THE JOURNAL OF FINANCE • VOL. LIX, NO. 1 • FEBRUARY 2004

How Do Exchanges Select Stocks for Option Listing?

STEWART MAYHEW and VASSIL MIHOV*

ABSTRACT

We investigate the factors influencing the selection of stocks for option listing. Exchanges tend to list options on stocks with high trading volume, volatility, and market capitalization, but the relative effect of these factors has changed over time as markets have evolved. We observe a shift from volume toward volatility after the moratorium on new listings ended in 1980. Using control sample methodology designed to correct for the endogeneity of option listing, we find no evidence that volatility declines with option introduction, in contrast to previous studies that do not use control samples.

BEGINNING WITH A HANDFUL of options listed on the Chicago Board Options Exchange (CBOE) in April 1973, the exchange-traded option market has since matured into a thriving industry. In the United States, options trade on five exchanges, with contracts on stock indices, exchange-traded funds, currencies, interest rates, and over 3,000 stocks. Total equities options volume traded on U.S. exchanges has risen from 5.7 million contracts in 1974 to over 722 million contracts in 2001 (Options Clearing Corporation, http://www.optionsclearing.com). Option markets have also thrived in Western Europe and other economies with well-developed capital markets.

In this paper, we study the listing choices made by option exchanges in the United States, in an effort to better understand what determines the success of financial innovation, and how derivative markets develop. Understanding this process has important implications for the continuing development of new securities markets domestically and globally. In the new century, innovation in equity derivative markets has continued, if not accelerated. For example,

*Mayhew is at the U.S. Securities and Exchange Commission and the University of Georgia and Mihov is at Texas Christian University. For their helpful comments, we would like to thank an anonymous referee; Chris Barry; Rick Green; Steve Mann; Anand Srinivasan; Andy Waisburd; and seminar participants at the University of Cincinnati, the 2000 Frank Batten Young Scholars Conference at the College of William and Mary, and the 2000 meetings of the Financial Management Association. We would like to thank Seoungpil Ahn and Eric Rincones for valuable research assistance. Mayhew thanks the Institute for Quantitative Research in Finance (the Q group) for financial support. Mihov thanks the Charles Tandy American Enterprise Center and the Luther King Capital Management Center for Financial Studies at TCU for financial support. The U.S. Securities and Exchange Commission disclaims responsibility for any private publication or statement of any SEC employee or Commissioner. This study expresses the authors' views and does not necessarily reflect those of the Commission, the Commissioners, or other members of the staff.

in May 2000, equity options began trading on the International Securities Exchange, the first fully electronic options exchange in the United States, and plans are under way for a second electronic option exchange, the Boston Option Exchange. The Commodity Futures Modernization Act of 2000 paved the way for futures on individual stocks, which began trading on OneChicago and Nasdaq-Liffe on November 8, 2002. Equity derivatives trading has also expanded to Eastern Europe and emerging markets around the world, in countries such as Israel, Hungary, Poland, Russia, the Czech Republic, Greece, Taiwan, Korea, Malaysia, India, and Mexico.

Our aim is to identify the characteristics that made stocks more likely to be selected for option listing, and to examine how these characteristics changed over time as the markets matured. Our empirical approach is to identify the universe of eligible stocks, and then use a logit framework to measure the extent to which the probability of option listing is related to characteristics such as the underlying stock's volume, volatility, and market capitalization. For volume and volatility, we include a long-term component, measured over the prior 250 trading days, and a short-term component, representing unusual activity over the past 30 trading days. Our analysis is based on observed listing decisions from 1973 to 1996, with the data partitioned into four subperiods, defined by regulatory changes in 1980, 1985, and 1991.

For the first few years after organized option trading began in 1973, the stocks selected for option listing tended to be on large, well-known firms with high trading volume. At this time, the Securities and Exchange Commission (SEC) had approved option trading on an experimental basis, and expressed concerns about whether the benefits would outweigh perceived dangers associated with options trading. In 1977, the SEC placed a moratorium on new listings, giving them a chance to review the option trading program. When the moratorium was lifted in March 1980, option trading had been established as a permanent institution. After this point, we find that exchanges began to focus more on choosing high volatility stocks.

We find that options were more likely to be listed on stocks with high long-term and short-term trading volume, but long-term trading volume appears to be more important for the early listings, with short-term volume becoming more important for the later listings. Firm size remained an important determinant of listing through the 1980s, but became unimportant in the 1990s. We also find evidence that after accounting for other factors, particular industries have enjoyed periods of popularity.

As mentioned above, our subperiods were identified ex ante on the basis of changing regulatory regimes. In order to determine whether these break points correspond to meaningful structural changes, we also estimate a switching logit model with endogenous break points. The switching model reveals a structural break in both the permanent and transitory volatility coefficients around the time of the moratorium. Also, it identifies two important breaks in the size coefficient, one at the end of 1973, and one in 1991.

Analysis of option-listing decisions may also shed light on the perennial question of how option introduction impacts the underlying stock market. Once

we recognize that option listing occurs endogenously as the result of decisions made by exchanges and regulators, it becomes difficult to interpret the results of option-listing studies. For example, Branch and Finnerty (1981), Skinner (1989), and many other authors have tested empirically whether option introduction influences the volatility of the underlying stock. If exchanges list options in response to or in anticipation of changing volatility, selection bias may introduce a spurious relation between option listing and volatility.

Conrad (1989), Skinner (1989), and others have suggested the possibility of a spurious decrease in volatility at the time of option listing if exchanges list options in response to temporary episodes of high volatility. It is unclear to us why exchanges should want to list options following temporary episodes of abnormal volatility. On the contrary, we would predict that exchanges would prefer to list options in response to a permanent shift in volatility, or perhaps even anticipating a future increase in volatility. This implies a spurious volatility increase associated with option listing. To test this, we compare volatility changes at the time of option listing with changes in a control sample of options that were not listed, but were rated as likely to be chosen, according to our estimated logit model. In all but the earliest subperiod, we find that stocks selected for option listing tend to experience a larger volatility increase, or a smaller decrease, than options in the control sample. To our knowledge, no prior study has documented a positive relation between option listing and volatility changes in the United States. Although this result may be interpreted as evidence that options affect the volatility of the underlying stock, we suspect that it simply reflects the tendency of forward-looking exchanges to list options in anticipation of high volatility. Consistent with this view, we note that the apparent volatility effect of option listing is observed only after the exchanges' selection criteria shifted in favor of high volatility stocks.

The remainder of this paper is organized as follows. Section I contains a brief review of the prior literature. In Section II, we review the listing process, including regulatory changes that have influenced option markets listing over the years, and then in Section III we outline our research hypotheses. In Section IV we describe the data used in our analysis, and we compare the characteristics of stocks selected for listing with those of previously optioned stocks and the universe of stocks that were eligible for listing. In Section V, we report our main results on the importance of various factors influencing the option-listing decision. Also in Section V, we verify that the predicted probabilities from our logit model help predict trading volume after listing, and we report the results of the switching model. In Section VI, we discuss implications for research on option-listing effects. Section VII concludes the paper and contains suggestions for future research.

I. Prior Literature

Various aspects of stock exchange listing have been addressed in the literature. Within this literature, perhaps the closest prior study is that of Cowan et al. (1992), who study the empirical determinants of listing on the NYSE.

Like them, we identify the set of firms eligible for listing and then compare the characteristics of those actually selected with those that were eligible but not selected. However, the question of which firms choose to list on a stock exchange is fundamentally different from that of which options are listed, in that the decision to list options is made by the exchanges, not by the firm. To our knowledge, there is no prior published research analyzing option-listing decisions, or analyzing how the listing decision has evolved over time.

Many authors have studied the effect of option listing on the underlying market. For surveys of the theoretical and empirical literature in this area, see Hodges (1992), Damodaran and Subrahmanyam (1992), and Mayhew (2001). Here let us summarize those results most relevant to the current study. Nathan Associates (1974), Skinner (1989), Conrad (1989), Detemple and Jorion (1990), and Damodaran and Lim (1991), among others, have documented an apparent decrease in volatility around the time of option listing. Subsequently, Bollen (1998) and others found similar results in control samples of stocks that were not selected for listing, suggesting that the apparent volatility effects may be spurious.

On the other hand, theoretical work by Cao (1999) suggests that the volatility effect of option listing can spill over to other stocks, particularly those with returns most highly correlated with the optioned stock. Thus, stocks in the control sample may not be immune to the effects of option listing. To the extent that option introduction changes state prices, and stocks in the same industry are more likely to span the same state space than stocks matched by market-driven characteristics, we would expect this spill-over problem to be more severe if the two samples are matched by industry, as in Bollen (1998). Like Bollen (1998), we compare volatility changes around option listing with those in a control sample, but we construct our control sample using quite a different method, one that is explicitly connected to our analysis of the listing decision.

II. Institutional Background

Unlike the stock market, where firms apply to be listed, decisions to list options are made within the exchanges. Generally, stocks are selected for option listing by committees composed of members of the exchange, after soliciting feedback from the general membership. Presumably, the main objective for an exchange is to maximize long-term profits for its members. In practice, according to industry sources, this amounts to listing those options expected to generate the highest trading volume. In addition, it is important to recognize that these decisions may be influenced by other factors associated with the broader institutional environment. In the United States, the option exchanges are member-owned self-regulating agencies. They are members of the Options Clearing Corporation (the common clearinghouse shared by all the option exchanges), and are subject to federal securities laws and the regulatory oversight of the Securities and Exchange Commission (SEC). The SEC has played an important role in determining the eligibility requirements for underlying

securities to be selected for option listing, and the rules regarding whether options can be listed on multiple exchanges.

When option trading began on the Chicago Board Options Exchange in 1973, the exchange was given "experimental status" for an unspecified period of time, during which the SEC would closely monitor the progress of the exchange's "pilot program" (SEC, 1973, Release No. 34-10490). Similar pilot programs were later instituted at the other exchanges. During the first few years of option trading, exchanges selected stocks for option listing in an environment of regulatory uncertainty, in which the long-term political viability of the exchanges depended on the continued approbation of the SEC.

In July 1977, the SEC requested that the exchanges submit to a "voluntary" moratorium on expansion, and announced plans for an extensive review of option trading. The resulting "Options Study," released to the public on February 15, 1979, summarized the benefits and risks of option trading, and identified specific "regulatory inadequacies." In March 1980, after the exchanges implemented rule changes to address the issues raised in the Options Study, the SEC announced the moratorium would be lifted, and option trading permitted to expand (SEC, 1980, Release No. 34-9985). After the moratorium, exchanges selecting stocks for option listing would have done so with the confidence that option trading was now a permanent institution.

Over time, there have been changes in eligibility requirements for option listing, as illustrated in Table I. For the initial listings beginning in 1973, the requirements were specified in broad, qualitative terms—underlying stocks were to be listed on a national exchange and have a "large number of shares outstanding which are widely held and actively traded" (CBOE, 1973, p. 83). Income and no-default requirements were added in 1975. In 1976, the minimum income requirement was increased, a no-deficit requirement was established, and exact criteria were specified with respect to public float, number of shareholders, underlying volume, and share price. Since 1981, we have observed a general trend toward relaxation of eligibility requirements. In 1981, the no-default, income, public float, number of shareholders, and share price requirements were generally relaxed, while the trading volume requirement was modified to allow stocks with higher volume only in the most recent year to be optioned. In 1985, the set of securities eligible for option listing was further expanded to include Nasdaq stocks. In 1991, eligibility requirements were even further relaxed.

Other structural and regulatory changes during the period of this study may have had an effect on the exchanges' listing policy. First, there have been changes in the number of competing option exchanges. From 1973 until 1975, options traded on only one exchange, the Chicago Board Options Exchange (CBOE). In 1975 and 1976, options were initiated on the American (Amex), Philadelphia (PHLX), Midwest, and Pacific Stock Exchanges (PSE). The Midwest exchange dropped out of the options business at the conclusion of the moratorium in 1980, selling their contracts to the CBOE. Also, the New York Stock Exchange had an options division from 1985 to 1997.

In addition, there have been changes in the policy regulating the cross-listing of options on multiple exchanges. Prior to 1976, options were listed on only one

Table I

Initial Listing Requirements for Underlying Securities

This table presents the requirements that the underlying common stocks of option contracts must meet or exceed.[a] Default is defined as default in the payments with respect to preferred stock, debt, or long-term leases. Income is defined as net income, after taxes, but before extraordinary items net of tax effect. Deficit is defined before extraordinary items. The requirements also include that the list of approved underlying securities are representative of issuers engaged in a wide variety of business activities.

Year	Exchange Listing	Public Float	Number of Shareholders	Trading Volume	Price	Default	Income
1973	Listed on a national exchange	"Large number of shares outstanding which are widely held and actively traded" (CBOE, 1973, p. 83)				N.A.	N.A.
1975	Listed on a national exchange	"Large number of shares outstanding which are widely held and actively traded" (CBOE, 1976, p. 2113)				No default in last 3 years	At least $250,000 for the last 3 fiscal years
1976	Listed on a national exchange	8,000,000	10,000	2,000,000 shares per year in each of last 2 years	$10.00 per share or higher each business day of the 6 calendar months preceding the listing	No default in last 3 years	At least $1,000,000 in 3 of last 4 years, including in the most recent year; no more than one annual deficit in the last 4 years and no deficit in the most recent year
1981	Listed on a national exchange	7,000,000	6,000	2,400,000 shares per year in the last 12 months	$10.00 per share or higher each business day of the 3 calendar months preceding the listing	No default in the last 12 months	At least $1,000,000 for the last eight quarters
1985	Listed on a national exchange or a national market system	Same	Same	Same[b]	Same	Same	Same
1991	Listed on a national exchange or a national market system	7,000,000	2,000	2,400,000 in the last 12 months	$7.50 per share or higher for the majority of business days during the 3 calendar months preceding the listing	N.A.	N.A.

[a]After 1991 the SEC allowed the listing of options on securities other than common stock, such as preferred non-convertible stock, ADRs and country funds.
[b]The stock of MCI Communication was exempt from this requirement.

exchange. In 1976 and 1977, multiple listing was allowed for some contracts. When the moratorium ended in 1980, the "allocation plan" went into effect, under which options could be listed on only one exchange.[1] When options on OTC stocks began trading in 1985, they were eligible for multiple listing. Multiple listing for all options resumed in 1990. At this time, all new option listings instantly became available for listing on multiple exchanges. Existing contracts already trading on one exchange were grandfathered over the next few years, and gradually became available for cross-listing.[2]

III. Hypotheses

The option exchanges are member-owned organizations. Listing decisions are made by the members, and member profits are an increasing function of the demand for trading, or the demand for immediacy. Thus, anticipated trading demand should be the dominant factor in the exchanges' choice of which options to list. Ceteris paribus, we would expect exchanges to select the most profitable contracts first. Thus, we hypothesize that option trading volume should be higher on options listed earlier.

We would expect underlying stock market volume to be an important predictor of option volume, for three reasons. First, to the extent that investors view the option market as a substitute venue for taking directional positions in the underlying stock, demand for immediacy in the option market and the underlying stock market will be influenced by some of the same factors. For example, the demand for trading either the stock or the option should be a function of the degree to which investors have heterogeneous beliefs. Second, additional demand for options trading is generated by investors who own the underlying asset and wish to write covered calls or buy protective puts. Third, a liquid stock market makes it easier for an option market maker to hedge, lowering the cost of financial intermediation, and thus lowering transaction costs in the option market.

We would also expect option volume to be higher for high volatility stocks, for several reasons. For high volatility stocks, there is more information coming into the market, and thus more potential for divergence of opinion among investors. The option market also serves as a venue for trading between investors with disparate volatility beliefs. If volatility forecasts vary more across investors for high volatility stocks than for low volatility stocks, we might expect to see higher option volume for high volatility stocks. In addition, investors who use option markets to hedge will have a greater demand to hedge high volatility stocks than low volatility stocks. And to the extent that risk-seeking investors

[1] It is our understanding that during this period, the exchanges would periodically "meet" with each other on conference calls, and take turns selecting eligible options from a previously submitted list of candidates.

[2] It should be noted, however, that in September 2000, the SEC determined that the exchanges improperly refrained from cross-listing listing each others' options until 1999, and in doing so, failed to comply with certain of their rules, including exchange act rule 19c-5. See SEC, 2000, Release No. 34-43268.

use the options markets as an outlet for gambling, they may find the higher volatility names more attractive.

In personal conversations, exchange officials have told us that in selecting stocks for option listing, the factors considered include (but are not limited to) trading volume, volatility, industry, and name recognition. This confirms our prior view with respect to volume and volatility, and corroborates the observation by Jennings and Starks (1986) that "option exchanges select listing candidates based on attributes like investor interest, trading activity and stock volatility" (1986, p. 108).

There are other dimensions of the listing decision that may evolve over time as the industry develops and matures. For example, during the initial period when option trading was still considered an experimental program and the exchanges faced the possibility of regulatory extinction, exchanges may have been reluctant to list options on highly volatile stocks, wishing to emphasize the risk-management role and deemphasize the speculative role of options. Once it became clear that option trading was here to stay, the exchanges may have become more willing to take risks.

More generally, we would suggest that an exchange interested in ensuring long-run viability should be concerned not only with generating immediate revenues, but should also consider other factors that promote long-run success. We would expect new exchanges to seek to invest in reputational capital, develop a strong, reliable customer base, and reduce the probability of failure in the face of unanticipated financial shocks. These considerations might provide further incentive for exchanges to select widely held, well-known stocks that are likely to generate predictable option volume from institutional traders and hedgers, as opposed to high volatility stocks predominantly traded by speculators.

A new exchange may face regulatory or technological constraints that limit the rate at which new contracts are listed. Thus, in the early days of a new option market, underlying stocks with attractive characteristics may remain unlisted for a time. Eventually, as these constraints are relaxed, we would expect the exchanges to list all contracts for which the benefits of listing are deemed to outweigh the costs. Once the industry has reached this point, those stocks that have not been selected for option listing are likely to remain unlisted until something happens to change the perceived costs or benefits of listing. Thus, over time we would expect exchanges to evolve from selecting stocks with desirable permanent characteristics to selecting stocks in response to changing market conditions.

IV. Data

A. Sample Selection

The first step in constructing our sample was to collect the data necessary to identify the universe of stocks eligible for option listing at every point in time. This was accomplished by comparing the characteristics of each non-optioned stock to the option listing requirements, summarized in Table I.

From CRSP, we obtained data on prior volume, share price, number of shares outstanding, exchange listing, and type of share for the all underlying securities in that database, as of each listing date (or as of the middle of each month, for the months in which there were multiple listing dates) during the period 1973 to 1996. Data on trading volume, share price, exchange listing, and type of share were used to directly classify many stocks as ineligible for option listing. We exclude ADRs and country funds from our sample, since they in turn are based on other underlying securities traded outside of the United States.

As mentioned above, precise eligibility requirements regarding shares outstanding and trading volume were not established until 1976. Before this time, the underlying shares were expected to be "widely held and actively traded" (CBOE, 1973, p. 83), but as no formal definition was established, it is unclear how one can determine what level would have been considered adequate. We reconstruct the universe of eligible stocks imposing the specific requirements delineated in 1976 as if they had existed in 1973.[3]

To establish whether securities meet the eligibility requirements with respect to income, we obtain data for income before extraordinary items, but after taxes, from the COMPUSTAT database, for the years in which the income requirement for eligibility existed (1975 to 1991). Also from COMPUSTAT, we obtain data for all securities whose debt is indicated to be in default by the assigned S&P rating, and use this information to identify additional firms that were ineligible for option listing.

To establish eligibility based on the public float criterion, we obtain data for the number of shares held by insiders from the Disclosure database, and subtract it from the number of shares outstanding. The Disclosure database reports the data since 1986. For the years before that, and for firms with missing insider ownership data, we rule out eligibility based on the public float requirement using simply the number of shares outstanding.[4] We also hand-collected insider ownership data from proxy statements for the period after October 1991 for the firms for which Disclosure does not provide this information.

From Disclosure we also obtain data on the number of shareholders, to establish eligibility based on this criterion. However, this number, as well as the original number published in the firms' 10K report, reflects only the number of registered shareholders. We find numerous examples of firms that were listed and appeared to be eligible with respect to other listing requirements, but had fewer shareholders than required, based on the number recorded in their 10K

[3] It is difficult to know exactly how to define eligibility in the earliest period of options trading, when eligibility was restricted only by qualitative statements such as "widely held" and "actively traded." We also considered a number of alternative assumptions with respect to eligibility requirements in this period. These robustness checks are described in Sections V.A and VI.

[4] This allows a small fraction of securities whose total number of shares barely exceeds the requirement for public float, and therefore we cannot rule them out as eligible, to enter the sample, although they may be ineligible. Given that insiders hold, on average, around 10 percent, including such firms would not seem to allow firms that are highly ineligible, based on this criterion, to enter the sample.

reports. Given that many shareholders hold their shares in street name, it is practically impossible to determine the true number of shareholders for each firm. In our conversations with representatives of CBOE, they confirmed that when listing a security, they often call brokerage firms to investigate the true number of current shareholders. However, such an investigation regarding the number of shareholders at remote points in time and for the universe of all listed securities is not possible. In fact, SEC has explicitly recognized the difficulty of this task for the options exchanges, and has used it as the main motivation to reduce the required number of shareholders to 2,000 from 6,000 in 1991. Therefore, we do not use the number of shareholders to rule out stocks as ineligible. However, this number is correlated with the number of shares outstanding, public float, and market capitalization (price times shares, which the public float and the price requirements collectively measure), so it is unlikely that the omission of this criterion allows securities that are obviously ineligible to enter the sample. This approach yields a total of 1,199,616 firm-months as of 226 listing dates during the period 1973 to 1996, of which we classify 913,343 as ineligible, leaving 286,273 firm-months that satisfy the option-listing eligibility requirements.

The next step was to identify the options that were actually chosen for listing. Listing dates for equity options listed on all domestic exchanges were obtained from a document provided by the CBOE. This document also contained information on delisting dates, where applicable. Combining the listing and delisting data, we constructed, at each point in time, the set of all stocks with options currently trading. By removing this set from the set of all eligible firms, we identified the set of options that were both eligible and available for option listing, resulting in a set of 164,836 option-listing opportunities. During this period, we have a record of 2,606 option listings, counting simultaneous multiple listings as a single event. Of these, 2,352 option listings may be found within our larger set of eligible, available, listing opportunities. These listings occurred on 2,255 unique firms.[5]

B. Description of the Sample

Figure 1 depicts the time series of the resulting sample size from 1973 to 1996. The lower line depicts the number of stocks with listed options, and the difference between the upper line and the lower line represents the number of eligible but non-optioned stocks. Although there have been a large number of options listed over the years, there has also been a large increase in the number of stocks eligible for option listing. In our analysis of option-listing effects, we will require that sufficient data be available to calculate variance over a 250-day window before and after the option-listing dates. There are 1,947 option-listed stocks that satisfy this requirement. Returns data around listing dates were

[5] Firms listed more than once include those that were cross-listed by a second exchange, but not during the same month as the original listing, and those that were first listed on one exchange, delisted, and then listed again at a later date.

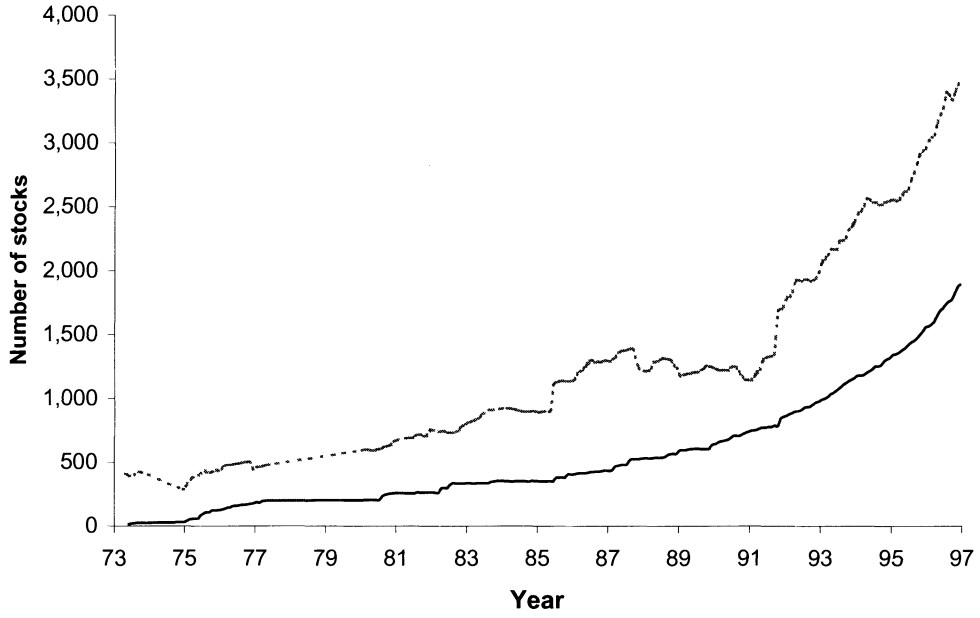

Figure 1. Optioned versus eligible non-optioned stocks: 1973 to 1996. The dashed line represents the total number of stocks, meeting the eligibility requirements for option listing, as of each month in which options were listed. The solid line represents the total number of stocks that have options listed.

extracted from CRSP, and we use these returns to calculate measures of volatility, over various horizons around the listing date.

For each month in our sample, and for each stock, we calculated the average daily trading volume over the 250 trading days prior to the fifteenth of the month, and the standard deviation of daily returns over the same period. For each month, we then calculated the means across monthly subsamples of stocks, including those stocks already optioned, those that were actually selected during that month, and those stocks eligible for listing, but not selected. Figure 2 shows how average daily trading volume differs across these three groups.

Note that the stocks selected for option listing generally have a higher trading volume than those not selected, and a lower trading volume than those previously selected. It is not surprising that prior trading volume appears to be an important determinant of option listing. In absolute (contract volume) terms, options that are eligible for option listing today tend to have a higher trading volume than the options that were selected for listing in the 1970s.

Figure 3 shows the prior volatility over the same three groups. This figure indicates that for the earliest listings in 1973, exchanges avoided high volatility stocks, as the prior volatility of the selected stocks is the same or lower than

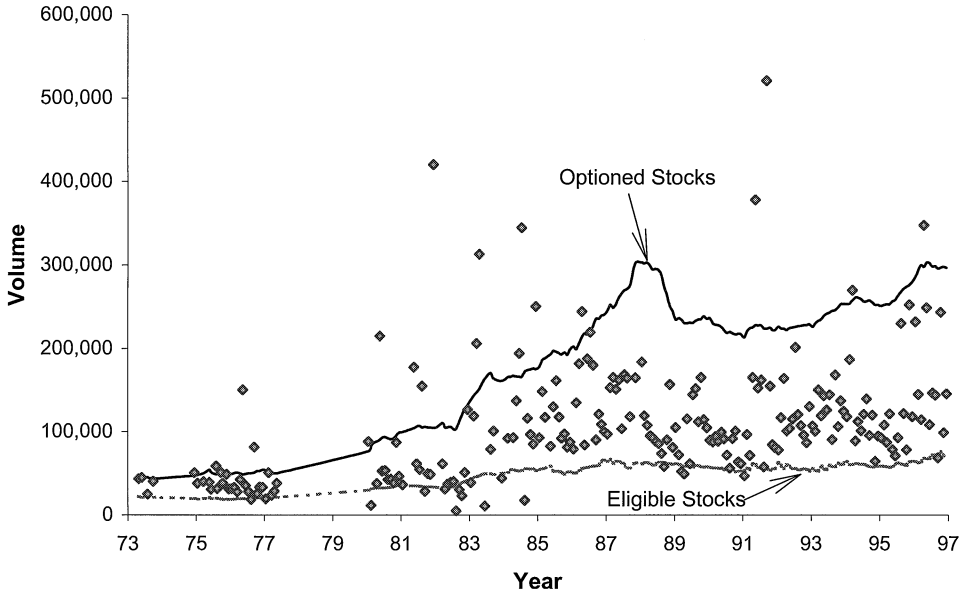

Figure 2. Average daily trading volume over the 250 prior trading days. The dots represent monthly observations of the average prior trading volume across all stocks selected for option listing during the month. The solid line represents the average volume across all stocks already optioned, and the dashed line represents the average volume across all non-optioned stocks that were eligible for listing, but not selected.

those that were eligible but not selected. The exchanges appear to have been somewhat inclined to list options on higher-volatility stocks from 1975 to 1977. After the moratorium, however, there appears to have been a particular focus on high volatility stocks, which persists more or less throughout the remainder of the sample.

Figure 4 compares the same groups on the basis of market capitalization. Here, a number of stylized facts may be observed. First, as expected, options were listed on larger stocks first, so that the stocks selected for option listing tend to be considerably smaller than those already optioned. However, once the really large stocks were already listed, it appears that firm size became less important in the listing decision, as evidenced by the fact that during the early 1980s, the average market capitalization of firms selected for option listing actually tended to be smaller than the average eligible but not selected firm. In the late 1980s, we appear to have returned to a regime where the stocks selected for option listing are larger than the average eligible firm. This may be related to the expansion of eligible firms to include OTC stocks in 1985. Then in the 1990s, we once again observe a large number of options listed on firms smaller than the average eligible firm. The numbers plotted in Figure 4 are corrected for inflation using monthly CPI, but the same trend is evident in real and nominal dollars.

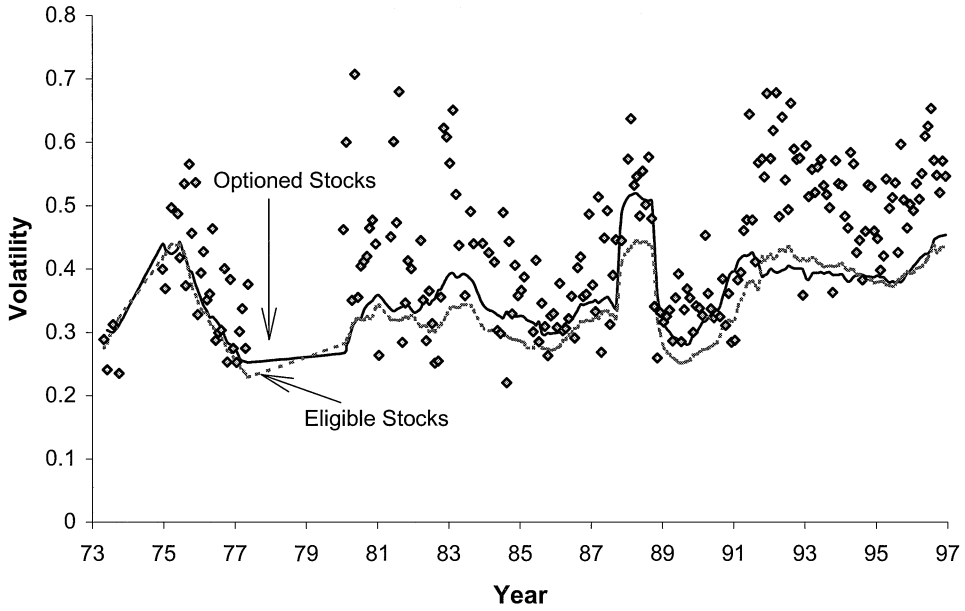

Figure 3. Prior volatility. Prior volatility is calculated as the annualized standard deviation of the continuously compounded daily stock returns over 250 trading days prior to listing. The dots represent monthly observations of the average prior volatility across all stocks selected for option listing during the month. The solid line represents the average volatility across all stocks already optioned, and the dashed line represents the average volatility across all non-optioned stocks that were eligible for listing, but not selected.

V. Results

A. The Determinants of Option Listing

In this section, we report the results of logistic regressions examining the relative importance of various factors influencing the exchanges' decision of which options to list. We estimate a logit model of the following form on a pooled data set containing monthly observations for all stocks classified as eligible for option listing but not yet optioned:

$$L(LIST) = \beta_0 + \beta_1 VOLUME + \beta_2 STD + \beta_3 ABVOL + \beta_4 ABSTD + \beta_5 SIZE + \varepsilon \quad (1)$$

where $L(LIST)$ is the log-odds ratio that a stock will be selected for option listing, *VOLUME* is average daily trading volume over the 250 trading days prior to the 15th of the month, *STD* is the annualized standard deviation of log returns over the same period, *ABVOL* is the ratio of 30-day to 250-day average daily trading volume, *ABSTD* is the analogous measure for volatility, and *SIZE* is the market capitalization of the firm in constant 1996 dollars.

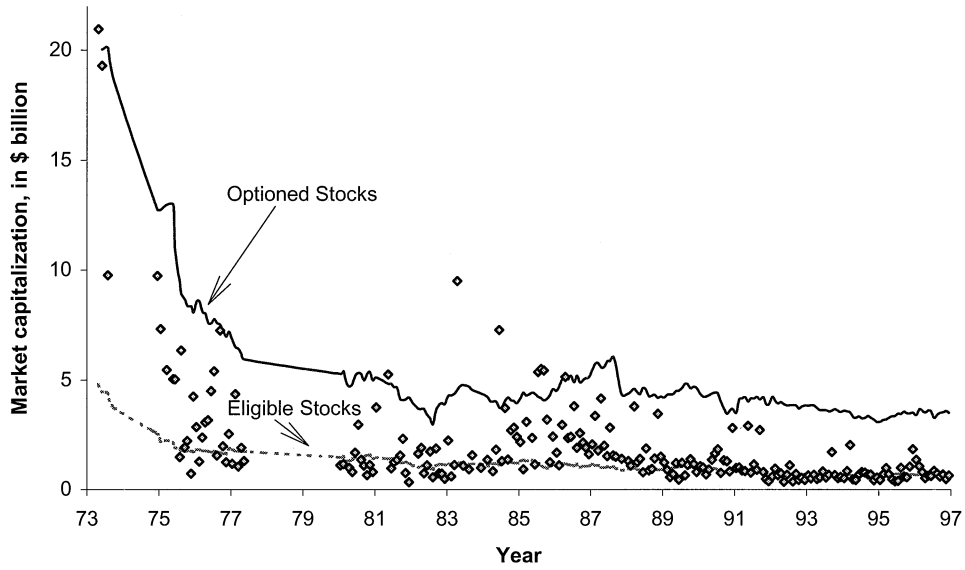

Figure 4. Market capitalization. Market capitalization at the time of listing is shown in billion constant (December 31, 1996) dollars, calculated as the product of the share price and number of shares outstanding. The dots represent observations of the average market capitalization across all stocks selected for option listing during the month. The solid line represents the average market capitalization across all stocks already optioned, and the dashed line represents the average market capitalization across all non-optioned stocks that were eligible for listing, but not selected.

We estimate this model estimated during the entire sample (1973 to 1996), as well as for various subperiods. The moratorium is a natural choice for a structural break, as several reforms were instituted around this time, and this was when the status of the option market changed from an experimental program to a permanent institution. We impose another structural break in May 1985, corresponding to the expansion of option-eligibility to include OTC stocks. We do not suggest that this fundamentally changed the nature of the economic decision faced by the exchanges. Rather, this significant increase in the universe of eligible stocks represents a sudden relaxation of a constraint. That this constraint was binding is indicated by the fact that the exchanges listed options on OTC stocks as they were permitted to do so. Finally, we put another structural break in October 1991, corresponding to another relaxation of the eligibility requirements. This break may also capture the move back from single listing to multiple listing after the dissolution of the allocation plan.

Table II reports the standardized slope estimates from the logit model. During the entire sample period, we find a positive coefficient on *VOLUME*, indicating that options are more likely to be listed on high volume stocks. The coefficient on *VOLUME* is positive and significant in all subperiods, except during 1985 to 1991, where it is not significantly different from zero (we note, however, that even in that subperiod, it is positive and significant for the newly introduced

Table II
Determinants of Option Listing

The table presents the standardized estimates from a logit model of option listing as a function of characteristics of the underlying stock (*p*-values in parentheses). The variables *VOLUME* and *STD* are the average daily trading volume and standard deviation of daily returns on the underlying stock over the prior 250 trading days. The variables *ABVOL* and *ABSTD* are ratios of 30-day to 250-day prior trading volume and standard deviation, and *SIZE* is the market capitalization of the firm in constant (December 31, 1996) dollars. The model is estimated on a population of pooled monthly observations of all stocks that are not yet optioned but are eligible for option listing. Results are reported for the whole sample, and for various subperiods.

Variables	1973–1977	1980–1985	1985–1991	1991–1996	1973–1996
VOLUME	0.2881	0.0795	−0.0100	0.1196	0.0748
	(0.000)	(0.000)	(0.5806)	(0.000)	(0.000)
STD	0.1491	0.3996	0.2651	0.2616	0.2675
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ABVOL	0.1028	0.1097	0.1532	0.2512	0.2003
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
ABSTD	−0.0019	0.0100	0.0798	−0.0082	0.0127
	(0.963)	(0.804)	(0.001)	(0.5679)	(0.249)
SIZE	0.0796	0.0875	0.2170	−0.0420	0.0700
	(0.000)	(0.000)	(0.000)	(0.057)	(0.000)
Number of observations	10,240	25,895	49,556	69,876	155,567
Percent classified correctly	82.2	75.0	71.5	75.1	72.8
Percent classified incorrectly	14.6	16.8	21.0	20.5	21.0
Percent tied	3.3	8.2	7.5	4.4	6.3

Nasdaq stocks). Based on the magnitude of the standardized estimates, trading volume appears to have been a more important factor in the listing decision prior to the moratorium. The coefficients on prior volatility are also positive and significant, but here the standardized coefficients indicate that volatility became a more important factor after the moratorium.

With respect to abnormal trading volume in the 30 days prior to option listing, we find that this coefficient is also positive and significant in every subperiod. Note, however, that while the coefficient on volume declines over time, the coefficient on abnormal volume increases. This supports the hypothesis that as markets mature over time, exchanges gradually shift from listing in response to permanent characteristics to listing in response to changing market conditions. New exchanges may face technological or regulatory constraints on the rate at which new options are listed, or may be prevented from listing desirable options due to eligibility constraints. Over time as these constraints are relaxed, exchanges begin to list options more in response to market conditions.

It has been suggested elsewhere that option exchanges are more likely to list options on stocks undergoing periods of unusually high volatility, and this might explain why volatility appears to decline after options are listed (see, e.g., Conrad (1989), and Skinner (1989)). We find little evidence in support of this claim. Examining the coefficients on abnormal volatility (*ABSTD*), we find a significant positive effect in only one subperiod (the late 1980s), and even

here, the magnitude of the standardized coefficient indicates that abnormal volatility is one of the least important factors.

We do find evidence of a tendency for exchanges to list options in periods when stocks in general have experienced declining volatility. We find in untabulated tests that over the full sample period, abnormal volatility is significantly lower than one (0.919) for the sample of stocks that were eligible but not selected for listing, indicating lower recent volatility relative to "long-term" volatility. However, for the sample of stocks that were selected for option listing, the median abnormal volatility is close to one (0.977).

Finally, examining the coefficients on *SIZE*, we see a significant, positive coefficient in every subperiod prior to 1991, indicating that larger firms were more likely to be listed. After 1991, this effect vanishes. This result is consistent with theoretical work by Mayhew (1998), who suggests that the move from single listing to multiple listing in 1990 fundamentally changed the exchanges' listing game. The main idea is that in a multiple-listing environment, exchanges may have the incentive to list early, as a preemptive move discouraging other exchanges from entering. The model implies that under multiple listing, exchanges are more likely to select options that do not currently have high trading demand, but have the potential for high demand in the future. This might explain why exchanges started selecting smaller stocks in the 1990s.

Recall that the eligibility requirements with respect to trading volume, shares outstanding, and underlying price were specified only in qualitative terms prior to 1976. Our analysis assumes that during the period 1973 to 1976, the de facto eligibility requirements were the same as the explicit requirements designated in 1976. Examining the actual listings during this period, we are confident that a $10 minimum stock price was a de facto requirement. To test the robustness of our conclusions with respect to trading volume and shares outstanding, we repeated our analysis under two alternative assumptions. First, we included as eligible only the stocks with above-median annual trading volume and number of shares. Second, we repeated the analysis under the extreme assumption that all exchange-traded stocks were eligible for listing during this period. Our main conclusions are robust to the definition of the eligible universe: Under these alternative definitions, there appears to be an even sharper change in focus away from volume in favor of volatility, and our results on option-listing effects are unchanged. We should note that the coefficient on volatility in the logit choice model appears to be sensitive to the definition of eligibility. The stocks in question tend to be small-cap, low-volume, high volatility stocks compared to the stocks that were listed, and we find the more of these that we classify as eligible, the lower is our estimated coefficient on volatility. In all cases, we document a significant change in focus from high volume stocks to high volatility stocks after the moratorium on new listings ended in 1980.

B. The Effect of Industry Membership and Underlying Trading Venue on Option Listing

Recall that one of the initial listing requirements was that the listed stocks be "representative of issuers engaged in a wide variety of business activities"

(CBOE, 1973, p. 84). Indeed, in our sample, the stocks selected for option listing represent 71 different industries (based on the two-digit SIC code definition). However, the number of selected stocks in each of these industries varies from one to 213.[6] There is also high industry variation in the number of eligible firm-years—from less than 20 (for six different industries) to more than 20,000.[7]

To test whether industry membership affects the probability that a stock is selected for optioning, we estimated a model that included industry indicator variables in addition to the other factors affecting option listing. In the interest of brevity, the coefficients are not reported here. We reject the null hypothesis of no industry effects for the entire sample based on both two-digit and one-digit SIC codes. Further, we found that different industries have been more popular in different subperiods. For example, controlling for all other factors affecting listing, manufacturing companies were more likely to be listed than other firms in our first subperiod (prior to 1980); service companies were more likely to be listed in the period 1980 to 1985; wholesalers and retailers tended to be more likely to be selected in the period 1985 to 1991; and once again service firms were more likely to be listed since 1991.

In addition, we used indicator variables to test whether the likelihood of option listing is a function of where the underlying stock trades. Controlling for the other factors affecting option listing, Nasdaq-listed stocks have been the most likely to be selected after they were made eligible for listing in 1985, while Amex-listed stocks have been the least likely. In the period immediately after they first became eligible (1985 to 1991), however, Nasdaq companies were less likely to be selected than NYSE firms.

C. Analysis of Subsequent Trading Volume in Option Contracts

Presumably, option exchanges choose to list those options that they believe are the most likely to generate high trading volume after listing. In this section, we verify that for the firms actually selected for option listing, the predicted probabilities arising from the logit model indeed help predict realized option volume.

Data on option trading volume were obtained from the Berkeley Options Data Base for those options traded on the CBOE between August 1976 and December 1995. For each stock listed during this period, we calculate the average options contract volume per trading day and the average number of trades per trading day (based on the prior 250 trading days, for consistency with our previous analysis).[8] For each stock eligible for option listing, we calculate the predicted probability of listing based on annual logit regressions, using the model specified in equation (1). Then we regress the average daily options volume and

[6] The most popular was two-digit SIC code 36, "*Electronic and Other Electrical Equipment and Components, Except Computer Equipment.*"

[7] The largest group of eligible stocks is two-digit SIC code 49, "*Electric, Gas, and Sanitary Services.*"

[8] For a few stocks listed within a year prior to August 1976, data on options volume are not available for the entire year after listing. Therefore, we report results based on the average daily volume rather than the total annual volume.

Table III

Analysis of Subsequent Option Trading Volume

The table presents a regression analysis of the option trading volume generated during the first year after the initial listing, as a function of the predicted probability of listing. Data on option trading volume were obtained from the Berkeley Options Data Base for those options traded on CBOE between August 1976 and December 1995. For each stock optioned during this period, we calculate the average options volume and average number of trades per trading day, for the first 250 trading days after initial listing. For each stock eligible for option listing, we calculate the predicted probability of listing based on annual logit regressions, using the specification from Table II. In Panel A, the dependent variable is the average option contract volume, and in Panel B, it is the average number of option trades. For both variables, we present the means (medians in parentheses) for each subperiod, and for the overall sample period.

	1976–1977	1980–1985	1985–1991	1991–1995	1976–1995
Panel A: Average Option Contract Volume					
Intercept	420.090	53.885	233.421	94.553	110.315
	(0.027)	(0.624)	(0.005)	(0.000)	(0.000)
Predicted probability of listing (%)	33.963	151.820	9.040	10.859	24.847
	(0.000)	(0.001)	(0.590)	(0.000)	(0.000)
Number of observations	28	44	132	417	621
Adjusted R^2	0.544	0.233	−0.005	0.121	0.178
Mean	1,060.200	364.980	249.170	137.440	210.594
Median	(602.796)	(161.668)	(71.957)	(77.960)	(84.967)
Panel B: Average Number of Option Trades					
Intercept	77.994	5.570	18.761	8.922	7.699
	(0.008)	(0.693)	(0.005)	(0.000)	(0.002)
Predicted Probability of listing (%)	5.269	22.877	1.016	0.541	3.530
	(0.000)	(0.000)	(0.451)	(0.000)	(0.000)
Number of observations	28	44	132	417	621
Adjusted R^2	0.554	0.299	−0.003	0.046	0.242
Mean	177.307	52.448	20.938	10.962	22.116
Median	(111.633)	(26.475)	(5.720)	(5.556)	(6.080)

average daily number of trades over the first year after listing against the predicted probability of listing. The results, presented in Table III, confirm that the predicted likelihood of listing ex ante is positively related to the realized volume ex post. Looking at the trend of adjusted R^2-statistics over time, we conclude that trading volume was much more predictable in the early subperiods than in the later subperiods.

Table III also reports the mean and median of the average daily option contract volume and the average daily number of trades, for each subperiod. We find that volume for newly listed options was much higher for the stocks selected for optioning early on, confirming that the exchanges selected stocks with high expected trading volume first.

D. Switching Regression

In an attempt to verify the breakpoints in the selection strategy that we observe from our analysis in Table II, we estimate a switching logit model as

follows. We add to equation (1) an indicator variable interacting with the coefficient of interest, where the indicator variable is set equal to zero prior to a breakpoint at time t, and one after time t. The breakpoint is then estimated endogenously along with the coefficients using the maximum likelihood criterion. To estimate whether the structural breaks are significant, we estimate the fit of the unrestricted switching coefficient model and the original model, and compare the difference in –2 log likelihood across models with a χ^2 critical value with one degree of freedom (two in the case of two coefficient switches). This is a simple, parsimonious approach to testing whether the structural breaks can be endogenously identified in the data, in which we test for structural breaks in each variable independently. A more comprehensive analysis would allow for structural breaks in all variables simultaneously.

For volatility, this procedure identifies a statistically significant switch in the coefficient for volatility occurring in September 1980, shortly after the moratorium. For trading volume, we find a significant switch in April, 1977 (the next-to-last listing prior to the moratorium). The coefficient on size switches in October, 1973, verifying our exploratory results from Figure 4 that the very first options were listed on the largest stocks, and then switched again in November 1991. The coefficient of abnormal volume changes in July 1988, and the coefficient of abnormal volatility also changes in April 1977. The results from the switching logit model tend to support the breaks in the selection strategy that we observe in Table II.

VI. Another Look at the Volatility Effect of Option Introduction

Once we recognize that option listing is endogenous, we may wish to reevaluate the literature on how option listing affects the underlying stock. Conrad (1989), Skinner (1989), and others have recognized the possibility that endogenous listing might bias the results of these tests. However, the main argument that has been raised is that exchanges are likely to list options in periods following abnormally high volatility, and this might explain the apparent volatility decrease at the time of listing. We would make a different argument. Inasmuch as high volatility leads to high option trading volume, we would expect exchanges to list options in periods when they anticipate high volatility. Thus, we would expect option listing to coincide with volatility increases, not decreases.

If option listing does influence the volatility of the underlying stock, it may be difficult to disentangle this effect from the selection bias resulting from endogenous listing. We would argue that one way to address this issue is to compare the apparent effects of option listing on volatility for early listings and later listings. Our reasoning is as follows. One way that option introduction can affect the volatility of the underlying stock is through its role in completing the market. It has been argued that the effect of listing new options should diminish over time as markets become more complete.[9] On the other hand,

[9] Detemple and Jorion (1990) summarize this argument, which is formalized in an earlier working paper by the same authors.

we would expect the selection bias associated with endogenous option listing to become more important over time. As indicated by the evidence presented above, exchanges appear to have evolved over time from selecting their options on the basis of the long-term characteristics of the underlying stocks, to listing options in response to changes in market conditions. Thus, we would expect any true option-listing effects to be manifest most clearly for the earliest listings, and the effects of selection bias to be most severe in later periods.

Pursuing this line of investigation, we use the logit model described in Section III to roll through our data and estimate ex ante probabilities of option listing for each eligible stock each month. We then construct two control samples of stocks that were not selected for option listing, but had a high predicted probability of being selected. The control samples are matched in time with the original sample, to correct for time-varying market volatility. We then compare the volatility change at the time of option listing for the optioned stocks with those in the control sample.

Each of the control samples is composed of 1,947 stock/dates, matched in time to the 1,947 actual listing events. The control samples were constructed by selecting, for each stock that was actually chosen for listing, a matching stock that was eligible for option listing on that date, but was not selected for listing any time within the subsequent 12 months. This ensures that the control sample is composed entirely of non-optioned stocks over the entire period over which post-event volume and volatility are measured. In addition, stocks that have already been included in the control sample within the preceding 12 months were excluded from consideration, in order to prevent overlapping volume or volatility windows in the control sample.

To construct the control samples, we first divided the sample into yearly subperiods and estimated annual coefficients for the logit model described in equation (1). Then, for each month in which options were listed, all the stocks that were eligible but not selected for option listing are ranked, on the basis of their predicted probability of listing, according to the logit model. Our first control sample is constructed by selecting for each month the n stocks having the highest predicted probabilities, where n is the number of stocks actually selected for listing in that month. Our second control sample is constructed by choosing the stocks that match the original sample as closely as possible in terms of probability of listing, as predicted by the logit model.

Next, we calculate the sample variance of raw continuously compounded daily returns before and after each event in the selected sample and the control samples. Panel A of Table IV reports the median ratio of stock variance after option listing to before option listing for each of the three samples and across various subperiods. To test whether option listing is associated with a change in volatility, we use the Wilcoxon rank-sum statistic to test whether the variance change is significantly different for the selected stocks from those in the control samples. Probability values are reported for four main subperiods.

The numbers in this table confirm the results of Skinner (1989), Conrad (1989), and others, that in the 1970s and early 1980s, option-listing dates coincide with decreases in volatility for stocks selected for option

Table IV
Volatility Effect

Panel A of the table presents the median (with means presented in Panel B) ratios of volatility after option listing to volatility before option listing, for stocks that were selected for option listing and two control samples of eligible stocks that were not selected, for various subperiods. Volatility is measured as the variance of daily stock returns over 250 trading days. Control sample 1 is constructed by matching the selected stocks with the same number of nonselected stocks that have the highest predicted probability of listing from a logit analysis at the time of listing. Control sample 2 is constructed by matching each selected stock with a nonselected stock that has the closest predicted probability of listing from a logit analysis at the time of listing. Probability values from a Wilcoxon rank-sum test for differences in the distribution of the sample of selected stocks and each control sample, and p-values from a t-test for equality of means, in Panels A and B, respectively, are reported in parentheses. In an additional column, we report the respective median and mean variance ratio during the same periods for the market, represented by the CRSP value-weighted index.

Period	Number of Observations	Selected Stocks	Control Sample 1	Control Sample 2	Market
			Panel A: Medians		
1973–1977	207	0.590	0.588	0.600	0.481
			(0.937)	(0.613)	
1980–1985	193	0.958	0.836	0.899	0.904
			(0.002)	(0.023)	
1985–1991	568	1.247	1.094	1.144	1.456
			(0.011)	(0.173)	
1991–1996	979	0.986	0.843	0.902	0.995
			(0.000)	(0.000)	
1973–1996	1947	0.997	0.857	0.923	0.999
			(0.000)	(0.000)	
			Panel B: Means		
1973–1977	207	0.787	0.778	0.847	0.806
			(0.872)	(0.334)	
1980–1985	193	1.084	0.902	0.932	1.049
			(0.000)	(0.002)	
1985–1991	568	1.506	1.556	1.447	1.828
			(0.656)	(0.454)	
1991–1996	979	1.185	1.020	1.124	1.139
			(0.000)	(0.381)	
1973–1996	1947	1.226	1.139	1.169	1.296
			(0.024)	(0.191)	

listing.[10] However, during the period 1973 to 1977, the volatility change for optioned stocks is statistically indistinguishable from that in the control samples. This is a period in which we would expect the selection bias to be relatively minor. We would conclude that in this period, option listing has no effect on volatility, consistent with the results reported by Bollen (1998). We do not claim

[10] We are able to replicate Skinner's results for his sample period fairly closely, using both raw and market-adjusted volatility ratios.

to know why volatility decreased in this period for both the optioned sample and the control samples. Perhaps for political reasons, exchanges were reluctant to list options at times when they forecast high volatility. Or perhaps this just happened to be a period of declining volatility. Note that during the 1985 to 1991 subperiod, volatility increases for both the sample of selected stocks and the control samples (see also the corroborative results reported by Lamoureux and Panikkath (1994) and Bollen (1998)).

In subsequent periods, the median variance change was higher for the selected stocks than for either of the control samples. This is consistent with the hypothesis that in this period, exchanges began listing options in anticipation of periods of high volatility. Note that the difference was highly significant during the period 1981 to 1985, became less significant after 1985 when option trading was expanded to OTC stocks, and then became highly significant again in the 1990s. Overall, the apparent increase in post-listing volatility of the selected stocks relative to the control samples begins roughly after the moratorium, that is, it coincides with the period when the exchanges' selection criteria shifted in favor of high volatility stocks. In our opinion, it is plausible that the option exchange members who are choosing which options to list can forecast changes in volatility. There is ample evidence in the time-series literature that volatility changes are at least somewhat predictable. If anyone has a natural informational advantage in predicting stock volatility, we suspect that it would be those who trade volatility for a living, and who have the best access to the option market data.

These volatility results are robust to alternative methodologies. These include using a market-adjusted measure of variance similar to that used by Skinner (1989), a measure of variance that is based on the assumption of zero mean return, and comparison of means instead of medians (see Panel B of Table IV). In addition, the volatility results are robust with respect to alternative assumptions regarding eligibility criteria prior to 1976.[11] In Table V, we also report the proportions of stocks with higher, lower, or unchanged volatility after listing within each sample. For each stock in each of the three samples, we perform an F-test for the equality of the stock return variance after listing versus before listing, and classify them as having as significantly higher/unchanged/lower variance based on a 5 percent confidence level. Then we calculate the number (proportions in parentheses) of observations in each category in each sample, for the various subperiods. Consistent with the results obtained from the comparison of the sample medians and means, a higher

[11] Recall that prior to December 1976, eligibility was restricted only by qualitative statements such as "widely held" and "actively traded." Our alternative assumptions included allowing as eligible the stocks with $10 minimum stock price and above-median number of shares and annual trading volume, and allowing as eligible all exchange-traded stocks during this period. Our main conclusions on the volatility effect are robust to these alternative definitions. The logit procedure that we use to construct the matched samples is not sensitive to the definition of eligibility prior to 1976 to identify (predict) the stocks that appeared good candidates to be selected, but were not listed; because of that, the results from our matched samples with respect to the volatility effect of option introduction are virtually identical under the different definitions of eligibility.

Table V

Proportions of Stocks with Changes in Variance

This table represents the proportions of stocks with changes in their post-listing volatility to pre-listing volatility for a sample of stocks that were selected for option listing and two control samples of eligible stocks that were not selected, for various subperiods. Volatility is measured as the variance of daily stock returns over 250 trading days. Control sample 1 is constructed by matching the selected stocks with the same number of nonselected stocks that have the highest predicted probability of listing from a logit analysis at the time of listing. Control sample 2 is constructed by matching each selected stock with a nonselected stock that has the closest predicted probability of listing from a logit analysis at the time of listing. For each stock in each of the three samples, we perform an F-test for equality of the stock return variance after listing versus before listing, and classify them as having significantly higher/unchanged/lower variance based on a 5 percent confidence level. Then we calculate the number (proportions in parentheses) of observations in each category in each sample, for the various subperiods.

Period	Number of Observations	Change in Variance	Selected Stocks	Control Sample 1	Control Sample 2
1973–1977	207	Increased	36 (0.174)	30 (0.145)	33 (0.159)
		Decreased	143 (0.691)	152 (0.734)	148 (0.715)
		No change	28 (0.135)	25 (0.121)	26 (0.126)
1980–1985	193	Increased	53 (0.275)	32 (0.166)	29 (0.150)
		Decreased	66 (0.342)	86 (0.446)	70 (0.363)
		No change	74 (0.383)	75 (0.389)	94 (0.487)
1985–1991	568	Increased	271 (0.447)	220 (0.387)	249 (0.438)
		Decreased	141 (0.248)	181 (0.319)	149 (0.262)
		No change	156 (0.275)	167 (0.294)	170 (0.299)
1991–1996	979	Increased	289 (0.295)	213 (0.218)	218 (0.223)
		Decreased	276 (0.282)	427 (0.426)	368 (0.376)
		No change	414 (0.423)	339 (0.346)	393 (0.401)
1973–1996	1947	Increased	649 (0.333)	495 (0.254)	530 (0.272)
		Decreased	626 (0.322)	846 (0.435)	736 (0.378)
		No change	672 (0.345)	606 (0.311)	681 (0.350)

proportion of the selected stocks experienced an increase in volatility relative to the stocks in the control samples, and a lower proportion of the selected stocks experienced a decrease in volatility relative to the stocks in the control samples. Also consistent with our previous findings, this result is not present in the first subperiod, 1973 to 1977, when the three samples appear to follow similar distributions. The actual means and medians of the variance and the annualized standard deviation for the three samples, across the different subperiods, are presented in Table VI.

VII. Conclusion

In this paper, we analyze the listing decisions made by U.S. option exchanges from 1973 through 1996. We find that exchanges have been more likely to list options on stocks with higher trading volume and higher volatility, and for the earlier listings, higher market capitalization. We verify that the same model that helps predict listing also helps predict trading volume after listing.

Table VI

Volatility before and after Option Listing

The table presents the means (medians in parentheses) of the volatility of the underlying stock before and after options listing for stocks that were selected for option listing and two control samples of eligible stocks that were not selected, for various subperiods. Volatility is measured as the variance of daily stock returns over 250 trading days. For ease of interpretation, the table presents the respective annualized standard deviations. Control sample 1 is constructed by matching the selected stocks with the same number of nonselected stocks that have the highest predicted probability of listing from a logit analysis at the time of listing. Control sample 2 is constructed by matching each selected stock with a nonselected stock that has the closest predicted probability of listing from a logit analysis at the time of listing.

	Selected Stocks		Control Sample 1		Control Sample 2	
Period	Before	After	Before	After	Before	After
1973–1977	0.3689	0.2957	0.4238	0.3406	0.4148	0.3395
	(0.3568)	(0.2858)	(0.3919)	(0.3279)	(0.3895)	(0.3221)
1980–1985	0.4126	0.4069	0.4930	0.4510	0.4195	0.3901
	(0.4062)	(0.3972)	(0.4897)	(0.4474)	(0.4095)	(0.3773)
1985–1991	0.3725	0.4062	0.4469	0.4781	0.3872	0.4170
	(0.3403)	(0.3741)	(0.4378)	(0.4421)	(0.3672)	(0.3707)
1991–1996	0.5320	0.5484	0.6281	0.5870	0.5443	0.5283
	(0.5232)	(0.5336)	(0.6150)	(0.5710)	(0.5235)	(0.4997)
1973–1996	0.4563	0.4660	0.5401	0.5155	0.4722	0.4620
	(0.4304)	(0.4276)	(0.5150)	(0.4820)	(0.4408)	(0.4156)

We also find that the relative importance of the factors influencing the listing decision has changed significantly over time. When the industry was young, the exchanges' political viability relied on the approval of regulators who viewed option trading as potentially dangerous, and the exchanges had a strong incentive to invest in institutional infrastructure and reputational capital. During this period, we find that exchanges selected large firms with high trading volume, and volatility does not appear to have been an important factor. After the industry matured, it appears that exchanges started selecting contracts with an eye toward generating speculative volume. Underlying trading volume and firm size became less important, and volatility became more important, particularly after the moratorium in the late 1970s.

Today, exchanges in emerging markets seem to be following a similar pattern. The new approach is to begin with index futures and options, which are ideal for attracting hedging demand, and then expand later to individual stock options. An interesting issue that remains unresolved is the extent to which this new approach can be successful. In the United States, stock index futures and options were introduced more than a decade after the introduction of individual stock options. In the absence of index derivatives, hedgers began using individual stock options, particularly IBM options, to hedge market risk. The liquidity afforded by this hedging demand represented an important impetus that contributed to the success of individual stock options. Much of this hedging demand shifted to index options after they were introduced, but by this time,

the market for individual stock options was well-established. With index products already in place in emerging markets, exchanges may find it difficult to generate much interest in individual stock options.

Another timely question is whether the individual stock futures market is likely to succeed. Stock futures trading was introduced in the United States on November 8, 2002. A casual inspection of the first sets of listings on Nasdaq-Liffe and OneChicago indicates a pattern somewhat similar to the initial selection for option listing that we document in this paper. It is not clear whether active markets in stocks, stock options, and stock index futures are sufficient to guarantee success for individual stock futures. Seeing how this market develops over the next few years will give us a broader understanding of financial innovation in mature derivative markets.

REFERENCES

Bollen, Nicolas P.B., 1998, A note on the impact of options on stock return volatility, *Journal of Banking and Finance* 22, 1181–1191.

Branch, Ben S., and Joseph Finnerty, 1981, The market impact of option listing, *Financial Review* 16, 1–15.

Cao, Henry, 1999, The effect of derivative assets on endogenous information acquisition and price behavior in a rational expectations equilibrium, *Review of Financial Studies* 12, 131–163.

Chicago Board Options Exchange, 1973, *Constitution and Rules* (Commerce Clearing House, Inc., Chicago, Illinois).

Chicago Board Options Exchange, 1976, *Constitution and Rules* (Commerce Clearing House, Inc., Chicago, Illinois).

Conrad, Jennifer, 1989, The price effect of option introduction, *Journal of Finance* 44, 487–498.

Cowan, Arnold R., Richard B. Carter, Frederick H. Dark and Ajai K. Singh, 1992, Explaining the NYSE listing choices of Nasdaq firms, *Financial Management* 21, 73–86.

Damodaran, Aswath, and Joseph Lim, 1991, The effects of option listing on the underlying stocks' return processes, *Journal of Banking and Finance* 15, 647–664.

Damodaran, Aswath, and Marti G. Subrahmanyam, 1992, The effects of derivative securities on the markets for the underlying assets in the United States: A survey, *Financial Markets, & Instruments* 1, 1–22.

Detemple, Jerome, and Philippe Jorion, 1990, Option listing and stock returns, *Journal of Banking and Finance* 14, 781–801.

Hodges, Stewart, 1992, Do derivative instruments increase market volatility? in Stewart Hodges, ed.: *Options: Recent Advances in Theory and Practice* (Manchester University Press, Manchester, UK).

Jennings, Robert, and Laura Starks, 1986, Earnings announcements, stock price adjustment, and the existence of options markets, *Journal of Finance* 41, 107–125.

Lamoureux, Christopher G., and Sunil K. Panikkath, 1994, Variations in stock returns: Asymmetries and other patterns, Working paper, University of Arizona.

Mayhew, Stewart, 1998, Option market microstructure and the economics of new listings, Working paper, University of Georgia.

Mayhew, Stewart, 2001, The impact of derivatives on cash markets: What have we learned? Working paper, University of Georgia.

Nathan Associates, 1974, *Review of Initial Trading Experience at the Chicago Board Options Exchange*, Washington, D.C.

Securities and Exchange Commission Release No. 34–10490, 1973.

Securities and Exchange Commission Release No. 34–9985, 1980.

Securities and Exchange Commission Release No. 34–43268, 2000.

Skinner, Douglas J., 1989, Options markets and stock return volatility, *Journal of Financial Economics* 23, 61–78.