Anthony W. Lynch
New York University

Richard R. Mendenhall
University of Notre Dame

New Evidence on Stock Price Effects Associated with Changes in the S&P 500 Index*

Since October 1989, Standard and Poor's has (when possible) announced changes in the composition of the S&P 500 index 1 week in advance. Because index funds hold S&P 500 stocks to minimize tracking error, index composition changes since this date provide an opportunity to examine the market reaction to an anticipated change in the demand for a stock. Using post–October 1989 data, we document significantly positive (negative) postannouncement abnormal returns that are only partially reversed following additions (deletions). These results indicate the existence of temporary price pressure and downward-sloping long-run demand curves for stocks and represent a violation of market efficiency.

I. Introduction

Papers investigating Standard and Poor's 500 Stock Index (S&P 500) composition changes over the 1976–88 period find a change-day positive (negative) abnormal return of approximately 3% (1.5%) for additions (deletions).[1] During this period it was S&P's policy to announce and implement changes in the composition of the index simultaneously. Their policy since October 1989, however, has been (whenever possible) to announce changes 1 week *prior to* their imple-

* We are very grateful to Standard and Poor's Corporation for providing data that made this research possible. We have benefited from helpful discussions with Yakov Amihud, Stephen Brown, and Robert Schwartz and from the valuable comments of John Affleck-Graves, Pierluigi Balduzzi, Larry Brown, Ned Elton, Silverio Foresi, Antti Ilmanen, Kose John, John Liew, David Musto, Cathy Niden, Eli Ofek, Ross Stevens, David Yermack, and seminar participants at New York University. The comments of an anonymous referee and the editor (Doug Diamond) greatly improved the paper. The able research assistance of Tania Vital-Ahuja is also acknowledged. This research was started when Mendenhall was a visiting faculty member at New York University.

1. For deletions, see Goetzmann and Garry (1986) who examined the seven deletions on November 30, 1983 (caused by the breakup of AT&T), and Harris and Gurel (1986) who examined the 1978–83 period (13 stocks). For additions, again see Harris and Gurel (1986) (84 stocks); Shleifer (1986), who examined the 1976–83 period (102 stocks); and Dhillon and Johnson (1991), who examined the 1978–88 period (187 stocks).

(*Journal of Business*, 1997, vol. 70, no. 3)

0021-9398/97/7003-0002$02.50

mentation. This article analyzes price and volume data for firms added to or deleted from the S&P 500 from March 1990 through April 1995.

For additions, we find a significant positive announcement day abnormal return. We also find a positive cumulative abnormal return of 3.807% over the period starting the day *after* the announcement and ending the day before the effective date of the change. Further, we find significant *negative* abnormal returns following the addition itself. The pattern of price movements for deletions is very similar but inverted. That is, returns are significantly *negative* between announcement and delisting and significantly *positive* following delisting.

Our results are interesting for a number of reasons. First, they can be interpreted in the context of the efficient market hypothesis (see Fama [1970, 1991] for a detailed discussion of the theory and evidence pertaining to market efficiency). The significant abnormal returns following the announcement date are inconsistent with semi–strong form market efficiency. It would have been possible for investors, using only publicly available information, to construct trading rules that earned economically significant abnormal returns. This result can be contrasted with studies examining the pre–October 1989 period, which find no significant daily abnormal returns following the announcement. Thus, while the pre–October 1989 results do not violate semi–strong form efficiency, those presented here clearly do.[2]

Second, the price reversal on and after the effective date of the index change indicates a significant temporary stock-price effect prior to the change. The price reversal that we document is consistent with heavy index-fund trading around the time of the change that moves stock prices temporarily away from their equilibrium values (the price-pressure hypothesis). This behavior is plausible since the managers of index funds are typically evaluated on the basis of their ''tracking error'' or the difference between their fund's return and the return on the index over any period. This price reversal is also strong evidence that the postannouncement-day abnormal returns do not simply represent a slow adjustment to any value-relevant information contained in S&P's announcement.

In contrast, the pre–October 1989 studies find no indication of a short-run price reversal, and their evidence regarding the existence of a longer-term reversal is mixed.[3] The lack of a temporary effect before October 1989 is also consistent with index funds' concern with tracking

2. Goetzmann and Garry (1986) provide some evidence that investors speculated on stocks to be dropped from the S&P 500 index at the time of the AT&T breakup. They find, however, that these efforts did not earn abnormal returns.

3. Harris and Gurel (1986) find that the price effect on the announcement/change date is gradually but completely reversed in the period after addition or deletion. Shleifer (1986) and Dhillon and Johnson (1991) find that the price effect is permanent. Dhillon and Johnson argue that Harris and Gurel's finding may be specific to their method of risk adjustment.

error. Before this date, index funds could not buy an added stock until after it had become part of the index. Any price premium paid by an index fund prior to October 1989, therefore, generated a negative expected tracking error. Index funds would be motivated, therefore, to delay trading (and perhaps to break up their orders) to avoid paying such a premium. However, a trade-off was involved since trading later exposed them to tracking error associated with not holding the already-added stock. Since October 1989, index funds have been able to purchase added stocks prior to their entering the index. Any price premium paid by index funds just prior to the change has no impact on expected tracking error since the stock enters the index at the inflated price. Hence, index funds, post–October 1989, are prepared to pay a premium to be able to buy an added stock just prior to its addition. Thus, index funds' concern with tracking error explains why a price reversal is only observed after October 1989.

Third, the finding of a significant temporary effect for additions as well as deletions is relevant to results reported in the block-trade literature. In particular, researchers studying block trades consistently find different temporary effects for buyer- versus seller-initiated blocks; seller-initiated blocks induce significant temporary price effects while buyer-initiated blocks do not (see Holthausen, Leftwich, and Mayers 1990; Chan and Lakonishok 1993; and Keim and Madhavan 1996). Any explanation for this asymmetry must also be able to explain the observed symmetry in temporary effects that we observe.

One hypothesis that has been advanced to explain the block-trade asymmetry is broker reluctance to take a short position to accommodate a block purchase. According to ''street wisdom,'' this reluctance results in a lack of intermediary involvement and no temporary effect for most buyer-initiated block trades (see Holthausen, Leftwich, and Mayers 1990; and Chan and Lakonishok, 1993). Unless brokers are more inclined to short stocks being added to the S&P 500 than they are to short other stocks, our results are inconsistent with this explanation for the block-trade asymmetry.

Fourth, the permanent price effect (excluding the announcement-day abnormal return) is found to be weakly positive for additions and significantly negative for deletions. This finding provides new evidence in support of downward-sloping long-run demand curves for stocks (downward-sloping demand hypothesis).

Shleifer (1986) and Harris and Gurel (1986) were the first papers to recognize that a permanent price response associated with addition to or deletion from the index is consistent with stocks possessing downward-sloping demand curves. As firms enter the S&P 500, index-fund buying removes a substantial fraction of the firm's shares from circulation. This demand by index funds reduces the stock's supply for nonindexing investors, causing the market clearing price to increase. For deletions, analogous logic predicts a price decrease. If long-term demand curves for stocks were horizontal, no permanent price effect would be expected.

However, there are other explanations for the permanent price effect documented for pre–October 1989 changes. The price movement could be due to the information content of S&P's addition and deletion announcements (the information hypothesis). For these announcements to have information content, S&P must have nonpublic information about firms and use this information to determine the composition of the index.[4] Alternatively, if S&P 500 inclusion affects stocks' liquidity, then this should have pricing implications (the liquidity hypothesis). Specifically, if being a member of the S&P 500 increases a stock's liquidity, then there should be a price increase (decrease) upon the announcement of addition (deletion; see Amihud and Mendelson 1986, 1993).[5]

The post–October 1989 price patterns that we present are able to disentangle these effects. While the significant announcement-day abnormal return (for additions and deletions) is consistent with all three hypotheses, the permanent price shift that we find after the announcement date is only consistent with downward-sloping long-run demand curves for stocks. Assuming the response to any value-relevant information in S&P's announcement or to perceived liquidity changes would occur on the announcement day (as implied by an informationally efficient market), the postannouncement price shift cannot be explained by either of these two hypotheses.

Finally, we examine trading volume around the time of the announcement and around the time of the index change. Consistent with index-fund managers attempting to minimize tracking error by trading immediately prior to the index change, the largest volume occurs on the day prior to the index modification. For example, for both additions and deletions, the fraction of shares traded on the day prior to the change is more than three times as great as that on the announcement

4. The information hypothesis is supported by Jain (1987), who observes significant stock-price movements when firms are added to (or deleted from) S&P auxiliary indexes (which are not mimicked by index funds), as well as by Dhillon and Johnson (1991), who examine the option and bond returns of firms being added to the S&P 500. Both Shleifer and Harris and Gurel discredit the information hypothesis using indirect arguments. Harris and Gurel cite investors' lack of interest in discovering index changes prior to September 1976 (when S&P's early notification service began) even though that information was readily available. Shleifer finds that firms with lower-rated debt (by S&P) do not have a stronger addition-day response than those with higher-rated debt.

5. Although not a proponent of the liquidity hypothesis, Shleifer (1986) raises the possibility that inclusion in the index may lead to closer scrutiny of the company by analysts and investors. This, in turn, may lead to greater institutional interest, greater trading volume, and lower bid-ask spreads. Harris and Gurel (1986) and Edmister et al. (1995), studying pre–October 1989 data, do find evidence of a permanent increase in trading volume following S&P 500 inclusion.

date, which also exhibits large volume relative to the preannouncement period.

It is beyond the scope of this article to develop in detail the theoretical underpinnings of the various hypotheses described above. However, the empirical results presented here may facilitate their rigorous development. We leave that task to future work. The next section describes the data and the research method used in this study, while Section III discusses the empirical implications of the four hypotheses described above and our results. Section IV offers a summary and a conclusion.

II. Data and Methodology

A. The Sample

We asked Standard & Poor's Corporation to supply us with data, including announcement dates and effective change dates, on the changes to the S&P 500 since October of 1989. They were able to furnish us with the 71 additions and deletions that occurred from March 1990 through April 1995. Daily stock returns are obtained from the Center for Research in Security Prices (CRSP) for the pre-1994 period and from Bloomberg after that time. For the pre-1994 period, the CRSP value-weighted index of New York Stock Exchange–American Stock Exchange (NYSE-AMEX) stocks is used as the market portfolio in abnormal return calculations. After the end of 1993, the daily return on the S&P 500 (obtained from Bloomberg) is used as the market return.

From the original sample of additions and deletions, we construct a ''complete'' sample and a ''clean'' sample. To construct the complete sample, observations were eliminated from the original sample for several reasons. First, we were unable to obtain announcement dates from S&P for three additions and three deletions. Second, we required that useable return data be available for at least 1 day over the event study windows. This constraint reduced the addition (deletion) sample by three (five). Finally, since this study relies on a separation between the announcement and change days, 10 observations from both the addition and deletion samples were omitted because the announcement did not precede the change date by at least 2 days.[6] The complete additions sample consists of 55 firms and the complete deletions sample consists of 53 firms.

There are two points to note regarding this complete sample. The first is that it includes some observations for which the index change

6. When a firm files for bankruptcy, it is S&P's policy to announce, after the close of trading on that day, that it is deleted from the index effective immediately. Seven of the cases failing to qualify for lack of separation between announcement and effective change date (both additions and deletions) were attributable to the deletion firm declaring bankruptcy.

does not lead to trading by index funds.[7] Including these firms will tend to dampen any price effects associated with index-fund trading. The second is that unrelated merger and spin-off activity around the time of the announcement and change will add noise to the abnormal returns. In an effort to build ''clean'' samples of additions and deletions that minimize these concerns, we eliminated any firm undergoing merger or spin-off activity at the time of the announcement. Since market participants would be expected to know which firms were undergoing such activity, the implication is that our ''clean'' samples could be formed using information available at the time of the announcement. To form the clean sample, a firm was deleted from the complete sample if any mention of announcement date merger or spin-off activity was reported in the *Dow Jones News Retrieval Service,* the *Wall Street Journal* or the 1991–94 issues of the S&P 500 Directory.[8] The clean additions sample contains 34 firms (9 mergers and 12 spin-offs are eliminated from the complete sample) and the clean deletions sample contains 15 firms (34 mergers and 4 spin-offs are eliminated).

Another concern is the impact of survivorship (see Brown et al. [1992] and Brown, Goetzmann, and Ross [1995] for discussions about the effects of survivorship bias). In particular, S&P sometimes announces that a change is conditional on approval of a corporate restructuring plan by a company's shareholders. Such approval may not be independent of the share price behavior of the sample firm, inducing a type of survivorship bias into the sample. This source of survivorship bias is, however, eliminated for the clean sample since any firm undergoing a merger or other restructuring activity at the time of the announcement is omitted.

More generally, survivorship may still affect the abnormal return point estimates if the probability of surviving is related to the criteria used to form the sample (see Brown and Pope [1995] for a further discussion).[9] However, it seems unlikely that survivorship can explain the magnitude of the abnormal returns observed (a 0.79% abnormal return per day between announcement and the change day for clean additions) or their patterns (which include reversals).

7. For example, on May 6, 1991, USX Corp split into USX–Marathon Group and USX–U.S. Steel Group. On that day, USX Corp was deleted from the S&P 500 and the two new firms were added. However, index funds would not trade since their shares in USX Corp would be converted into shares in the two new firms.

8. It seems unlikely that a firm in the S&P 500 or one large enough to be added to the index could be undergoing merger or spin-off activity unreported in any of these three sources.

9. For example, the abnormal returns of the clean additions sample may be affected by survivorship if the probability of surviving conditional on being added to the S&P 500 and not being associated with any merger activity differs from the unconditional probability of surviving.

B. Methodology

We use an event-study methodology with two event dates for each sample: the announcement date of the addition/deletion (AD) and the effective date of the addition/deletion (CD). Since S&P typically announce changes after the close of trading on a particular day, the following day is taken as the announcement day (AD). Since the change is implemented using the closing price of a particular day, the following day is taken as the change day (CD).

Abnormal return calculation. The abnormal return for stock *i* on day τ [$AR_i(\tau)$] is defined as the deviation of the stock's raw return from that of the market. The sample mean abnormal return (MAR) for event day τ is used as a measure of the abnormal price movement on that day. We are also interested in determining the abnormal return over windows whose lengths sometimes vary across firms, for example, the total abnormal return from being added to or deleted from the S&P 500. A stock's cumulative abnormal return over the window from τ_1 to τ_2 is calculated by summing the stock's abnormal returns over that window and is denoted $CAR(\tau_1, \tau_2)$. The stock's average abnormal return over the window, $AAR(\tau_1, \tau_2)$, is the stock's $CAR(\tau_1, \tau_2)$ divided by the number of days in the window.

Two measures of the abnormal return over a window of interest (τ_1, τ_2) are obtained by taking sample averages of firm CARs and firm AARs. These averages are designated as $MCAR(\tau_1, \tau_2)$ and $MAAR(\tau_1, \tau_2)$, respectively, and are both weighted sums of the ARs in the window. If the window's length varies across firms, however, the relative weights assigned by each differ. MCAR gives the same weight to every AR in the window while MAAR places a greater weight on the ARs of firms for whom the window is short. Consequently, MAAR (MCAR) has greater power when the abnormal performance is concentrated in short (long) window firms.[10]

Clearly, more sophisticated models of the return generating process can be used to calculate abnormal returns. However, the results obtained using the market model are very similar to those reported here using market-adjusted returns.[11] The market model abnormal returns for additions (deletions) tend to be slightly less positive (negative) on average than market-adjusted returns, possibly reflecting the bias in the

10. When the number of days in the window is the same for all firms, only MCAR is reported since MAAR is just a scalar multiple of MCAR and the associated *t*-statistics are the same for both.

11. Since index additions (deletions) are likely to have performed well (poorly) just prior to the change, using daily returns over this period to estimate market model parameters may produce upwardly (downwardly) biased alpha estimates. For this reason, the market model is estimated using returns from 872 to 673 days prior to the announcement day (requiring at least 100 nonmissing daily returns).

estimated alphas discussed in note 11. Even so, inferences are rarely affected. Any material differences are mentioned in the results section.

Abnormal volume calculation. Volume data are obtained from CRSP for those firms added to or deleted from the S&P 500 up to December 1994. The measure of volume that we employ is defined as follows:[12]

$$\upsilon_i(\tau) = \log[1 + V_i(\tau)]/\log[1 + E_i(\tau)], \qquad (1)$$

where $V_i(\tau)$ is dollar volume on day τ for stock i, and $E_i(\tau)$ is the dollar value of the outstanding shares on stock i on day τ. This volume measure approximates the dollar trading volume expressed as a fraction of the value of stock outstanding.[13]

Abnormal value (AV) is estimated using a procedure from Ajinkya and Jain (1989).[14] We begin by regressing the firm's transformed volume on that of the market:

$$\upsilon_i(\tau) = \phi_{0,i} + \phi_{1,i}\upsilon_M(\tau) + e_i(\tau)$$
$$\text{for } \tau = \text{AD} - 258, \ldots, \text{AD} - 109, \qquad (2)$$

where $\upsilon_M(\tau)$ is $\log[1 + V_M(\tau)]/\log[1 + E_M(\tau)]$ and the market is represented by all NYSE-AMEX stocks on the CRSP. A firm is omitted if it has missing volume data over the 150-day estimation period. Ajinkya and Jain find that the residual from this regression is AR(1) for U.S. equities and use an estimated generalized least squares (EGLS) procedure to estimate the regression coefficients.[15] Since the events considered here are likely to involve a sequence of days with abnormal volume, abnormal volume is estimated treating the lagged residual as being equal to its unconditional value of zero, as discussed in Ajinkya and Jain (1989). Thus, the abnormal volume for firm i on date τ is[16]

$$\text{AV}_i(\tau) = \upsilon_i(\tau) - [\phi_{0,i} + \phi_{1,i}\upsilon_M(\tau)]. \qquad (3)$$

12. In the numerator of the volume measure, 1 is added to the dollar volume of shares traded to accommodate zero volume. The denominator also adds one to the dollar value of shares outstanding so that the measure equals 1 when volume equals the total number of shares outstanding.

13. Ajinkya and Jain (1989) find that this transformed variable has a distribution that is much closer to normal than are raw volume numbers.

14. Meulbroek (1992) and Yermack (1995) both use a market model approach to estimate abnormal volume, though their specification is slightly different from ours.

15. The EGLS procedure we employ involves estimating equation (2) using OLS regression, then regressing the rresidual from that regression on its own lag and using the slope coefficient from that regression as an estimate of the AR(1) coefficient used to transform the data as in the Cochrane-Orcutt procedure. Finally, we perform an OLS regression using the transformed data to arrive at the estimates of $\phi_{0,i}$ and $\phi_{1,i}$. See Judge et al. (1985) for a discussion of EGLS and the Cochrane-Orcutt procedure.

16. As an alternate measure of abnormal volume, we also use the deviation of $\upsilon_i(\tau)$ from its sample average over the period from AD − 258 to AD − 109. Again a firm is omitted if it has missing volume data over this period. Inferences are not changed when using this alternate measure.

Mean abnormal volume for event day τ, $MAV(\tau)$ is the sample average AV for stocks with usable volume data on that date.

Significance tests. All significance tests are performed using a cross-sectional variance estimator as described in Asquith (1983) and a time-series variance estimator as in Ruback (1982). The latter has the advantage of a sample size that depends on the time-series length and not the number of firms in the sample, while the former is robust to an increase in the variance of AR around the event dates.[17] Details of the variance calculations are provided in the appendix.

III. Hypotheses and Results

A. *Empirical Implications of the Competing Hypotheses*

Four possible explanations for price movements around the time of an index change are discussed above: temporary price pressure associated with index-fund trading (the price-pressure hypothesis); downward-sloping long-run demand curves for stocks (the downward-sloping demand hypothesis); S&P's change announcements contain value-relevant information (the information hypothesis); and addition or deletion affects the stock's liquidity (the liquidity hypothesis). To help untangle these explanations, we focus attention on five windows over the event period:

1. *run-up window* runs from the day after the announcement (AD + 1) through the day before the change day (CD − 1);[18]
2. *release window* runs from the change day (CD) until the release-ending day;[19]
3. *postrelease window* runs from the day following the release-ending day until the end of the event window 10 days after the change day (CD + 10);
4. *post-AD permanent effect window* runs from the day after the announcement (AD + 1) until the release-ending day; and

17. The cross-sectional variance estimator is also robust to the variance effects of survivorship; i.e., the variance of a firm's AR over the last 3 years conditioning on surviving those 3 years may differ from its postannouncement AR variance conditional on being included in the sample. For further details see Kothari and Warner (1996).

18. Keim and Madhavan (1996) present a model that predicts a positive relation between the temporary price impact of a block trade and order size. In the context of the price-pressure hypothesis, their model suggests that the temporary price impact on each day is increasing in the level of index-fund trading. Consistent with the notion that index funds care about tracking error, it is assumed that most funds rebalance their portfolios on the day before the change (CD − 1). It follows that the largest temporary effect occurs on the day before the change. Consequently, the price-pressure hypothesis implies a price reversal that commences on the change day (CD).

19. Under the price-pressure hypothesis, any price release ends when all index funds have completed their trades. The criterion used to determine the release-ending day is described in Sec. III*B,* ''Price Results.''

5. *total permanent effect window* runs from the announcement day (AD) until the release-ending day.

Figure 1 depicts the time sequencing of the announcement and the change and indicates exactly when the different windows begin and end.

Table 1 summarizes the implications of each hypothesis for the MAR on AD and CD − 1 and for the MCAR over the five windows. While table 1 presents predictions only for additions, predictions are symmetric for deletions; that is, table entries of positive, zero, and negative imply negative, zero, and positive abnormal returns, respectively, for deletions. The posited effects for the price-pressure and downward-sloping demand hypotheses assume that most funds rebalance their portfolios on the day before the change (CD − 1). Predictions for two extreme cases associated with each of these two hypotheses are presented in table 1.

For the downward-sloping demand hypothesis, the associated permanent price effect may not occur until index funds make the purchases (in the case of an addition) that reduce the stock's supply for active investors (no-anticipation case). At the other extreme, the price effect could occur on the announcement day if the actions of risk arbitragers, anticipating the upcoming price change, move the price to its new equilibrium level on this day (full-anticipation case). In reality, arbitragers may cause partial price movement on the announcement day. In addition, trading by some arbitragers and index funds between AD and CD − 1 may cause positive (negative) abnormal returns for additions (deletions) over this interval. Finally, testing for a nonzero MCAR over the *post-AD permanent effect window* is a conservative test of the downward-sloping demand hypothesis. It is conservative because some (or all) of the AD price movement may be caused by downward-sloping demand curves, but this test attributes the entire AD abnormal return to other causes (i.e., to price pressure, information, or liquidity).

We specify two similar extreme cases for the price-pressure hypothesis. Again, the timing of price movements depends on the extent to which market participants attempt to profit from index-fund behavior and the extent to which index funds concentrate their trading on day CD − 1. Either way, however, the price release starts on the change day as index-fund trading starts to decline. Consequently, since the downward-sloping demand hypothesis implies a zero MCAR over the *release window,* the best test of the price-pressure hypothesis examines the *release window* for a price reversal.

The final rows in table 1 indicate abnormal return predictions for the information and liquidity hypotheses. Under the information hypothesis, an addition announcement by S&P is assumed to be good news, while a deletion announcement is assumed to be bad news. The predictions for the liquidity hypothesis assume that inclusion in the

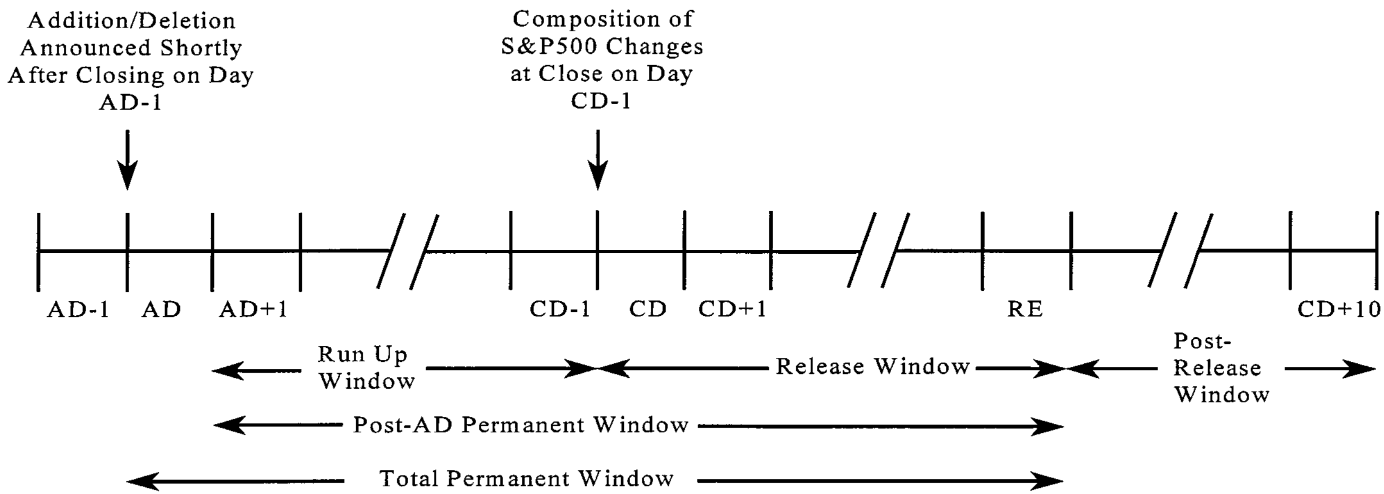

FIG. 1.—Time line of the announcement and implementation of an S&P 500 change. AD is the announcement day; CD is the change day; RE is the release-ending day.

TABLE 1 Predictions of Hypotheses for Event Days and Specific Event Windows

	Event Day—MAR		Windows—MCAR				
Hypotheses	AD	CD − 1	Run-up	Post-AD Permanent	Total Permanent	Release	Postrelease
Price-pressure/no anticipation	Zero	Largest MAR in run-up	Positive	Zero	Zero	Negative	Zero
Price-pressure/full anticipation	Positive	Zero	Zero	Negative	Zero	Negative	Zero
Downward-sloping demand/no anticipation	Zero	Largest MAR in run-up	Positive	Positive	Positive	Zero	Zero
Downward-sloping demand/full anticipation	Positive	Zero	Zero	Zero	Positive	Zero	Zero
Information	Positive	Zero	Zero	Zero	Positive	Zero	Zero
Liquidity	Positive	Zero	Zero	Zero	Positive	Zero	Zero

NOTE.—The predictions in this table are applicable to firms being *added* to the S&P 500. Predictions for firms being deleted are perfectly symmetric, e.g., positive, zero, and negative entries in this table imply that the prediction for the deletions sample is negative, zero, and positive, respectively. See Sec. II*B* for definitions of MAR and MCAR; AD = announcement day; CD = change day. Specific event windows are defined as *run-up window*, the time period from AD + 1 through CD − 1; *post-AD permanent*, from AD + 1 until the release-ending day; *total permanent*, from AD until the release-ending day; *release*, from the release-starting day (taken as CD) until the release-ending day; *postrelease*, from the day following the release-ending day until CD + 10.

S&P 500 increases liquidity, while being deleted decreases liquidity. The predictions for both the information and liquidity hypotheses assume that the market is informationally efficient.

Since trading-volume predictions are less extensive, they are not specified in table 1. If index-fund trading is concentrated on the day before the change, then, for both additions and deletions, we should observe the largest MAV over the *run-up window* occurring on the day before the change (CD − 1). The liquidity hypothesis implies that MAV is positive (negative) after the change day for additions (deletions).

B. Price Results

Tables 2 and 3 present mean abnormal returns around the two event days for additions, while tables 4 and 5 display the same results for deletions. Figure 2 plots mean cumulative abnormal returns for the clean additions (part A) and clean deletions (part B). A natural concern is the small number of clean observations—especially deletions. Each of the four hypotheses for price movements around index composition changes (price-pressure, downward-sloping demand, information, and liquidity) predicts a roughly symmetric price effect for additions and deletions. Thus, we alleviate the small sample problems by combining the additions and deletions after multiplying the deletion firms' abnormal returns by minus one. While the point estimates contain little new information, hypothesis testing is more powerful because of the larger sample sizes. These results (unreported) are discussed whenever inferences are affected.

Part A of tables 2 and 4 presents daily mean abnormal returns relative to the announcement date, while part B of tables 2 and 4 reports daily mean abnormal returns relative to the change date. Tables 3 and 5 display multiple-day window results. Each table contains results for the clean sample and the complete sample. The subsequent discussion focuses on the results for the clean samples since these show the effects of addition to and deletion from the S&P 500 in those cases for which we are sure that index funds have an incentive to trade.

For each of the 10 event days after the announcement date shown in part A, only those firms for which the change date has not yet occurred are used. Thus, the sample size declines with the passage of event time past the announcement date. This presentation allows the magnitude of the abnormal returns between the announcement date and the change date to be assessed using part A without contamination from any reversal that may occur on or after the change date. Similarly, for each of the 10 event days prior to the change date shown in part B, only those firms for which the announcement date has occurred on a prior day are used.

Results for AD appear as event day 0 in part A of tables 2 and 4.

TABLE 2 **Daily Market-Adjusted Abnormal Returns (AR) for Firms Added to S&P 500, March 1990–April 1995**

	Clean Sample					Complete Sample				
Event Day	*N*	MAR	t_C(MAR)	t_T(MAR)	% AR > 0	*N*	MAR	t_C(MAR)	t_T(MAR)	% AR > 0
A. AD = 0:										
−10	34	−.018	−.06	−.04	.53	48	−.204	−.69	−.63	.50
−9	34	.383	1.52	.98	.71*	49	.239	.98	.75	.61
−8	34	−.728	−2.88	−1.86	.29*	49	−.549	−2.35	−1.73	.35*
−7	34	−1.004	−2.46	−2.57	.32*	49	−.809	−2.61	−2.54	.39
−6	34	.038	.11	.10	.41	49	.419	1.43	1.32	.53
−5	34	−.162	−.58	−.41	.41	49	−.276	−1.22	−.87	.43
−4	34	−.419	−1.38	−1.07	.35	49	−.107	−.43	−.34	.43
−3	34	−.056	−.20	−.14	.47	49	.172	.65	.54	.51
−2	34	.052	.13	.13	.56	50	.147	.45	.47	.54
−1	34	−.295	−1.02	−.75	.41	50	−.245	−1.00	−.78	.44
0	34	3.158	6.66	8.08	.91*	50	2.859	7.40	9.07	.88*
1	34	.825	2.20	2.11	.65	50	.925	2.74	2.94	.68*
2	32	1.129	3.58	2.80	.72*	44	.618	2.10	1.84	.68*
3	28	.976	2.58	2.27	.61	39	1.049	3.38	2.94	.62
4	24	.788	1.52	1.69	.79*	33	.891	1.92	2.30	.76*
5	6	−.624	−.38	−.67	.33	11	−.249	−.26	−.37	.36
6:10	≤4					≤9				

B. CD = 0:										
−6: −10	≤4					≤9				
−5	6	1.781	1.97	1.91	.83	11	1.251	2.21	1.86	.73
−4	24	.728	1.64	1.56	.63	33	.688	2.03	1.77	.64
−3	28	.891	2.33	2.07	.57	39	.489	1.38	1.37	.56
−2	32	1.327	4.00	3.29	.75*	44	1.176	4.16	3.50	.70*
−1	34	1.127	2.03	2.88	.74*	50	1.514	3.37	4.81	.76*
0	34	−.726	−2.35	−1.86	.29*	50	−2.018	−1.87	−6.41	.24*
1	34	−.606	−1.95	−1.55	.18*	55	−.615	−1.87	−2.05	.24*
2	34	−.469	−1.01	−1.20	.50	55	−.380	−1.06	−1.26	.47
3	34	.127	.37	.33	.50	55	.054	.18	.18	.51
4	34	−.216	−.68	−.55	.47	55	.128	.51	.43	.56
5	34	−.616	−1.53	−1.57	.47	55	−.372	−1.13	−1.24	.45
6	34	.292	.76	.75	.56	55	−.119	−.41	−.40	.49
7	34	.107	.36	.27	.50	55	.156	.56	.52	.51
8	33	.239	.69	.60	.48	54	.320	1.13	1.06	.50
9	33	−.176	−.43	−.44	.42	54	−.183	−.58	−.60	.44
10	33	−.228	−.54	−.57	.48	54	−.350	−1.17	−1.15	.41

NOTE.—The samples are described in Sec. II*A* and the calculation of $AR_i(\tau)$ is discussed in the first part of Sec. II*B*, which also defines MAR(τ). N is the number of firms used, and t_C(MAR) uses the cross-sectional variance estimator in eq. (A1); t_T(MAR) uses the time-series variance estimator in eq. (A2). All equations are in the appendix. The cross-sectional t-statistics are distributed Student's t with $(N - 1)$ degrees of freedom, while the time-series t-statistics are approximately normally distributed. AR is expressed as a percentage.

* % > 0 is significantly different from .5 using a binomial test with a 5% cutoff.

TABLE 3 Long Window Statistics for Daily Market-Adjusted Abnormal Returns (AR) for Firms Added to S&P 500, March 1990–April 1995

		Clean Sample					Complete Sample				
Specific Event Window	Event Days	N	MCAR	t_C	t_T	% CAR > 0	N	MCAR	t_C	t_T	% CAR > 0
Run-up	AD + 1, CD − 1	34	3.807	4.15	4.25	.79*	50	3.490	5.22	4.79	.80*
Post-AD permanent	AD + 1, CD + 7	34	1.701	1.23	1.22	.71*	50	.084	.05	.07	.66*
	AD + 1, CD + 10	33	1.760	1.52	1.12	.73*	49	.120	.07	.10	.65*
Total permanent	AD, CD + 7	34	4.859	3.44	3.36	.74*	50	2.943	1.73	2.52	.70*
	AD, CD + 10	33	4.864	3.86	3.02	.73*	49	2.936	1.75	2.27	.69*
Release	CD, CD + 7	34	−2.106	−1.83	−1.96	.32*	50	−3.406	−2.28	−3.94	.36*
Postrelease	CD + 8, CD + 10	33	−.165	−.20	−.19	.58	54	−.213	−.38	−.32	.52
		N	MAAR	t_C	t_T	M	N	MAAR	t_C	t_T	M
Run-up	AD + 1, CD − 1	34	.794	4.75	4.39	189	50	.811	5.70	5.43	282
Post-AD permanent	AD + 1, CD + 7	34	.112	1.05	1.06	461	50	−.016	−.12	−.19	682
	AD + 1, CD + 10	33	.110	1.47	1.14	547	49	.001	.01	.01	816
Total permanent	AD, CD + 7	34	.339	3.42	3.35	495	50	.195	1.54	2.39	732
	AD, CD + 10	33	.291	3.87	3.13	580	49	.169	1.64	2.26	865

NOTE.—The samples are described in Sec. II*A;* definitions of MCAR(τ_1, τ_2) and MAAR(τ_1, τ_2) are found in Sec. II*B*. M is the number of days in the window summing across firms; t_C(MCAR) and t_C(MAAR) use the cross-sectional variance estimator in eq. (A1); t_1(MCAR) and t_T(MAAR) use the time-series variance estimator in eq. (A2). Both equations are in the appendix. The cross-sectional t-statistics are distributed Student's t with ($N - 1$) degrees of freedom, while the time-series t-statistics are approximately normally distributed. AR is expressed as a percentage.

* % > 0 is significantly different from .5 using a binomial test with a 5% cutoff.

In all four cases (addition and deletion samples both clean and complete) the announcement-day abnormal return is significantly different from zero in the expected direction. For example, the abnormal return is 3.158% (−6.263%) with a cross-sectional *t*-statistic of 6.66 (−3.56) for the clean additions (deletions). Table 1 indicates that these announcement-day abnormal returns are consistent with all four hypotheses described above. In particular, (partial) anticipation under the price-pressure or downward-sloping demand hypotheses as well as the information or liquidity hypotheses all predict the observed announcement-day abnormal returns.

Results for the run-up window (AD + 1, CD − 1) appear as the top row of tables 3 and 5. The MCAR and MAAR for this window are significantly positive for the additions and significantly negative for deletions; for example, MCAR is 3.807% (−12.690%) with a cross-sectional *t*-statistic of 4.15 (−4.59) for the clean additions (deletions). These results are consistent with the price-pressure and downward-sloping demand hypotheses (as table 1 indicates), but inconsistent with market efficiency. Thus, it seems unlikely that the previously documented returns around S&P 500 index composition changes can be attributed solely to the information and liquidity hypotheses. The CAR for additions over this period (AD + 1, CD − 1) can be interpreted as the sum of the daily returns on a strategy that each day goes long the stock $1 and short the market $1. It seems unlikely that transaction costs would completely eliminate the 3.807% return.[20] Further, although this strategy is not a riskless arbitrage, it yields a positive return 79% of the time. The magnitude of this abnormal return is highlighted by part A of figure 2. One interesting question is whether the profit from this type of strategy has eroded over time. Unfortunately, we do not have sufficient data to perform any reliable subperiod analyses.

As discussed above, the price-pressure hypothesis predicts a price release beginning on the change day. Consistent with this implication, part B of table 2 reports a negative mean abnormal return of −0.726% on the addition date (denoted as event day 0 in pt. B) for the clean sample. This is significantly less than zero at the 2% (10%) level using the cross-sectional (time-series) *t*-statistic. The fraction of firms exhibiting a positive abnormal return is 29% which is significantly lower than 50% at the 5% level.

To identify the release-ending day, a criterion based on abnormal

20. The average bid-ask spread would have to be of the order 3.8% to explain the mean CAR for the (AD + 1, CD − 1) window; this seems unlikely. Also, the strategy of going long $1 in the added ‘‘clean’’ stock on the announcement day and short $1 in the market and holding this position until the day before the change (i.e., without rebalancing) earns a return that is positive 79% of the time and has a mean of 3.968% (*t*-statistic = 4.02). Thus, the AD + 1 to CD − 1 return does not depend on daily rebalancing and so is robust to the associated transaction costs.

TABLE 4 Daily Market-Adjusted Abnormal Returns (AR) for Firms Deleted from S&P 500, March 1990–April 1995

	Clean Sample					Complete Sample				
Event Day	*N*	MAR	t_C(MAR)	t_T(MAR)	% AR > 0	*N*	MAR	t_C(MAR)	t_T(MAR)	% AR > 0
A. AD = 0:										
−10	15	1.674	1.47	2.64	.53	52	.257	.57	.91	.48
−9	15	−1.778	−1.98	−2.81	.33	52	.663	.60	2.34	.48
−8	15	−.543	−.57	−.86	.33	52	−.368	−1.10	−1.30	.40
−7	15	1.921	.95	3.03	.73	52	.247	.37	.87	.58
−6	15	−.933	−.81	−1.47	.47	52	.131	.33	.46	.58
−5	15	3.279	1.45	5.17	.87*	52	1.085	1.52	3.83	.65*
−4	15	.345	.29	.54	.47	52	.316	.79	1.11	.48
−3	15	−.030	−.03	−.05	.40	52	−.473	−.98	−1.67	.48
−2	15	−1.435	−1.53	−2.26	.47	52	−.188	−.52	−.66	.46
−1	15	−.544	−.37	−.86	.27	52	−.063	−.14	−.22	.44
0	15	−6.263	−3.56	−9.88	.13*	52	−1.463	−2.15	−5.16	.44
1	15	−3.609	−3.71	−5.69	.13*	51	−.787	−1.58	−2.75	.45
2	12	−.321	−.29	−.45	.42	46	.638	.59	2.11	.48
3	12	−3.224	−2.80	−4.55	.25	41	−.882	−2.01	−2.76	.37
4	8	−6.447	−2.05	−7.43	.13	33	−1.754	−1.98	−4.93	.36
5	4	−10.528	−2.65	−8.58	.00	10	−4.901	−2.25	−7.58	.30
6:10	0					≤6				

B. CD = 0:										
−10: −6	0					≤6				
−5	4	−1.713	−1.47	−1.40	.25	10	−.618	−1.13	−.95	.30
−4	8	−3.514	−3.55	−4.05	.00*	33	−.888	−2.17	−2.49	.39
−3	12	−1.727	−1.38	−2.44	.33	40	−.308	−.61	−.95	.45
−2	12	−1.203	−1.30	−1.70	.33	45	−.746	−1.86	−2.45	.40
−1	15	−8.016	−3.97	−12.65	.13*	50	−2.570	−3.17	−8.89	.40
0	14	5.590	2.98	8.52	.86*	40	1.976	2.36	6.11	.60
1	14	−.653	−.45	−.99	.43	37	.322	.46	.96	.51
2	14	−2.019	−.84	−3.08	.64	37	−.299	−.32	−.89	.62
3	14	.572	.61	.87	.50	36	.202	.47	.59	.56
4	14	−.094	−.15	−.14	.64	35	.202	.66	.58	.57
5	14	1.243	.88	1.89	.57	35	.795	1.29	2.30	.51
6	14	.706	.41	1.08	.43	34	.425	.59	1.21	.53
7	14	−.452	−.34	−.69	.57	33	−.179	−.30	−.50	.55
8	14	−1.484	−2.30	−2.26	.43	33	−.761	−2.19	−2.14	.39
9	14	−.190	−.19	−.29	.43	33	−.118	−.25	−.33	.45
10	14	2.987	1.97	4.55	.71	33	.779	1.05	2.19	.45

NOTE.—See note to table 2.
* % > 0 is significantly different from .5 using a binomial test with a 5% cutoff.

TABLE 5 Long Window Statistics for Daily Market-Adjusted Abnormal Returns (AR) for Firms Deleted from S&P 500, March 1990–April 1995

		Clean Sample					Complete Sample				
Specific Event Window	Event Days	N	MCAR	t_C	t_T	% CAR > 0	N	MCAR	t_C	t_T	% CAR > 0
Run-up	AD + 1, CD − 1	15	−12.690	−4.59	−10.28	.07*	50	−2.986	−1.86	−4.62	.38
Post-AD permanent	AD + 1, CD + 5	14	−8.875	−2.90	−4.54	.21	34	−1.629	−.73	−1.40	.41
	AD + 1, CD + 10	14	−7.308	−2.74	−3.09	.14*	32	−1.719	−.78	−1.20	.34
Total permanent	AD, CD + 5	14	−15.711	−3.69	−7.69	.07*	34	−4.552	−1.61	−3.76	.32*
	AD, CD + 10	14	−14.144	−3.84	−5.80	.14*	32	−4.781	−1.74	−3.24	.31*
Release	CD, CD + 5	14	4.639	1.36	3.13	.71	34	2.990	1.97	3.58	.65
Postrelease	CD + 6, CD + 10	14	1.567	.78	1.15	.57	33	.114	.12	.15	.45
		N	MAAR	t_C	t_T	M	N	MAAR	t_C	t_T	M
Run-up	AD + 1, CD − 1	15	−2.869	−5.04	−9.38	66	50	−.857	−3.18	−6.22	264
Post-AD permanent	AD + 1, CD + 5	14	−.884	−2.59	−4.74	148	34	−.264	−1.43	−2.55	396
	AD + 1, CD + 10	14	−.475	−2.64	−3.12	218	32	−.172	−1.50	−1.97	535
Total permanent	AD, CD + 5	14	−1.444	−3.15	−8.12	162	34	−.513	−2.11	−5.19	430
	AD, CD + 10	14	−.881	−3.57	−5.97	232	32	−.356	−2.36	−4.20	567

NOTE.—See note to table 3.
* % > 0 is significantly different from .5 using a binomial test with a 5% cutoff.

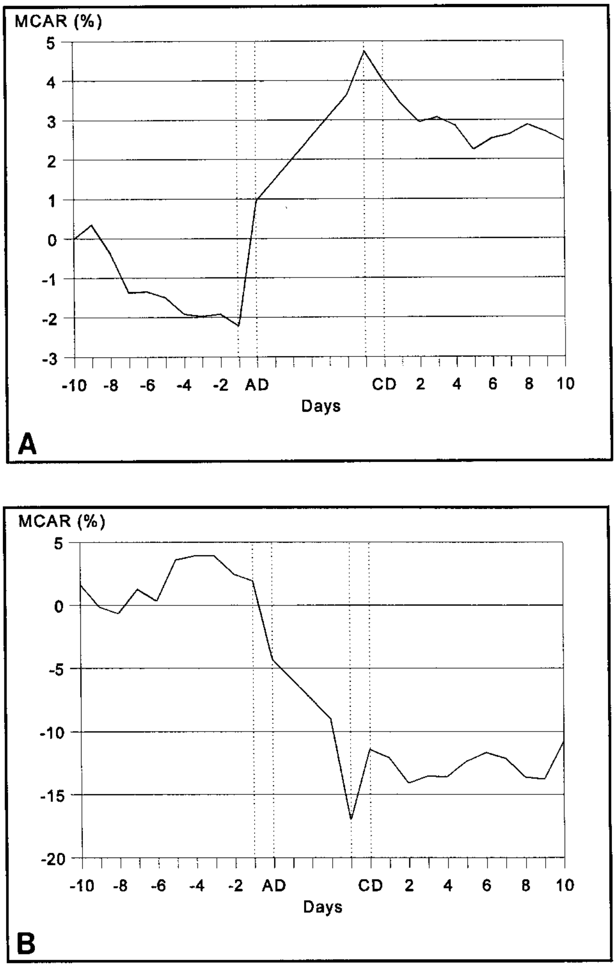

FIG. 2.—*A*, clean additions; *B*, clean deletions. MCAR plots for firms added to and deleted from the S&P 500, 1990–95; mean cumulative abnormal returns (MCARs) around the announcement time (AD) and the effective change date (CD) for firms added to the S&P 500 (clean sample). Since the number of trading days between AD and CD varies across firms, the interval AD + 1 through CD − 2 inclusive is displayed as 5 days (actual average = 4.56 days) for additions and 3 days (actual average = 3.40 days) for deletions. The MCARs are displayed as if each daily MAR over this interval were the interval's MCAR divided by five for additions and three for deletions.

volume is applied to the clean samples.[21] This criterion relies on recent theoretical work concerning block trades (see, e.g., Keim and Madhavan 1996) that explains the documented temporary price pressure as being compensation for the liquidity being provided by the counterparties. These models predict a positive relation between order size and price. Any temporary price pressure for index changes that is due to index-fund trading would be driven by the same factors as those driving the temporary price pressure observed for block trades. Thus, it is the large index-fund trades associated with adding or deleting the relevant stock that drives any temporary price pressure. For this reason, the price pressure ends once trading volume has returned to its normal postchange level. The volume is estimated to have returned to its normal postchange level on the earliest day after the change day with an MAV that is lower than the average MAV for all later days through CD + 10. The implied release-end day is CD + 7 for additions and CD + 5 for deletions.[22]

The mean CAR for the release window is reported in table 3 as −2.106% for clean additions and significantly different from zero at the 5% (10%) level using the time-series (cross-sectional) *t*-statistic. The fraction of CARs that are positive is significantly less than 50% at the 5% level. Deletions also exhibit a price reversal. The price release on the change day (CD) for the clean deletions sample is 5.59% and is significant at 5% using the cross-sectional or time-series *t*-statistic. The mean CAR over the release window is 4.639% but is only significant using the time-series *t*-statistic.

Taken together, the addition and deletion results provide strong evidence of a significant price reversal following S&P 500 composition changes. The combined sample (results not reported) further confirms this conclusion by exhibiting an MCAR over the release window that is significantly negative at the 5% level using either *t*-statistic. We conclude that price-pressure effects contribute to the abnormal return patterns that occur around index changes. It is possible, however, that downward-sloping demand curves also play a role, and we now address this issue.

Tables 3 and 5 report results for the post-AD permanent window using the volume-based release-end day and the end of the event window (CD + 10). As discussed above, the abnormal return over this post-AD permanent window provides a lower bound on the permanent

21. Since longer-horizon CARs have greater sampling variability, extending the release, post-AD, and total permanent effect windows beyond the actual release-ending day reduces the power of the tests. This reduced power motivates our attempts to determine the actual release-ending day instead of using the last day observed (CD + 10).

22. For the combined sample, MAV for an event day is taken as a weighted average of the MAVs for the additions and deletions on that day; the implied release-ending day is CD + 9.

price effect associated with the downward-sloping demand curve hypothesis. Given the price reversal documented above, choosing a premature release-ending day would overstate the abnormal return for this post-AD permanent window. However, note that the MCAR for the post-release window in tables 3 and 5 is insignificant for all four samples. This suggests that the criterion for determining the release-end day probably does not end the release period prematurely. Despite this, the MCAR and MAAR for the post-AD permanent window are significant (using either *t*-statistic) for the clean deletions (table 5) and clean combined samples (unreported) regardless of the release-ending day employed. For the clean additions, the MCAR is of the predicted sign but not significant. Thus, the additions evidence is less supportive of the downward-sloping demand hypothesis than the deletions or combined-sample evidence. Even so, the fraction of positive CARs is always on the predicted side of 50% for all three clean samples (including combined, which is not reported) and is significant in five of six tests (three clean samples times two release-ending days). Taken together, this evidence provides additional support, relative to the pre–October 1989 studies, that stocks possess downward-sloping demand curves.

A final question is the total magnitude of the CAR associated with being added to or deleted from the S&P 500 index. In table 3, the mean CAR for clean additions over the total permanent window is greater than 4.8% and is significant at the 5% level for each assumed release-ending day. For the complete additions sample, the mean CAR over this window is about 2.94%, which is comparable to the announcement/change-day effect found in earlier studies that used analogous samples (e.g., Harris and Gurel 1986; Shleifer 1986; and Dhillon and Johnson 1991). For the clean deletion sample, the mean CAR over the total permanent window in table 5 is −15.7% using the release-ending day (CD + 5) and is −14.1% using CD + 10; it is always significant at the 1% level. The magnitude of this decline is illustrated in figure 2. It seems that a significant negative permanent price effect is associated with deletion from the S&P 500.

To summarize, the abnormal price movements for the addition and deletion samples provide consistent evidence concerning the four hypotheses presented above and market efficiency. The significantly positive (negative) abnormal return from AD + 1 to CD − 1 for additions (deletion) is inconsistent with semi–strong form market efficiency. The price reversal on and following the effective change date supports the price-pressure hypothesis. The weakly positive (significantly negative) abnormal return from AD + 1 through the release-ending day for additions (deletions) supports the downward-sloping demand hypothesis. Finally, while we can rule out the information and liquidity hypotheses as complete explanations for the price patterns observed around S&P 500 composition changes, we cannot rule out the possibility that they contribute to the announcement-day returns and, therefore, to the total permanent price effect.

C. Volume Results

Table 6 reports mean abnormal volume by day, relative to the event, for the two additions samples (complete and clean), while table 7 does the same for the two deletions samples. For both tables, part A's event time is relative to the announcement date, while part B's is relative to the addition/deletion date. As with tables 2 and 4, only firms whose change dates have not yet occurred are used to calculate any given day's mean AV in part A, and only firms whose announcement dates have already past are used for any given day in part B. Since the log transformation used to calculate AV understates high volumes, figure 3 contains plots of the daily means for dollar volumes expressed as a fraction of the dollar value of shares outstanding (mean fractional volumes, MFVs) for the clean additions (part A) and clean deletions (part B).

For additions, part A of table 6 shows that abnormal volume is unremarkable up until one day before the announcement. Each of six consecutive days starting with the announcement day exhibits significantly positive abnormal volume at the 5% level for each additions sample. Part B reveals that the largest abnormal volume occurs on the day prior to addition with a *t*-statistic greater than 13 for each sample. In particular, the clean sample's point estimate of AV is 11.612%, which compares to 5.784% for the announcement day and 1.334% for the day prior to the announcement.[23] This result is consistent with index funds doing most of their purchasing on this date to minimize tracking error.

It is interesting that this relatively large abnormal volume on the day preceding addition is not associated with relatively large abnormal return. Instead, the MAR for the clean sample on the day prior to addition is 1.127%, which compares to 3.158% on the announcement day. Comparing the parts labeled ''A'' for figures 3 and 2 clearly illustrates this pattern of volume and returns. Explaining the patterns in these two figures is a challenge for future theoretical work.

As can be seen by comparing the two parts of figure 3, the volume results for deletions reported in table 7 are generally very similar to those for additions. The largest abnormal volume is on the day before deletion (CD − 1), followed by the announcement day (AD). Abnormal volume is unremarkable until AD but the next 6 days (including AD) are all significantly positive. It is interesting that MAV remains sig-

23. The log transformation understates the difference in raw dollar volume across these three days. For the day before addition, the announcement day and the day before the announcement, the MFVs are 4.39%, 1.39%, and 0.57%, respectively (see fig. 3).

nificantly positive from CD through until CD + 8 for the clean deletions sample.

IV. Conclusion

This article analyzes price and volume data for firms added to and deleted from the S&P 500 since October 1989. Because of the temporal separation of the announcements from the index changes during this period, this new data set has the potential to contribute to our understanding of several issues associated with the determination of market-clearing prices for individual stocks.

For both additions and deletions, the data reveal a distinct pattern of stock-price movements. Specifically, for additions, while we find a significantly positive announcement effect, we also find a positive abnormal return of about 3.8% over the period starting the day after the announcement and ending the day before the effective date of the change. Further, we find a significant *negative* abnormal return following the addition. Firms being deleted from the index also exhibit a significant postannouncement drift and a significant price reversal, but in directions opposite to those for additions.

Our results can be interpreted in the context of the efficient market hypothesis. The significant abnormal returns *following* the announcement date are inconsistent with semi–strong form market efficiency. It would have been possible to construct trading rules that use publicly available information to earn positive abnormal returns, particularly between the announcement day and the change day. This violation of market efficiency is anomalous. While the rationale for the trading patterns of index funds is clear, the reason why risk arbitragers do not trade the profits away on the announcement day is less obvious. However, with more data, it becomes possible to test whether the run-up effect has declined over time. Evidence of such a decline would indicate that the inefficiency existed because the market was not fully aware of the implications of index-fund behavior around index changes. We are currently gathering such evidence.

The price reversal after addition and deletion strongly suggests the existence of temporary price effects, caused by index-fund trading associated with S&P 500 composition changes. It also has implications for a well-documented asymmetry in the block-trade literature: seller-initiated block trades exhibit a similar price reversal, but buyer-initiated trades do not. The symmetry of our price reversal results for additions and deletions is a new empirical fact that any potential explanation of the block-trade asymmetry must also address. Fully reconciling our findings with the temporary effects documented for block trades and pre–October 1989 index composition changes is an issue requiring additional research.

TABLE 6 Daily Market Model Abnormal Volume (AV) for Firms Added to S&P 500, March 1990–December 1994

	Clean Sample					Complete Sample				
Event Day	N	MAV	t_C(MAV)	t_T(MAV)	% AV > 0	N	MAV	t_C(MAV)	t_T(MAV)	% AV > 0
A. AD = 0:										
−10	28	.176	.28	.27	.50	35	.301	.58	.54	.51
−9	28	−.224	−.49	−.34	.43	35	−.216	−.53	−.38	.46
−8	28	−.532	−.87	−.83	.32	35	−.120	−.21	−.21	.37
−7	28	.890	1.09	1.38	.54	35	.715	1.02	1.28	.54
−6	28	.470	.71	.73	.57	35	.507	.92	.90	.57
−5	28	.315	.54	.49	.46	35	.357	.70	.64	.49
−4	28	−.046	−.07	−.07	.50	35	−.019	−.03	−.03	.51
−3	28	.454	.83	.71	.43	35	.377	.78	.67	.43
−2	28	.178	.32	.28	.50	35	.153	.31	.27	.54
−1	28	1.334	2.47	2.07	.68	35	1.606	2.77	2.86	.66
0	28	5.784	11.45	8.99	.96*	35	5.247	10.09	9.35	.94*
1	28	4.276	6.09	6.64	.86*	35	4.010	6.67	7.14	.86*
2	26	4.031	4.34	6.26	.81*	31	3.598	4.17	6.41	.77*
3	22	4.774	4.68	7.42	.86*	27	4.525	5.10	8.06	.85*
4	19	9.782	8.45	15.20	1.00	23	8.789	7.10	15.66	.91*
5	5	4.078	2.18	6.34	.80	8	3.059	2.17	5.45	.75
6:10	≤3					≤6				

B. CD = 0:										
−10: −6	≤3					≤6				
−5	5	1.754	1.43	2.73	.80	8	1.803	1.87	3.21	.75
−4	19	3.166	4.44	4.92	.79	23	3.216	5.39	5.73	.83*
−3	22	2.582	4.85	4.01	.86*	27	2.476	4.29	4.41	.78*
−2	26	4.320	6.93	6.71	.88*	31	4.174	6.39	7.44	.87*
−1	28	11.612	19.28	18.04	1.00*	35	10.481	13.56	18.67	1.00*
0	28	5.270	11.31	8.19	1.00*	35	4.703	10.18	8.38	1.00*
1	28	3.538	6.61	5.50	.86*	35	3.253	6.87	5.80	.89*
2	28	3.221	5.67	5.00	.86*	35	3.043	6.06	5.42	.86*
3	28	2.108	4.93	3.27	.82*	35	2.044	5.11	3.64	.80*
4	28	2.118	3.90	3.29	.75*	35	1.893	3.76	3.37	.71*
5	28	2.243	4.26	3.48	.75*	35	2.505	4.15	4.46	.77*
6	28	1.859	4.55	2.89	.75*	35	2.087	5.44	3.72	.80*
7	27	1.634	3.45	2.54	.74*	34	1.593	3.75	2.84	.74*
8	27	1.745	2.79	2.71	.70*	34	1.561	2.85	2.78	.65*
9	27	1.701	3.92	2.64	.78*	34	1.551	3.98	2.76	.74*
10	27	2.070	4.24	3.22	.81*	34	2.259	4.45	4.02	.82*

NOTE.—The samples are described in Sec. II*A*. The calculation of $AV_i(\tau)$ and $MAV(\tau)$ is discussed in the middle of Sec. II*B*. N is the number of firms used; $t_C(MAV)$ is calculated using the cross-sectional variance estimator defined in eq. (A1); $t_T(MAV)$ is calculated using the time-series variance estimator defined in eq. (A2). Both equations are in the appendix. The cross-sectional t-statistics are distributed Student's t with $(N - 1)$ degrees of freedom, while the time-series t-statistics are approximately normally distributed. AV is expressed as a percentage.

* % > 0 is significantly different from .5 using a binomial test with a 5% cutoff.

TABLE 7 Daily Market Model Abnormal Volume (AV) for Firms Deleted from S&P 500, March 1990–December 1994

	Clean Sample					Complete Sample				
Event Day	*N*	MAV	t_C(MAV)	t_T(MAV)	% AV > 0	*N*	MAV	t_C(MAV)	t_T(MAV)	% AV > 0
A. AD = 0:										
−10	13	1.372	1.08	1.12	.69	42	1.983	2.54	4.28	.71*
−9	13	.342	.28	.28	.62	42	1.886	2.26	4.07	.62
−8	13	−.411	−.32	−.34	.46	42	.818	.97	1.77	.55
−7	13	2.054	2.21	1.68	.62	42	2.074	3.22	4.48	.62
−6	13	1.069	.99	.88	.46	42	1.942	2.76	4.19	.62
−5	13	1.178	.91	.96	.62	42	2.884	4.31	6.23	.74*
−4	13	.262	.17	.21	.54	42	1.821	2.35	3.93	.69*
−3	13	−.171	−.14	−.14	.46	42	1.362	1.91	2.94	.62
−2	13	−2.084	−1.25	−1.71	.38	42	1.238	1.51	2.68	.64
−1	13	.063	.04	.05	.54	42	1.266	1.75	2.73	.69*
0	13	8.139	7.64	6.66	1.00*	42	4.911	6.92	10.61	.86*
1	13	7.739	8.67	6.34	1.00*	41	4.804	7.73	10.37	.85*
2	11	6.697	5.55	5.48	1.00*	37	4.972	6.51	10.74	.86*
3	11	9.588	4.72	7.85	1.00*	32	6.163	5.88	13.31	.94*
4	7	10.976	3.11	8.99	.86	25	7.962	5.80	17.20	.92*
5	3	14.964	9.50	12.25	1.00	7	6.960	2.31	15.03	.86
6:10	0					≤4				

B. CD = 0:										
−10: −6	0					≤4				
−5	3	6.354	11.66	5.20	1.00	7	3.599	2.75	7.77	.86
−4	7	7.025	6.02	5.75	1.00*	25	3.642	4.36	7.87	.80*
−3	11	7.376	6.02	6.04	1.00*	32	4.651	5.84	10.05	.88*
−2	11	5.222	3.58	4.28	.91*	37	4.363	6.26	9.45	.89*
−1	13	14.974	10.19	12.26	1.00*	41	9.637	9.33	20.81	.93*
0	12	10.613	5.46	8.69	1.00*	32	5.808	4.70	12.55	.81*
1	12	5.954	4.16	4.88	.83*	28	3.605	3.49	7.79	.75*
2	12	4.291	4.52	3.51	.83*	28	2.380	2.85	5.14	.71*
3	12	5.258	2.79	4.31	.67	27	2.550	1.96	5.51	.67
4	12	5.037	4.15	4.12	.92*	26	1.986	1.58	4.29	.77*
5	12	3.071	2.48	2.51	.83*	26	.432	.39	.93	.65
6	12	4.447	2.06	3.64	.83*	26	.151	.09	.33	.62
7	12	3.287	4.50	2.69	.83*	24	.435	.34	.94	.67
8	12	3.876	3.69	3.17	.92*	24	1.651	1.12	3.57	.71*
9	12	1.418	1.29	1.16	.67	24	−.058	−.05	−.13	.54
10	12	3.142	1.68	2.57	.75	24	1.035	.72	2.24	.67

NOTE.—See note to table 6.
* % > 0 is significantly different from .5 using a binomial test with a 5% cutoff.

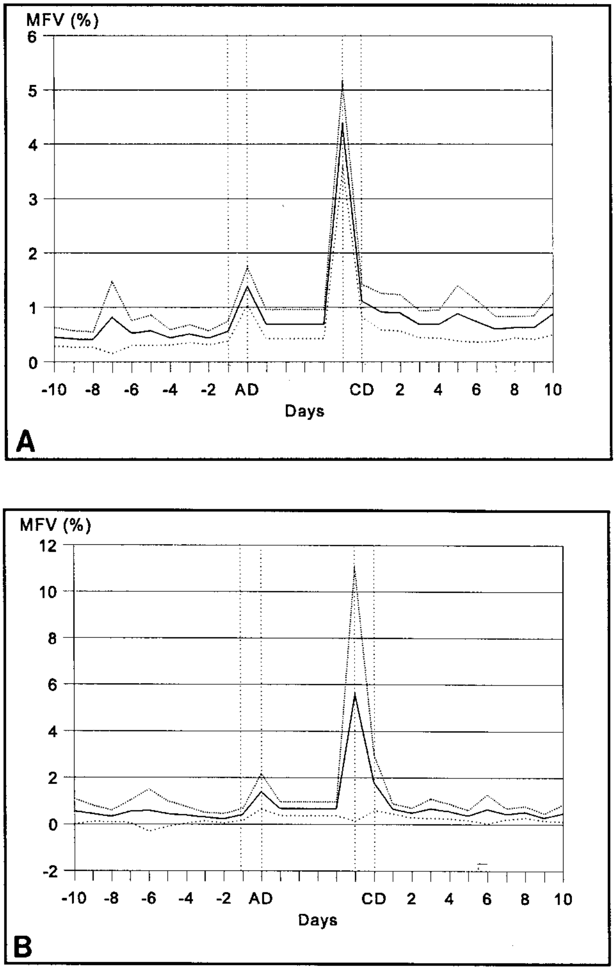

FIG. 3.—*A*, clean additions; *B*, clean deletions. MFV plots for firms added to and deleted from the S&P 500, 1990–94; mean volume as a fraction of shares outstanding (MFV) around the announcement date (AD) and the effective change date (CD) for firms added to and deleted from the S&P 500 (clean sample). Since the number of trading days between AD and CD varies across firms, the interval AD + 1 through CD − 2 inclusive is displayed as 4 days (actual average = 4.00 days) for additions and as 4 days (actual average = 3.57 days) for deletions. The MFVs are displayed as if each daily MFV over this interval was the interval's mean cumulative FV divided by 4.00 for additions and 3.57 for deletions. Dotted lines are two standard errors from the point estimates.

We also find that, for additions, the cumulative abnormal return from the day following the announcement through the price reversal is weakly positive. We interpret this abnormal return as a lower bound on the price effect caused by index-fund trading in the presence of downward-sloping long-term demand curves. Results for firms being deleted from the S&P 500 are stronger than those for additions. Taken together, the two results provide new evidence in support of downward-sloping long-run demand curves for stocks.

It is interesting that our postannouncement abnormal return results seem qualitatively similar to the significantly positive (negative) abnormal returns found by Eades, Hess, and Kim (1984) in the week prior to (following) stocks' ex-dividend dates. In both cases, there is an event known in advance by the market (the change day in our sample, the ex-dividend date in theirs) and abnormal returns prior to and after this event. A closer comparison of the market's behavior around each event may lead to a greater understanding of the driving forces behind these abnormal returns.

The article also presents volume results indicating that the day before addition or deletion is associated with particularly high volume. Explaining how the behavior of index funds and investors can generate the observed patterns of returns and trading volume for the added and deleted firms is an interesting task for future work.

Appendix

Significance Tests

Two types of standard error calculations are employed to assess the significance of abnormal returns and abnormal volumes. The first uses the cross-sectional dispersion of each metric to estimate its variance.[24] For the MAR(τ) abnormal return measure, the cross-sectional variance is given by

$$s_C^2[\mathrm{MAR}(\tau)] = \frac{1}{N(\tau)} \sum_{i=1}^{N(\tau)} [\mathrm{AR}_i(\tau) - \mathrm{MAR}(\tau)]^2/[N(\tau) - 1]. \qquad \text{(A1)}$$

Under the assumption that the $\mathrm{AR}_i(\tau)$'s are cross-sectionally independently and identically distributed normal, the resulting t-statistic for MAR(τ) is Student-t distributed with $N(\tau) - 1$ degrees of freedom. A directly analogous calculation gives a variance estimate for the MCAR(τ_1, τ_2) and MAAR(τ_1, τ_2) abnormal return measures and for the MAV(τ) abnormal volume measure.

The second method of calculating standard errors uses a times series of obser-

24. Asquith (1983) has used this cross-sectional error estimator for mean cumulative abnormal return in a context where the number of days in the window varies across firms. The advantage of the cross-sectional estimator relative to the time-series estimator presented below is its robustness to any increase in the variance of firm abnormal return around the two event dates. See Brown and Warner (1985) for a further discussion of this issue.

vations from a prior period as in Ruback (1982). The method assumes that each firm's AR follows an MA(1) process and that these processes are identical and independent across firms. Letting $n_i(\tau_1, \tau_2)$ be the number of days between τ_1 and τ_2 for firm *i*, this variance estimate for MCAR(τ_1, τ_2) is given by

$$s_T^2[\text{MCAR}(\tau_1, \tau_2)] = \frac{1}{N(\tau_1, \tau_2)} \sum_{i=1}^{N(\tau_1, \tau_2)} s_T^2[\text{CAR}_i(\tau_1, \tau_2)], \qquad \text{(A2)}$$

where

$$s_T^2[\text{CAR}_i(\tau_1, \tau_2)] = n_i(\tau_1, \tau_2) s_T^2[\text{AR}(\tau_0)] + 2[n_i(\tau_1, \tau_2) - 1] s_T[\text{AR}(\tau_0), \text{AR}(\tau_0 + 1)];$$

$$\text{av}_T[\text{AR}_i(\tau_0)] = \frac{1}{48} \sum_{\tau=\tau_b}^{\tau_b+47} \text{AR}_i(\tau);$$

$$s_T^2[\text{AR}(\tau_0)] = \frac{1}{48\, N(\tau_b, \tau_b + 47)} \sum_{i=1}^{N(\tau_b, \tau_b+47)} \sum_{\tau=\tau_b}^{\tau_b+47} \{\text{AR}_i(\tau) - \text{av}_T[\text{AR}_i(\tau_0)]\}^2;$$

and

$$s_T[\text{AR}(\tau_0), \text{AR}(\tau_0 + 1)] = \frac{1}{47\, N(\tau_b, \tau_b + 47)} \times \sum_{i=1}^{N(\tau_b, \tau_b+47)} \sum_{\tau=\tau_b}^{\tau_b+46} \{\text{AR}_i(\tau) - \text{av}_T[\text{AR}_i(\tau_0)]\} \times \{\text{AR}_i(\tau + 1) - \text{av}_T[\text{AR}_i(\tau_0)]\}.$$

A directly analogous variance estimate can be derived for MAAR(τ_1, τ_2). The associated *t*-statistic is normally distributed asymptotically. Since MAR(τ_0) is just MCAR(τ_0, τ_0), setting $n_i(\tau_0, \tau_0)$ equal to one in (A2) provides a variance estimate for MAR(τ). An analogous variance estimate can be obtained for MAV(τ).[25] For MCAR, τ_b is equal to (AD − 672) and for MAV(τ), τ_b is equal to (AD − 108) which in each case is the day after the relevant market model estimation period.

Finally, for each event day τ, the fraction of firms in the sample for which AR(τ) is positive is reported. A test of the hypothesis that the sign of each AR(τ) has probability 0.5 of being positive is performed under the assumption that the signs of the firms' ARs are independent (see Hollander and Wolfe [1973] for details of this binomial test). Analogous tests are performed for the fraction of firms with positive CARs over various windows and for the fraction of firms with positive AVs on each event-time day.

25. This time-series estimator is not identical to Ruback's for two reasons. First, the window length here often varies across stocks, a condition that cannot be easily accommodated by Ruback's estimator. Second, although the window length is the same across stocks for MAR(τ) and MAV(τ), the number of firms used to calculate these measures is often much smaller than the number of firms with data over the variance estimation period. Ruback notes that if the number of firms used in the variance estimation period is more than the number used to calculate MCAR(τ_1, τ_2), his *t*-statistic will be upward biased; our *t*-statistic explicitly allows for sample size differences in the two periods.

References

Ajinkya, B., and Jain, P. 1989. The behavior of daily stock market volume. *Journal of Accounting and Economics* 11:331–59.

Amihud, Y., and Mendelson, H. 1986. Asset pricing and the bid-asked spread. *Journal of Financial Economics* 17:223–49.

Amihud, Y., and Mendelson, H. 1993. Does market microstructure matter? Evidence from the Tel Aviv Securities Exchange. Working paper. New York: New York University, Stern School of Business.

Asquith, P. 1983. Merger bids, uncertainty and stockholder returns. *Journal of Financial Economics* 11:51–83.

Brown, S.; Goetzmann, W.; Ibbotson, R.; and Ross, R. 1992. Survivorship bias in performance studies. *Review of Financial Studies* 5:553–80.

Brown, S.; Goetzmann, W.; and Ross, R. 1995. Survival. *Journal of Finance* 50:853–73.

Brown, S., and Pope, P. 1995. Post-earnings announcement drift: Market inefficiency or research design biases? Working paper. New York: New York University, Stern School of Business.

Brown, S., and Warner, J. 1985. Using daily stock returns: The case of event studies. *Journal of Financial Economics* 14:3–31.

Chan, L., and Lakonishok, J. 1993. Institutional trades and intra-day stock price behavior. *Journal of Financial Economics* 33:173–200.

Dhillon, U., and Johnson, H. 1991. Changes in the Standard and Poor's 500 list. *Journal of Business* 64:75–85.

Eades, K.; Hess, P.; and Kim, H. 1984. On interpreting security returns during the ex-dividend period. *Journal of Financial Economics* 13:3–34.

Edmister, R.; Graham, S.; and Pirie, W. 1995. Trading cost expectations: Evidence from S&P 500 index replacement stock announcements. Working paper. Oxford: University of Mississippi, Department of Economics and Finance.

Fama, E. 1970. Efficient capital markets: A review of theory and empirical work. *Journal of Finance* 25:383–417.

Fama, E. 1991. Efficient capital markets: II. *Journal of Finance* 46:1575–1618.

Goetzmann, W., and Garry, M. 1986. Does delisting from the S&P 500 affect stock price? *Financial Analysts Journal* 42:64–69.

Harris, L., and Gurel, E. 1986. Price and volume effects associated with changes in the S&P 500 list: New evidence for the existence of price pressures. *Journal of Finance* 41:815–29.

Hollander, M., and Wolfe, D. 1973. *Nonparametric Statistical Methods.* New York: Wiley.

Holthausen, R.; Leftwich, R.; and Mayers, D. 1990. Large-block transactions, the speed of response, and temporary and permanent stock-price effects. *Journal of Financial Economics* 26:71–95.

Jain, P. 1987. The effect on stock price from inclusion in or exclusion from the S&P 500. *Financial Analysts Journal* 43:58–65.

Judge, G.; Griffiths, W.; Hill, C.; Lütkepohl, H.; and Lee, T. 1985. *The Theory and Practice of Econometrics.* New York: Wiley.

Keim, D., and Madhavan, A. 1996. The upstairs market for large block transactions: Analysis and measurement of price effects. *Review of Financial Studies* 9:1–36.

Kothari, S., and Warner, J. 1996. Measuring long-horizon security performance. Working paper. Rochester, N.Y.: University of Rochester, Graduate School of Business Administration.

Meulbroek, L. 1992. An empirical analysis of illegal insider trading. *Journal of Finance* 47:1661–99.

Ruback, R. 1982. The effect of discretionary price control decisions on equity values. *Journal of Financial Economics* 10:83–105.

Shleifer, A. 1986. Do demand curves for stocks slope down? *Journal of Finance* 41:579–90.

Yermack, D. 1995. Good timing: CEO stock option awards and company news announcements. Working paper. New York: New York University, Stern School of Business.