The Rodney L. White Center for Financial Research

S&P 500 Indexers, Delegation Costs and Liquidity Mechanisms

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04-03

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Current Draft: March 20, 2003

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ABSTRACT

The largest S&P 500 indexers replicate the index with tracking errors of just several basis points per year. Maintaining such small errors requires a nearly exact-replication strategy and precludes profiting from trading much before or after index changes. A strategy of trading at the open following the announcement of a change, rather than at the change, adds 19.2 basis points more return per year with virtually no added risk, but with substantial tracking errors. This additional return is a measure of the delegation cost in monitoring an indexer through tracking errors. The paper then shows that less than half of indexers always follow an exact-replications strategy, consistent with the hypothesis that they are trying to recoup some of these delegation costs. Further, market mechanisms have evolved that allow some exact-replication indexers to recapture a portion of these costs. [JEL: G12]

Moneys invested to track the S&P 500 totaled nearly $1 trillion as of the end of 2000, or roughly 8 percent of the market value of the 500 stocks in the index. Though index funds are clearly a significant investment vehicle, there has been little research into the investment strategies that indexers use.

Those who direct a manager to replicate the returns on the S&P 500 will evaluate that manager by how closely the managed returns track the index returns. The difference between the return realized by the indexer and the return on the index itself is called tracking error, and any tracking error, be it positive or negative, indicates a failure to track the index. In practice, tracking errors are often small. The tracking error of Barclays Global Investors, the largest indexer, averages 0.022 percent, or 2.2 basis points, per year over the last decade with a standard deviation of 2.8 basis points per year. Such small tracking errors, year by year, enable an investor to monitor an indexer's ability with precision.

The pioneering studies of Shleifer (1986) and Harris and Gurel (1986) initiated an extensive literature that has uniformly found abnormal returns when S&P adds or deletes a stock from its index.[1] The stylized conclusion is that stocks added to the index realize, on average, positive abnormal returns from the time of the announcement through the close on the change day, and a partial reversal thereafter. The earliest studies found abnormal returns of roughly 3 percent, while Bos (2000), the most recent study, finds abnormal returns of close to 10 percent, perhaps reflecting the growth of indexed funds over these years. Those studies that have examined deletions find that the reverse applies to these changes.

In an important study, Beneish and Whaley (1996) use intraday data and show that prices do not adjust immediately when a stock is added to the index, suggesting a profit opportunity. Indeed, they conclude that indexers could enhance their returns by buying "earlier in the announcement period (in the extreme, with market-on-open orders on the

[1]Later studies include: Beneish and Whaley (1996); Blouin, Raedy, and Shackelford (2001); Bos (2000); Dhillon and Johnson (1991); Edmister, Graham, and Pirie (1994); Kaul, Mehrotra, and Morck (2000); Lynch and Mendenhall (1997); and Wurgler and Zhuravskaya (1999)

morning following the announcement)."[2]

Whether indexers will adopt such an early-trading strategy depends, among other things, on the magnitudes of the potential tracking errors and the willingness of their investors to accept such errors—something that Beneish and Whaley did not examine. This study calculates the returns from their suggested strategy and finds that from 1995 through 2000 an indexer that adopts this early-trading strategy, rather than trading at the closing price on the day of the change, would have enhanced its return on average by 19.2 basis points per year. The additional returns were positive in five of these six years. Although the variance of these enhanced returns, as well as the covariances with other assets, is virtually unchanged, the standard deviation of the annual tracking error is 23.9 basis points—much greater than that of Barclays. As a consequence, an investor who requires that an indexer maintain tracking errors of just a few basis points a year is giving up additional returns, averaging 19.2 basis points per year. Forgoing these additional returns can be viewed as an agency cost in delegating investment decisions.

Beneish and Whaley conclude further that if indexers adopt this early-trading strategy, the partial adjustment to announcements of changes in the index will disappear, with virtually all of the adjustment occurring immediately. Since their study was published in 1996, indexers would have known of their findings for most of the years of this study—1996 though 2000. That the early trading strategy enhanced returns for five out of the six years ending in 2000 implies that market forces have not eliminated this partial adjustment. As argued below, this partial adjustment may stem from the fundamental directive to indexers to maintain minimal tracking errors. Further, if maintaining minimal tracking errors is the directive, one might expect market mechanisms to evolve that would allow indexers to maintain minimal tracking errors and perhaps even allow the larger indexers to use their bargaining power to recapture some of these forgone additional returns.

[2]Beneish and Whaley (1996), p. 1929.

The paper is organized as follows: Section 1 describes investment strategies that have been used to track the S&P 500 and discusses the magnitudes of the possible tracking errors. Section 2 provides direct estimates of the return characteristics of the early-trading strategy. Section 3 examines the investment strategies utilized by indexers. Section 4 documents trading mechanisms that have evolved to allow indexers, at the least the larger ones, to minimize tracking errors while simultaneously capturing some of the costs of delegating investment decisions. Section 5 concludes the paper.

1 Strategies to Replicate the S&P 500

The S&P 500 is widely publicized, broad-based, and frequently used to benchmark returns. The market value of the 500 stocks in the index is $11.7 trillion as of the end of 2000, or 68.7 percent of the market value of US publicly traded equity.[3]

Annually, S&P publishes a list of the leading S&P 500 fund managers and their assets under management.[4] These assets totaled nearly $1 trillion as of the end of 2000 ($870 billion in non-enhanced products and $63 billion in enhanced products) and represent 8.0 percent of the total market value of the index. The management of index funds is highly concentrated with the top three indexers managing 58 percent of all S&P 500 index funds—a fact that subsequent arguments will utilize.

1.1 The S&P 500

Each stock in the S&P 500 is weighted in proportion to the market value of its common stock. Unlike other broad indexes, such as the NYSE Composite, the Wilshire 5000, or the Russell 2000, the criteria for inclusion are subjective. According to S&P, the companies

[3]US publicly traded equity is the sum of corporate equities held by U.S. investors, equity issued in the U.S. by U.S. corporations and held by foreigners, and U.S. holdings of foreign equity, as estimated in Board of Governors of the Federal Reserve System (2001), p. 82

[4]Standard & Poor's (2001), p. 59–60.

included in the index "tend to be the leading companies in leading industries within the U.S. economy."[5] Consistent with this statement, the market value of the index is heavily concentrated in the largest stocks. As of the end of 2000, the largest 10 of the 500 companies represented 23.1 percent of the market value of the index; the largest 50 companies, 55.7 percent; and the largest 250, 90.9 percent.

S&P regularly drops and adds companies. From 1995 through 2000, S&P announced 235 changes to the components of its index. Additionally, S&P periodically changes the number of shares outstanding of a component company that it uses in calculating the index. For large changes, such as 5 percent or more, S&P updates the number of shares immediately.[6] For small changes, S&P waits until the end of the calendar quarter to update its index. In calculating the value of its index, S&P prices each stock by the price of the last transaction on the primary market. Consistent with this practice, the closing value of the index is based upon the closing prices on the primary market, not the consolidated closing prices across all markets.

1.2 Replication Strategies

S&P states that the two main strategies that indexers use to replicate the index are full, or exact, replication and sampling.[7] An exact-replication strategy requires holding all 500 stocks at all times in exact proportion to their weights in the index. Since changes to the index take place at the closing prices of the primary market, an indexer who wants no tracking error must buy the added stock and sell the deleted stocks at these closing prices. Additionally, the indexer would also have to adjust its holdings in each of the other 499 stocks, except when the market values of the added and deleted stocks are identical—an unlikely event. Similarly, a change to the index, such as a reduction of shares outstanding

[5]Ibid., p. 2.
[6]Ibid., p. 33
[7]Ibid., pp. 61-62.

when a company repurchases its own stock, would also require trading in all 500 stocks.

Sampling strategies maintain portfolios of fewer than 500 stocks. These include stratified sampling, holding only the largest stocks, and optimization procedures. These strategies are likely to produce greater tracking error, but have the potential of reducing trading costs, broadly defined, leading to enhanced returns.

The choice between exact replication and sampling is driven by the tradeoff that an indexer faces between enhancing returns and minimizing tracking errors. In practice, the largest indexers track the index quite closely. Barclays Global Investors is the largest manager of S&P 500 index funds: As of the end of 2000, it managed $212 billion in S&P index funds, or roughly one quarter of all moneys invested in S&P 500 index funds. Barclays reports that from 1991 through 2000, the tracking error of its Equity Index Fund before management expenses averaged 2.2 basis points per year (Table 1). The annual tracking errors are always close to zero with a maximum error of 7 basis points in 1997 and a minimum error of -3 basis point in 1990. The standard deviation of its tracking error was 2.8 basis points per year. The positive average tracking error of 2.2 basis points means that Barclays enhanced its return over these years—a possibly surprising result, particularly since Barclays' returns are after trading costs.[8] A spokesman for Barclays stated that it enhances returns by lending securities and by "smart" trading.

The tracking errors for Vanguard, the third largest S&P 500 indexers after State Street Global Advisors, are somewhat larger than Barclays, but still small. From 1991 through 2000, the tracking error of its Vanguard 500 before expenses averaged 8.5 basis points. The standard deviation of its tracking error was 11.7 basis points per year. For the last three years, Vanguard was able to enhance returns sufficiently to cover its expenses. These larger tracking errors indicate that Vanguard deviates more than Barclays from an exact-replication

[8]Trading costs are capitalized into the value of a traded assets, so that Barclays' returns include trading costs.

strategy. Consistent with this observation, Vanguard states in its prospectus that it will use derivatives when "favorably priced," and it presumably utilizes "smart" trading techniques as well.

These tracking errors are small in comparison to those of more active management styles. Of the equity funds that had been in existence throughout 2000, there were 922 non-index funds that Morningstar classified as large blend, the same classification that Morningstar assigns to S&P 500 index funds. Of these 922 funds, 76 has betas with respect to the S&P 500 from 0.98 to 1.02 and an R-squared of 90 percent or more, suggesting that they are being benchmarked to the S&P 500. The average tracking error was -34 basis points, which indicates lower returns than the index. The standard deviation of the tracking error was 383 basis points.

1.3 The Strategies of Mutual Funds

For the most part, mutual funds indexed to the S&P 500 hold every stock in the index, which is consistent with an exact-replication strategy. As of December 31, 2000, the Morningstar database contained information on 2,992 domestic diversified equity funds with a three-year track record and equity style indicator.[9] Their combined assets totaled $2.5 trillion. Of these 2,992 funds, 82 had in their name the words "index" or "S&P 500," or some variant. Morningstar reports that all have a beta with respect to the S&P 500 of between 0.98 and 1.01, and all have an R-squared of 1.00. The assets of these funds represent 9.3 percent of the assets of these 2992 domestic diversified equity funds.

Of these 82 funds, 63 held between 499 and 502 stocks; 14 held more than 502 stocks, but none held more than 507 stocks; 3 held 466 to 487 stocks; 2, two classes of shares for the same fund, held only 240 stocks. These numbers are close to what would be expected if the

[9]Many of these funds represent claims on the same portfolio of assets and are really just different classes of stock that a mutual fund issues, usually with different fee structures.

investment strategies of most S&P index funds approximate an exact-replication strategy.[10]

1.4 The Logic of an Exact Replication Strategy

That most mutual funds indexed to the S&P 500 hold approximately 500 stocks is no accident. It is virtually impossible to maintain tracking errors in the neighborhood of the 2 to 3 basis points as reported by Barclays without holding all 500 stocks in close proportions to the weights in the S&P 500.

Even if a portfolio has a seemingly high R-squared with respect to the S&P 500, tracking errors can be large. For example, consider a portfolio with an R-squared of 0.99 with respect to the S&P 500 and a beta of one. If the standard deviation of the S&P 500 is 20 percent per year, which is close to its historical value from 1926 through 2000, routine calculations show that the standard deviation of the portfolio return is 20.1 percent per year—virtually identical to 20 percent. But the standard deviation of the tracking error is 201 basis points per year, implying much greater tracking errors than those of Barclays or of Vanguard. Even with an R-squared of 0.9999, the standard deviation of the tracking error is still 20 basis points per year.

The Appendix presents a model that demonstrates the extreme sensitivity of the magnitude of tracking errors to slight deviations from index weights. This model utilizes the market weights of each of the 500 stocks in the S&P 500 as of the end of 2000 and assumes a plausible single-factor return generating function for each stock. In this model, the standard deviation of annual returns for the single-factor is 20 percent per year, and the standard deviation of the S&P 500 is 20.28.

One sampling strategy is to invest in the largest 100 stocks. According to the model, such a strategy has a standard deviation is 20.53 percent, which is not much greater than

[10]That most of these funds hold roughly 500 stocks does not in itself indicate that they follow an exact-replication strategy, as that would require that the weights of the stocks in their portfolios equal the weights in the S&P 500 at all times. Matching the stockholding information in Morningstar to the S&P holdings given in Vestek could not be done with sufficient accuracy to allow the needed comparison.

the 20.28 percent for the index. However, the standard deviation of the tracking error is 145 basis points, even though the R-Squared of this strategy with respect to the index is 0.9951.

Even dropping one stock from the index may result in significant tracking error. Dropping Nabor, the largest of the smallest 250 stocks, leads to a tracking error with a standard deviation of 2.6 basis points per year. The standard deviation of this portfolio is the same as the index to four significant figures.

In sum, an indexer that wishes to maintain tracking errors of the small magnitudes of those of Barclays or Vanguard must invest in ways that closely approximate an exact-replication strategy. Otherwise, the tracking errors are likely to be larger than those observed in practice.

2 Enhancing an Index Return

If the prices of stocks added to and deleted from the S&P 500 do not always adjust fully by the opening of trading on the day following the announcement, an early-trading strategy of buying and selling immediately at the open, rather than at the close on a change day, could enhance returns. The section addresses three questions: First, what is the additional return? Second, what is the tracking error? Third, by how much does this early-trading strategy change the variance of total return and the covariances with other asset classes? The section begins with a description of the data.

2.1 Data

The primary data sources that were used in the calculating the returns of the early-trading strategy are Vestek, CRSP, and S&P Directory. The Vestek database provides for each stock in the index the following month-end data: Cusip number, shares outstanding, and the month-end closing price.[11] The composite closing prices come from CRSP. The S&P

[11]The shares outstanding in Vestek are contemporaneous data. The shares outstanding in CRSP are sometimes adjusted to correspond to what CRSP considers the surviving company with the benefit of hindsight.

Directory is the primary source for the announcement and change dates. The sample covers the six years 1995 though 2000. The securities in Vestek and CRSP are first matched by Cusip numbers, and then each match is checked by comparing the closing price on Vestek with the closing price on CRSP. When a match failed this second test, closing prices from CRSP were searched to find the correct company.

2.2 The Early-Trading Strategy

From 1995 through 2000, the price returns (the return without dividends) for the early-trading strategy exceeded the corresponding returns on the S&P 500 by an average of 1.6 basis points per month.[12] The standard deviation of the monthly tracking error was 6.90 basis points. Thus, the t-statistic for the null hypothesis that the additional return is zero is 1.97. On an annualized basis, the additional return is 19.2 basis points and the standard deviation of the tracking error is 23.9. Even though the annual tracking error can be large, the early-trading strategy enhanced returns in five of the six years from 1995 through 2000. In 1995, the return on the early-trading strategy of 34.24 percent exceeded the return on the index of 34.11 by 13 basis points. The annual tracking error was thus 13 basis points. The annual tracking errors for the subsequent years were: 28.9 basis points in 1996, -5.4 basis points in 1997, 43.9 basis points in 1998, 12.9 basis points in 1999, and 32.1 basis points in 2000.

The correlation between the monthly returns of the early-trading strategy and the S&P

On occasion, the shares outstanding from the two sources differ substantially. Since the Vestek numbers are contemporaneous and those from CRSP are not, the Vestek numbers on shares outstanding are used to track more closely the shares used by S&P. To obtain shares outstanding within a month, the month-end shares outstanding from Vestek are adjusted forward using the share adjustment factors from CRSP. When there is an addition within a month, the month-end shares outstanding from Vestek for that month for that security are adjusted backwards, again using CRSP data.

[12]The opening price for Nasdaq stocks is the volume-weighted average price over the first 30 second after 9:30. Cf. Market Regulation Committee. In a limited number of cases, a stock begins trading only on or after the time at which it is added. In that case, it was purchased at the closing price on the change date, or if this price was not available, at the opening price following the change date. The opening price for NYSE stocks is the price of the first reported trade on the NYSE.

500 is 0.9998683. The standard deviations of monthly returns of the two series are 4.2541 for the early-trading strategy and 4.2528 percent—the same to three significant figures. That portfolios with such similar total returns could result in a standard deviation of tracking error of 6.90 basis points per month is illustrative of how sensitive tracking error is to small deviations from an exact-replication strategy.

The magnitude of this tracking error is driven almost exclusively by the less-than-perfect correlation between the returns on the early-trading-strategy and those on the S&P 500 itself, and not by the differences in standard deviations of these two return series. If the standard deviation of the returns for the early-trading strategy were the same to four decimal places as the standard deviation of total return of the S&P, namely 4.2541 percent per month, the usual formula for the standard deviation of the difference of two random variables with a correlation of 0.9998683 shows that the standard deviation for the tracking error is still 6.90 basis points. Only if the standard deviations of the tracking errors were reported to four significant figures would there be a difference.

The overall risk characteristics of the early-trade returns and the index returns are virtually the same. The standard deviation of either is the same to three significant figures—4.25 percent per month, and further the covariances of either any other assets are virtually the same.[13] In the mean-variance space, the early-trading strategy with its enhanced return virtually dominates the index. Yet, index fund managers may eschew this early-trading strategy, as potential tracking errors with a standard deviation of 23.9 basis points per year may be unacceptable.

A possible criticism of the above analysis is that the returns for the early-trading strategy

[13]Let r_{sp} be the return on the index, r_{et} be the return on the early trading strategy, and r_{oa} be the return on any other asset. If b is the slope coefficient in a regression of r_{sp} on r_{et} and ϵ is the residual of that regression, $\mathrm{Cov}\,(r_{sp},\, r_{oa}) = b\,\mathrm{Cov}\,(r_{et},\, r_{oa}) + \mathrm{Cov}\,(\epsilon,\, r_{oa})$. This last covariance is close to zero in the likely scenario that both $\sigma(\epsilon)$ and $\rho\,(\epsilon,\, r_{oa})$ are close to zero. If one assumes that this last covariance is 0 and since the estimate of b is 0.99956, the covariances using r_{et} are 0.04 percent greater than the covariances using r_{sp}.

are based upon the shares outstanding from Vestek, which are not exactly the same as those that S&P uses. As mentioned above, S&P does not adjust immediately the number of shares outstanding for changes of less than five percent, but waits until the end of the quarter, while Vestek may adjust the number of shares it reports at other intervals. To determine the sensitivity of the incremental returns of the early-trading strategy to this difference, the study recalculated the S&P 500 index using the closing prices from CRSP and the month end outstanding shares from Vestek adjusted forward or backward within a month using the share adjustments from CRSP. This recalculated series is the same as S&P would have calculated had it used these publicly available data.[14]

The monthly returns of the early-trading strategy averaged 2.3 basis points more than the recalculated index–slightly greater than the 1.6 basis point reported above. The standard deviation of the monthly tracking error is 5.1 basis points, slightly less than the 6.9 basis points reported above.[15] Thus, the results stand whether the returns on the early-trading strategy are compared to the actual S&P 500 or to the recalculated the index. The enhancement in returns is economically important, but the magnitude of the tracking errors is greater than those of Barclays and Vanguard.

3 Indexers' Investment Strategies

If there were no transaction costs, an indexer could guarantee a tracking error of zero by trading at the closing prices on the day of a change to the index. Thus, if all indexers

[14]This recalculated series utilizes the consolidated closing prices for NYSE stocks, while S&P utilizes the closing prices on the NYSE. The following footnote compares the returns on the published S&P 500 with those on this recalculated index and finds that the two series are very close.

[15]It is instructive to compare the published S&P 500 index with the recalculated index. The standard deviation of monthly returns are similar: 4.253 percent for the published index and 4.247 for the recalculated index. The correlation between the two indexes is 0.9999312. Yet, the standard deviation of the difference of the monthly returns between the two indexes is 5.0 basis points. Thus, an indexer who wants to maintain annual tracking errors of just several basis points must weight its portfolio with the virtually the same number of shares that S&P uses in its own calculation. In meet this need, S&P sells this information in a product titled *Index Alert*, which is updated four times a day.

followed such an exact-replication strategy, one might think that the volume at the close on the change day would be a minimum of eight percent of the outstanding shares of any company added to or deleted from the index. However, some changes to the index require no trading at all, and others an indeterminate amount of trading. This section begins with a description of the types of changes that are made to the index and their trading implications for exact-replication indexers. This section then analyzes those changes where a minimum volume of eight percent is expected.

3.1 Types of Changes and Trading Activity

The type of change dictates the required trading activity of exact-replication indexers. When S&P adds a company not already in the index (a non-S&P company), or deletes an S&P company, an exact-replication indexer must buy or sell the affected stock in proportion to its market value. Of all types of additions, this type requires the maximum trading. By contrast, some changes allow an indexer a choice of two or more stocks in which to trade, and thus the trading in each security is indeterminate. An example is the creation of a new S&P firm from a merger of an S&P firm and a non-S&P firm. Here the indexer could buy the S&P firm or the non-S&P firm, or both, in proper amounts to acquire a position in the surviving firm proportional to its ultimate market value. Finally, some additions or deletions require no trading at all: for example, a separation of an S&P company into two new S&P companies, a merger of two S&P companies into a new S&P company, or an acquisition of an S&P company by another S&P company.[16]

Over the six years from 1995 through 2000, S&P announced 235 changes to the S&P 500, each involving both an addition and a deletion. There were more changes in the last three years (147) of the sample than in the first three years (88). The number of Nasdaq

[16]When two S&P companies combine to form a new S&P company, S&P deletes the two companies and adds the new S&P company and a non-S&P company. When an S&P company acquires another S&P company, the acquired company is dropped and another non-S&P company added. With any deletion, there is a matching addition, which must be a non-S&P company. Trading would be required for this addition.

companies that S&P has added has gradually increased from 4 of 33 companies in 1995 to 24 of 58 stocks in 2000.

Since the focus of this section is how indexers trade, the following analyses utilize only those additions and deletions requiring maximum trading: 184 additions and 59 deletions. There were four additions with more than 30 days between the announcement and the change days, and these were dropped in view of the possibility of intervening events. There were 13 deletions with an opening price on the change day of less than $5.00, and these were dropped as the percentage bid-ask spread is large for these types of stocks. In 2000, Nasdaq phased in after-hour trading and commingled the reporting of such trading with the closing trades, making it impossible to identify closing volume. This commingling involved 19 Nasdaq additions, and these were dropped from any analysis involving volume.

3.2 Definitions

Since the trading activity of an exact-replication indexer is proportional to a firm's shares outstanding, the volume numbers in this paper are always expressed as a percentage of shares outstanding. Normal daily volume for a stock is defined as the average daily volume over the 40 trading days prior to and including the day of the announcement. The volume on the day of the announcement is included, as the announcement always occurs after the close of trading on the primary market. The term "day" will always mean a trading day. Daily abnormal volume for a stock is defined as the difference between the actual volume for that day and the corresponding normal volume for that stock. Cumulative abnormal volume over a number of days is the sum of the daily abnormal volumes over those days.

The study also presents actual, or unadjusted, volumes for specific intervals within a day, such as from 9:30 to 10:00 or at the close, and gives the normal volume for the same time intervals for comparison purposes. The normal volume for any such interval is defined as the average actual volume for that interval over the prior 40 days preceding the announcement.

3.3 Trading Volume

The trading volume at the close on a change day is approximately half of the eight percent that would be required if all S&P 500 indexers were to follow an exact-replication strategy. For example, the volume at the close for additions of NYSE stocks averages 3.6 percent of the shares outstanding when the announcement precedes the change by two or more days and 4.3 percent when the change occurs the day following the announcement (Table 2).[17]

The corresponding figure for Nasdaq stocks is 5.8 percent. On the surface, this suggests that indexers more closely approximate exact-replication strategies for Nasdaq stocks. However, Nasdaq is a dealers' market, and in a dealers' market a trade from one public investor to another is typically reported twice. For example, a public investor might sell shares to a dealer (one report), and the dealer in turn might resell the shares to another public investor (another report). There can also be trades between dealers (a further report). To estimate the magnitude of this "multiple counting," Nasdaq was kind enough to provide the data necessary to determine the actual proportion of volume due to public investors for each added or deleted Nasdaq stock analyzed here. These data imply that the volume that ultimately represents trades from one public investor to another is 47.8 percent of the reported volume. Thus, the closing volume of 5.8 percent should be adjusted downwards to 2.8 percent to make the volume numbers comparable to those of NYSE stocks. With this adjustment, there is somewhat less trading at the close for Nasdaq stocks than for NYSE stocks.

If many indexers followed the early-trading strategy, the volume in the first half hour of trading on the day following the announcement should be much greater than normal. For NYSE stocks, this initial volume from 9:30 until 10:00 on the day following the announcement

[17] These percentages exclude trading on the Pacific Stock Exchange from the close of NYSE trading through 4:30 Eastern Time. During this half hour, trading on this Exchange is accomplished through an auction market, and it is not possible to guarantee that an execution will occur at the closing price of the NYSE. There were 79 additions with trading on the Pacific during this half hour with an average volume of 0.04 percent. There were 17 deletions with an average volume of 0.08 percent. Excluding this volume has virtually no effect on the substantially larger numbers in the text and table.

when this announcement precedes the change by two or more days is only 0.14 percent of the shares outstanding for additions, compared to 0.04 percent for a normal a day, and 0.15 percent for deletions, compared to 0.05 percent for a normal day.[18] The Nasdaq volume is difficult to interpret because of the potential double counting; thus, the subsequent analyses will focus on the volume for NYSE stocks. The low volume at the open for NYSE stocks provides strong evidence that most indexed assets do not pursue the early-trading strategy of buying at the open or shortly thereafter—a strategy that would enhance returns by 19.2 basis points per year.

Thus, few indexed assets utilize the early-trading strategy, and only half follow an exact-replication strategy. Yet, virtually all S&P-indexed mutual funds hold approximately 500 stocks. If the holdings of these mutual funds are typical of other indexers, indexers not following an exact-replication strategy must be utilizing a less extreme strategy of trading at some other time than the close on the change day. Indeed, there is sufficient volume to accommodate all indexers if they all wanted to hold 500 stocks. The cumulative volume from the open following the announcement through 20 days after change is 10.2 percent for additions of NYSE stocks and 14.9 percent for deletions (Table 3).

4 Liquidity at the Close

Though not all indexed assets trade at the close on a change day, there is still a significant volume at the close, presumably due in part to indexers. This section examines two questions: First, how does the market provide the required liquidity to these indexers? Second, and possibly interrelated, who captures any anticipated abnormal returns? This section begins with a description of possible trading techniques that indexers can use to trade at the closing price. Although this description come from interviews with a limited number of practitioners,

[18] Sixteen of the 106 NYSE additions and 3 of the 41 NYSE deletions did not open until after 10:00. These stocks are included at zero volume in the volume reported for the first half hour of trading. If these stocks were excluded, the average for additions would have been 0.16 and for deletions, 0.16.

the trading techniques themselves have testable implications. The empirical analyses below are consistent with these implications.

4.1 Trading Procedures

The closing mechanisms on Nasdaq and the NYSE differ. The NYSE has a formal mechanism that determines the closing price and guarantees an investor an execution at that price. Nasdaq has no such mechanism. Nasdaq defines the closing price as the price of the last reported trade.[19] There is no direct way for an investor to participate in this trade. For a Nasdaq stock, an investor that wishes to trade at the closing price must enter into a bilateral agreement with a counterparty. After observing the closing price, the counterparty will trade the agreed number of shares at that price. In view of the differences in these closing mechanisms, the two market are analyzed separately.

4.1.1 Nasdaq

On Nasdaq, a counterparty that enters into a bilateral agreement to trade with an indexer at the closing price can obtain the required shares in several ways: buy on its own account the agreed upon shares prior to the close on the change date, sell shares short at the closing price on the change date and cover later, or arrange for another investor, like a hedge fund, to provide the shares. Similarly, in the case of a deletion, the counterparty can sell short prior to the close and cover by buying from the indexer, buy from the indexer at the close and sell later, or arrange for a third party to buy the indexer's shares.

According to the interviewed practitioners, counterparties sometimes pay indexers for entering into such bilateral agreements to trade at the close, and the empirical evidence below confirms this observation. If a counterparty is willing to pay, it must be the case that

[19]The close of trading on NASDAQ is 4:00 Eastern Time, with an allowance of 90 seconds for lags in reporting of trades, and the closing price is the price of the last reported trade. There are various time stamps associated with any trade. The closing prices reported on CRSP are not always the same as the price of the last trade reported on TAQ. Thus, the time stamp on TAQ is not the time stamp used in determining the closing price. In the analysis below, the closing price for Nasdaq stocks is therefore taken from CRSP.

it receives some type of benefit. One possible benefit is that a counterparty that intends to take a large speculative position would know to whom that position can be unwound; of course, the indexer also benefits by knowing that the trade will take place at the closing price. Another possible benefit is that a counterparty that enters into such an agreement to trade a large position knows the trading strategy of that indexer. With that knowledge, the counterparty can extract more information from reported volume and prices. For example, if there were a print of a large trade a couple of hours prior to the close, the counterparty may be better able to assess the future trading strategies of other traders and indexers.

To explain payment from a counterparty to an indexer, it is not enough to say that a counterparty may receive benefits from entering into a bilateral agreement to trade at the close. The counterparty would not pay unless it had to. Thus, it must be the case that either (1) the indexer is worse off from entering into a bilateral agreement and requires compensation, or (2) the indexer has sufficient market power to extract a portion of the counterparty's benefits. The first reason is unlikely since the indexer minimizes tracking error by trading at the closing price. The second reason is consistent with the previously reported high concentration in the management of indexed assets.

4.1.2 NYSE

Unlike Nasdaq, the NYSE has a formal closing mechanism or auction, which guarantees the execution of a previously submitted market-on-close (MOC) order. Thus, indexers do not need to enter into bilateral agreements with counterparties to trade NYSE stocks at the closing price, as they do for Nasdaq stocks. However, practitioners indicate that such bilateral agreements exist and that indexers are paid to enter into these agreements. The evidence below confirms that such bilateral agreements do indeed exist.

On the NYSE, agents can provide liquidity to indexers by entering MOC orders, rather than using bilateral agreements, and be assured of execution at the NYSE closing price.

The question then is what would induce a counterparty to pay an indexer to enter into an agreement to trade at the closing price, rather than participating in the NYSE closing auction. Consider an addition to the index and an agent that seeks to profit from providing liquidity to large indexers. In submitting a MOC sell order, that agent faces uncertainty in that the MOC price will depend upon the trading strategy of large indexers. The agent might expect a closing price of P_h if a particular large indexer submits a MOC buy order, but a lesser price P_l if that indexer follows some alternative trading strategy. By entering into a bilateral agreement with that indexer, the agent has the assurance that that indexer will buy a specific number of shares at the close, resulting in an expected closing price of P_h. Again, as on Nasdaq, a counterparty that enters into a bilateral agreement with a large indexer may obtain valuable knowledge of the trading strategy of that indexer.

In principle, the two parties could submit their matched orders to the floor of the NYSE for execution at the close, but the evidence below suggests that at least some of these bilateral agreements are executed and reported on non-NYSE markets. One possible reason for this choice is that one or both may not want to expose their large orders to the floor of the NYSE if such exposure might have a deleterious effect upon the closing price. Another possible reason is that it is easier to enforce the agreement on a non-NYSE market as there is some anonymity on the NYSE floor.

4.2 Some Institutional Detail

Establishing the existence of bilateral agreements and payments for entering into such agreements utilizes specific institutional details in the execution of trades and the reporting of their prices. If a dealer trades from its own inventory with a public investor, a so-called principal trade, the dealer charges no commission, profiting solely from the spread. The reported price is the net price. If a dealer facilitates a trade between two public investors, a so-called agency trade, the dealer would normally charge a commission. The price reported

on the tape is the gross price, before commissions. The net or actual price to either party is the gross price adjusted for any commissions.

During the years of this study, most trades in Nasdaq stocks were principal trades. This institutional fact can be used to establish that payments are made to enter into bilateral agreements. To illustrate with an addition, an indexer might enter into a bilateral agreement with a dealer to buy a predetermined number of shares at the closing price less a "payment" of 1/16. If the closing price turned out to be $20, the indexer would buy the shares at the better price of $19 15/16. This trade would be reported after the close with a condition code of T on the TAQ database at $19 15/16. Thus, finding for additions that a substantial volume of trading occurs at a lesser price than the closing price is evidence of such payments to indexers. In short, indexers receive a better price relative to the closing price.

The existence of bilateral agreements for NYSE stocks can be established by exploiting specific reporting procedures for trades in these stocks. The NYSE has a formal mechanism to determine the price and volume of the last trade. This trade determines the closing price. After the report of this trade, any further trades in NYSE stocks cannot be reported on the NYSE and must be reported through some other venue, primarily regional exchanges or Nasdaq. Thus, trades subject to bilateral agreements would have to be reported on these other venues after the close on the NYSE. If most trades of NYSE stocks are agency trades, the price of most of the trades reported after the close on the NYSE would be the NYSE closing price.

4.3 Payments

For Nasdaq stocks, an exact-replication indexer that entered into an agreement to buy or sell at the close but at a better price than the closing price would effectively be receiving a "payment." When an indexer is buying at the close, a better price from the indexer's point of view is a price that is less than the closing price. Consistent with the existence of such

payments, 61 percent of the closing volume for additions of Nasdaq stocks is reported with a price less than the closing price (Table 4).[20] Approximately 30 percent is reported at the closing price, which is consistent with the waiving of "commissions." Only 9.9 percent of the closing volume is reported with a price greater than the closing price, which is consistent with the payment of "commissions." When an indexer is selling at the close, a better price from the indexer's point of view is a price that is greater than the closing price. Again consistent with the existence of payments, 70 percent of the closing volume is reported at a price greater than the closing price. These results are consistent with counterparties paying indexers to participate in trades at the closing price.

4.4 Bilateral Agreements

The existence of bilateral agreements to trade NYSE stocks at the NYSE closing price would be established if there were a substantial volume in NYSE stocks reported after the NYSE close on other markets at the NYSE closing price. Consistent with this observation, roughly one third of the closing volume for additions of NYSE stocks is reported on non-NYSE markets, and roughly one quarter for deletions.[21] Moreover, approximately 95 percent of the volume reported on non-NYSE markets is at the NYSE closing price. Of those few trades that are reported with prices different from the NYSE close, most have better prices from the indexers' perspective. This finding is consistent with dealers being the counterparty and paying indexers to enter into such trades. This study does not have any data that would allow a determination of what payments, if any, are made to indexers for agreeing to trade

[20]The difference between the closing price and reported better price averaged 0.3 percent of the closing price, which is 15 cents on a 50-dollar stock. This average should be interpreted as an upper bound on the size of the "payments" to indexers. It is an upper bound because of the possibility that the trade to the indexer involves two reported trades. A market maker may have agreed to buy the shares from a hedge fund at 0.45 percent less than the closing price and to sell these shares at 0.15 percent less than the closing price. The average discount is 0.3 percent, but the payment to the indexer is just 0.15 percent.

[21]For comparison, the average daily percentage of the closing volume of NYSE stocks in the S&P 500 reported on non-NYSE markets is 7.6 percent from 1995 through 2000. This average is calculated first by averaging for each trading day the percentage of closing volume for NYSE stocks in the S&P 500 that is reported on non-NYSE markets and second by averaging these daily averages across days.

at the NYSE closing price after the NYSE close. However, this evidence is consistent with the existence of bilateral agreements to trade NYSE stocks at the closing price.

4.5 Returns

Counterparties that sell shares added to the index to indexers at the closing price on the change day can provide that liquidity in two ways: Buy the shares prior to the close on the change day or sell the shares short at the close (and cover the short sale at a later date). To make these trades profitable on average, these liquidity providers must expect prices to adjust upwards gradually to the close on the change day and then fall following the change. The reverse pattern must occur for deletions, with a drop in price and then an increase. These patterns of abnormal returns are consistent with prior studies. This section confirms these patterns using the more recent years of this study.

The average returns from the close on the announcement day to the close on the change day are 10.0 percent for additions and -10.2 percent for deletions (Table 5). The magnitude of these returns is greater than those in earlier studies, perhaps reflecting the growth of indexed assets, but are close to those found in the recent study by Bos (2000). Consistent with the incremental returns for the early-trading strategy, 63 percent of the adjustments for additions occurs by the next morning's open when the announcement precedes the change day by two or more day. The remaining 37 percent of the adjustment occurs from the opening following the announcement to the change day and presents potential trading opportunities. This adjustment is faster than the adjustment found by Beneish and Whaley (1996), who report that only 45 percent of the adjustment occurs immediately. The adjustment for deletions is slower than for additions: 59 percent of the adjustment occurs from the open following the announcement through the closing price when the change day precedes the announcement by two or more days. Beneish and Whaley (1966) did not analyze deletions. When the announcement immediately precedes the change day, virtually all of the adjustment occurs

by the opening of the change day.

In equilibrium, liquidity providers must expect sufficient compensation for the risks to which they expose themselves in providing liquidity to indexers. For a large trade, these risks could be substantial. For example, the average returns for additions from the open following the announcement to the close on the change day when the announcement precedes the change day by two or more days is 3.7 percent, but the standard deviation of this return is 9.8 percent—nearly three times the average return. The required return will depend upon the amount of additional risk that must be borne. The dollar magnitude of this risk to any individual counterparty depends upon the size of its position, the degree to which it can hedge the risk, and the cost of the hedge.[22] The observed pattern of average returns is consistent with this equilibrium.

5 Conclusion

The largest S&P 500 indexers maintain minimal tracking errors, often within several basis points of the index. To maintain such small errors, an indexer must follow a nearly exact-replication strategy. Even dropping one stock for a year can produce significant tracking error. That virtually every S&P 500 mutual fund holds very close to 500 stocks is evidence of how important is the magnitude of the tracking error.

The pioneering work of Beneish and Whaley (1996) find that stock prices adjust only gradually to an announcement by S&P of a change to its index. They conjecture that this gradual adjustment will give way to an immediate adjustment if indexers begin to trade earlier to capture any abnormal returns. This paper, which examines a later period than Beneish and Whaley (1966), finds that this lack of adjustment has persisted and that an early-trading strategy of trading at the open immediately following an announcement of a change to the index results in an average annual enhancement of returns of 19.2 basis points

[22] Cf. Wurgler and Zhuravskaya(1999)

from 1996 through 2000 with virtually no change in the variance of total returns or the covariances with other asset classes. Further, an analysis of trading volume at the open following the announcement finds very little abnormal volume, which means that the bulk of indexers have not adopted this early-trading strategy.

A possible reason that indexers have not adopted this early-trading strategy is that it involves an unacceptable level of tracking error. Even though the correlation of returns of this early-trading strategy with the index is 0.99998683, the standard deviation of the tracking error is 23.9 basis points per year. If the goal of maintaining minimal tracking error is paramount, indexers will not trade early as conjectured by Beneish and Whaley. The tracking errors are just too great. On the surface, this means that indexers are giving up 19.2 basis points per year in order to maintain minimal tracking errors. This enhancement of 19.2 basis points per year can be viewed as an agency cost in delegating the management of a portfolio to an indexer and requiring minimal tracking errors.

While not all indexers trade at the close on the change day, there is still significant volume at the close. One might expect that large indexers, those who have bargaining power, would try to recover some of these foregone abnormal returns in a way that guarantees minimal tracking errors. They could accomplish this goal by entering into bilateral agreements with counterparties that would guarantee an execution at the closing price with a payment of some type for entering into such an agreement. The paper finds evidence that such "payments" exist for Nasdaq stocks. It finds also that such bilateral agreements exist for NYSE stocks, even though the formal closing mechanism of the NYSE guarantees an execution at the closing price.

Market mechanisms have thus evolved that allow some indexers, probably the larger ones with bargaining power, to execute at the closing price while recapturing some of the abnormal returns that counterparties expect to realize. The counterparties will not give up the entire expected abnormal returns as they must receive an appropriate compensation for

the risks that they are bearing in providing liquidity at the close. If so, and if indexers must keep their tracking errors to a minimum, one would expect that the adjustment in prices to a change in the index would never be immediate. It is this gradual adjustment in prices both before and after the close on the change date that compensates counterparties for the risks that they bear in providing liquidity to indexers.

Appendix

To demonstrate the extreme sensitivity of the magnitude of tracking errors to slight deviations from index weights, consider a world in which there are 500 stocks with the same market values as those of the 500 stocks in the S&P 500 as of the end of 2000. In this world, assume that the function that generates the returns of each stock is statistically identical. By maintaining identical return-generating functions for each stock, the subsequent analysis can concentrate on the effects of changing the weights on the component stocks.

The return-generating function of each stock is the one-factor model

$$r = \pi + \epsilon_i, \tag{1}$$

where π is a mean-zero factor common to all securities and ϵ_i is a mean-zero independent disturbance for each security i. By selecting the variance of π to be 0.04 and the variance of ϵ to be 0.12, the common factor π will explain 25 percent of the variance of the total return.

In this model, the return for the S&P 500 is

$$r_{500} = \pi + \overline{\epsilon_{500}}, \tag{2}$$

where $\overline{\epsilon_{500}}$ is a weighted average of the ϵ's for the 500 component stocks and the weights are proportional to the market values of the actual stocks in the index as of the end of 2000. The variance of r_{500} is the sum of the variance of the common factor and the variance of the weighted average of the unique disturbances. The resulting standard deviation of r_{500} is thus 20.28, 28 basis points greater than that of the common factor.

Similarly, the return of a portfolio invested in a subset of n of the 500 stocks in the index, where the weight given to each stock is proportional to its market value, is the same form as equation (2). The difference is that $\overline{\epsilon_{500}}$ is replaced with some other weighted average $\overline{\epsilon_n}$.

S&P has suggested that some indexers buy only the largest stocks. In this stylized model, the standard deviation of a value-weighted portfolio of the largest 100 stocks in the index

is 20.53, which is not much different from the 20.28 for the S&P 500 itself. The R-squared is 0.9951, which is 1.00 to two decimal places. Yet, the standard deviation of the tracking error is 145 basis points per year.

Even deleting a single stock can introduce meaningful tracking error. Consider dropping Nabor, whose market value as of the end of 2000 is the median of all 500 stocks. Specifically, Nabor is the largest stock of the smallest 250 stocks with a market value of $8.7 billion, which represents just 0.07 percent of the market value of the 500 stocks in the index. If this one stock is dropped and investments are maintained in the other 499 stocks in market proportions, the standard deviation of the portfolio return remains the same as that of the S&P 500 to four decimal places, but the standard deviation of the tracking error is 2.6 basis points.

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Table 1

Tracking Errors of Barclays and Vanguard against the S&P 500 1990-2000

This table contains the annual tracking error and summary statistics of the S&P 500 index funds of Barclays and Vanguard. Tracking error is the realized annual return including dividends less the corresponding return on the S&P 500. A positive error means the managed fund had a greater return than the index. Barclays provided to this study their tracking errors, which are before any expenses charged to its clients but are after transaction costs. (Transaction costs are capitalized into the purchase or selling price of a security.) The Vanguard tracking errors after expenses are calculated from the returns shown in Vanguard reports and the S&P returns from Ibbotson. The Vanguard tracking errors before expenses is the sum of its tracking errors after expenses and its actual expenses.

Year	Tracking Errors (Percent per Year)		
	Barclays	Vanguard 500	
	Before Expenses	Before Expenses	After Expenses
2000	0.00	0.23	0.05
1999	0.03	0.21	0.03
1998	0.04	0.22	0.04
1997	0.07	0.02	-0.17
1996	0.03	0.01	-0.19
1995	0.05	0.22	0.02
1994	0.01	0.06	-0.13
1993	0.04	0.09	-0.10
1992	-0.01	-0.06	-0.25
1991	0.01	-0.13	-0.33
1990	-0.03	0.07	-0.15
Simple Average	0.022	0.085	-0.107
Average Absolute Deviation	0.029	0.120	0.133
Standard Deviation	0.028	0.117	0.122
Assets under Management December 2000 Billions of Dollars	211.70		148.00

Table 2

Intraday Volume as a Percent of Outstanding Shares for Changes to the S&P 500 Index 1996-2000

Panel A presents the normal volume as a percent of shares outstanding in the pre-event period for the indicated time periods. Normal volume is the average daily volume in the 40 trading days preceding the announcement averaged over the indicated events. Panel B presents the actual volume for changes when the annoucement precedes the change day by two or more days. It contains the actual volume on the day following the annoucement and on the change day. The adjusted Nasdaq close volume is the reported Nasdaq volume adjusted downwards for the "double counting" that occurs in a dealer market. Panel C presents the actual volume on the change day when the change occurs the day following the announcement. The closing volume for NYSE-listed stocks is defined as the closing volume on the NYSE plus all volume reported on Nasdaq and the regional exchanges after that close. Volume on the Pacific from the close on the NYSE through 4:30 Eastern Time is dropped. The closing volume for Nasdaq-listed stocks is the volume of the last trade plus the volume of all trades after the close with a T condition code.

	Additions			Deletions		
	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total
A. Normal volume in pre-event period						
9:30 - 10:00	0.04	0.14	0.06	0.05	0.03	0.04
10:00 - 3:00	0.31	0.89	0.45	0.32	0.25	0.31
3:00 to Close	0.09	0.27	0.13	0.09	0.07	0.09
Close	0.01	0.01	0.01	0.01	0.01	0.01
Observations	124	37	161	41	5	46
B. Annoucement preceding change by 2 or more trading days						
Actual volume on day following the announcement						
9:30 - 10:00	0.14	0.62	0.24	0.15	0.20	0.15
10:00 - 3:00	1.02	2.52	1.33	0.99	1.21	1.01
3:00 to Close	0.27	0.57	0.33	0.26	0.35	0.27
Close	0.01	0.12	0.03	0.03	0.03	0.03
Actual volume on change day						
9:30 - 10:00	0.15	0.41	0.20	0.14	0.08	0.13
10:00 - 3:00	1.18	3.12	1.58	1.33	1.41	1.33
3:00 to Close	0.79	1.91	1.02	1.06	1.77	1.14
Close	3.58	5.84	4.05	4.43	6.47	4.65
Adjusted Nasdaq Close		2.79			3.09	
Observations	106	28	134	41	5	46
C. Annoucement with change the following day						
Actual Volume on Change day						
9:30 - 10:00	0.39	0.48	0.42			
10:00 - 3:00	2.85	3.49	3.06			
3:00 to Close	0.72	2.66	1.37			
Close	4.33	5.66	4.77			
Adjusted Nasdaq Close		2.71				
Observations	18	9	27			

Table 3

Daily Volume as a Percent of Outstanding Shares for Changes to the S&P 500 Index 1996-2000

Panel A presents the average normal daily volume as a percent of shares outstanding in the pre-event period. Normal volume is the average daily volume in the 40 trading days preceding the announcement. Panel B presents the average abnormal volume for various time periods. Daily abnormal volume is the difference between the actual volume and the normal daily volume. The number of observations is the same as in Table 2 for all but the intervening days. The number of observations for the intervening days are 97 for NYSE additions, 23 for Nasdaq additions, 38 for NYSE deletions, and 5 for Nasdaq deletions. The t-values of all of the abnormal volume percentages are greater than 1.96.

	Additions			Deletions		
	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total
A. Normal daily volume	0.45	1.31	0.65	0.47	0.36	0.45
B. Abnormal volume						
Cumulative						
Annnoucement through change day	7.18	13.16	8.56	8.91	13.74	9.43
Days 1 to 20 after change	3.05	10.09	4.67	6.02	13.29	6.83
Day following change	0.80	2.04	1.08	1.40	1.78	1.44
Total	10.23	23.25	13.23	14.93	27.03	15.26
Announcement preceding change by 2 or more trading days						
Day following announcement	1.01	2.39	1.30	0.95	1.44	1.00
Intervening days						
Daily average	0.40	1.09	0.53	0.53	1.32	0.62
Cumulative	0.90	1.84	1.08	1.59	2.92	1.74
Change day	5.25	9.83	6.21	6.49	9.38	6.80
Announcement with change the following day						
Change day	7.74	11.39	8.96			

Table 4

Detailed Breakdown of Closing Volume on Change Day for Changes to the S&P 500 Index 1996-2000

This table breaks down the closing volume according according to the market place to which it is reported. It also breaks down the non-NYSE volume in NYSE-listed stocks according the reported price relative to the NYSE closing price. It further breaks down Nasdaq volume reported with a condition code of T and after the close of trading on Nasdaq according to the reported price relative to the Nasdaq closing price. CRISP is the source of the Nasdaq closing price. A better price for an addition is a price that is less than the closing price, and for a deletion, a price that is greater than the closing price. Equal and worse prices are similarly defined. The closing volume for NYSE-listed stocks is defined as the closing volume on the NYSE plus all volume reported on Nasdaq and the regional exchanges after that close. Volume on the Pacific from the close on the NYSE through 4:30 Eastern Time is dropped. The closing volume for Nasdaq-listed stocks is the volume of the last trade plus the volume of all trades after the close with a T condition code. Since volume cannot be negative, any average volume greater than zero is significant at any arbitrary level. Table 2 contains the number of observations.

	Additions			Deletions		
	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total
A. Annoucement preceding change by 2 or more trading days						
Actual volume at close on change day						
Close	3.58	5.84	4.05	4.43	6.47	4.65
Source of closing volume						
NYSE	2.46	0.00	1.95	3.52	0.00	3.14
Non-NYSE markets	1.12	5.84	2.10	0.91	6.47	1.51
Nasdaq	0.93	5.84	1.95	0.78	6.47	1.40
Regional exchanges	0.19	0.00	0.15	0.13	0.00	0.11
Percentage breakdown of non-NYSE closing volume						
Percent at lesser price	5.0	60.7	16.6	1.4	2.0	1.5
Percent at close price	94.3	29.4	80.8	95.2	28.0	87.9
Percent at greater price	0.7	9.9	2.6	3.3	70.0	10.6
C. Annoucement with change the following day						
Actual Volume at close on change day						
Close	4.33	5.66	4.77			
Source of closing volume						
NYSE	2.95	0.00	1.97			
Non-NYSE markets	1.39	5.66	2.81			
Nasdaq	1.36	5.66	2.79			
Regional exchanges	0.02	0.00	0.01			
Percentage breakdown of non-NYSE closing volume						
Percent at better price	7.0	58.9	24.3			
Percent at close price	92.5	29.5	71.5			
Percent at worse price	0.4	11.6	4.1			

Table 5

Percentage Returns for Various Intervals for Changes to the S&P 500 Index 1996-2000

This table presents precentage returns for various intervals for stocks added to or deleted from the S&P 500 index from 1996 through 2000. It includes the 19 xxx Nasdaq-listed stocks for 2000 that were excluded in the analysis of volume. The closing prices are the closing prices on the primary market. The statistics presented are the average returns, the standard deviation of these returns (not the standard deviation of the average), and the t-statistic.

	Additions			Deletions		
	Return	St Dev	t-value	Return	St Dev	t-value
A. All events						
Announcement-day close to change-day close	10.04	10.31	13.06	-10.16	6.93	-9.95
Change-day close to next-day open	-0.67	2.00	-4.49	0.11	5.04	0.15
Change-day close to next-day close	-1.09	3.90	-3.74	1.09	5.13	1.45
Next-day close to close 20 days after change	-0.29	11.25	-0.35	3.45	11.53	2.03
Number of observations	180			46		
B. Announcement preceding change by 2 or more trading days						
Annoucement-day close to next-day open	6.36	3.54	22.15	-4.21	3.48	-8.19
Next-day open to change-day close	3.66	9.79	4.61	-6.14	7.35	-5.66
Percentage price adjustment after open	37			59		
Change day						
Open to close	0.84	5.03	2.05	-2.00	4.54	-3.00
Open to 3:00 pm	0.23	3.21	0.89	-0.85	3.38	-1.72
3:00 pm to Close	0.59	3.47	2.09	-1.14	3.65	-2.12
Number of observations	152			46		
C. Announcement with change the following day						
Annoucement-day close to next-day open	8.38	3.77	11.76			
Next-day open to change-day close	0.60	4.02	0.79			
Percentage price adjustment after open	7					
Change day						
Open to close	0.60	4.02	0.79			
Open to 3:00 pm	0.95	3.42	1.47			
3:00 pm to Close	-0.34	2.06	-0.88			
Number of observations	28					

The Rodney L. White Center for Financial Research

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The Rodney L. White Center for Financial Research is one of the oldest financial research centers in the country. It was founded in 1969 through a grant from Oppenheimer & Company in honor of its late partner, Rodney L. White. The Center receives support from its endowment and from annual contributions from its Members.

The Center sponsors a wide range of financial research. It publishes a working paper series and a reprint series. It holds an annual seminar, which for the last several years has focused on household financial decision making.

The Members of the Center gain the opportunity to participate in innovative research to break new ground in the field of finance. Through their membership, they also gain access to the Wharton School's faculty and enjoy other special benefits.

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