THE JOURNAL OF FINANCE • VOL. LX, NO. 6 • DECEMBER 2005

Financial Market Design and the Equity Premium: Electronic versus Floor Trading

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ABSTRACT

We assemble the announcement and actual introduction dates of electronic trading by the leading exchanges of 120 countries to examine the impact of automation, controlling for risk factors and economic conditions. Dividend growth models and international CAPM suggest a significant decline in the equity premium, especially in emerging markets. Consistent with this reduction in the equity premium in the long run, there is a positive short-term price reaction to the switch. Further analysis of trading turnover supports the notion that electronic trading enhances the liquidity and informativeness of stock markets, leading to a reduction in the cost of capital.

RAPID TECHNOLOGICAL ADVANCEMENTS IN TELECOMMUNICATIONS and the Internet are transforming the basic business model of a stock exchange. In an increasingly competitive world with low barriers to entry, exchange owners are rapidly recognizing that efficient market design and trading mechanisms are crucial to winning greater market share, in terms of both trading volume and number of listings. Accordingly, scores of stock exchanges around the world have introduced fully automated and transparent electronic trading systems, replacing their trading floors on which brokers manually match orders using an open-outcry system.[1] This paper empirically examines whether this major change in market microstructure has helped the listed firms lower their cost of equity because of improvements in liquidity and the informational environment in the secondary market.

Computerized trading systems can improve liquidity in secondary markets through lower trading costs (spreads, fees, brokerage, and commissions paid by investors). They increase the amount of publicly available information about a

*Jain is from Fogelman College of Business and Economics, the University of Memphis. The paper is abstracted from my doctoral dissertation at Indiana University. I would like to thank Utpal Bhattacharya, Ian Domowitz, Craig Holden, Richard Green (the former editor), Robert Jennings, an anonymous referee, and seminar participants at Indiana University, the University of South Carolina, the University of Texas at Dallas, the Midwest Financial Association Meeting 2002, the Financial Management Association Meeting 2002, the Eastern Finance Association Meeting 2003, and the American Finance Association Meeting 2004 for their comments and suggestions. Financial support from the Center of International Business Education and Research is gratefully acknowledged. All errors are my responsibility.

[1] During the last 10 years, most new exchanges started as fully electronic because the costs of developing, operating, and maintaining electronic systems are typically far lower vis-à-vis trading floors.

stock's demand and supply by transparently displaying and efficiently archiving quotes, depths, orders, and transactions. Higher transparency reduces information asymmetry faced by market participants in real time (Pagano and Roell (1996)) and deters abusive practices such as insider trading and front running of customers' orders. In addition, electronic systems are capable of attracting new pools of liquidity both by providing affordable remote access to investors and by retaining unexecuted orders in a consolidated order book for possible matching with future orders. Liquidity begets liquidity and creates network externalities. Electronic trading reduces barriers to market-making activity, allowing individual investors to compete with brokers that have exchange seats. On automated electronic trading systems, profit-seeking value traders can closely monitor the market and become suppliers of liquidity even without a presence on the trading floor. This phenomenon is further facilitated by the manifestly higher speed of execution and settlement of trades on electronic systems and other differences discussed in the Appendix.

Exchange officials in both developed and emerging markets (Germany, Italy, and Pakistan) commonly cite cost reduction and investor protection as the main reasons for automating. While the academic literature and financial press have documented the merits of electronic systems in day-to-day trading, there is relatively little research on their long-term effects on the equity premium. Amihud and Mendelson (1986) show that investors expect lower returns from stocks with higher liquidity. Easley and O'Hara (2004) show that investors demand a higher (lower) return to hold stocks with greater private (public) information. Although their focus is on cash flow information, greater public access to order flow information is likely to have similar beneficial effects, too, as discussed in Franke and Hess (2000). O'Hara (2003) argues that particular trading systems may provide more information or better information (p. 1342). This can facilitate price discovery, lower traders' risks, and hence affect asset returns. Therefore, one can expect a lower equity premium on the electronic exchanges if those exchanges offer traders better liquidity, lower trading costs, and better information than the floor-based exchanges.

Domowitz and Stiel (2001) document the economic significance of this effect through an examination of U.S. and European exchanges from 1996 to 1998. None of the exchanges, however, explicitly switched from floor to electronic trading in the time period of their study. A related set of papers by Amihud, Mendelson, and Lauterbach (1997), Kalay, Wei, and Wohl (2002), and Muscarella and Piwowar (2001) find that the move from call-auction trading to continuous trading by the Israeli and the French exchanges resulted in positive price reactions.

Nonetheless, there is no dearth of arguments that challenge this view. The world's largest stock exchange, the New York Stock Exchange (NYSE), still relies heavily on floor trading. Beneviste, Marcus, and Wilhelm (1992) argue that floor trading mitigates information asymmetry and lowers the bid-ask spread because brokers build their reputations through repeated face-to-face interactions. Our counterargument is that electronic systems have the potential

to replicate the reputation effects by disclosing the identity of counterparties ex ante, as is done on yahoo.com, amazon.com, and ebay.com auctions. Schmidt, Iversen, and Treske (1993), Theissen (2001), and Venkataraman (2001) find that spreads are wider on the electronic exchanges than on the floor-based exchanges although the latter study acknowledges the difficulties in controlling for other differences among exchanges in listed firms' characteristics, insider trading laws, competition for order flow, and trading volume. Even if we were to discount the results in these studies as sample-specific and believe that electronic markets have better liquidity, Constantinides (1986), Vayanos (1998), Kadlec and McConnell (1994), and Barclay, Kandel, and Marx (1998) argue that bid-ask spreads have only a negligible second-order effect on expected returns. Thus, it appears meaningful to resolve these seemingly contradictory views empirically in a multicountry setting that can provide a bird's-eye view of, as well as detailed insights into, the benefits of automation.

Our study contributes to the growing literature that examines the impact of market microstructure on asset pricing. The main hypothesis tested in this paper is that the automation of the trading process leads to a reduction in the equity premium that investors demand. We gather new information on stock exchanges in 120 countries and find that the leading stock exchange in 101 of those countries has introduced screen-based electronic trading within the last 25 years. The advantages of using such a comprehensive sample are manifold. First, it enhances our understanding of how many exchanges around the world perceive each system to be relatively stronger than the other. Is the reliance on the trading floor by the NYSE an exception or the rule? Second, it lets us revisit the sporadic evidence from the few single- or dual-country studies to examine whether their findings about the positive stock price reactions are pervasive or limited in their generality. The previous studies cited above examine a move from discrete call trading to continuous trading. Is a similar effect obtained when exchanges switch from continuous floor trading to continuous electronic trading? Third, by looking at the long-term patterns in the cost of equity, we are able to test whether the positive price reaction to the switch is a sign of temporary optimism by investors who are newly afforded remote access and greater control in equity trading, or whether the price reaction is permanent, implying a decline in the equity premium in the long run. Fourth, the wide cross-sectional variety in the financial markets helps us address the possibility that electronic trading may be preferable in certain financial and legal environments, whereas floor trading might be better in others.

We analyze the time series of monthly returns on stock exchanges of 56 countries and annual returns of 15 additional countries from December 1969 to August 2001. We use two different methods to estimate the equity premium, namely, the dividends growth model preferred by Fama and French (2002) and an international asset pricing model suggested by Bekaert and Harvey (1995). Dividend yields fell by 0.04% per month, or 48 basis points per annum, after the introduction of electronic trading. The international capital asset pricing model (ICAPM) suggests a much sharper decline. In a regression model with the equity premium as the dependent variable and electronic trading as

the key explanatory variable, we control for world-market risk, idiosyncratic country-specific risk, liberalization, financial integration, level of economic development, gross domestic product (GDP) growth rate, time trend, and time variation in betas, all in a GARCH framework. The regression coefficient for electronic trading is negative and statistically significant. The reduction in the equity premium is more pronounced in emerging markets than in developed markets, both in absolute and proportional terms. Instead of emphasizing these average point estimates, this study looks at 71 exchanges individually as there are significant cross-country differences. This country-by-country analysis also enables the use of the same set of listed firms on an exchange before and after the introduction of electronic trading and thus avoids the problem of imperfect matching of stocks across electronic and floor regimes. Depending on the measure used, between 62% and 83% of the regime shifts are associated with a reduction in the cost of equity. The results can be explained in part by improvements in the liquidity measures. We show that the relative monthly trading turnover increases by 3.31% of market capitalization after the introduction of electronic trading.

Consistent with the reduction in the equity premium in the long term, we find that there is a positive price jump around the dates of announcement and implementation of electronic trading. Average excess-over-world abnormal return (AR) in the announcement-month is 8.99%. The excess-over-world cumulative abnormal return (CAR) up to the announcement-month, benchmarked against their levels 24 months before the announcement, is an impressive 29.63%. Even 2 years after the announcement, CAR persists over 28.69%.

The remainder of the paper is organized as follows. Section I contains this study's hypotheses. Data sources are outlined in Section II. Empirical methodology and results are presented in the following two sections. Section V concludes.

I. Testable Hypotheses

We attempt to address the microstructure debate about the efficacy of floor versus electronic trading by investigating the impact of automation on the equity premium:

$H1_0$: Improvement in stock market liquidity and informativeness induced by the introduction of electronic trading lowers the equity premium and, thus, reduces the cost of equity for listed firms.

In our hypothesis, the inverse relationship between liquidity and the equity premium is based on the unequivocal predictions and empirical findings in Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Datar, Naik, and Radcliffe (1998), Jones (2001), Pastor and Stambaugh (2003), Swan and Westerholm (2002), and O'Hara (2003).

An immediate implication of the first hypothesis is that when securities move to a lower equity premium regime, they should experience a price jump:

$H2_0$: When stocks move from floor to electronic trading, they will observe a positive price reaction.

Tests similar to the second hypothesis have been performed on a stand-alone basis by Amihud et al. (1997), Kalay et al. (2002), and Muscarella and Piwowar (2001) for moves from discrete call-auction trading to continuous trading by the Tel Aviv Stock Exchange and the Paris Bourse. We believe, however, that it is important to test the first and second hypotheses together to rule out some alternative explanations for either one. For instance, the equity premium can appear lower as a result of a reversal in long-term stock market returns, but such a phenomenon would reject the second hypothesis. Similarly, a price jump can result from positive fundamental news occurring in coincidence with the automation of trading. This type of situation, however, would not prevent the rejection of the first hypothesis. Thus, a failure to reject both hypotheses would be a stronger indication that electronic trading leads to a lower cost of equity.

Note that one size does not fit all. Intensity of information arrival (Franke and Hess (2000)), inherent liquidity of a stock or the stock market (Madhavan and Sofianos (1997) and Theissen (2001)), level of economic development, enforcement of insider trading laws, and other aspects of a country's economic environment can all affect the relative importance of information obtained from a transparent electronic limit order book vis-à-vis information gained by observing traders on the floor. Particularly in emerging markets, if formal laws are ineffective because enforcement is difficult, full automation and transparency can be an alternative way of reducing information asymmetry and can cause greater reduction in the cost of equity:

$H3_0$: The magnitude of change in the equity premium after the introduction of electronic trading is a function of a country's economic and financial environment and the characteristics of its stocks.

II. Data

Our sample starts with a set of 120 countries around the world as listed in Table I. We first gather the dates of introduction of electronic trading by the largest exchange in each country.[2] This information is obtained from 12 annual volumes of the *Handbook of World Stock, Derivative, and Commodity Exchanges* from 1990 to 2001 and is cross-checked with information given on exchanges' home pages on the Internet. Email responses received from exchange officials provide confirmation and clarification. We collect announcement dates for automation from the Lexis Nexis news retrieval service.

[2] In this paper, the term "electronic trading" is defined as fully automated matching and execution of trades by a computer algorithm. If the orders on any exchange are only routed electronically and the intervention of a broker is required for final execution of trades, then such an exchange is not classified as an electronic exchange.

Table I

Dates of Introduction of Automated Trading, Liberalization, and Other Events

This table shows the establishment year (Estb) for the leading exchange in 120 countries. This is followed by the key survey information collected in this study, that is, the date of the introduction of electronic trading (Elec) on the largest exchange in each country. The source of information about automation follows in the adjacent column. The starting date of data availability (Data) for the stock market index in Datastream, S&P Emerging Markets Database, MSCIData.com, or the exchange's own website is shown next. Data frequency (Freq) is monthly for 56 countries and annual for 15 countries. The date of the first insider trading law enforcement (Insd) is from Bhattacharya and Daouk (2002), and official liberalization date (Lib) is from Bekaert and Harvey (2000).

	Country	Estb	Elec	Source of Information	Data	Freq	Insd	Lib
1	Australia	1859	1987	Handbook 94	1969	Monthly	1996	December 1969
2	Austria	1771	1996	Handbook 01	1969	Monthly	No	December 1969
3	Belgium	1801	1996	Handbook 98	1969	Monthly	1994	December 1969
4	Canada	1878	1977	Steve.Kee@tse.com	1969	Monthly	1976	December 1969
5	Denmark	1919	1988	www.xcse.dk/uk/kf/historie	1969	Monthly	1996	December 1969
6	Finland	1912	1988	Handbook 98	1987	Monthly	1993	December 1969
7	France	1826	1986	Venkataraman (2001)	1969	Monthly	1975	December 1969
8	Germany	1585	1991	Handbook 98	1969	Monthly	1995	December 1969
9	Hong Kong	1891	1986	www.hkex.com.hk/exchange/history/history.htm	1969	Monthly	1994	December 1969
10	Ireland	1793	2000	mark.scully@ise.ie	1987	Monthly	No	December 1969
11	Italy	1808	1994	Handbook 01	1969	Monthly	1996	December 1969
12	Japan	1878	1982	www.tse.or.jp/english/about/history.html	1969	Monthly	1990	December 1980
13	Luxembourg	1929	1991	www.bourse.lu/english/informations/en_historique.html	1987	Monthly	No	December 1969
14	Netherlands	1600	1994	Handbook 98	1969	Monthly	1994	December 1969
15	New Zealand	1915	1991	www.nzse.co.nz/exchange/about/brief_history.html	1987	Monthly	No	July 1984
16	Norway	1819	1988	Bloomberg Terminal	1969	Monthly	1990	December 1969
17	Portugal	1825	1991	Handbook 98	1987	Monthly	No	July 1986
18	Singapore	1930	1989	info.sgx.com/SGXWeb_ST.nsf/docname/ST_Milestones	1969	Monthly	1978	December 1969
19	Spain	1831	1989	Handbook 01	1969	Monthly	1998	January 1978
20	Sweden	1863	1989	stockholmsborsen.se/exchange/index.asp	1969	Monthly	1990	December 1969
21	Switzerland	1938	1996	Handbook 01	1969	Monthly	1995	December 1969
22	United Kingdom	1773	1997	Handbook 01	1969	Monthly	1981	December 1969
23	U.S.-NYSE	1792	2000	www.nyse.com/press/NT0002893A.html	1969	Monthly	1961	December 1969

Emerging Markets

24	Albania	1996	Floor	www.asc.gov.al/tiranastock.html	N/A	N/A	No	
25	Argentina	1854	1995	www.internationalspecialreports.com	1987	Monthly	1995	November 1989
26	Armenia	1993	1996	www.yse.am	N/A	N/A	No	
27	Azerbaijan	1993	1997	www.az/bicex/	N/A	N/A	No	
28	Bahamas	1999	2000	ADillette@bisxbahamas.com	N/A	N/A	No	
29	Bahrain	1987	1999	www.bahrainstock.com/developments.asp	1996	Monthly	No	
30	Bangladesh	1954	1998	Handbook 01	1994	Monthly	1998	
31	Barbados	1987	2000	Handbook 01	1987	Annual	No	
32	Bermuda	1971	1998	www.bma.bm	1992	Annual	No	
33	Bhutan	1993	Floor	www.safe-asia.org/rsebhutan.htm	N/A	N/A	No	
34	Bolivia	1979	Floor	Handbook 01	N/A	N/A	No	
35	Botswana	1989	Floor	Handbook 01	1989	Annual	No	
36	Brazil	1890	1990	Handbook 98	1987	Monthly	1978	May 1991
37	Brunei	2002	2002	www.ibx.com.bn/main.asp?data=aboutus	N/A	N/A	No	
38	Bulgaria	1991	1997	bse@bse-sofia.bg	1993	Annual	No	
39	Cayman Islands	1997	1997	www.csx.com.ky/	N/A	N/A	No	
40	Channel Islands-Guernsey	1998	1998	www.cisx.com/	N/A	N/A	No	
41	Chile	1893	1989	Handbook 01	1987	Monthly	1996	January 1992
42	China	1990	1990	Tiehang (1996)	1989	Monthly	No	
43	Colombia	1928	1996	www.ifc.org/emdb/weekly/sept2096/latin/latin.html	1989	Monthly	No	February 1991
44	Costa Rica	1976	1991	bnv@internet.bnv.co.cr	1994	Annual	No	
45	Croatia	1918	1999	www.zse.hr/brief.html	1997	Monthly	No	
46	Cyprus	1996	1999	Marios.Tziakouris@CSE.com.cy	1996	Monthly	No	
47	Czech	1871	1998	www.pse.cz/burza/historie.asp#keyevents	1994	Monthly	1993	
48	Ecuador	1969	1999	padillar@ccbvq.com	1993	Annual	No	
49	Egypt	1890	1997	Lexis-Nexis	1994	Monthly	No	
50	El Salvador	1992	1994	Handbook 01	N/A	N/A	No	
51	Estonia	1996	1996	kristi@tse.ee	1996	Monthly	No	
52	Fiji	1978	Floor	www.spse.com.fj/publish/about.shtml	N/A	N/A	No	
53	Georgia	2000	2000	info@gse.ge	N/A	N/A	No	
54	Ghana	1989	Floor	stockex@ghana.com	1990	Annual	No	
55	Greece	1876	1992	Lexis-Nexis	1987	Monthly	1996	December 1987
56	Guatemala	1986	Floor	Handbook 01	N/A	N/A	No	
57	Honduras	1992	1993	Handbook 01	N/A	N/A	No	

(continued)

Table I—*Continued*

	Country	Estb	Elec	Source of Information	Data	Freq	Insd	Lib
58	Hungary	1864	1998	Handbook 01	1993	Monthly	1995	
59	Iceland	1985	1989	ingibjorg.r.gudjonsdottir@icex.is	1997	Monthly	No	
60	India	1875	1995	Handbook 01	1989	Monthly	1998	November 1992
61	Indonesia	1912	1995	Handbook 01	1987	Monthly	1996	September 1989
62	Iran	1966	1994	movahed@tse.or.ir	1990	Annual	No	
63	Israel	1953	1997	www.tase.co.il/html2/about/overview/history.htm	1992	Monthly	1989	
64	Ivory Coast	1974	1999	Handbook 01	1995	Annual	No	
65	Jamaica	1968	2000	Handbook 01	1987	Monthly	No	
66	Jordan	1978	2000	Handbook 01	1987	Monthly	No	December 1995
67	Kazakhstan	1997	1997	www.emgmkts.com/kazkommerts	N/A	N/A	No	
68	Kenya	1954	Floor	Handbook 01	1992	Annual	No	
69	Kuwait	1984	1995	Handbook 97	1994	Monthly	No	
70	Kyrgyk	1995	1999	Handbook 01	N/A	N/A	No	
71	Latvia	1993	1997	www.rfb.lv/info/overview.html	1997	Monthly	No	
72	Lebanon	1920	2000	www.bse.com.lb/bse.htm	1996	Monthly	No	
73	Lithuania	1926	1993	Handbook 01	1994	Annual	No	
74	Macedonia	1996	2001	mia@mse.org.mk	N/A	N/A	No	
75	Malawi	1996	Floor	Handbook 01	N/A	N/A	No	
76	Malaysia	1973	1992	www.klse.com.my/aboutus/1965-89.htm	1987	Monthly	1996	December 1988
77	Malta	1992	1996	Handbook 01	N/A	N/A	No	
78	Mauritius	1988	2001	www.semdex.com/profile.htm	1989	Annual	No	
79	Mexico	1894	1996	Handbook 01	1987	Monthly	No	May 1989
80	Moldova	1994	1998	www.moldse.md/default.htm	N/A	N/A	No	
81	Mongolia	1991	1999	www.mse.mn/history.htm	1995	Annual	No	
82	Morocco	1929	1997	www.casablanca-bourse.com/homeen.html	1994	Monthly	No	
83	Mozambique	1999	1999	www.ssbgeo.com/gem2000/Mozambique.pdf	N/A	N/A	No	
84	Namibia	1992	1998	Handbook 01	1992	Annual	No	
85	Nepal	1983	Floor	Handbook 01	1994	N/A	No	
86	Nigeria	1960	1999	Handbook 01	1992	Monthly	No	August 1995
87	Oman	1988	1998	Handbook 01	1996	Monthly	1999	
88	Pakistan	1947	1997	Handbook 98	1989	Monthly	No	February 1991
89	Palestine	1995	1997	psexchng@palnet.com	N/A	N/A	No	
90	Panama	1990	1999	mbrea@panabolsa.com	1992	Annual	No	

91	Papua, New Guinea	1998	1999	www.pomsox.com.pg/history.htm	N/A	N/A	No	
92	Paraguay	1977	Floor	Handbook 01	N/A	N/A	No	
93	Peru	1951	1995	www.bvl.com.pe/english/index.html	1992	Monthly	1994	
94	Philippines	1927	1993	Lexis-Nexis	1987	Monthly	No	June 1991
95	Poland	1817	1996	Handbook 98	1992	Monthly	1993	
96	Romania	1882	1995	cercetare@bvb.ro	1997	Annual	No	
97	Russia	1992	1994	www.micex.com/profile/history_94.html	1994	Monthly	No	
98	Saudi Arabia	1984	1990	www.tadawul.com.sa/	N/A	N/A	No	
99	Serbia	1989	Floor	Handbook 01	N/A	N/A	No	
100	Slovakia	1991	1994	www.bsse.sk/Content/EN/StockExchange/history.htm	1993	Annual	No	
101	Slovenia	1989	1993	ljse.si/StrAng/LJSEProf/Menu/ob_int.htm	1994	Monthly	1998	
102	South Africa	1887	1996	Handbook 01	1992	Monthly	No	
103	South Korea	1956	1988	english.koscom.co.kr/history	1980	Monthly	1988	January 1992
104	Sri Lanka	1896	1997	tushara@cse.lk	1992	Monthly	1996	
105	Swaziland	1990	Floor	Handbook 01	N/A	N/A	No	
106	Taiwan	1961	1985	www.tse.com.tw/docs/introduce/introtseF.htm	1981	Annual	1989	January 1991
107	Tanzania	1998	Floor	www.darstockexchange.com/history.asp	N/A	N/A	No	
108	Thailand	1974	1991	www.set.or.th/en/about/how/trading/system_p1.html	1987	Monthly	1993	September 1987
109	Trinidad & Tobago	1981	Floor	Handbook 01	1992	Annual	No	
110	Tunisia	1969	1996	Handbook 01	1991	Annual	No	
111	Turkey	1866	1993	www.ise.org/about/majordev.htm	1987	Monthly	1996	August 1989
112	Uganda	1997	Floor	www.ugandacapitalmarkets.co.ug/~market information	N/A	N/A	No	
113	Ukraine	1992	1996	akolomiets@pfts.com	1997	Monthly	No	
114	United Arab Emirates	2000	2000	helpdesk@dfm.co.ae	N/A	N/A	No	
115	Uruguay	1867	1994	Handbook 01	N/A	N/A	No	
116	Uzbekistan	1994	1996	Handbook 98	N/A	N/A	No	
117	Venezuela	1840	1992	Handbook 01	1981	Annual	No	January 1990
118	Vietnam	2000	Floor	Small Handbook 01	N/A	N/A	No	
119	Zambia	1994	Floor	Handbook 01	1997	Annual	No	
120	Zimbabwe	1896	Floor	Handbook 01	1994	Monthly	No	June 1993

Notes. N/A indicates nonavailability of data. The primary information source column abbreviates *The Handbook of World Stock, Derivative and Commodity Exchanges* to "Handbook" followed by the volume (year). Website addresses eliminate the characters *http://* and *www* as needed to save space. Some long Internet addresses (Argentina, Bermuda, Slovakia, Sweden) are truncated to show the homepage address; complete links are available from the authors. Finally, @ indicates an email address and implies that information is gathered from email correspondence with exchange officials.

In order to compare the equity premium before and after the introduction of electronic trading, we obtain dividend yields (53 countries) from Datastream International (DSI) and monthly (56 countries) or annual (71 countries) stock market indexes from Morgan Stanley Capital International (MSCI), International Finance Corporation (IFC), DSI, or directly from the exchanges.[3] The indexes do not start on the same date for every country. The earliest starting point is December 1969. The number of months for which returns data is available ranges from a low of 49 months (adding both floor and electronic months) for Croatia and Latvia to a high of 380 months each for 18 developed nations. We filter out data for six outlier exchange-months that represent more than 50% devaluation of the country's currency due to unusual circumstances such as a currency crisis.[4] For most of our tests, we eliminate 11 exchanges on which floor and electronic trading coexist, as indicated in Table II. To eliminate possible data errors, we also jettison observations in which values either increase to more than double or decline to less than half in successive years. Inclusion of these outlier months and potentially erroneous data slightly magnifies the drop in the cost of equity, lending even stronger support to the primary hypothesis in the paper. This exercise results in a final sample size of 9,758 monthly returns.

We gather monthly dollar-denominated market capitalization on the stock market indexes on these exchanges and dollar trading volumes from DSI. Missing observations are replaced with annual market capitalization from the *Guide to World Equity Markets*, 1997 to 2001, and the *Handbook of World Stock, Derivative, and Commodity Exchanges*, 1990 to 2001, in order to retain these exchange-months in our sample. Next, we gather data on trading turnover before and after automation for 63 exchanges (52 in final sample) and spreads before and after automation on a few exchanges from DSI and the online archives of the World Federation of Exchanges (formerly known as the International Federation of Stock Exchanges—FIBV), at www.fibv.com or from IFC. Missing data on turnover are replaced with information from the *Guide to World Equity Markets*, 1997 to 2001.

Finally, several papers such as Bekaert and Harvey (1995), Henry (2000), and Bhattacharya and Daouk (2002) show that the economic development of nations, the liberalization of markets, and the first enforcement of insider trading laws are important variables that enhance the liquidity of stock markets and reduce the cost of equity for firms. Therefore, we use the dates provided in these respective papers as control variables. Two more control variables are included. Quarterly GDP data are obtained from DSI for each country to compute the rate of economic growth, which is one of the key drivers of stock

[3] Datastream market indexes have a representative sample of stocks covering a majority of market capitalization in each market. New listings are not added as constituents between review points. We use fixed index values that are not recalculated retroactively when constituents change. However, results are qualitatively similar with recalculated index values, which are based on long-term performance of current constituents and which avoid distortions due to stocks entering or leaving an index.

[4] Three months of data from Argentina, two from Venezuela, and one from Indonesia are filtered out.

markets. Additionally, quarterly export and import data are acquired from DSI to compute the level of financial integration as Bekaert and Harvey (1995) suggest that it affects the sensitivity of returns to world-market returns.

III. Does Electronic Trading Reduce the Cost of Equity for Listed Firms?

A. Global Shift from Floor to Electronic Exchanges

The pattern of global shift from floor trading to automatic screen-based trading is graphed in Figure 1 for the leading exchanges in 120 countries. The first exchange to introduce electronic trading was the Toronto Stock Exchange, in 1977. The last exchange to do so in our sample is Macedonia, in 2001 (Brunei launched an electronic exchange in 2002, beyond our sample period). The technology was first introduced by a U.S. brokerage firm, Instinet, in 1969. However, the NYSE, the leading U.S. exchange, introduced the facility of fully automated trading, known as *Direct+*, only in December 2000 although electronic routing of orders on SuperDOT has been in place since 1985.[5] Today, the leading exchange in 101 of the 120 sample countries has electronic trading. Of these 101 exchanges, 85 are fully electronic, with no floor trading. These events provide natural experiments for testing the impact of this major aspect of market design on the equity premium.

B. Measuring the Equity Premium and Liquidity

Expected returns are estimated with six alternative measures, namely, monthly dividend yields, dividend growth model, total returns including dividend and capital gains in local currency, dollar-denominated total returns, excess-over-world returns, and excess-over-T-bill returns. It is necessary to conduct the analysis using both local currency indexes and U.S. dollar indexes to rule out the possibility that dollar appreciation drives all the results.

The first measure is simply the average dividend yield, $A(\mathrm{DY}_t)$, obtained by dividing the dividend for a period with the opening stock price for that period. The dividend yield for an index in Datastream is the total dividend amount for the index, expressed as a percentage of the total market value for the constituents of that index.[6]

[5] This paper considers the switch to a fully automated system as the relevant move. Exceptions such as SuperDOT are analyzed in robustness checks. Table II identifies NYSE and 10 other exchanges where floor trading coexists with electronic trading. We exclude these 11 exchanges from the sample for conducting cleaner statistical tests.

[6] Aggregate dividend yield $A(\mathrm{DY}_t)$ from a country index is averaged in the time series as follows: $A(\mathrm{DY}_t) = \sum_{t=1}^{T} \frac{\mathrm{DY}_t}{T}$. This average dividend yield is calculated for the floor-months $A(\mathrm{DY}_t)_{floor}$ and then again for the electronic months $A(\mathrm{DY}_t)_{electronic}$; the difference between the two numbers is reported for each country in Table II. Datastream provides the aggregate dividend yield DY_t separately for every country-index for each month computed as follows: $\mathrm{DY}_t = \frac{\sum_{i=1}^{C}(d_t * n_t)}{\sum_{i=1}^{C}(p_{t-1} * n_t)} * 100$, where d_t is the dollar dividend per share of stock i in month t, p_{t-1} is the last period's closing price for stock i, n represents the number of shares outstanding for firm i, and C is the number of constituents in a country index such as 500 in the S&P 500 index.

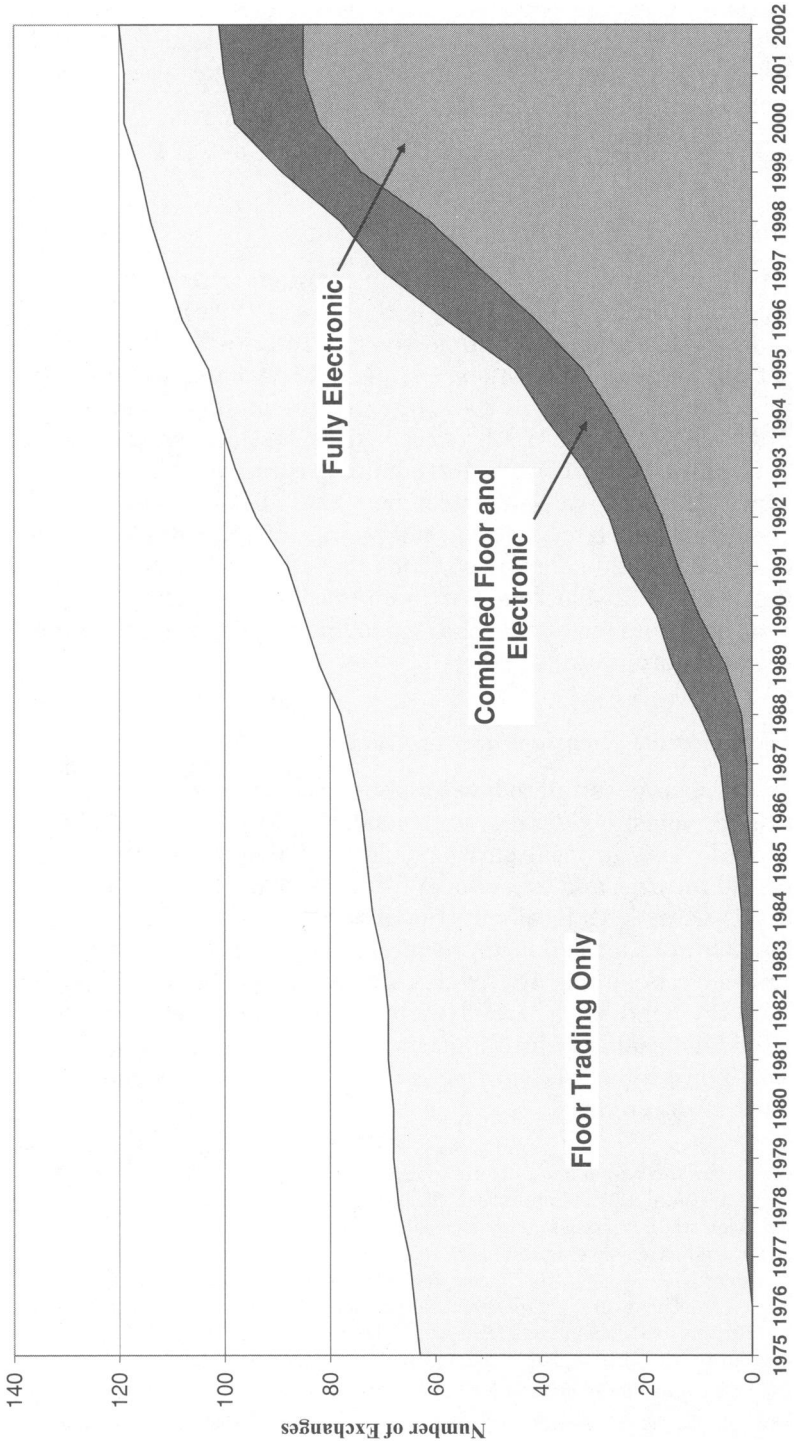

Figure 1. The global shift from floor trading to electronic trading. Based on automation of the leading stock exchange in 120 countries from 1975 to 2002.

In a recent paper, Fama and French (2002) suggest that although the dividend growth model and average realized returns have produced similar estimates of the expected U.S. equity premium historically, the two measures have diverged significantly in more recent periods. They argue that the dividend model produces estimates closer to the true expected equity premium because average realized returns are contaminated by price jumps associated with declining discount rates. Heeding their suggestion, we include a dividend growth model in our analysis of the equity premium before and after the introduction of electronic trading. According to this model, the average stock return, $A(R_t)$, is the average dividend yield, $A(\mathrm{DY}_t)$, plus average rate of capital gain, $A(\mathrm{GP}_t)$:

$$A(R_t) = A(\mathrm{DY}_t) + A(\mathrm{GP}_t). \tag{1}$$

We estimate this equation from stock market indexes including dividends in local currency as well as U.S. dollars to obtain our second and third measures of the equity premium.

Fama and French (2002) assume that the dividend–price ratio, D_t/P_t, is stationary (i.e., mean reverting). Stationarity implies that if the sample period is long, the compound rate of dividend growth approaches the compound rate of capital gain. Thus, an alternative estimate of expected stock return, $A(\mathrm{RD}_t)$, is given by the following dividend growth model:

$$A(\mathrm{RD}_t) = A(\mathrm{DY}_t) + A(\mathrm{GD}_t), \tag{2}$$

where $\mathrm{GD}_t = A(\$\mathrm{Div}_t - \$\mathrm{Div}_{t-1})/\$\mathrm{Div}_{t-1}$ is the growth rate of dividends. In order to arrive at the monthly growth in dividends, we calculate the absolute amount of dollar dividends, $\$\mathrm{Div}_t$, by multiplying the percentage dividend yield, DY_t, for a country's index in Datastream with the total market value for the constituents of that index for that month.

We use equation (2) to obtain the fourth measure of the cost of equity reported in Table II. The last two measures of the equity premium are based on excess returns. *Excess-over-world return* for a month is defined as the difference between the dollar-denominated return from stock market i in month t and the return from the MSCI world-market index in that month:[7]

$$\textit{Excess-over-world \$ return}_{it} = \textit{Gross \$ return}_{it} - \textit{World \$ return}_t. \tag{3}$$

For our sixth and last measure, we compute the excess returns by subtracting the risk-free rate from the gross equity returns:

$$\textit{Excess-over-T-bill \$ return}_{it} = \textit{Gross \$ return}_{it} - (\textit{One-month USD T-bill yield}_t). \tag{4}$$

[7] Although the calculation of excess return over world return in equation (3) is somewhat simplified, as it implicitly assumes that all countries have a unit beta with respect to the world index, Brown and Warner (1980) show that this model performs no worse than the market model. Moreover, estimating unique country betas only further strengthens the inferences drawn in this paper as discussed in Section III.G.

Finally, we measure liquidity using relative turnover and a liquidity measure developed by Amihud (2002). *Turnover* is defined at monthly intervals as

$$\textit{Monthly trading turnover} = \textit{Dollar trading volume/Market capitalization}. \quad (5)$$

Amihud (2002) defines stock illiquidity as the average ratio of the absolute return to the trading volume $|R_{iyt}|/VOLD_{iyt}$, where R_{iyt} is the return on stock i on day t of year y and $VOLD_{iyt}$ is the respective daily volume in dollars for U.S. stocks. This ratio gives the price impact of the order flow. We modify this measure to suit our international context:

$$Liquidity_{Amihud} = VOLD_{it}/|R_{it}|. \quad (6)$$

We measure volumes in 100,000 units of local currency of each country, and we observe data at the monthly, rather than daily, frequency. In order to give consistent meaning to our two liquidity measures, we take the inverse of Amihud's (2002) measure. Thus, we expect that equity premium measures are negatively correlated with the liquidity measures.

C. *Average Returns and Liquidity before and after the Introduction of Electronic Trading*

In this section, we examine the impact of electronic trading on equity returns in 71 countries for which returns data are available. In order to sharpen the tests and avoid confounding events such as liberalization, we exclude periods that occur more than 10 years before or after automation. This results in 9,052 exchange-months comprising 4,070 floor-months and 4,982 electronic-months. In Figure 2, we compare the equity premium and turnover in floor and electronic markets.

We observe that all six alternative ways of measuring the cost of equity yield the same result: Electronic trading has lower expected returns compared with floor trading. The pooled differences range from a drop of 0.01% per month for dividend measures to a drop of 1.60% for realized dividends plus capital gains measured in local currency.

Trading turnover in the pooled sample increases from 6.34% of market capitalization per month to 9.24%. This represents an almost 3% gain in liquidity. All changes in expected return and liquidity measures are statistically significant at the 1% level except the dividend model, which is significant at the 5% level. The liquidity improvement results are consistent with the vast market microstructure literature on specific markets such as the United States, Britain, France, Germany, Singapore, New Zealand, Australia, and India. (See Domowitz and Steil (1999) for an excellent summary and Jain (2004) for international evidence.) Time-series data of closing spreads are also available from DSI but only for six exchanges, namely, Portugal, Spain, Italy, Switzerland, United Kingdom, and France. We examine the average quoted bid-ask spread 2 years before and 2 years after automation for the largest stocks on these exchanges. For all six exchanges, spreads drop significantly after the introduction

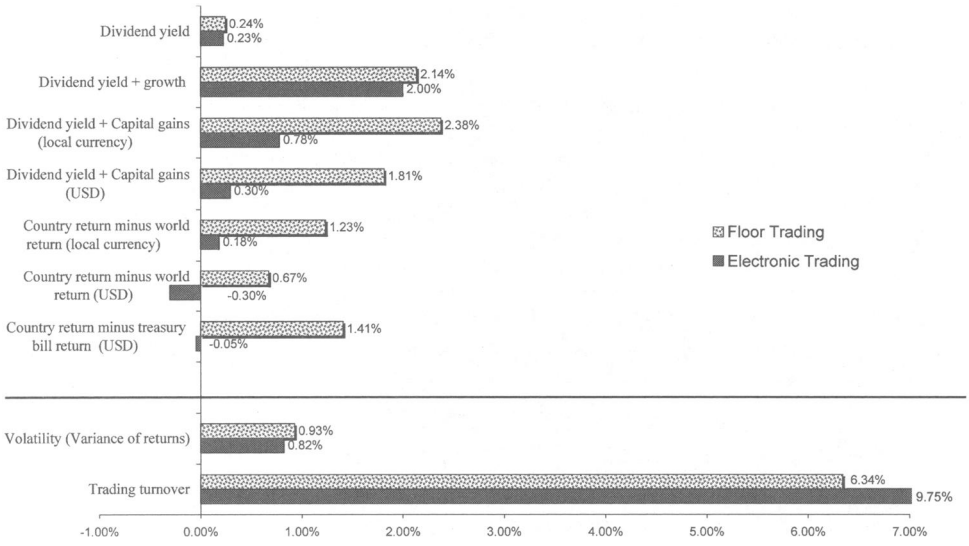

Figure 2. Declining cost of equity and improving liquidity after automation.

of electronic trading. For instance, spreads in Spain fall from 0.33% in floor trading to 0.23% after automation. In Switzerland, electronic spreads of 0.12% are half of those in floor trading. On average, the spreads fall by 39% from floor trading levels. Apart from retail trading costs, institutional trading costs have also declined over time around the world as documented in Chiyachantana et al. (2004).

D. Country-by-Country Analysis

Next, we look at each stock exchange individually and compare the average excess returns and liquidity before and after the introduction of electronic trading per Table II. This approach offers three benefits. First, it ensures a more controlled experiment because the same set of listed firms on an exchange is used before and after the introduction of electronic trading, resulting in an apples-to-apples comparison. Second, the differences in legal environment and other country-specific factors are not an issue with this type of analysis. Third, this analysis also ensures that the results are not being driven by one or two outlier countries, but rather are more general.

The six measures of the equity premium are placed in the first six columns of Table II and the two liquidity measures are in the last two columns. We find that between 62% and 83% of the regime shifts are associated with a reduction in the cost of equity. For instance, the expected return measure based on dividends plus capital gains in dollars indicates that 59 of the 71 countries observe a decline in the equity premium. Automation also results in an increase (decrease) in liquidity in 75% (25%), or 47 of the 63 countries, as measured by trading turnover.

Table II

Country-by-Country Analysis of Declining Equity Premium after Automation

This table reports the changes in the equity premium for 71 exchanges after the introduction of electronic trading. Changes in dividend yield (DY), dividend yield plus capital gains in local currency (DYCG), dividend yield plus capital gains in U.S. dollars (DYCG$), dividend yield plus dividend growth (DYG), country return minus world return in U.S. dollars (ERW$), and country return minus U.S. dollar T-bill return (ERT) are reported. Each measure is calculated for the floor trading months and the electronic trading months, and the differences are reported here. Changes in trading turnover (TURN) and $\text{Liquidity}_{\text{Amihud}}$ (LIQ) are in the last two columns.

		Dividend-Based Measures				Excess Returns		Liquidity	
	Country	DY	DYCG	DYCG$	DYG	ERW$	ERT	TURN	LIQ
	Panel A: Developed Countries								
1	Australia	−0.04%	−1.52%	−1.13%	−1.76%	−0.30%	−0.82%	0.0253	0.1022
2	Austria	0.01%	−0.46%	−1.19%	−0.01%	−0.84%	−1.14%	0.3063	0.0035
3	Belgium	−0.17%	0.06%	−0.88%	−0.83%	−0.38%	−0.83%	0.1724	0.0277
4	Canada	−0.08%	0.79%	0.45%	−0.46%	−0.41%	0.18%	0.0291	0.1070
5	Denmark	−0.10%	−0.19%	0.27%	0.75%	0.80%	0.59%	0.0375	0.0306
6	Finland	−0.02%	−0.48%	−0.37%	−0.50%	0.67%	−0.26%	0.0212	0.0321
7	France	−0.18%	−1.13%	−0.60%	0.51%	−0.24%	−0.31%	−0.0170	0.2452
8	Germany[a]	−0.11%	−0.21%	−0.58%	−0.19%	−0.10%	−0.29%	0.1345	0.5507
9	Hong Kong	−0.08%	0.31%	0.76%	0.43%	1.03%	1.05%	0.0105	0.1119
10	Ireland	−0.08%	−0.66%	−0.60%	0.55%	2.01%	−0.61%	−0.0171	−0.0019
11	Italy	−0.07%	−0.48%	−0.85%	−1.72%	−0.39%	−0.75%	0.0546	0.2640
12	Japan	−0.10%	−0.17%	0.17%	−0.40%	−0.59%	0.19%		
13	Luxembourg	−0.14%	−1.41%	−1.39%	1.14%	−1.54%	−1.20%	0.2398	0.0007
14	Netherlands	−0.22%	0.20%	−0.67%	−0.24%	−0.07%	−0.60%	0.0908	0.2557
15	New Zealand	−0.04%	0.76%	0.80%	−0.26%	0.81%	1.02%	0.0001	0.0060
16	Norway	−0.12%	−0.82%	−0.85%	−1.77%	−0.22%	−0.54%	0.0529	0.0219
17	Portugal	0.07%	1.48%	1.32%	−0.70%	1.29%	1.53%	0.0277	0.0143
18	Singapore	−0.09%	−0.68%	−0.67%	−1.11%	−0.01%	−0.35%	0.0358	0.0455
19	Spain[a]	0.03%	−0.54%	−0.31%	−1.08%	0.26%	0.01%	0.0271	0.6578
20	Sweden	−0.04%	−1.11%	−0.89%	−0.64%	−0.31%	−0.57%	−0.0146	0.1201
21	Switzerland	−0.09%	0.16%	−0.65%	−0.27%	−0.41%	−0.61%	0.0246	0.4347
22	United Kingdom[a]	−0.17%	−0.74%	−0.98%	−1.40%	−0.48%	−0.93%	0.0543	2.4975
23	U.S.-NYSE[a]	−0.20%	−2.94%	−2.94%	−0.33%	−0.28%	−2.90%	0.0018	6.1955
	Panel B: Emerging Countries								
24	Argentina[a]	0.12%	−8.45%	−4.39%	−2.30%	−4.44%	−4.35%	0.0032	0.0055
25	Bahrain	0.00%	−1.88%	−1.88%	0.86%	0.57%	−1.90%		−0.0002
26	Bangladesh	0.06%	−1.68%	−2.03%	1.02%	−0.74%	−2.02%	0.0366	0.0003
27	Barbados		−1.97%	−1.93%		0.21%	−1.94%	−0.0114	−0.0002
28	Bermuda		−0.09%	−0.09%		−0.82%	−0.09%		
29	Brazil[a]	−0.27%	6.84%	−2.88%	−4.05%	−2.84%	−2.66%	−0.0545	0.0489
30	Bulgaria		−2.75%	−0.98%		−0.96%	−0.98%		0.0067
31	Chile[a]	−0.46%	−1.42%	−1.47%	−1.15%	−1.02%	−1.27%	0.0003	0.0011
32	China	−0.04%	0.48%	1.97%	−2.08%	0.71%	2.23%	−0.0023	0.0003
33	Colombia	0.04%	−2.83%	−2.88%	−1.06%	−2.81%	−2.85%	0.0067	0.0003
34	Croatia	−0.03%	2.20%	2.40%	3.15%	4.03%	2.38%	0.0009	
35	Cyprus		1.71%	1.54%		3.14%	1.52%	0.2461	0.0058

(*continued*)

Table II—*Continued*

	Country	Dividend-Based Measures				Excess Returns		Liquidity	
		DY	DYCG	DYCG$	DYG	ERW$	ERT	TURN	LIQ
					Panel B: Emerging Countries				
36	Czech	0.03%	−0.08%	0.02%	2.73%	1.52%	0.04%	0.0201	0.1031
37	Ecuador[a]		−0.15%	−2.18%		−1.34%	−2.19%		−0.0174
38	Egypt[a]	0.22%	−3.74%	−4.21%	−1.74%	−3.23%	−4.19%	0.0549	0.0063
39	Greece	−0.03%	−1.84%	−1.87%	1.04%	−2.10%	−1.71%	0.0492	0.0350
40	Hungary	−0.02%	−3.66%	−2.80%	2.68%	−1.65%	−2.82%	0.1212	0.0124
41	India	0.06%	−2.55%	−1.88%	−2.12%	−2.18%	−1.86%	0.0400	0.0544
42	Indonesia	−0.03%	−2.86%	−2.59%	0.51%	−2.51%	−2.55%	0.0195	0.0144
43	Israel	0.15%	−0.20%	−0.11%	−1.83%	0.94%	−0.14%	0.0240	0.0343
44	Jordan	0.01%	−0.23%	−0.14%	1.68%	2.28%	−0.16%	−0.0030	
45	Korea	−0.21%	−1.49%	−1.96%	0.76%	−1.28%	−1.70%	0.1715	0.1802
46	Kuwait		−4.04%	−4.07%		−3.62%	−4.02%	0.0260	0.0068
47	Latvia		−8.68%	−8.41%		−9.35%	−8.40%	0.0148	0.0001
48	Lebanon[a]	−0.05%	−1.46%	−1.60%	−3.17%	1.63%	−1.55%	0.0077	0.0001
49	Malaysia	−0.05%	−0.93%	−1.21%	−0.04%	−1.53%	−1.07%	0.0299	0.0668
50	Mexico	−0.12%	−2.11%	−1.26%	−0.38%	−1.13%	−1.21%	−0.0577	0.0074
51	Morocco	−0.02%	−2.09%	−2.20%	2.67%	−1.43%	−2.18%	0.0203	0.0022
52	Oman	0.24%	−3.85%	−3.85%	2.82%	−3.47%	−3.84%	−0.0225	−0.0018
53	Pakistan	0.43%	−2.23%	−2.36%	−2.04%	−1.99%	−2.27%	0.1372	0.0129
54	Peru[a]	0.13%	−4.00%	−3.40%	−3.57%	−2.79%	−3.48%	−0.0123	0.0004
55	Philippines	−0.03%	−1.53%	−1.91%	1.21%	−2.21%	−1.79%	0.0149	0.0106
56	Poland	0.00%	−7.82%	−6.73%	0.24%	−6.10%	−6.78%	−0.0340	0.0060
57	South Africa	−0.05%	−2.66%	−3.09%	0.63%	−2.47%	−3.14%	0.0287	0.0359
58	Sri Lanka	0.31%	−1.77%	−2.16%	0.67%	−1.31%	−2.20%	−0.0024	−0.0001
59	Thailand	−0.11%	−3.38%	−3.67%	−1.41%	−3.73%	−3.45%	0.0023	0.3505
60	Turkey	−0.40%	−1.26%	−2.24%	−2.24%	−2.33%	−2.17%	0.1238	0.0512
The following are based on annual data									
61	Iran		−6.47%	−3.36%		−4.15%	−3.36%	−0.0789	−0.1759
62	Ivory Coast		−2.41%	−2.76%		−1.75%	−2.76%		
63	Jamaica		0.16%	1.02%		3.51%	1.00%	−0.0756	−0.0163
64	Mauritius		−2.04%	−2.07%		0.41%	−2.04%		
65	Mongolia		−4.10%	−3.20%		−3.78%	−3.20%	−0.2097	−0.0010
66	Namibia		−3.47%	−2.67%		−2.80%	−2.67%	−0.0011	0.0006
67	Nigeria		−2.30%	−2.51%		0.20%	−2.30%	0.0504	0.0182
68	Panama		−4.81%	−5.63%		−3.87%	−4.81%	0.0008	0.0118
69	Taiwan		0.34%	0.60%		1.91%	0.25%		
70	Tunisia		−1.50%	−2.05%		−2.23%	−2.06%	0.0342	0.0119
71	Venezuela		−5.98%	−5.27%		−4.77%	−5.25%	0.0678	0.6120

(*continued*)

The average decline in the equity premium ranges from −0.04% for dividend yields to −1.71% based on dividends plus capital gains in local currencies. As the distribution of changes in the equity premium around the world might violate the assumption of normality, we employ a nonparametric test of statistical significance of these changes. The Wilcoxon–Mann–Whitney rank sum test examines the equality of the centers of location of two samples to infer whether

Table II—*Continued*

Panel C: Summary Statistics: Average Change and Proportion of Countries That Experience Reduction								
	DY	DYCG	DYCG$	DYG	ERW$	ERT	TURN	LIQ
Average change	−0.04%	−1.71%	−1.66%	−0.32%	−1.03%	−1.58%	3.31%	20.66%
(*t*-statistic)	(−1.95)*	(−5.47)**	(−7.28)**	(−1.43)	(−3.91)**	(−6.88)**	(3.36)**	(1.99)*
Proportion of countries	72%	82%	83%	62%	72%	82%	25%	14%
Panel D: Wilcoxon Rank Sum Tests for Full Sample and Reduced Sample								
$U = \{\text{Rank Sum} - n*(n+1)/2\}$	1195	1263**	1139**	1279	1694**	1172**	2817**	2948**
$Z = \{U - E(U)\}/\text{Std}(U)$	−1.62	−5.13	−5.64	−0.47	−3.37	−5.50	2.91	3.50
Without coexisting floors in the sample:								
U	754	910**	824**	988	1218**	838**	2035**	2135**
Z	−1.47	−4.67	−5.12	0.95	−3.05	−5.05	3.12	3.72

** and * indicate statistical significance at the 1% and 5% levels, respectively.
[a]Represents exchanges with coexisting floors.

they are from the same population. The test makes no assumptions about the distribution of the underlying series. The first step involves ordering all floor and electronic equity premiums in a combined series and assigning ranks to each country-regime. These ranks are then summed separately for floor and electronic samples. The test statistic U is the higher of the two sums. Under the null hypothesis of no change, the expected value is $E(U) = n*(n+1)/4$ and its standard deviation, σ_U, is the square root of $n*(n+1)*(2n+1)/24$; $\{U - E(U)\}/\sigma_U$ is distributed approximately normally $N(0, 1)$. Z-values thus obtained indicate that changes in four of the six expected return measures and changes in turnover are statistically significant at the 1% level and changes in dividends are significant at nearly the 10% level.

Wilcoxon rank sum tests are performed for both the entire sample and a reduced sample that excludes 11 countries with coexisting floors. The direction and statistical significance of the test statistic are the same in both specifications. The rest of the tables in the paper report the results with the smaller sample that excludes coexisting floors; the results with the full sample support our findings even more strongly.

Among the countries that experience a reduction in dividend yield, 81% also experience an increase in turnover. Specifically, dividend yields drop in 38 of the 53 countries. Turnover data are missing for 2 of these 38 countries and 81%, or 29, of the remaining 36 countries see an increase in trading turnover. The correlation between the two variables is −8%. Similarly, among the countries that experience a reduction in dividends plus capital gains, 74% experience an increase in turnover. The alternative liquidity measure, $Liquidity_{Amihud}$, is shown in the last column of Table II and reveals a tremendous improvement in liquidity after automation in 86% of the sample countries. Markets sustain 20.66% more volume per unit of price impact in electronic markets than in

floor markets. Standard t-tests and Wilcoxon rank sum tests indicate that the improvements are statistically significant.

Thus, it appears that cost reduction and liquidity improvement go hand-in-hand. We also formally explore this relationship by estimating six regressions with equity premium measures as dependent variables and $Liquidity_{Amihud}$ as the explanatory variable. An emerging market dummy is also included to account for differences in economic development. In these regressions, average turnover has the expected negative coefficient, which is statistically significant with most measures. Results are not reported for the sake of brevity but can be readily obtained from the authors.

E. Regression Analysis

In this section, we conduct a regression analysis that controls for factors shown in past studies to account for differences in equity returns across countries. We use three measures of expected returns as dependent variables in three separate regressions:

$$return_{it} = \alpha + \beta_0 electronic_{it} + \beta_1 world_t + \beta_2 enforce_{it} + \beta_3 liberal_{it} + \beta_4 cap_{it} + \beta_5 develop_i + \beta_6 integrate_{it} + \beta_7 GDP\_growth_{it} + \varepsilon_{it}, \quad (7)$$

where $return_{it}$ is dividend yield, dividend plus growth, or excess-over-T-bill returns from stock market i in month t; $world_t$ on the right-hand side represents the world average of the left-hand side variable in month t (i.e., $world_t$ is the average world dividend in month t for the dividend models, it is the excess return from the MSCI world-market index in month t for the excess return model, and it is the average world turnover in the turnover equation); $electronic_{it}$ is an indicator variable that captures the trading mechanism (it takes the value of 0 during the floor trading regime and the value of 1 after a stock exchange switches to an electronic platform); $enforce_{it}$ takes the value of 1 after the first enforcement of insider trading laws in a country; $liberal_{it}$ takes the value of 1 after the financial markets in a country are liberalized;[8] cap_{it} is the market capitalization of index companies or all listed companies on stock exchange i in month t expressed in trillions of U.S. dollars; $develop_i$ takes the value of 1 if the country is classified as a developed economy by MSCI and 0 otherwise; GDP data, available on a quarterly basis, are used to compute GDP_Growth_{it}; and $integrate_{it}$ is a measure of integration[9] of country i with the rest of the world at time t.

[8] Liberalization refers to a process in which a government lifts barriers to capital flows and opens its stock markets to foreign investors. Stulz (1999) proposes that liberalization reduces the cost of equity because of improved risk sharing and improved corporate governance. Bekaert and Harvey (2000) and Henry (2000) empirically confirm that liberalization reduces the cost of equity. We obtain official liberalization dates from Table I in Bekaert and Harvey (2000).

[9] Integration is defined as follows: $Integrate_{it} = (Export_{it} + Import_{it})/GDP_{it}$. This measure has been used in several papers such as Bekaert and Harvey (1995) and Bhattacharya and Daouk (2002).

Table III

Effect of Electronic Trading in a Regression Framework

Dividend yield, dividend growth, excess return, and turnover regressions are based on exchange-months from 42, 42, 60, and 52 countries, respectively, for which all required data are available and where floor and electronic trading do not coexist. Electronic trading is an indicator variable that signifies the introduction of electronic trading in the country. World market is the (1) average world dividend in month t for the dividend models, (2) world excess return for the excess return model, and (3) world turnover ratio for the turnover equation. Market capitalizations are in trillions of U.S. dollars. Integration of the markets is measured by the ratio of exports plus imports to GDP. GDP growth rate is computed by dividing quarterly growth by three. The remaining variables in Panel A are indicator variables for date of first enforcement of insider trading laws, official liberalization date, and developed versus emerging market. Panel B introduces an interaction between electronic trading and financial market development. A time trend control variable is also added. Time trend gives the relative position of the month from the starting date in the data.

Dependent Variable→	Dividend Yield (DY)	Dividend Yield Plus Growth (DYG)	Excess Returns (ERT)	Turnover
Panel A: Electronic Trading, Equity Premium, and Trading Turnover				
Number of observations	7064	7064	9758	5406
Adjusted R^2	18.31%	0.29%	13.39%	4.75%
Instruments				
Intercept	0.0018**	0.0199**	0.0055*	0.0241**
Electronic trading	−0.0003**	−0.0016*	−0.0049*	0.0263**
World market	0.4273**	0.0000	0.0081**	0.8175**
Enforced insider laws	−0.0001**	−0.0011	−0.0002	−0.0270**
Liberalized market	−0.00004	0.0042**	0.00001	−0.0374**
Market capitalization	−0.0005**	−0.0008	−0.0038	−0.0017
Developed market	0.0002**	−0.0052**	0.0003	0.0023
Integration of market	0.00003	0.0017*	−0.0004	−0.0021
GDP growth	0.0005	−0.0047	−0.0015	0.0289
Panel B: Interaction Between Electronic Trading and Level of Economic Development				
Intercept	0.0045**	0.0001	0.0419**	0.1442**
Electronic * developed	0.0001	−0.0020	0.0046	0.0122*
Electronic * emerging	−0.0005**	−0.0020	−0.0113**	0.0398**
World market	0.3434**	0.0000	0.0081**	0.9142**
Enforce insider laws	−0.0001**	−0.0010	−0.0008	−0.0245**
Liberalized market	−0.00002	0.0040**	0.0002	−0.0398**
Market capitalization	−0.0005**	−0.0009	−0.0042*	−0.0012
Developed market	−0.0002**	−0.0048*	−0.0111**	0.0228**
Integration of market	0.0001*	0.0016*	0.0003	−0.0020
Time trend	−0.0001**	0.0007	−0.0009*	−0.0037*
GDP growth	0.0004	−0.0045	−0.0020	0.0282

** and * indicate statistical significance at 1% and 5% levels, respectively.

The results of this analysis are shown in Table III, which reports the estimates for the pooled regression equation (7).[10] The coefficient on electronic trading is negative and statistically significant at the 5% level for all measures of expected returns, although only three measures are reported for the sake of brevity: *Electronic* has a coefficient of −0.0003 for dividend yields, −0.0016 for the dividend growth model, and −0.0049 with the excess return measure as

[10] The magnitude and statistical significance of average coefficients from unreported country-by-country regressions are similar to those in the reported pooled regressions.

the dependent variable. This supports the first hypothesis that the advent of electronic trading is associated with a reduction in the cost of equity, with estimates ranging from 0.35% to 5.86% per annum. The electronic dummy has a statistically significant positive coefficient of 0.0263 in the turnover regression, signifying substantial improvement in liquidity.

The coefficients on control variables generally bear signs consistent with those in the prior literature cited in Section II. The coefficient on world dividends is positive for dividend models, and the coefficient on world excess return is positive and highly significant for the country excess return regression. Cost of equity is lower in larger markets as indicated by the negative coefficients on market capitalization. The enforcement of insider trading laws has a negative coefficient that is also statistically significant for the dividend model. Results for market liberalization are mixed, with negative coefficients in dividend equations and positive coefficients in dividend growth equations.[11] In Panel B of Table III, we introduce an interaction variable between electronic trading and economic development because the preautomation level of equity returns is lower in developed markets than in emerging markets. The variable *electronic* $*$ *developed* is set to 1 for all exchange-months if electronic trading is in place and the market is developed. It is set to 0 if either of these conditions is not met. The other interacting variable, *electronic* $*$ *emerging*, is analogously assigned values for emerging markets. Given that many countries in the emerging markets started their capital markets within the sample period, the level of risk, which is initially high, could decline as the market matures. We add a *time trend* variable in Panel B to control for this possibility. Electronic trading is associated with a lower cost of equity especially in emerging markets, in which both the absolute and the proportional magnitude of cost reductions are larger than in developed markets. Trading turnover regressions suggest that liquidity improvements are also much higher in emerging markets than in developed markets. The coefficient on *time trend* is negative, ruling out the possibility that we are simply capturing an ever increasing trend in turnover. As a robustness check, we replace the *time trend* variable with a *last decade dummy* variable, which is assigned a value of 0 before 1990 and 1 after January 1, 1990; estimates remain virtually unchanged.

All in all, the multivariate analysis in this subsection confirms the findings of the univariate comparisons discussed earlier. Electronic trading is associated with a lower cost of equity, particularly in emerging markets. In the next section, we show that this result holds true even after allowing for a world-market risk factor and time variation in betas.

F. A Conditional International Asset Pricing Model

One can argue that the reduction in the equity premium occurs due to time variation in betas and market risk before and after automation. In this section,

[11] Enforcement and liberalization are not consistently significant in our full sample or the sample centered around electronic trading. However, they do turn out to be significant in samples centered around insider law enforcement dates and liberalization dates, respectively, when we replicate the previous studies on these topics.

we investigate this possibility by using Bekaert and Harvey's (1995) ICAPM, which takes into account the changing exposure to world and domestic market risk:

$$(return_{it} - r_{ft}) = \alpha_0 + \phi\lambda_{\text{cov}}h_{iwt} + (1-\phi)\lambda_{\text{var}}h_{it} + e_{it}, \tag{8}$$

where $return_{it}$ is the monthly dollar return of the stock market index of country i at time t, r_{ft} is the monthly return of the 1-month U.S. T-bill at time t, α_0 is a constant to be estimated, ϕ is a measure of the level of integration of the country with the world market, λ_{cov} is the estimated price of the covariance risk with the world index, h_{iwt} is the conditional covariance of the monthly return of the stock market index of country i with the monthly return of the world index at time t, λ_{var} is the estimated price of own-country variance risk (which we restrict to be the same across all countries), h_{it} is the conditional variance of the monthly return on the stock market index of country i at time t, and e_{it} is the residual error term. The independent variables in equation (8)—conditional covariance h_{iwt} and conditional variance h_{it}—are separately estimated pair-wise for each country i and world index from the multivariate ARCH model specified in Table IV.

In the model, the level of integration, ϕ_{it}, of the markets of country i with the world markets at time t captures the dependence of an economy (measured by GDP) on exports and imports. The variable ϕ_{it} can take values between 0 and 1; when its value is 0, we assume that the country's financial markets are completely segmented and when its value is 1, we assume that the markets are fully integrated with the rest of the world. Bekaert and Harvey (1995) find that increases in this ratio are associated with increased importance of world risk factors relative to local risk factors for the returns generation process. As a robustness check, we also restrict the value of ϕ_{it} to 0.5, thus giving equal importance to the world index and the domestic index. This restriction does not change the results in any significant way.

The results for the international asset pricing model in equation (8) are given in Table IV. Both the covariance risk with the world and the own-country variance risk are priced. The price of each risk is positive and significant at the 1% level. If the introduction of electronic trading does not affect the equity returns, then the residual e_{it} in equation (8) should be orthogonal to the electronic trading variable. However, in Table V we show that this is not the case. We regress the residuals on a number of variables as follows:

$$\begin{aligned} e_{it} = {} & \delta_0 + \delta_1 electronic_{it} + \delta_2 enforce_{it} + \delta_3 liberal_{it} + \delta_4 cap_{it} \\ & + \delta_5 develop_i + \delta_5 trend_{it} + \delta_5 growth_{it} + \eta_{it}, \end{aligned} \tag{9}$$

where e_{it} is the residual from the international asset pricing equation (8), and $electronic_{it}$, $enforce_{it}$, $liberal_{it}$, cap_{it}, $develop_i$, $trend_{it}$, and $growth_{it}$ retain their definitions from Section III.E.

Panel A of Table V shows the results of regression equation (9). All variables except electronic trading are orthogonal to the residuals from the asset pricing model. The coefficient on electronic trading is a negative −0.0029

Table IV

Effect of Electronic Trading: ICAPM with Time-Varying Betas

The following regression is based on equity index returns from December 1969 to June 2001. First, an ICAPM is estimated using the maximum likelihood criterion:

$$(return_{it} - r_{ft}) = \alpha_0 + \phi\lambda_{\text{cov}}h_{iwt} + (1-\phi)\lambda_{\text{var}}h_{it} + e_{it},$$

where $return_{it}$ is the monthly dollar return of the stock market index of country i at time t, r_{ft} is the monthly return of the 1-month U.S. T-bill at time t, α_0 is a constant to be estimated, ϕ is a measure of the level of integration of the country with the world market, λ_{cov} is the price of the covariance (with world index) risk to be estimated, h_{iwt} is the conditional covariance of the monthly return of the stock market index of country i with the monthly return of the world index at time t, λ_{var} is the price of own-country variance risk to be estimated, h_{it} is the conditional variance of monthly return on the stock market index of country i at time t, and e_{it} is the residual error term. The measure for level of integration of the markets of country i with the world markets at time t, ϕ_{it}, is defined as follows:

$$\phi_{it} = \left(\frac{\exp\left(\frac{exports_{it} + imports_{it}}{gdp_{it}}\right)}{1 + \exp\left(\frac{exports_{it} + imports_{it}}{gdp_{it}}\right)} - 0.5 \right) * 2.$$

The independent variables in the ICAPM above, h_{iwt} and h_{it}, are separately estimated pairwise for each country i and world index using a multivariate ARCH model introduced by Bollerslev, Engle, and Wooldrige (1988):

$$(return_{it} - r_{ft}) = c_1 + \varepsilon_{it},$$

$$(world_t - r_{ft}) = c_2 + \varepsilon_{wt},$$

$$h_{it} = b_1 + a_1\left(1/2\varepsilon^2_{it-1} + 1/3\varepsilon^2_{it-2} + 1/6\varepsilon^2_{it-3}\right),$$

$$h_{iw} = b_2 + a_2\left(1/2\varepsilon^2_{wt-1} + 1/3\varepsilon^2_{wt-2} + 1/6\varepsilon^2_{wt-3}\right),$$

$$h_{iwt} = b_3 + a_3(1/2\varepsilon_{it-1}\varepsilon_{wt-1} + 1/3\varepsilon_{it-2}\varepsilon_{wt-2} + 1/6\varepsilon_{it-3}\varepsilon_{wt-3}),$$

$$\varepsilon_{it}, \varepsilon_{wt} \sim N\left(\begin{bmatrix}0\\0\end{bmatrix}, \begin{bmatrix}h_{it} & h_{iwt}\\ h_{iwt} & h_{wt}\end{bmatrix}\right),$$

where $world_t$ is the dollar monthly return of the world-market index at time t, ε_{it-j} is the innovation in monthly return of the stock market of country i at time $t-j$, $j \in \{0, 1, 2, 3\}$, ε_{wt-j} is the innovation in monthly return of the world-market index at time $t-j$, $j \in \{0, 1, 2, 3\}$, and h_{wt} is the conditional variance of monthly return of the world-market index at time t. As in Engle, Lilien, and Robins (1987), the weights of the lagged residual vectors are taken to be 1/2, 1/3, and 1/6, respectively. The constants a_2, b_2, and c_2 are constrained to be identical for all country-world pairs.

	Coefficient	Std. Error	p-Value
Alpha	0.0037**	0.0013	0.0037
Price of covariance risk with respect to world	4.4004*	2.0197	0.0294
Price of own-country variance risk	1.4017**	0.1377	<0.0001

** and * indicate statistical significance at 1% and 5% levels, respectively.

and is statistically significant. Thus, after controlling for time variation in betas, the introduction of electronic trading lowers the cost of equity for listed firms. The regressions with interaction terms, shown in Panels B and C, indicate that the drop in the equity premium is much sharper for emerging markets (−0.67% and statistically significant) than for developed markets (0.07% and

Table V

Effect of Electronic Trading on Residuals from ICAPM Model

The residuals from the ICAPM in Table IV form the dependent variable in the following regression equation:

$$e_{it} = \delta_0 + \delta_1 electronic_{it} + \delta_2 enforce_{it} + \delta_3 liberal_{it} + \delta_4 cap_{it} + \delta_5 develop_i + \delta_5 trend_{it} + \delta_6 growth_{it} + \eta_{it},$$

where e_{it} is the residual from ICAPM, *electronic* is an indicator variable that signifies the introduction of electronic trading in the country, *enforce* becomes 1 after the date of the first enforcement of insider trading laws, *liberal* becomes 1 after the official liberalization date, *cap* is market capitalization in trillions of U.S. dollars, *developed* versus emerging market classification is based on MSCI, *trend* gives the relative position of the month from the starting date in data (December 1969), and *growth* is the GDP growth rate.

	Coefficient	Std. Error	p-Value
Panel A: Effect of Automation of Trading after Controlling for Risk Factors and Other Events			
Intercept	0.0070	0.0149	0.6367
Electronic trading	−0.0029	0.0027	0.2845
Enforcement of insider trading laws	−0.0024	0.0023	0.2964
Liberalization	−0.0039	0.0029	0.1779
Market capitalization	−0.0039	0.0022	0.0732
Developed markets	0.0013	0.0027	0.6470
Time trend	−0.0001	0.0004	0.8962
GDP growth	−0.0040	0.0175	0.8178
Panel B: Interaction between Automation and Level of Economic Development			
Intercept	0.0025	0.0013	0.0552
Electronic × developed	−0.0035	0.0022	0.1133
Electronic × emerging	−0.0067**	0.0023	0.0040
Panel C: Equity Premium, Automation, Development, and Other Events			
Intercept	0.0100	0.0133	0.4517
Electronic × developed	0.0007	0.0030	0.8265
Electronic × emerging	−0.0067*	0.0031	0.0303
Enforcement of insider trading laws	−0.0030	0.0023	0.1957
Liberalization	−0.0058*	0.0027	0.0288
Market capitalization	−0.0045*	0.0022	0.0424
Time trend	−0.0001	0.0004	0.8596
GDP growth	−0.0029	0.0175	0.8681

** and * indicate statistical significance at 1% and 5% levels, respectively.

insignificant). This is true even in proportional terms as the average dollar returns before the introduction of electronic trading were 1.39% in developed markets and 2.14% in emerging markets.

G. Robustness of Results

We use both gross and excess returns and both full samples and a variety of subsamples and find consistent results for all combinations. Subsamples are

constructed by excluding the NYSE, 10 other exchanges on which floor and electronic trading coexist, and observations more than 10 years away from the date of automation. Such exclusions do not affect our conclusions materially. Country-by-country analysis also provides compelling evidence that outliers are not responsible for the main findings of this study. Nevertheless, we carry out additional robustness checks in this section.

First, we drop the biggest Internet boom and bust periods from January 1999 to August 2001 from the sample and rerun all the tests. The results are even stronger for the remaining sample of 8,068 exchange-months. For instance, in the Table III-type regression with excess returns as the dependent variable, the coefficient on electronic trading becomes more negative, from −0.0049 for full sample to −0.0071 for the reduced sample, and also increases in statistical significance. In the Table V-type ICAPM framework, the coefficient on electronic trading changes slightly from −0.0029 for full sample to −0.0023 for the reduced sample and it remains statistically significant.

Second, we allow for some transition period during which the electronic trading systems gain popularity. This is accomplished by deleting a period of 1 year (and then 2 years) from the sample immediately after automation. Results do not change much as the regression coefficient on the electronic trading dummy in the Table III-type regression is still −0.0049 and the ICAPM coefficient for automation in emerging markets is −0.0024 after excluding the transition period. Results are similar if we allow 2 years for popularity to take hold.

Third, we re-include the periods of excessive currency devaluation into the sample, which only strengthens the result.[12] Table III-type regression coefficient is −0.0062; the ICAPM coefficient is −0.0056 and is highly significant with this slightly bigger sample.

Fourth, we modify equation (3) to allow for unique country betas instead of assuming a beta of one:

$$(Return_{Country} - Riskfree_{U.S.\,T\text{-}bill}) = \alpha' + \beta'(Return_{World} - Riskfree_{U.S.\,T\text{-}bill}) + \varepsilon. \quad (10)$$

Betas are estimated in a 60-month floor trading period immediately preceding automation, and then the excess returns in the electronic trading period are computed using these estimates. This analysis further strengthens the inferences in this paper. For instance, this country-beta-based measure suggests that 73% of countries experience a reduction in the equity premium after automation. The magnitude of reduction is also 33 basis points higher.

Fifth, we include a trend variable as an independent control variable in regression equation (7), with excess returns as the dependent variable to account for the possibility that returns might be undergoing a downward trend over the years. The coefficient for electronic trading is still significant, and the coefficient on the trend variable is insignificant, ruling out the possibility of a secular

[12] Throughout the study, we delete 6 out of 9,758 exchange-months in which a country's currency devalues by over 50% to eliminate outliers, but we include them here as a robustness check.

downward trend in returns. Nevertheless, this line of thought is developed further by estimating another equity premium measure, namely, the excess return over the expected return calculated from a trend before the switch to electronic trading.[13] This analysis serves two purposes. First, it confirms that the cost of equity is not on its way down before automation, but rather it starts declining only after automation. Second, the average excess return using this methodology is −0.60% in our sample, suggesting an even steeper decline in the cost of equity than those derived from other measures. For trading turnover, too, we estimate excess-over-forecasted turnover using a similar trending procedure and find that average excess turnover is 0.0314, which is even higher than the original estimate of 0.0263 in the turnover regression reported in Table III.

Sixth, it is conceivable that stock exchanges introduce electronic trading after stock market booms and, thus, that the lower returns observed in electronic trading periods reflect a long-term reversal of returns.[14] We date the stock market peaks in each country to shed light on this alternative explanation and find that stock markets in 42 out of the 71 countries experience their in-sample peaks well after the introduction of automated trading. On average, the market peak is achieved 6 years after automation. This means that automation is generally not followed by long-term reversals in stock prices. Instead, the markets are still rising after automation, albeit at a slower pace because the expected returns are lower in the electronic regime. Similarly, for the remaining 29 countries with stock market peaks in the floor trading regime, this peak is attained almost 3 years before automation on average and more than 13 years ago in some cases. Thus, for these remaining markets, long-term reversals affect both the floor and electronic trading period returns.

IV. Is There a Positive Price Reaction When Stocks Move from Floor to Electronic Trading?

In this section, we examine the short-term returns around the introduction of electronic trading to test the hypothesis that when stocks move from floor to electronic trading, they experience a price jump. We assemble both the dates of the announcement of a plan to switch to electronic trading and the dates of the abolition of floor trading on 69 exchanges. These are in addition to the dates of the actual introduction of electronic trading. The price response to automation might start from the date of formal announcement of such a switch or even earlier if market participants informally come to know of these developments. The average gap between the announcement of a switch and the actual introduction of electronic trading is 21 months. In Figure 3, we chart the month-by-month cumulative excess-over-world returns for a period from 24 months

[13] We do this in the following manner: (i) Estimate α_0 and α_1 in the regression model $(return_{it} - r_{ft}) = \alpha_0' + \alpha_1' Trend_{it} + \varepsilon$, using the floor trading period; (ii) Calculate the forecasted return for the electronic trading period using the estimates obtained above: $Forecast_{it} = \alpha_0 + \alpha_1 Trend_{it}$; (iii) Compute *Excess return in electronic regime* = $Return_{it} - Forecast_{it}$ for each country; and, (iv) Calculate average excess return across countries.

[14] We are thankful to the referee for pointing this out.

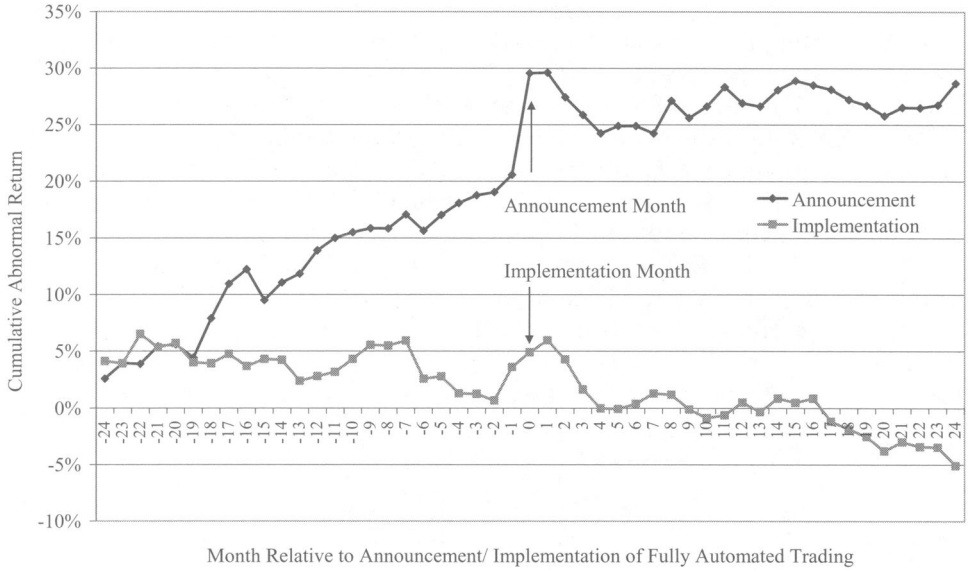

Figure 3. Cumulative abnormal returns around automation.

before the announcement date to 24 months after this date. In this simple event study, we estimate per the following regression the country betas during the 60-month estimation period (or less, depending on data availability) starting 72 months before the announcement of switch and ending 12 months before the announcement:

$$(Return_{Country} - R_f) = \alpha' + \beta'(Return_{World} - R_f) + \varepsilon. \tag{11}$$

The ARs in the announcement-month and the following period are calculated as

$$Abnormal\ Returns\ = (Return_{Country} - R_f) - \beta(Return_{World} - R_f) \tag{12}$$

for each country, where R_f is the risk-free U.S. T-bill return, and

$$Cumulative\ Abnormal\ Return\ (CAR)\ up\ to\ month\ t = \sum_{i=-24\ \text{to}\ t} Abnormal\ Return_i. \tag{13}$$

We repeat this exercise with the actual implementation dates. The price reaction in the implementation month is merely 0.67%. In contrast, the announcement-month reaction of 8.99% is economically and statistically significant at the 1% level (t-stat is 3.36). The actual implementation is a non-event as the market has likely discounted the news fully by then. The *CAR* up to the announcement-month, benchmarked against its levels 24 months before announcement, is an impressive 29.63%. Even 2 years after announcement,

CAR remains over 28.69%. The results are consistent with our second hypothesis that automation produces a positive price reaction. It is possible to study the short-term announcement effect of the switch more precisely by gathering additional daily data on returns. We leave this task for future research.

The magnitude of the price reaction (8.99%) to an announcement is comparable with results in several papers that study price discounts due to illiquidity. Amihud et al. (1997) find a 5.5% average CAR on 120 stocks that transfer from a call market to a continuous market on the Tel Aviv Stock Exchange. Muscarella and Piwowar (2001) find that firms switching from single price-fixing to continuous trading on the Paris Bourse experience a positive CAR of 5.4%. In their sample, the exchange switched some firms from the more liquid continuous trading mechanism back to the less liquid single price-fixing mechanism and such firms had a negative CAR of −5%. Thus, the market recognizes the benefits of automation, and stock market valuations improve when the switch to electronic trading is announced.

V. Conclusion

This study finds that automation of trading lowers the cost of equity for listed firms due to improvements in liquidity and informativeness of stock markets. The decline in the cost of equity is 0.03% in dividend yields, 0.16% per month according to the dividend growth model, and 0.49% per month according to the ICAPM. The findings are robust to the inclusion of several control variables such as market size, financial liberalization, enforcement of insider trading laws, level of economic development, world-market returns, time trend in returns, and time-varying betas and risk factors. The reduction is more pronounced in emerging markets than in developed markets. The cost reduction result holds qualitatively even when the analysis is restricted to certain subperiods, for example, when the Internet boom and bust periods are excluded or a transition period is allowed for popularity of electronic exchanges. Nevertheless, we do not intend to overemphasize the point estimates of reductions in the cost of capital due to significant cross-country differences. Instead, the most striking take-home results are that 83% of the regime shifts (59 of 71 exchanges) are associated with a reduction in the cost of equity, and 75% of the switches are associated with an improvement in liquidity. By performing this exchange-by-exchange analysis using the same stocks for electronic and floor trading regimes, this study also avoids the problems associated with imperfect matching of stocks.

In addition to the reduced cost of equity, the announcement of the introduction of electronic trading is associated with a positive price reaction of 8.99% in listed stocks around the date of the announcement of the switch. These patterns support the notion that electronic markets improve the liquidity, informativeness, and valuation of listed stocks, all of which help reduce the cost of equity.

As usual, the findings have to be interpreted keeping in mind the limitations of any international study with such a broad scope. The main focus of this study is fully automatic execution of trading, and thus the exchange design after the

event is clearly defined. The term "floor trading," however, is used to represent the market design before the switch and is somewhat symbolic in nature as it includes different versions and levels of trading with at least some manual interference. Future research can explore whether some manual systems are associated with lower capital costs than others.

The perceptible positive aspects of electronic trading entreat a move away from floor-based toward automated screen-based electronic trading. A push for this change should come from the listed firms and their investors, particularly if the stock exchange owners' business incentives are not aligned with their own. This study also serves to establish an important linkage between financial market microstructure and asset prices. The results implore inclusion of both market design factors and liquidity factors into asset pricing models.

Appendix

Key Institutional Differences between Floor Trading and Electronic Trading

Institutional Feature	Floor	Electronic
Identity of counterparty as discussed in Beneviste et al. (1992)	The identity of the counterparty broker is known before the trade	The identity of the counterparty is usually revealed posttrade although a few exchanges display broker identity pretrade
Ex ante transparency of available liquidity	Usually only the best bid and offer are known to traders	Usually the top-five best buy and sell prices (and sometimes the whole book) are displayed on traders' screens
Speed of matching trades or immediacy	Trades are matched manually based on an open-outcry system and take 10 seconds to several minutes	Trades are matched automatically by a computer algorithm within a second
Operating cost and order processing costs	Higher	Lower (Domowitz and Stiel (1999))
Speed and cost of settlement	Settlement is often paper-based, with a considerable lag	Usually faster, dematerialized settlement and lower costs
Order book	Order book often does not exist, and quotes are valid only as long as "breath is warm"	Order book matches or accumulates customers' limit orders, and quotes are valid until withdrawn

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