The Rodney L. White Center for Financial Research

On Replicating the S&P 500 Index

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08-02

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Abstract

To minimize tracking error, S&P 500 index funds often follow inflexible, nearly exact replication strategies. This inflexibility causes stocks with relatively low floating supply to experience abnormally high negative or positive returns upon addition or deletion on average. Moreover, the alternative of trading at the open following the announcement of a change, rather than when the change occurs, results in 25.9 basis points more return per year with virtually no incremental variance. If investment principals knew in advance of these additional returns, they may nonetheless have rationally chosen to forgo such added returns to better monitor their agents. The early-trading strategy has much higher tracking errors than the 2.7 basis-point average of the largest indexer. [JEL: G12]

This version: April, 2002

We have received helpful comments and advice from Richard Kihlstrom, Craig MacKinlay, David Musto, Gus Sauter, Duane Whitney, Jeffrey Wurgler, and participants at the Wharton Finance Friday-lunch workshop, the European Financial Association meetings, Virginia Tech, Arizona State University, Penn State University, and the University of North Carolina at Chapel Hill. However, the authors bear full responsibility for errors and omissions. We gratefully acknowledge financial support from the Rodney L. White Center. Jianshan Xu has provided outstanding research assistance, and we thank him.

Moneys invested to replicate 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 major asset class, there has been little research into the investment strategies that indexers use.

In evaluating an investment strategy, an indexer's obvious concern is tracking error, defined as the difference between its portfolio return and the index return. Any tracking error, be it positive or negative, indicates a failure to track the index. In practice, tracking errors are often small. The average absolute tracking error for Barclays Global Investors, the largest indexer, is 2.7 basis points per year over the last decade. As shown below, the strategy of an indexer desiring such low tracking errors must conform quite closely to an exact-replication strategy. An exact-replication strategy entails holding all 500 stocks in the index and adjusting the portfolio for any change in the index at the closing price on the day of that change.

An extreme focus on tracking error precludes slight modifications in strategy that may offer additional returns with little or no increase in total risk. As an example, prior studies have found uniformly that when a stock is added to the index, that stock realizes on average positive abnormal returns from the announcement day through the change day, and when a stock is deleted, that stock realizes negative abnormal returns. Thus, trading as soon as possible after an announcement of a change might enhance an indexer's return.

This study indeed finds that an indexer that adjusts the portfolio weights at the opening price on the day following the announcement of a change, rather than at the closing price on the day of the change, would gain an additional return of 25.9 basis

points per year. Even though the return increases, the standard deviation of portfolio returns remains the same to three digits—almost a case of stochastic dominance.

The question then is why indexers, if they knew in advance of this additional return, did not try to capture it when there is virtually no increase in total risk. The answer may lie in agency theory. As shown below, capturing this additional return results in tracking errors that are much greater than those of Barclays. If tracking error is a measure of the ability of a principal to monitor an agent, a principal might well select an index strategy with small tracking error instead of a higher return or enhanced strategy with larger tracking error. If so, these 25.9 basis points can be interpreted as a direct measure of agency costs of delegating investment discretion.

The paper is organized as follows: Section 1 describes investment strategies that have been used to replicate the S&P 500 and discusses the magnitudes of the possible tracking errors. Section 2 analyzes the volume and return reaction of stocks that are added to or deleted from the S&P 500 around the event and how restrictions on the floating supply of a stock affect the magnitudes of these returns. Section 3 concludes the paper.

1. Strategies to Replicate the S&P 500

The S&P 500 is widely publicized, broad-based, and frequently used as a benchmark. 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 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.[1]

[1] Board of Governors of the Federal Reserve System (2001), p. 82

Annually, S&P publishes a list of the leading S&P 500 fund managers and their assets under management. These assets totaled nearly $1 trillion as of the end of 2000: $870 billion in non-enhanced products and $63 billion in enhanced products. These investments represent 8.0 percent of the total market value of the index. The actual money invested to replicate the S&P 500 is probably greater than the S&P cites, as S&P includes only the assets of identified managers.

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 included in the index "tend to be the leading companies in leading industries within the U.S. economy."[2] 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.[3] For small changes, S&P waits until the end of the calendar quarter to update its index. The S&P index, including its closing value, is

[2] Standard & Poor's (2001), p. 2.
[3] Ibid., p.33

always based upon the last transaction price on the primary market, not the composite price on 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.[4] 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 adjust its portfolio weights to any such changes at these closing prices. To do so, 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, other changes to the index, such as a reduction of shares outstanding when a company repurchases its own stock, 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. As shown below, these strategies are likely to produce greater tracking error, but have the potential of reducing trading costs or, equivalently, of enhancing returns.

The choice between exact replication and sampling is driven by the tradeoff that an indexer faces between enhanced returns and potential 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 with the goal of replicating the S&P 500, or roughly one-quarter of all money indexed to the

[4] Ibid., pp 61-62

S&P 500. Barclays reports that from 1991 through 2000, its Equity Index Fund had an average annual absolute tracking error of 2.7 basis points with a maximum error of 7 basis points in 1997 and a minimum error of –1 basis point in 1992. These errors exclude management fees and other fees that Barclays charges directly to its clients. The standard deviation of its annual tracking error is 2.5 percent.

Prior to 1998, the tracking errors before expenses of the Vanguard 500 Index Fund were similar to those of Barclays—1 basis point in 1997 and 2 basis points in 1998. After expenses, the tracking errors were -17 basis points in 1997 and -19 basis points in 1998. From 1998 on, Vanguard appears to have been willing to accept more tracking error before expenses in an attempt to enhance its returns. Before expenses charged to the fund, its tracking error was 23 basis points in 2000, 21 basis points in 1999, and 22 basis points in 1998. After expenses, the tracking error was 5 basis points in 2000, 3 basis in 1999, and 4 basis points in 1998. Thus, during each of these three years, Vanguard was able to enhance returns sufficiently to cover its expenses. From 1998 on, it appears that Vanguard has deviated somewhat from an exact-replication strategy, and consistent with this observation, Vanguard states in its prospectus that it will use derivatives when "favorably priced."

The examples of Barclays and Vanguard demonstrate the tradeoff between tracking error and potential enhancements to return. Still, even for the Vanguard 500 Index fund, the tracking errors are small in comparison to more active management. For comparison, the tracking errors for the actively managed Vanguard Windsor, which frequently compares itself to the S&P 500 and has a performance fee based upon this

index, was 2500 basis points in 2000, -947 basis points in 1999, and -2777 basis points in 1998.

1.3 The Strategies of Mutual Funds

For the most part, the investment strategies of mutual funds indexed to the S&P 500 approximate exact-replication strategies, as these funds tend to hold virtually every stock in the index. As of December 31, 2000, the Morningstar database contained information on 3,110 domestic diversified equity funds with a three-year track record.[5] Their combined assets totaled $2.5 trillion. Of these 3,110 funds, 84 had in their name the words "index" or "S&P 500," or some variant. All have a beta with respect to the S&P 500 of between 0.98 and 1.01, and all but one have an R-squared of 1.00. The assets of these funds represent 9.3 percent of the assets of all domestic diversified equity funds.

Of these 84 funds, 65 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 held only 240 stocks. These numbers are consistent with the proposition that the investment strategies of most S&P index funds approximate an exact-replication strategy.[6]

1.4 The Logic of an Exact Replication Strategy

That most mutual funds whose goal is to track the S&P 500 hold approximately 500 stocks is no accident. It is virtually impossible to maintain tracking errors in the

[5] 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.

[6] That most of these funds hold roughly 500 stocks does not in itself indicate that they follow an exact-replication strategy. To establish this result would require that the weights of the stocks in their portfolios equal the weights in the S&P 500 for the same date. 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.

neighborhood of the 2 to 3 basis points reported by Barclays without holding all 500 stocks in close proportions to the weights in the S&P 500. As shown below, omitting even a few stocks is likely to introduce unacceptable tracking errors.

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 even those of Vanguard. Even with an R-squared of 0.9999, the standard deviation of the tracking error is still 20 basis points per year.

To demonstrate further 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

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

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

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

where $\overline{\varepsilon_{500}}$ 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, slightly 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 $\overline{\varepsilon_{500}}$ is replaced with some other weighted average $\overline{\varepsilon_n}$.

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 all the

stock 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.

In sum, an indexer that wishes to maintain tracking errors of the small magnitudes that Barclays has obtained must invest in ways that closely approximate an exact-replication strategy. Specifically, such indexers must make most of their adjustments to changes in the index at or close to the closing price on the day of the change.

2. Volume and Return Reactions

Prior literature has found that the abnormal returns for additions to the S&P 500 averaged around 3 percent in the 1980s and have gradually increased to 7 percent or more in the 1990s.[7] Subsequent to the addition, most studies find some reversal of the prior abnormal returns, but the reversal is not complete.[8]

The empirical analyses in this section update the results of prior studies, particularly that of Beneish and Whaley (1996), and expand them in four ways. First, this study exploits systematically the implications of an exact-replication strategy to classify additions and deletions according to the level of trading in which indexers would engage. Second, it presents separate analyses for NYSE-listed stocks and Nasdaq-listed stocks.[9] The reason is that the NYSE has a formal closing mechanism that facilitates the execution of orders at the closing price. The Nasdaq has no such formal mechanism,

[7] The studies of the 1980s include Shleifer (1986), Harris and Gurel (1986), Dhillon and Johnson (1991), and Edmister, Graham, and Pirie (1994) The studies of the 1990s include Beneish and Whaley (1996), and Bos (2000).). The exception to the 1990 studies is Lynch and Mendenhall (1997), who study the first half of the 1990s and find only a 4 percent abnormal return.
[8] Only Harris and Gurel (1986) report a complete reversal.

which may make it more difficult to trade the desired volume at the closing price. Third, it examines the implications of indexing strategies with intraday trading and return data. If all indexers follow an exact-replication strategy, the trading volume at the close on the change date, as a percent of shares outstanding, should be around 8 percent. Fourth, it relates the magnitude of the abnormal return of added or deleted stocks to the floating supply of the shares of those stocks. When S&P adds a stock to its index, exact-replication indexers must buy that stock in proportion to its shares outstanding, and those shares must come from the floating supply. When that floating supply is restricted, indexers must therefore buy a greater proportion of that supply. A plausible conjecture is that the price must rise by a greater percentage to induce a greater proportion of the holders of the floating supply to sell their stock. Similarly, when a stock is deleted and its floating supply is restricted, its price must drop by a greater percent.

This section begins with a description of the data. It then presents the empirical results on volume and returns.

2.1 Data

The primary data sources are Vestek, TAQ, CRSP, S&P Directory, and SEC Forms 14-A and 13-G. The Vestek database provides at month-end the following information for each stock in the index: Cusip number, shares outstanding, and the month-end closing price.[10] To obtain shares outstanding within a month, the month-end shares outstanding from Vestek are adjusted forward using the share adjustment factors

[9] We thank Gus Sauter for suggesting this partition.

[10] 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. On occasion, the shares outstanding from the two sources differ substantially. Since the Vestek numbers are contemporaneous and the S&P 500 is calculated with contemporaneous data, the Vestek

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. The composite closing prices come from CRSP, and the closing prices on the primary market come from TAQ. TAQ is also the source of intraday volume and trade prices. The S&P Directory is the primary source for the announcement and change dates. The holdings of insiders come from the SEC filings and are used to measure the floating supply.

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 Change Characteristics

Over the six years from 1995 through 2000, S&P announced 235 changes to the S&P 500. There are slightly more changes in the last three years of the sample than in the first three years (Table 1). The number of Nasdaq-listed companies that S&P has added has gradually increased from 4 of 33 companies in 1995 to 24 of 58 stocks in 2000.

The trading activity of exact-replication indexers varies according to the nature of the change. Some changes require no trading: 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.[11] When S&P adds a non-S&P company, a company not already in the index, or deletes an S&P company, an exact-

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numbers on shares outstanding are used to track more closely the shares used by S&P.

[11] 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

replication indexer must buy or sell the effected stock in proportion to its market value. Of all types of additions, this type requires the maximum trading. Finally, 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.

A change to the index that this paper classifies as a no-trading event could still generate abnormal volume and returns, though it would not be due to the trading of exact-replication indexers. The 1984 split-up of AT&T into eight new companies, a new AT&T and seven Baby Bells, illustrates this phenomenon. When the Baby Bells started trading on a when-issued basis in mid-November of 1983, S&P had not yet announced which of these eight companies would be included in the index, and the press indicates that there was uncertainty as to which companies would be included. Upon the split-up, exact-replication indexers would receive shares in all eight companies. If some of these eight companies were not included in the index, these indexers would have to sell those companies. If demand curves for individual securities were downward sloping, this selling by indexers would result in price declines. In this situation, other market participants might assess the probability that a specific Baby Bell would be excluded from the index and trade in anticipation of the price decline. Any such anticipatory trading would likely cause some of the potential price adjustment to occur prior to the S&P announcement. When S&P ultimately makes its announcement, the uncertainty

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company, the acquired company is dropped and another non-S&P company added.

about which companies would be dropped from the index is resolved and there may be further price adjustments with perhaps greater than normal volume based on this new information.

On November 30, 1983, Dow Jones announced that the new AT&T would be included in the Dow 30 and that the seven Baby Bells would not be included; in this same story, Dow Jones reported as if it were a foregone conclusion that AT&T would be also added to the S&P 500. On December 1, 1983, S&P made the surprising announcement that all seven Baby Bells would be in the index.[12] On December 2, market participants adjusted their holdings based on this new information. The volume of the seven Baby Bells averaged 274 percent of the average daily volume over the prior three days and the average return on the Baby Bells was 1.1 percent, which compares to the S&P return on that day of -0.6 percent.

How other market participants react to any change in the index depends upon the degree to which the change is anticipated. If S&P's announcement were a complete surprise, market participants could only trade after the announcement in anticipation of the demand from indexers. If the announcement were anticipated, some trading would likely occur before the announcement and some trading after the announcement as the uncertainty is resolved.

The sample of additions includes 180 of maximum trading, 26 of indeterminate trading, and 23 of no trading (Table 1). The sample of deletions includes 46 of maximum trading, 65 of indeterminate trading, and 89 of no trading. Six additions and 35 deletions were not analyzed for one of the following four reasons. First, the announcement

[12] Fowler (1983) writes in The *New York Times* of December 1, 1983: "Surprising many on Wall Street,

occurred after the firm ceased to exist or there was no trading on the day of the change. Second, the announcement preceded the change date by more than 30 days. Third, the share price on the announcement day was less than $5.00; Keim (1989) shows how the large percentage spreads on low-price stocks can introduce errors in the calculation of returns. Fourth, the firm went bankrupt.

Classifying additions and deletions according to the trading implications of an exact-replication strategy differs from prior studies that have classified changes according the proximity of major news stories. For example, Beneish and Whaley (1996) divide changes into those with and without contemporaneous news stories, where contemporaneous news stories are defined as occurring within two days of the announcement. They analyze only those changes without contemporaneous news to separate price and volume effects from news stories. Thus, their sample, like those of other prior studies, may include events that this study would classify as having indeterminate or no trading activity.

2.3 Volume

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 announcement itself always occurs after the close of trading on the primary market. The term "day" will always be used below to mean trading day. Daily abnormal volume for a stock is defined as the difference between the actual volume for

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the Standard & Poor's Corporation yesterday added to its 500-index all seven of the regional companies. . .

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 calculates actual 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. Normal volume for any interval is defined as the average actual volume for that interval over the prior 40 days preceding the announcement. In these cases, this study does not present abnormal volume.

2.3.1 Daily volume

The cumulative abnormal volume for additions and deletions is consistent with the classification of changes as maximum, indeterminate, or no trading (Table 2). For maximum-trading additions, the cumulative abnormal volume is 7.4 percent for NYSE-listed stocks and 16.4 percent for Nasdaq-listed stocks; for maximum-trading deletions, the cumulative abnormal volume is 9.0 percent for NYSE-listed stocks and 13.8 percent for Nasdaq-listed stocks. These percentages exceed those for changes classified as indeterminate trading. Changes classified as no trading have cumulative abnormal volume that is either statistically indistinguishable from zero or close to zero.

Cumulative abnormal volume for Nasdaq-listed stocks is considerably larger than that for the NYSE, consistent with Nasdaq's being primarily a dealer's market and the NYSE's being primarily an auction market. On Nasdaq, a trade is often reported twice--once when the dealer buys from the public and once when it sells to the public. On the NYSE, public investors more often than not trade directly with each other, resulting in only one report of the trade. Thus, comparing volume across the two markets should be done with great care.

When the change occurs two or more days after the announcement, the bulk of the cumulative abnormal volume for events of maximum trading occurs on the day of the change, with an additional 5.3 percent of shares outstanding above normal changing hands for NYSE-listed stocks and 12.7 percent for Nasdaq-listed stocks (Table 3). This abnormal volume for NYSE-listed stocks is about two thirds of the estimated proportion of the market value of the S&P 500 that is indexed. Because of the dealer structure of Nasdaq, reported volume cannot readily be compared to the required trading by indexes. When the change occurs the day following the announcement, the abnormal volume is 8.1 percent for NYSE-listed stocks and 13.00 for Nasdaq-listed stocks. Volume remains abnormally high on the day following the change, and then falls to near normal levels. The results are similar for deletions.

2.3.2 Intraday Volume

When an addition of an NYSE-listed stock occurs two or more days after the announcement, the volume on the change day is thus only two thirds of the volume that would be required if all indexers followed an exact-replication strategy. Importantly, a substantial portion of this volume occurs before the close. The actual, not abnormal, volume for NYSE-listed stocks before the close totals 2.10 percent, leaving 3.63 percent at the close (Table 4). The closing volume itself is spread across markets: 2.39 percent on the NYSE, 0.97 percent on Nasdaq, and 0.27 percent on other markets. Nasdaq's volume at the close is 6.97 percent, but since Nasdaq is a dealer's market, as mentioned above, this volume overstates the actual trading from one public investor to another. The qualitative results are comparable for deletions. Similarly, when the change occurs the day following the announcement, a substantial portion of the volume occurs before the

close. Thus, the holdings of a large fraction of indexed assets appear to be adjusted not only at the close but during change day as well.

In comparison, the actual volume on the day after the announcement when the change occurs two or more days later is much smaller. In particular, the volume at the first opportunity to trade in normal business hours, the 9:30 – 10:00 A.M. period, is 0.28 percent for NYSE-listed stocks and 0.93 percent for Nasdaq-listed stocks. This relatively low volume in comparison to the proportion of indexed investments confirms that most indexers do not adjust their portfolio immediately after the announcement. It further suggests that the positions taken by arbitrageurs in normal trading hours after the announcement are small compared to the shares that will subsequently change hands.

2.4 Returns

Returns are measured three ways: raw returns; returns conditional on a one-factor market model, using the CRSP value-weighted index; and returns conditional on a three-factor model, using the CRSP value-weighted index, the CRSP small cap or decile-one stock index, and the Nasdaq 100 index. The factor coefficients are estimated using weekly returns immediately preceding the announcement date. Three years of data are used when available, but never less than one year. CRSP reports consolidated closing prices, whereas S&P uses the closing prices on the primary market. For Nasdaq-listed stocks, the two are the same, but if the last trade of a NYSE-listed stock occurs on another market after the last trade on the NYSE, the two can differ. The difference can be particularly pronounced when the last trade occurs on the Pacific Stock Exchange, which closes a half hour later than the NYSE at 4:30.

To account for these differences, this paper uses the closing prices on the primary market in calculating the raw returns from the announcement day forward, not the prices from CRSP. The raw returns are adjusted for stock dividends and splits but not cash dividends, while the returns from CRSP are further adjusted for cash dividends. These differences produce a slight inconsistency in the conditional returns. For instance, the one-factor conditional return is the raw return calculated with closing prices from the primary market less the return conditional on the CRSP value-weighted index, which is based upon consolidated closing prices and dividends. In principle, this inconsistency could bias the results, but it will turn out that the pattern of the actual returns is very similar to the pattern of the conditional returns.[13]

2.4.1 Announcement through Change Date

The returns from the close on the announcement day to the close on the change day conform to predictions (Table 5). The factor-adjusted returns are slightly less than the unadjusted returns, as the factors had positive means over the sample period. However, the differences across measures are not large. The average return for events of maximum trading is 10.1 percent for additions and -10.2 percent for deletions. The average return for events classified as indeterminate or no trading range are generally insignificant, although the estimates for indeterminate events is generally about half that of maximum events.

The magnitudes of the returns for maximum-trading changes are greater than those reported in most prior studies. There are three possible reasons. First, there has

[13] Another bias stems from the use of weekly data in estimating the factor models and then applying these models to obtain daily conditional expected returns. Again the empirical results below indicate that any such bias is trivial.

been a steady increase in these returns from the 1980s through the 1990s, and the time period for this study is at the end of this period. Second, as pointed out above, every change in this study is analyzed conditional on the trading activity of exact-replication indexers, and most previous studies have not systematically excluded events requiring no trading or indeterminate trading.[14] An estimate of the bias from including all additions is 1.23%, the difference between the abnormal return of 10.10% percent for additions of maximum trading and the abnormal return of 8.87% for all additions. Third, with the exception of Beneish and Whaley (1996), prior studies have used the consolidated closing price to measure returns, rather than the closing price on the primary market; as pointed out above, these prices can sometimes be significantly different.[15] To assess the potential bias, the study recalculated the actual returns for additions of maximum trading using consolidated prices from CRSP. The resulting return is 0.45 percent less than that using the closing prices on the primary market.

There is a substantial difference in average returns for additions of maximum trading between NYSE-listed and Nasdaq-listed stocks: 8.7 percent for NYSE and 13.2 percent for Nasdaq. Similar differences occur for deletions: –9.9 percent for NYSE-listed stocks and –12.6 for Nasdaq-listed stocks. The analysis below finds that neither time trends nor obvious variations in the characteristics of firms listed on the NYSE and on Nasdaq fully explain these differences.

[14] An notable exception is Bos (2000), which excludes events that in this study are classified as events of no trading but does include some events that this study would classify as indeterminate trading. As a consequence, the magnitude of the price effects that Bos reports is closer to those of this study than to other studies cited in footnote 7.

[15] For example, on the day of the announcement that America Online, Inc., would be added to the index, the following occurred in chronological order. AOL closed trading on the NYSE at $122.875. S&P announced that AOL would be added to the index. AOL closed trading on the Pacific Stock Exchange at $138.00. CRSP recorded a closing price of $138.00.

2.4.2 The Immediacy of the Adjustment

Beneish and Whaley (1996) find that the returns to a stock that was added to or deleted from the S&P 500 from October 1989 through June 1994 did not adjust fully immediately after the announcement. They conjecture that this phenomenon will "disappear." This study finds that it has not disappeared, but that it has diminished.

When the change day for an addition occurs two or more days after the announcement, the average return from the close on the announcement day to the open the next day is 5.6 percent for NYSE-listed stocks and 8.2 percent for Nasdaq-listed stocks (Table 6, Part A).[16] There is a further additional return of 3.2 percent from this opening to the closing price on the primary market on the day of change for NYSE-listed stocks and 5.0 for Nasdaq-listed stocks. Thus, roughly two-thirds of the adjustment occurs immediately regardless of the market, leaving one third of the price adjustment occurring after the open following the announcement. When the change day occurs immediately after the announcement, most of the adjustment takes place on average by the open of the change day. To put these numbers in perspective, Beneish and Whaley (1996) found that only that 45 percent of the adjustment occurs immediately, leaving 55 percent of further adjustment after the open following the announcement.

For deletions, a substantially greater fraction of the adjustment in prices occurs from the opening following the announcement to the close on the change dates. Beneish and Whaley (1996) did not examine deletions. The average returns for deletions are greater in magnitude for Nasdaq-listed stocks than for NYSE-listed stocks, but the returns

[16] The opening price for Nasdaq-listed stocks is the volume-weighted average price over the first five minutes of trading. This is the price that is used in the calculating the exercise-settlement value of NDX options. Cf: Market Regulation Committee v. Morgan Stanley & Co, Inc., et al. (2000), footnote 6.

for Nasdaq-listed stocks should be viewed with caution. These returns are based upon only five observations. In view of this limited number of observations, the text will not report further any returns for Nasdaq deletions.

One possible reason for the slower adjustment of prices for deletions is that it may be more expensive to trade in anticipation of subsequent price movements of deletions, as these trades may involve short sales. Another possible reason is that the average market value of maximum-trading additions is more than tenfold the average market value of maximum-trading deletions—$10.5 billion versus $0.8 billion. If there are fixed costs of taking a position, trading strategies involving additions are more profitable than those involving deletions.

It is important to note that returns from the opening after the announcement to the close on the change date are quite variable; for instance, the standard deviation of NYSE-listed additions with two or more days to the change is 9.2 percent.[17] Although an exact-replication indexer might on average add return by trading at the opening, the tracking error from any particular trade could be negative and substantial. More generally, if principals monitor indexers by the magnitude of their tracking error, any tracking error, be it positive or negative, indicates failure to track the index.

2.4.3 Reversals

Consistent with prior studies, the returns following the change day partially reverse the abnormal returns prior to and including the change date. From the close on the primary market on the change date to the close on the primary market on the following day, the return for NYSE-listed additions of maximum trading is –-0.80

[17] These standard deviations are not reported in the tables.

percent, but much of this return, -0.53 percent, occurs from the close on the change date to the opening on the next day on the primary market. The reversal for Nasdaq-listed stocks is greater than for NYSE-listed stocks: -2.00 percent from the close on the announcement day to the next day close with -1.28 percent of this reversal occurring by the opening of the next day. In contrast, most of the reversal for NYSE-listed deletions occurs not from the close to the open, but from the open following the change date to the close of that date.

There is a further reversal from days 2 through 20 after the change date for both additions and deletions. For additions, the reversal averages –3.49 percent; for deletions, it averages 1.68 percent.

2.4.4 Returns on Change Day

When an addition of maximum trading occurs two or more days after its announcement, the average return on the change day from open to close is 0.92 percent, indicating that even by the change date, the prices have not fully adjusted. There are substantial differences within the day between the NYSE and Nasdaq. Virtually all of the price adjustment on the NYSE occurs in the last hour of trading. The average return in this last hour is 0.75 percent, while the return from the opening price to 3:00 is virtually zero. Throughout this entire trading day, returns are highly volatile. For instance, the standard deviation of returns in this last hour is 2.84 percent. In contrast, the price adjustments for Nasdaq-listed additions occur throughout the trading day. The volatility of these returns is even greater than the volatility of NYSE stocks.

2.4.5 Floating Supply and other Variables

The extreme price increases experienced by Yahoo! following the announcement of its addition to the S&P 500 was a main motivator for undertaking this study. Its price increased from $212.75 at the close of trading on the announcement day to $348.00 at the close on the change date—an extraordinary increase of 64 percent. At the time, the floating supply of Yahoo! was only 40 percent of the shares outstanding; if all indexers had followed an exact-replication strategy, they collectively would have acquired approximately 8 percent of the shares outstanding on the change date, which translates into 20 percent of this floating supply.

The returns for the Yahoo! addition lead to the conjecture that the magnitude of the abnormal returns of an addition and deletion is a positive function of the holdings of insiders. To induce a larger proportion of the holders of the floating supply to sell their stock when it is added to the S&P 500, the price must rise by a greater percentage; when a stock is deleted, the price must fall by a greater percentage to induce investors to buy it.

The multivariate analysis of maximum-trading changes confirms this conjecture (Table 7). The dependent variable is the percentage abnormal return from the close on the announcement day to the close on the change day, as estimated by the three-factor model using prices from the primary market. To combine both additions and deletions in one regression, the sign of the abnormal return for deletions is reversed. Statistical significance is calculated with heteroskedastic-corrected standard errors.

The initial set of explanatory variables includes insider holdings as a percentage of shares outstanding, the root mean square error from the three-factor model, and the raw return over the year preceding the change. Additionally, the natural logarithm of the

market capitalization of shares outstanding and yearly dummies are included as controls to verify robustness. Any analysis including both NYSE-listed and Nasdaq-listed stocks includes a dummy variable with a value of 1 for Nasdaq-listed stocks.

The predicted sign on insider holdings is positive, as in the Yahoo! example. Root mean-square error is a measure of substitutability of the added or deleted stock with other stocks; smaller values indicate greater substitutability. The arguments of Wurgler and Zhuravskaya (1999) predict that this sign will be positive. This sign is also predicted to be positive if there are indexers who follow a sampling strategy. When a stock becomes a part of the index, its idiosyncratic variance becomes a part of the index return. When idiosyncratic variance is high, sampling indexers are more inclined to buy the stock to capture this component of returns. When idiosyncratic variance is low, they may instead buy substitutes or not trade at all, thereby avoiding the adverse price change of the added stock. A similar argument applies to deletions. The predicted sign on the one-year prior return is positive for tax reasons, as discussed in Blouin, Raedy, and Shackelford (2001). Further, the univariate evidence in this paper suggests a return difference between NYSE and Nasdaq stocks. The dummy variable for a Nasdaq listing accounts for this possibility in the multivariate analysis. Finally, a separate multivariate analysis is performed for NYSE and Nasdaq stocks to determine whether the relation between returns and the other variables differs across market structure.

As predicted, the coefficient on the insider holdings is positive: 0.27 with a t-statistic of 4.1. The coefficient on mean-squared error is 1.00 with a t-statistic of 1.9, consistent with the evidence in Wurgler and Zhuravskaya. The coefficient on the Nasdaq dummy is 3.2 with a t-statistic of 2.5, indicating that the structure of the market matters

even after controlling for the other factors. The coefficient on the prior one-year return is indistinguishable from zero.

An examination of the residuals reveals three potential outliers associated with the addition of Yahoo!, Broadcom, and Broadvision, all internet stocks. The coefficient on insiders excluding these observations is 0.18 with a t-statistic of 3.4. Other robustness checks also find a significant relation between event returns and insider holdings.[18]

The reason for the statistically significant coefficient on the market-structure dummy is unclear, as there are no obvious structural differences between the NYSE and Nasdaq that would explain a lasting difference in returns. Perhaps, the same explanation of a favorable news story that applies to internet stocks also applies more generally to any technology stock during 1999 and 2000, and, since Nasdaq lists more of these stocks than the NYSE, the market dummy is picking up this effect.[19]

2.5 Enhancing an index return

That the prices of stocks added to and deleted from the S&P 500 do not always adjust fully by the opening of the day following the announcement suggests that a strategy of buying and selling immediately at the open could add value. The section addresses two questions: First, what is the additional return? Second, what is the effect

[18] To examine the sensitivity of these results to any internet effect, two analyses are run. The first reruns the regression of abnormal returns on the first part of the sample from January 1995 through November 1998, a period prior to the internet era. The coefficient on insiders is 0.10 with a t-value of 1.9. The second reruns the regression on the last part of the sample from January 1997 through December 2000 but with the addition of a proxy for internet likeness, which is measured by the coefficient in a regression of each stock's return on an internet index. The internet index is TheStreet.com index from January 1999 and after and an equal-weighted average of all available component stocks in that index prior to January 1999. The coefficient on insiders is 0.274 with a t-statistic of 2.5. In both regressions, the other independent variables are the logarithm of market value and the exchange dummy.

[19] Cooper, Dimitrov, and Rau (2000).

on tracking error? In regard to this second question, recall that Barclays' average absolute tracking error over the past decade is 2.7 basis points per year.

The data that S&P uses in calculating its index differs in two important ways from the data available through CRSP and Vestek. First, S&P uses the closing prices from the primary market and not consolidated closing prices. Second, S&P does not always adjust immediately the number of shares outstanding in its calculations to changes in the actual number of shares outstanding. Since basis points matter to index funds, this study recalculated the S&P 500 index using the prices, share adjustments, and price adjustments from CRSP and shares outstanding from Vestek. The resulting series is the same as Standard & Poor's would have calculated had it used these publicly available data. The recalculated series of monthly returns averaged 0.007 basis points less than the S&P monthly returns with a standard deviation of 0.05 basis points. Thus, the recalculated S&P 500 tracks the actual S&P 500 quite closely.

Using these publicly available data, this study calculated the return on a strategy that traded those stocks that were added to or deleted from the index at the opening price following the announcement instead of at the close on the change date. There are two exceptions to this strategy. First, in some cases, a stock did not trade until it was 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. Second, there was, of course, no trading for additions and deletions for which an exact-replication indexer would not have to trade.

From 1995 through 2000, buying at the opening adds an average of 2.2 basis points per month, and the monthly standard deviation of this additional return or tracking

error is 5.4 basis points, implying a t-statistic of 3.49. On an annualized basis, the additional return is 25.9 basis points, and the standard deviation of the tracking error is 18.6 basis points.[20] In each of these six years, the annual tracking error is positive.

The incremental return was particularly large in three months in 1999 and 2000: 31.7 basis points in December 1999, 13.4 basis points in June 2000, and 18.1 basis points in July 2000. But even if the two years containing these months are excluded, the strategy of buying at the opening following the announcement adds additional returns. From 1995 through 1998, the monthly additional return is 2.0 basis points with a standard deviation of 3.1 basis points, implying a t-statistic of 4.47. On an annualized basis, the additional return is 23.6 basis points, and the standard deviation of the tracking error is 10.8 basis points.

Some index fund managers may find tracking errors with an annual standard deviation of 18.6 percent unacceptable. However, from an investor's point of view, the standard deviation of a portfolio's returns from either buying at the open following the announcement or at the close on the change day is the same to three significant figures—4.28 percent per month. If this early-trading strategy of buying at the open has a greater expected return with no change in standard deviation, it would stochastically dominate the exact-replication strategy.[21]

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[20] The annualized additional return is 12 times the monthly additional return, and the annualized standard deviation is the square root of 12 times the monthly standard deviation. These annualized numbers do not take into account compounding. One way to adjust for compounding is to average the difference of the six calendar annual returns of the two strategies; this average is 28.4 basis points. There are not enough annual data to calculate reliably the standard deviation of annual tracking errors with compounding.

[21] Stochastic dominance involves a choice between two mutually exclusive portfolios. An investor who holds other assets as well will also be concerned with the covariances between pairs of assets. It is likely that the covariance of the replicated S&P index with any other asset will be similar in value to the covariance of the early-trading strategy with that asset. The correlation of returns between the replicated

That trading at the opening price following the announcement rather at the closing price on the change day increases returns over the years 1995 through 2000 should come as no surprise. It has already been established that, on average, not all of the adjustment of price to an announcement of a change in the index occurs immediately. The salient result in this section is that this delay translates into an added return of 25.9 basis points per year but with a tracking whose standard deviation is 18.6 basis points. This additional return may be a lower bound, as this paper has not examined index substitution strategies using derivatives—a strategy that Vanguard can use.

3. Conclusion

Exact replication of the S&P 500 index requires that an indexer adjust its portfolio to any changes in the index at the close of trading on the day of the change. Even small deviations from such a strategy can result in tracking errors that are substantial when compared to the average absolute tracking error of 2.7 basis points obtained by Barclays, the largest indexer. That most S&P 500-index mutual funds hold close to 500 stocks is evidence consistent with indexers following an exact-replication strategy. However, the closing volume on the day a stock is added to or deleted from the index is less than half of what is predicted if all indexers were following an exact-replication strategy. These facts suggest that many indexers do deviate somewhat from an exact-replication strategy; the small deviations that they do take are presumably to enhance returns, but at the expense of small tracking error.

S&P index and the early-trading strategy is 0.999922, suggesting that correlation of the returns of either strategy with the returns of another asset will be close to 1. That the standard deviation of either strategy is the same to three decimal places establishes that the covariances will be similar in value whichever strategy is used.

An exact-replication strategy requires that an indexer hold each stock in proportion to its market value. If exact replication is the norm, a reasonable conjecture is that the demand of indexers in response to index changes will have a greater impact on prices as the supply of the stock becomes more restricted. The empirical results confirm this conjecture and suggest that an index weighted by floating supply might cause less distortion to asset prices, such as the Russell indexes or the Toronto Stock Exchange 300 Composite Index.[22]

This study finds that the price of a typical stock that is added to or deleted from the index and requires maximum trading does not adjust fully immediately after the announcement nor has it fully adjusted by the opening on the change date. The lag in the adjustment is less than that observed by Beneish and Whaley (1996) for the first part of the 1990s.

This finding suggests that an indexer could enhance realized returns by buying at the opening following the announcement rather than waiting until the close on the change date. Following this early-trading strategy, an indexer could have earned on average over the years 1995 through 2000 an addition 25.9 basis points per year. While this strategy increases the standard deviation of the tracking error to 18.6 basis points per year, it would have resulted in no significant change to the standard deviation of the portfolio return.

The obvious question is whether these additional returns of 25.9 basis points per year will persist in the future. The answer depends upon two factors: how quickly prices adjust after the announcement of a change and the number of additions and deletions per

[22] It is difficult to construct indexes that would have no distortionary effects on asset prices. Madhavan

year. Beneish and Whaley (1996) predict that the lag in the adjustment will "disappear," and this study confirms that the lag has diminished since the time period of their study. Further, there were twice as many changes from 1995 through 2000 as there were in the prior six years;[23] If these earlier years are closer to normal, there may be less opportunities in the future to profit from any lag in the price adjustment.

If an indexer traded at the open following the announcement in an attempt to capture this additional return, that indexer would incur additional tracking error. To the extent that indexers continue to focus on tracking error and do not try to capture this additional return, this additional return can be interpreted as a direct measure of agency cost. Indexers presumably focus on tracking error because the principals who hire them want small tracking errors as a means of monitoring them.

If all indexers tried to capture this additional return by trading at the open following the announcement, the lag in the price adjustment would likely disappear. In that case, indexers pursuing the early-trading strategy would just incur additional tracking error with no additional return. Thus, if tracking errors matter, the universal adoption of the early trading strategy is not a Nash equilibrium.

(2000) documents the distortionary effects from the way in which the Russell indexes are rebalanced.

[23] From January 1, 1989 through December 31, 1994, Standard & Poor's added and dropped 93 companies.

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Table 1

Additions and Deletions to the S&P 500

1995 through 2000

The sample contains all changes to the S&P 500 Index that were announced from 1/1/1995 through 12/31/2000. S&P publications and Lexis/Nexus are the primary sources for these changes. Panel A presents the total number of additions and deletions by year and by market place. Panel B presents the changes according the requred trading activities of full-replication indexers. Some changes require no trading, while other changes require buying or selling the affected stock in proportion to its market value--a change of maximum trading. Still other changes require an indeterminate amount trading. Panel B also documents the changes not analyzed and the corresponding reasons.

	Additions			Deletions		
A. Number of changes by year	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total
1995	29	4	33	29	4	33
1996	20	4	24	21	3	24
1997	24	7	31	27	4	31
1998	39	9	48	45	3	48
1999	27	14	41	39	3	42
2000	34	24	58	56	1	57
Total	173	62	235	217	18	235
B. Number of changes by type						
Maximum trading						
Subjective S&P change	124	56	180	32	5	37
Spin-off and both removed				9		9
Indeterminate trading						
S&P firm and non-S&P firm combine into S&P firm	13	1	14	11	1	12
S&P firm and non-S&P firm combine into non-S&P firm			-	38	3	41
Spin-off and one in index and one dropped from index	11	1	12	11	1	12
No trading			-			
Spin-off and both into index	14		14	3		3
S&P firm and S&P firm combine into S&P firm	8	1	9	81	5	86
Not analyzed						
Bankruptcy				1		1
No available data on change day	2		2	15	2	17
Price less than $5				12	1	13
More than 30 days between announcement and change	1	3	4	4		4

Table 2
Total Abnormal Volume
1995 through 2000

Panel A presents normal daily volume for stocks added to or deleted from the S&P index in units of percent of outstanding shares, calculated as the average for the 40 trading days prior to and including the announcement day. Abnormal volume is calculated by summing the actual volume between the announcement through the change day and subtracting the stock's normal daily volume times the number of days. Announcements of changes occur after the close of trading and the actual change occurs on the next or subsequent day. The table presents the sample averages with the t-statistic in parentheses.

	Additions			Deletions		
	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total
A. Normal daily volume	0.48	1.65	0.79	0.62	1.21	0.66
B. Cumulative abnormal volume, announcement through change date, by type						
Maximum trading	7.39	16.43	10.20	9.04	13.83	9.56
	(22.88)	(18.36)	(21.56)	(19.22)	(11.72)	(19.59)
Indeterminate trading	2.09	6.04	2.39	3.22	3.86	3.27
	(3.09)	(2.28)	(3.55)	(5.04)	(1.30)	(5.23)
No trading	2.02	3.14	2.07	0.83	-2.55	0.64
	(1.58)		(1.69)	(3.39)	(-0.49)	(1.78)
C. Number of observations						
Maximum trading	124	56	180	41	5	46
Indeterminate trading	24	2	26	60	5	65
No trading	22	1	23	84	5	89

Table 3
Daily Volume for Changes Requiring Maximum Trading
1995 through 2000

Volume is expressed as a percentage of share outstanding. Normal volume is the average volume over the 40 trading days preceding the announcement. Abnormal volume is the difference between a stock's average daily volume over the indicated period and and the normal daily volume for that stock. When there are three or more trading days between the announcement and the change, the table displays the average daily abnormal volume for the intervening days. Intervening days begin two trading days after the announcement and end one trading day before the change.Panel A presents the average abnormal volume, and panel B presents the number of observations. Each average abnormal volume has a t-value greater than 1.96.

	Additions			Deletions		
	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total
A. Average daily abnormal volume						
Announcement preceding change by two or more days trading days						
Day following announcement	1.13	2.78	1.63	1.03	1.49	1.08
Daily average for intervening days	0.41	1.11	0.61	0.54	1.33	0.63
Change day	5.29	12.70	7.53	6.51	9.39	6.83
Announcement with change the following day						
Change day	8.06	13.00	9.82	none	none	none
All events						
Day following change day	0.85	1.96	1.19	1.45	1.82	1.50
Days 2 - 20 after change day	0.13	0.30	0.18	0.25	0.61	0.29
B. Number of observations						
Announcement preceding change by two or more days						
Day following announcement	106	46	152	41	5	46
Intervening days	97	38	135	38	5	43
Change day	106	46	152	41	5	46
Announcement with change the following day						
Change day	18	10	28	none	none	none
All events						
Day following change day	124	56	179	40	5	46
Days 2 - 20 after change day	124	56	179	40	5	46

Table 4
Intraday Volume for Changes of Maximum Trading Events
1995 through 2000

Volume is expressed as a percentage of outstanding shares. Panel A presents normal volume defined as the average volume for the indicated time period over the 40 trading days preceding the announcement day and includes all events in panel B and C. Panel B displays average actual volume for those events where the change day is two or more days after the announcement, and panel C displays average actual volume for those events where the change occurs the day following the announcement. Panel B of table 3 contains the number of observations. Closing volume for NYSE-listed stocks is the sum of the NYSE volume at the close and the volume printed by other markets after 4:00 pm at the NYSE closing price. Closing volume for Nasdaq-listed stocks is the sum of the prints after 4:00 pm that are not labelled out of sequence. Italicized numbers indicate t-statistic of less than 1.96.

	Additions			Deletions		
	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total
A. Normal volume in pre-event period						
9:30 - 10:00	0.06	0.22	0.11	0.06	0.03	0.06
10:00 - 3:00	0.31	1.10	0.56	0.32	0.25	0.31
3:00 - 4:00	0.08	0.31	0.15	0.08	0.07	0.08
Close	0.01	0.05	0.02	0.02	0.01	0.02
Number of observations	124	56	180	41	5	46
B. Actual volume for events with announcement preceding change by two or more days						
Actual volume on day following announcement						
9:30 - 10:00	0.28	0.93	0.48	0.24	0.26	0.24
10:00 - 3:00	1.02	2.84	1.57	0.99	1.21	1.01
3:00 - 4:00	0.24	0.75	0.39	0.24	*0.37*	0.26
Close	0.04	0.11	0.06	0.04	0.02	0.04
Actual volume on change day						
9:30 - 10:00	0.19	0.57	0.31	0.18	0.10	0.17
10:00 - 3:00	1.18	3.43	1.86	1.33	1.41	1.33
3:00 - 4:00	0.73	3.56	1.59	0.83	2.31	0.99
Close	3.63	6.97	4.65	4.66	5.93	4.80
Details on closing volume						
Volume on NYSE	2.39	none	1.67	3.46	none	3.08
Volume on Nasdaq	0.97	6.97	2.79	0.90	5.93	1.44
Volume on other exchange	0.27	none	0.19	0.31	none	0.28
Number of observations	106	46	152	41	5	46
C. Actual volume for events with the change the following day						
Actual volume on change day						
9:30 - 10:00	0.73	0.77	0.74	none	none	none
10:00 - 3:00	2.85	4.28	3.36	none	none	none
3:00 - 4:00	1.17	3.15	1.88	none	none	none
Close	3.88	5.72	4.54	none	none	none
Details on closing volume						
Volume on NYSE	2.58	0.00	1.66			
Volume on Nasdaq	1.18	5.72	2.80			
Volume on other exchange	0.13	0.00	0.08			
Number of observations	18	10	28			

Table 5
Returns from the Announcement through the Change
1995 through 2000

Returns are from the close on the announcement day through the close on the change day and expressed as a percent. The one-factor model uses the return on the CRSP Value Weighted index. The three-factor model adds the return on the Nasdaq 100 index and the return on a small-cap portfolio (the CRSP decile 10 portfolio). Each stock's factor loading is estimated using weekly returns over the 1 to 3 years prior to the announcement day, if available. There were 8 additions with less than one year of prior returns, and these additions were not used. Italicized numbers indicate a t-statistic of less than 1.96 or only one observation.

	Additions			Deletions		
	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total
A. Cumulative abnormal return announcement through change date, by type						
Maximum trading						
raw returns	8.65	13.24	10.10	-9.87	-12.59	-10.17
1-factor abnormal returns	8.16	13.42	9.84	-10.58	-12.72	-10.81
3-factor abnormal returns	7.98	13.43	9.72	-10.73	-12.87	-10.96
Indeterminate trading						
raw returns	*5.87*	*2.70*	*5.63*	*1.62*	*-4.43*	*1.15*
1-factor abnormal returns	*5.83*	*8.30*	*6.04*	*1.22*	*-1.43*	*1.02*
3-factor abnormal returns	*5.62*	9.74	*5.96*	*1.08*	*-1.41*	*0.89*
No trading						
raw returns	*2.42*	*6.70*	*2.59*	*-0.11*	2.35	*0.03*
1-factor abnormal returns	*0.88*	*6.08*	*1.11*	*0.36*	*1.36*	*0.41*
3-factor abnormal returns	*0.52*	*5.50*	*0.75*	*0.31*	*0.22*	*0.30*
B. Number of observations						
Maximum trading	119	56	175	41	5	46
Indeterminate trading	22	2	24	60	5	65
No trading	21	1	22	84	5	89

Table 6
Returns for Various Time Intervals for Maximum-trading Events
1995-2000

This table contains average returns for various intervals for various types of events, taken from the TAQ dataset, in percent. These returns are adjusted for stock dividends and splits but not for cash dividends. Panel A displays average returns for events where the change date is two or more days after the announcement date; panel B displays average returns for events where the change date occurs the next day; and panel C displays returns following the change day for all of the events combined. The number of observations is the same as in panel C of Table 3. Italicized numbers indicate a t-statistic of less than 1.96.

	Additions			Deletions		
	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total
A. Announcement preceding change by two or more days						
Close on announcement day to next-day open	5.63	8.14	6.39	-4.50	-1.84	-4.21
Open following announcement to close on change day	3.22	4.96	3.74	-5.57	-10.86	-6.15
Percentage price adjustment occurring after the open	36%	38%	37%	55%	86%	59%
Change day						
Open to Close	0.80	*1.19*	0.92	-1.71	-4.47	-2.01
Open to 3:00 pm	*0.00*	*0.63*	*0.19*	*-0.98*	*0.19*	*-0.85*
3:00 pm to close	0.75	*0.55*	0.69	*-0.73*	-4.60	-1.15
B. Announcement with change the following day						
Close on announcement day to next day open	7.46	10.10	8.41	none	none	none
Open following announcement to close on change day	*0.01*	*1.98*	*0.71*	none	none	none
Percentage price adjustment occurring after the open	0%	16%	8%			
Change day						
Open to Close	*0.01*	*1.98*	*0.71*	none	none	none
Open to 3:00 pm	*-0.06*	*2.66*	*0.95*	none	none	none
3:00 pm to close	*0.02*	*-0.71*	*-0.25*	none	none	none
C. All Events						
Close on change day to next-day open	-0.53	-1.28	-0.76	*-0.25*	3.09	*0.12*
Close on change day to next-day close	-0.80	-2.00	-1.17	*0.70*	3.93	*1.06*
Days 2 - 20 after change day	*-1.83*	*0.80*	*-1.01*	*2.24*	13.77	*3.52*

Table 7
Conditional Returns from the Announcement through the Change for Maximum-trade Events
1995-2000

This table presents regressions of percentage abnormal returns on insider holdings and other variables estimated using the sample of maximum-trading events. The abnormal returns are those from the 3-factor model with the sign reversed for deletions. The independent variables are: insider holdings as a percent of outstanding shares, 5% holders other than insiders as percent of outstanding shares, an exchange dummy equal to 1 for Nasdaq-listed companies, a dotcom factor defined as the coefficient on TheStreet.com internet index in a 4-factor model, the natural logarithm of the market value of the outstanding shares measured in million of dollars, the residual RMSE in percent from the 3-factor model, the prior-year unadjusted return in percent, and year dummies. The pooled regressions include both additions and deletions. The sample period for those regressions that include the dotcom variable runs from December 1998 through December 2001, as December 1998 marked the inclusion of the first dotcom, AOL, into the internet index. Eleven observations were dropped from the sample: 3 changes for which insider holdings were unavailable (2 additions and 1 deletion) as well as the 8 changes for which there was less one year of prior returns. Heteroskedasticity consistent t-statistics are presented in parentheses.

	Pooled						Separate	
	NYSE	Nasdaq	Total	NYSE	Nasdaq	Total	Additions	Deletions
Intercept	23.02	-18.11	12.39	26.40	-54.83	9.26	-29.13	54.96
	(2.52)	(-0.83)	(1.31)	(2.15)	(-1.65)	(0.73)	(-1.35)	(3.61)
Insider holdings	0.15	0.49	0.27	0.17	0.45	0.33	0.25	0.21
	(2.01)	(5.70)	(4.08)	(1.53)	(6.10)	(3.42)	(4.06)	(2.24)
5% holders	0.04	0.06	0.04					
	(0.80)	(0.63)	(0.10)					
Exchange			3.24			5.07	3.24	-0.04
			(2.47)			(2.14)	(2.20)	(-0.01)
Dotcom				13.32	14.96	17.30		
				(1.22)	(2.65)	(2.60)		
ln (mktcap)	-1.16	0.49	-0.67	-1.41	3.07	-0.54	2.09	-3.78
	(-1.99)	(0.35)	(-1.17)	(-1.76)	(0.54)	(-0.66)	(1.49)	(-3.41)
Residual RMSE	0.54	1.70	1.00	0.20	1.93	0.72	0.47	0.89
	(1.23)	(1.72)	(1.91)	(0.35)	(2.26)	(1.47)	(0.96)	(2.66)
Prior-year return	0.00	0.00	0.00					
	(-0.15)	(-0.16)	(0.10)					
Y1996	-0.36	-3.47	-0.50					
	(-0.18)	(-0.81)	(-0.29)					
Y1997	-0.91	1.01	-0.89					
	(-0.49)	(0.28)	(-0.48)					
Y1998	1.39	-6.82	-0.74					
	(0.75)	(-1.96)	(-0.44)					
Y1999	-3.58	-3.17	-2.34					
	(-1.94)	(-0.85)	(-1.37)					
Y2000	-3.24	-7.03	-3.20					
	(-1.63)	(-1.41)	(-1.70)					
Adjusted R-square	8.8%	32.2%	18.6%	6.3%	52.9%	37.8%	22.8%	27.3%
Observations	157	61	218	64	34	98	173	45