology was used in a takeover study by Asquith (1983), who combined the abnormal return from the announcement day to the outcome day since, as here, the time interval varied for each case in his sample.

[14]The CAR for days A-5 through A-1 was 2.15%, mostly due to the abnormal return on day A-4, which was 1.235% (SE = 0.211%). This lends support to the leakage theory.

[15]For example, on February 20, 1991, a news item in a leading Israeli Newspaper (Haaretz) reports that the TASE is constructing a new trading arena into which it expects to transfer about 40 securities for trading by the V-Method. The reporter provides a list of 11 stocks that were candidates for the transfer. Two months later, 8 stocks from that list were indeed transferred. Also, on January 9, 1992, the TASE announced that about 10 stocks would be transferred to the V-Method, and that the list with the stock names would be announced on January 26, 1992. Indeed, on that day the TASE's board of directors announced a list of 11 stocks to be transferred.

by its announcement date A_i and transfer date T_i. The following model was estimated for each event i over days A_i-5 through T_i+160:

(1) $$R_{it} = \alpha_i + \beta_i RM_t + \Sigma^3_{j=1} \gamma_{ij} D_{ijt} + \varepsilon_{it} \ ,$$

where R_{it} is the equally-weighted day-t return on transfer-portfolio i, i=1,2,...,17, RM_t is the daily return on the value-weighted TASE index, and α_i, β_i and γ_{ij} are constant coefficients. The abnormal return was estimated by using dummy variables, defined as follows:[16]

(1.1) D_{i1t} = 1/5 on days A_i-5 to A_i-1;

D_{i2t} = 1/2 on days A_i and A_i+1;

D_{i3t} = $1/k_i$ on days A_i+2 to day T_i+30, k_i being the number of days during this period.

In this model, the regression coefficients γ_{ij} measure the *cumulative* abnormal return over each of the three time intervals associated with the three dummy variables. We also calculated the sum of the dummy-variable coefficients for each event

$$SUM_i = \gamma_{i1}+\gamma_{i2}+\gamma_{i3},$$

where SUM_i represents CAR_i over days A_i-5 to T_i+30.

For our tests, we calculated the averages of the estimated coefficients across the 17 events, $A\gamma_j=\Sigma_i\gamma_{ij}/17$, j=1, 2, 3, and the average of SUM_i. The t-statistics are calculated in the ordinary way: $t(A\gamma_j) = A\gamma_j/(SD\gamma_j/17^{\cdot})$, where $SD\gamma_j$ is the cross-sectional standard deviation of the 17 estimated coefficients γ_{ij}.

INSERT TABLE 1 HERE

The estimation results, presented in Table 1, show a highly significant price increase at the announcement of the transfer of stocks to the V-Method. The mean CAR over the pre-announcement period, $A\gamma_1$, and over days A to A+1, $A\gamma_2$, are positive and significant, as evidenced by their t-statistics. $A\gamma_3$, the post-announcement CAR, is insignificantly different from

[16]See Thompson (1985), Malatesta (1986), Karafiath (1988).

zero. SUM, which estimates the CAR over the entire period A-5 to T+30, has a mean of 5.517% which is highly significant. Further tests on the significance of the 17 estimated t-statistics, t_{ij}, which are distributed approximately as the standard normal random variable, confirm the robustness of our results (Table 1, Column (2)).

Given the relatively small number of transfer events, the means could be affected by outliers. Column (3) presents the medians of the estimated regression coefficients of model (1) and of SUM. We observe that the key medians are similar in magnitude to the means.

Column (4) of Table 1 presents the number of positive and negative coefficients γ_{ij} for each j, and the respective binomial probability of observing the indicated number of negative γ_{ij} under the null hypothesis that the probability is 0.5. The results show that the null is soundly rejected at better than the 0.05 level for γ_{i2} and for SUM.

While the improvement in liquidity after the transfer was anticipated on the announcement day, its full benefit could be consummated only in trading that started on the transfer day.[17] Only then were investors able to exploit the higher liquidity and lower transaction costs, which would induce them to pay more for these stocks. Thus, we also estimated the CAR from day A-5 through (including) the transfer day T, defining the dummy variable D_{i2t} in model (1) over days A_i to T_i and calculating $SUMT_i = \gamma_{i1} + \gamma_{i2}$. The results show that $SUMT_i$ was positive for all 17 events. The mean SUMT was 7.547% (t=6.95) and its median was 7.650%.

Overall, the results strongly support the existence of a positive price effect due to the transfer of stocks to the V-Method. The price increase was permanent, economically meaningful and statistically significant.

[17]Christie and Huang (1994) showed that when stocks transfer from NASDAQ to the NYSE, the bid-ask spread narrows only from the day of the transfer. In 6 out of the 17 transfers, day T was day A+1, whereas in 11 cases (82 stocks) the transfer occurred after day

3.3. Liquidity Externalities

Trading is characterized by *liquidity externalities*, or spillovers, across securities (A-M (1988b, 1990, 1991c)):[18] when the values of two securities, *A* and *B*, are correlated, an improvement in the trading mechanism for security *A* will have a positive effect on the liquidity of *B*. This is because when a better trading mechanism improves value-discovery for *A*, traders in *B* can use the (improved) observed prices of *A* to make a better inference on the value of *B*. In addition, when the returns on *A* and *B* are highly correlated, the two securities may serve as partial substitutes in investors' portfolios.

We examine the existence of liquidity externalities as follows. A subsample of TASE companies have two classes of stock with identical claims on capital (including cash distributions and liquidation) but different voting rights.[19] We call such stocks *twin stocks*. The two classes of twin stocks typically have differences in liquidity due to differences in the number of shares outstanding and float. We consider twin stocks where the *primary stock* - usually the more liquid of the twins - was transferred to the V-Method, while the *secondary stock* continued to be traded by the C-Method. The sample includes 23 twin stocks in 12 transfer events.

The null hypothesis is that the transfer of the primary stock to the V-Method had no effect on the corresponding secondary stock. There are two alternative hypotheses:

(1) *The liquidity externality hypothesis*. Section 3.2 demonstrates that stocks gain when they are transferred to the improved trading mechanism of the V-method. If there are positive liquidity externalities, the *secondary* stock should also enjoy some of the benefits of the improved

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A+1.

[18]Liquidity externalities for individual securities were introduced in Mendelson (1985). On the public-good type externality of services provided in the securities markets, see Cohen *et. al* (1986, Ch. 8).

[19]The ratio of voting rights between the two classes is usually 5:1.

trading method for the primary stock, resulting in a price increase for the secondary stock. The hypothesis is thus that at the announcement,

(i) the price of the *secondary* stock increases, but

(ii) by *less* than the price increase of the *primary* stock.

(2) *The substitution hypothesis*. If investors' demand for the twin stock is not perfectly elastic,[20] the improved liquidity of the primary stock makes it more attractive relative to the secondary stock, thereby reducing the demand for the secondary stock. Under this hypothesis, the secondary stock's price will decline.

INSERT FIGURE 2 HERE

These hypotheses are examined using our subsample of 23 twin stocks. Figure 2 shows the average CAR over days A-5 through T+30 for both primary and secondary stocks. The CAR for the secondary stocks from day A-5 to T (transfer) was 3.3% compared with 7.8% for the primary stocks. This result supports both parts of the liquidity externality hypothesis: *(i)* prices of secondary stocks increase even though the improved trading method is available only to the primary stocks; and *(ii)* the price increase is greater for the primary stocks, which directly benefit from the improved trading method.

To test the statistical significance of these results, we estimated model (1) for the secondary stock portfolios, with the dummy variables set to measure the CAR over the period A-5 to T.[21] The mean SUMT was 4.88% ($t = 2.83$) and the median was 4.62%. This supports part *(i)* of the liquidity externality hypothesis: there was a significant increase in the price of the secondary stocks that continued to trade under the C-Method when their twins were transferred to

[20]See Shleifer (1986). For example, the stock may provide a comparative advantage in some states of the world.

[21]The secondary stocks' estimation model includes a lagged market return because, being traded on the C-Method, some of these stocks adjust their prices gradually to the market. See analysis in section 3.4.2 below.

the V-Method.

To test part *(ii)* of the liquidity externality hypothesis we calculated DR_{it}, the difference between the portfolio returns on the primary and secondary stocks in event i on day t. Using DR_{it} as the dependent variable in model (1), we found that the cumulative differential return over the period A-5 to T, SUMT, had a mean of 4.25% (t=2.34) and a median of 5.07%. This shows that the price increase of the secondary stocks, which enjoyed a liquidity externality, was significantly lower than the price increase of the primary stocks that directly benefitted from higher liquidity under the V-Method.

3.4. Liquidity, Efficiency and the Trading Mechanism

The V-Method was expected to improve market quality compared to the C-Method. Next, we examine how the liquidity and efficiency of trading were affected by the transfer from the C-Method to the V-Method.

3.4.1. Liquidity

Liquidity in the TASE cannot be measured by bid-ask spreads because there are no designated market-makers or specialists who post bid and ask quotes.[22] We use instead two common measures of liquidity: the stock's trading volume and the stock's liquidity (or Amivest) ratio.

(1) *Trading Volume (V):* this measure of liquidity is often used by practitioners and academics. Theoretically, the trading volume or trading frequency of a given security increases in its liquidity, other things equal (Mendelson (1982, 1985), A-M (1986)). Thus, an increase in the trading volume of a stock after its transfer to the V-Method reflects an increase in its liquidity.

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[22]In a market like the TASE, it is still theoretically possible to impute a bid-ask spread from the limit prices of the marginal buy and sell orders that could not be executed. These data,

INSERT FIGURE 3 HERE

We calculated the relative volume of each stock (the stock's volume as a percent of the market volume) for each event-day S, and then averaged the relative volumes across the 120 stocks. The resulting time series are presented in Figure 3. Clearly, the transfer of stocks to the V-Method is associated with a dramatic increase in their trading volumes.[23] Noteworthy is the upward trend in the relative trading volume of the transferred stocks prior to the announcement. This trend probably contributed to the likelihood that these stocks would be selected for transfer to the V-Method.

To test the rise in volume for our sample, we define the change in the relative volume as

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

where V_j and VM are, respectively, the average daily trading volume on stock j and on the market (in monetary units), and the subscripts indicate "before the announcement" (days A-155 through A-31) and "after the transfer" (T+31 through T+160). DV_j was positive for 78% of the transferred stocks; its mean was 0.492% (t=7.27), the median was 0.421%.

(2) *Liquidity Ratio (LR)* (also called the Amivest measure of liquidity): measures the trading volume associated with a unit change in the stock price. Higher LR implies greater market liquidity or depth. The liquidity ratio is defined as[24]

$$LR_j = \Sigma_t V_{jt} / \Sigma_t \bullet R_{jt} \bullet ,$$

where V_{jt} and R_{jt} are, respectively, the volume and return on stock j on day t, and the summation is over the days in the estimation period. The relative change in LR for stock j is defined by

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

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however, are unavailable.

[23]These results are consistent with Lauterbach and Ungar's (1992) findings in their exploratory analysis on the very early stages of the V-Method.

where the subscripts are defined above. DLR was positive for 85% of the transferred stocks, with a mean of 0.87 (t=10.90) and a median of 0.87.[25] In summary, the transfer to the V-Method was associated with a significant increase in liquidity.

The results are thus consistent with our hypothesis on the positive relation between liquidity and stock values: the stocks transferred to the V-Method enjoyed both substantial liquidity gains and significant price increases. Naturally, the impact of the transfer varied across stocks. Thus, a further examination of our hypothesis is provided by estimating the cross-sectional model

$$(2) \qquad CAR_j = \delta \bullet DLIQ_j + \Sigma^{16}_{k=1} \zeta_k \bullet DUMEVENT_{kj} + \kappa_j \ ,$$

where CAR_j is the cumulative abnormal return on stock j from day A-5 to day T+30, DLIQ is the change in liquidity as measured by DV or DLR, and $DUMEVENT_{kj} = 1$ when stock j is in event k (zero otherwise). By our hypothesis, $\delta > 0$.

The estimation results were as follows. For DLIQ defined as DV, $\delta = 5.10$ (t=2.03), and for DLIQ defined as DLR, $\delta = 4.17$ (t = 1.80).[26] Both coefficients are significant at better than 5% (one tail test). This shows that across stocks too, the price increase after the transfer to the V-Method was related to the improvement in liquidity.

3.4.2. Efficiency

Improving market efficiency was a stated objective of the TASE in instituting the V-Method (TASE (1987)). This implies an improvement in the value discovery process by which information is incorporated into stock prices. Continuous trading enables investors to obtain

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[24]See Cooper, Groth and Avera (1985), Khan and Baker (1993).

[25]DLR is interpreted as follows: after the transfer to the V-Method, there was an increase of 0.87 NIS in the trading volume that was associated with a change of 1% in the stock price. This means that the market had more depth.

[26]The standard errors were estimated using White's (1980) method. The estimated coefficients may be biased towards zero due to the problem of errors-in-the-variables. Here, the explanatory variable, DLIQ, is a noisy estimate of the improvement in liquidity of the

information about the value of a stock after having observed *both* contemporaneous market movements and the transaction prices of the same stock and related (similar) securities.[27] This should enable investors to incorporate information into the stock price more quickly and with greater precision compared to the C-Method. Therefore, under the V-Method the pricing errors relative to the contemporaneous market index will be smaller because of *(a)* faster adjustment to changes in the market index, and *(b)* smaller firm-specific errors given the information available from the observed prices of the same and related stocks. In what follows, we first examine the pricing errors before and after the stock transfer to the V-Method, and then study their sources.

A-M (1989, 1991b) introduced the Relative Return Dispersion, based on the variance of returns *across* securities, as a descriptive measure of the efficiency of a trading mechanism. Christie and Huang (1990, 1995) used the cross-sectional dispersion of equity returns to study the tendency of asset prices to move together over the business cycle and in extreme market moves.

The Relative Return Dispersion (RRD) is defined by

$$RRD_S = (1/120) \bullet \Sigma^{120}_{i=1} \varepsilon^2_{iS} \quad ,$$

where ε_{iS} is the simple market-model residual of stock i on event-day S; the market model was estimated separately before and after the announcement date. The RRD measures for each day S the dispersion of the returns on the individual stocks around the market. Since the dispersion of *values* due to firm-specific information should be independent of the trading mechanism, systematic differences in RRD between the "before" and "after" periods indicate differences in efficiency.

INSERT FIGURE 4 HERE

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transferred stocks, and thus its estimated effect is smaller than its true effect.

[27]This is consistent with the existence of liquidity externalities, discussed in Section 3.3. Amihud, Mendelson and Murgia (1990) observed that in the Milan *Borsa*, pricing errors in the call auction were reversed towards the market during the continuous trading session that followed the call.

The behavior of RRDs, shown in Figure 4, is consistent with greater efficiency after the transfer to the V-Method: The average of RRDs over days A-155 through A-31 was 8.79, compared with 5.79 over the period T+31 through T+160.

We next examine the change in the two factors that may contribute to inefficiency under the C-Method: *(a)* lagged adjustment to changes in the market index, and *(b)* high firm-specific noise. We estimated for each stock the lagged market model regression

(3) $$R_{jt} = \alpha_j + \beta_j \bullet RM_t + l\beta_j \bullet RM_{t-1} + \varepsilon_{jt},$$

where R_{jt} is the return on stock j on day t, RM_t is the market return, β_j and $l\beta_j$ are the coefficients for current and lagged RM, respectively, and ε_{jt} is the residual whose variance is denoted by $Var(\varepsilon)$. The model was estimated separately over two periods: before the announcement, days A-155 through A-31, and after the transfer, days T+31 through T+160.

<u>INSERT TABLE 2 HERE</u>

The results, presented in Table 2, are consistent with the hypothesis that the V-Method (in particular, the ability to trade throughout the day) improved efficiency.

(a) Adjustment to market information. Under the C-Method, there was a significant adjustment lag to the market index: the mean of $l\beta$ was 0.146, highly significant. After the transfer to the V-Method, $l\beta$ declined for most stocks and its mean became practically zero, implying that stock prices adjusted promptly to market information. The coefficient β of the contemporaneous market return correspondingly increased after the transfer so that the mean of $\beta + l\beta$ remained about the same (1.075 before vs 1.100 after). Thus, while the fundamental relation between the returns on individual stocks and the market was unaffected by the change, traders' ability to react to market movements on the same day (rather than having to wait for the following day's call) increased market efficiency. While this outcome is directly predictable given the change in the

trading mechanism, it is reassuring that the results are strong and statistically significant.

(b) Firm-specific information. Continuous trading enables to learn firm-specific information and to trade on it through the same trading day. Thus, we examined whether the transfer to the V-Method lowered the variance of the residuals from the *lagged* market model (3), which controls for the effects of delayed adjustment to the market. Indeed, the results in Table 2 show that after the transfer the residual variance, $Var(\varepsilon)$, declined for most stocks, and its average was lower by about a third. While the change in market microstructure should not have changed any fundamental information about the stocks (other than the change in their liquidity), it had a favorable effect on the precision with which new firm-specific information was incorporated in stock prices.

3.4.3. The Interaction of Liquidity and Efficiency Improvements

Finally, we propose that the improvements in liquidity and efficiency, brought about by the improvement in market microstructure, are positively correlated (A-M (1988b)). To test this hypothesis, we used the two measures of change in efficiency discussed above: the change in the β coefficient of the lagged RM,

$$dl\beta_j = l\beta_{j,AFTER} - l\beta_{j,BEFORE},$$

and the change in the variance of the market model residuals,

$$dVar(\varepsilon)_j = \log(Var(\varepsilon)_{j,AFTER}) - \log(Var(\varepsilon)_{j,BEFORE}).$$

Both measures were obtained from model (3), estimated over both the "before" and "after" periods. We then estimated the cross-sectional models

$$(4) \qquad dl\beta_j = \eta \cdot DV_j + \Sigma^{16}_{k=1} \zeta_k \cdot DUMEVENT_{kj} + \kappa_j \ ,$$

and

$$(5) \qquad dVar(\varepsilon)_j = \theta \cdot DV_j + \Sigma^{16}_{k=1} \zeta_k \cdot DUMEVENT_{kj} + \kappa_j \ ,$$

where DV_j is the change in volume as defined above, and the dummy variables $DUMEVENT_{kj}$ are as defined in model (2).[28] By our hypothesis on the interaction between liquidity and efficiency changes, we expect $\eta < 0$ and $\theta < 0$. That is, improved liquidity should reduce the lag in price adjustment and the return noise.

The estimated coefficients were $\eta = -0.114$ (t = 4.05) and $\theta = -0.062$ (t = 1.20).[29] Both η and θ had the expected sign, although only η was significantly different from zero.[30]

In summary, the results suggest that improvements in liquidity are associated with greater efficiency in the dissemination of information into stock prices.

4. Conclusions

In this paper we showed that improvements in market microstructure are valuable. Specifically, we found that stocks that were transferred to a more efficient trading method in the TASE enjoyed significant and permanent price increases. Since the transfer of stocks was mandated by the TASE and was not a decision made by the companies' managements, it represents a pure market microstructure event: the transfer does not reflect private information of the companies' insiders and the results are not due to self-selection. Rather, the price appreciation found for stocks transferred to the new trading method reflects the value of improved market microstructure that brings about improvement in liquidity.

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[28]We did not use the liquidity ratio as a measure of liquidity for this test because both DLR and the efficiency measures were generated from the same return data, raising the possibility of a spurious relation between them. Regressions using DLR gave rise to similar results: $\eta = -0.106$ (t = 3.69), and $\theta = -0.184$ (t = 3.90).

[29]The regression standard errors were estimated using White's (1980) method. Again, the estimated coefficients may be biased towards zero due to the problem of errors-in-the-variables; see footnote 26.

[30]In addition, we estimated the relation between the change in β *itself* and DV, obtaining a regression coefficient of 0.18 with t=6.23, consistent with our hypothesis. This is the mirror

Stock liquidity improved following the transfer to the new trading method: there was a large and significant increase in the market-adjusted trading volume and in the liquidity ratio. Across stocks transferred to the new method, the value gains were positively associated with the increase in liquidity. The new method also led to improved efficiency of the value-discovery process. Stock prices adjusted faster to market information, and the noise in stock prices declined. These efficiency gains were positively related to the liquidity improvement across stocks. The greater efficiency made stock prices more informative, and the improved trading system benefitted the market as a whole. We also found that the benefits of the improved trading method generated positive externalities (or spillovers) for related stocks which continued to trade under the old trading method. These stocks, although not directly affected by the more liquid new trading method, also appreciated when their "twin" stocks were transferred to the new method.

Our results highlight the value of improving the quality of trading mechanisms (A-M (1988b)). In Israel, the value benefits were a very large multiple of the investment in the improved trading system. Our methodology can be extended to the study of liquidity events in other securities markets that changed their microstructure, such as in Europe and in emerging markets. It would be interesting to define the market-microstructure events for the changes occurring in these markets and to study their impact on securities values.

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image of the results for $dl\beta$, given no change in the fundamentals.

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Table 1: Estimated Value Effects of Stock Transfers to the V-Method

Results for the event-study model

(1) $R_{it} = \alpha_i + \beta_i RM_t + \Sigma^3_{j=1}\gamma_{ij}D_{ijt} + \varepsilon_{it}$,

for 120 TASE stocks that transferred from the C-Method to the V-Method of trading over the period 1988-1994, aggregated in 17 transfer events. R_{it} is the equally-weighted day-t return on transfer-portfolio i, i=1,2,...,17, RM_t is the daily return on the value-weighted TASE market index (returns are in percentage points, with 1% presented as 1) and α_i, β_i and γ_{ij}, j=1, 2, 3 are constant coefficients. The announcement day is denoted by A and the transfer day by T. For each event i, i=1, 2, ... 17, model (1) was estimated for the portfolio of transferred stocks from day A_i-5 to day T_i+160. The coefficients of the 3 dummy variables D_{ij} estimate the cumulative abnormal returns (CAR) over three periods:

(1.1) D_{i1}: day A_i-5 to A_i-1;
D_{i2}: day A_i to A_i+1;
D_{i3}: day A_i+2 to T_i+30.
$SUM_i = \gamma_{i1}+\gamma_{i2}+\gamma_{i3}$ is the CAR from day A_i-5 to day T_i+30.

The results are documented as follows.

Column (1): average of the estimated coefficients across events (t-statistic in parentheses).

Column (2): $t(At\gamma_j)$, the t-statistic for the means of the 17 sample $t\gamma_{ij}$ statistics from the regression of model (1), $t\gamma_{ij} = \gamma_{ij}/SE(\gamma_{ij})$. The mean and standard deviation of the 17 t-statistics, $At\gamma_j$ and $SDt\gamma_j$, are used to calculate the ordinary t-statistic $t(At\gamma_j) = At\gamma_j/(SDt\gamma_j/17^{\cdot})$. The t-tests for α and β are analogous.

Column (3): medians of the 17 estimated coefficients.

Column (4): number of positive and negative estimated coefficients. In parentheses: the binomial probability that γ_{ij} is equally likely to be positive or negative, against the alternative hypothesis that it is positive.

Column (5): weighted average of the estimated coefficients of model (1) over the 17 estimations, the weights being the number of stocks in each event (portfolio) (t-statistics are in parentheses).

The last row documents the results from model (1), where the dummy variable D_{i2} is for day A to T, D_{i3} for day T+1 to T+30 and $SUMT_i = \gamma_{i1}+\gamma_{i2}$, CAR from day A-5 to day T.

Variable	Mean ($A\gamma_j$) (t-statistic) (1)	t($At\gamma_j$) statistic (2)	Median (3)	Pos:Neg (Binomial Probability) (4)	Weighted Mean (t-statistic) (5)
Intercept	-0.067 (-2.19)	-2.39$^+$	-0.106	5:12 (0.975)	-0.074 (-2.41)$^+$
β	1.139 (26.49)*	10.64*	1.135	17:0 (0.000)	1.114 (27.82)*
D1: A-5 to A-1	2.133 (2.30)$^+$	2.34$^+$	0.970	12:5 (0.072)	2.360 (2.61)$^+$
D2: A to A+1	3.035 (4.42)*	5.36*	3.325	15:2 (0.001)	2.860 (4.48)*
D3: A+2 to T+30	0.349 (0.21)	0.56	0.129	9:8 (0.500)	1.095 (0.70)
SUM: A-5 to T+30	5.517 (3.05)*		6.380	13:4 (0.025)	6.31 (3.95)*
SUMT: A-5 to T	7.547 (6.95)*		7.650	17:0 (0.000)	6.992 (6.16)*

* Significant at 0.01
$^+$ Significant at 0.05

Table 2: Changes in efficiency

Estimated parameters of the market model

(3) $$R_{jt} = \alpha_j + \beta_j \bullet RM_t + l\beta_j \bullet RM_{t-1} + \varepsilon_{jt}.$$

R_{jt} is the daily return on stock j on day t, RM_t is the market daily return and ε_{jt} is the residual return. β_j and $l\beta_j$ measure the beta coefficients for contemporaneous and lagged RM, and Var(ε) is the estimated residual variance. There are 120 stocks transferred to the V-Method over the 1988-1994 period. The "before" period is days A-155 through A-31 and the "after" period is days T+31 to T+160 (A is the announcement day and T is the transfer day).

	β	lβ	Var(ε)
Before announcement:			
Mean	0.929	0.146	8.791
(Std. Error)	(0.027)#1	(0.022)*0	(0.743)
Median	0.959	0.118	6.251
After transfer:			
Mean	1.108	-0.008	5.929
(Std. Error)	(0.026)*1	(0.017)#0	(0.522)
Median	1.091	-0.020	4.289
Difference After-Before:			
Mean	0.180	-0.154	-2.862
(Std. Error)	(0.037)*0	(0.023)*0	(0.578)
Median	0.104	-0.130	-2.010
Positive:Negative	77:43+	35:85+	23:97+

*0, *1: The mean is significantly different from 0 or 1, respectively (at the 0.05 level).

#0, #1 : The mean is not significantly different from 0 or 1, respectively (at the 0.05 level).

+ : The proportion of cases which are positive is significantly different from 0.50 (at the 0.05 level).

Figure Legends

Figure 1: Cumulative Abnormal Returns for Stocks Transferred to the V-Method. Average cumulative abnormal returns (CAR) for 120 stocks that were transferred from the C-Method to the V-Method of trading on the Tel Aviv Stock Exchange (TASE) between December 6, 1987 and the end of 1994. "A" on the event day axis aggregates the time period from the day of the announcement by the TASE of the stocks selected for transfer through the day before the transfer (the number of days in this period varied). "T" is the transfer day. The CAR for each stock was estimated over the period A-5 through T+30. The market model from which the parameters were estimated is

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

where R_{nt} is the return on stock n on day t and RM_t is the daily return on the TASE value-weighted index (returns are the logarithm of relative price changes). α_n and β_n are constant coefficients, and ε_{nt} are the residuals. The market model was estimated over days T+31 through T+160.

Figure 2: Cumulative Abnormal Returns for Twin Stocks. Average CAR for 23 twin-stock pairs in 12 transfer events on the TASE. In each case, the firm had two classes of stock listed. One class (the "primary" stock) transferred from the C-Method to the V-Method of trading while the other class (the "secondary" stock) continued to be traded under the C-Method. See Figure 1 for more details regarding the data and estimation. "A" on the event day axis aggregates the time period from the day of the announcement by the TASE of the primary stocks selected for transfer to the V-Method through the day before the transfer (the number of days in this period varies). "T" is the transfer day.

Figure 3: Relative volumes before and after stock transfers to the V-Method. Trading volumes relative to the market volume for 120 stocks that were transferred from the C-Method to the V-Method on the TASE. For each day t, the daily trading volume of each stock was calculated as a percentage of the market volume on the same day. The results were then averaged over the 120 transferred stocks for each event day. MA(10) is the 10-day moving average for the relative volume time series, and "mean" represent the mean relative volume before (days A-155 through A-31) and after (days T+31 through T+160) the event period. (A = announcement, T = Transfer).

Figure 4: Relative Return Dispersions (RRD) before and after stock transfers to the V-Method. Relative Return Dispersions (RRD) of 120 stocks that were transferred from the C-Method to the V-Method on the TASE. The Relative Return Dispersion for event-day S is defined by

$$RRD_S = (1/120) \cdot \Sigma^{120}_{i=1} \varepsilon^2_{iS} .$$

ε_{iS} is the simple market-model residual of stock i on event-day S, where the market-model was estimated separately before and after the event day. Outliers have been omitted. MA(10) is the 10-day moving average of the RRD series, and "mean" represents the mean RRD's before (days A-155 through A-31) and after (days T+31 through T+160) the event period (A = announcement, T = Transfer).