CHANGES IN TRADING VOLUME AND RETURN VOLATILITY ASSOCIATED WITH S&P 500 INDEX ADDITIONS AND DELETIONS

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ABSTRACT

When a stock is added into the S&P 500 Index, it in effect becomes cross-listed in the Index derivative markets. When index-based trading strategies such as index arbitrage are executed, the component stocks are directly affected by such trading. We find increased volatility of daily returns, plus increased trading volume for the underlying stocks. Utilizing a list of S&P 500 Index composition changes over the period September 1976 to December 2005, we study the market-adjusted volume turnover and return variance of the stocks added to and deleted from the Index. The results indicate that after the introduction of the S&P 500 Index futures and options contracts, stocks added to the S&P 500 experience statistically significant increase in both trading volume and return volatility. Both daily and monthly return variances increase following index inclusion. When stocks are removed from the index, though, neither volatility of returns nor trading volume experiences any significant

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change. So, we have new evidence showing that Index inclusion changes a firm's return volatility, and supporting the destabilization hypothesis.

An old Wall Street adage says "It takes volume to make prices move."

INTRODUCTION

Exchange trading in S&P 500 futures and options contracts began in 1982 and 1983, respectively. The popularity of these contracts soared soon after their introductions (see Vijh, 1994). The implied dollar trading volume in these contracts soon exceeded that in the cash securities. Harris (1989) reported, "By 1987, the average daily dollar volume in the S&P 500 futures contracts alone exceeded the dollar volume of cash S&P 500 trade by a factor of about two, while the dollar value of the daily net change in total open interest is about 8% of S&P 500 stock dollar volume."[1]

When a stock is added into an index such as the S&P 500, it in effect becomes cross-listed in the index derivative markets, thus becoming subject to substantially increased arbitrage pressure. Prices of index futures and options are co-integrated with the spot market, linked to the prices of underlying securities by index arbitrage. The existence of index derivatives contracts creates additional routes for arbitrageurs to trade. Moreover, index-based trading strategies create additional order flows that must be absorbed by the market.

In general, there is a positive relationship between trading volume and the magnitude of price changes in the financial markets (see, for example, Karpoff, 1987). Stoll and Whaley (1987) point out the cash settlement feature of index futures contracts, which require index arbitrageurs to unwind positions in the spot index securities. The "unwinding" of index arbitrage positions, instead of the traditional delivery settlement method, tends to induce price pressures that temporarily cause price movements in the component shares. Short-term price changes, resulted from program trading transactions that buy or sell a large portfolio of component stocks (block trades), are inevitable in the presence of index-based trading programs.[2]

The results of this study include four key findings. First, we learn that stocks being added to the S&P 500 Index experience significantly higher trading volume and return volatility (in both daily and monthly stock return series) following the effective date of inclusion (not the announcement date, but the date the inclusion becomes effective). This increase is evident only during the period after index derivatives trading had become well established (during the second sub-period of the sample, 1986–2005). This finding suggests that the increase in volatility may be related to heavy trading in the derivatives contracts.

Second, for index deletions, there is no significant change in either trading activity or return volatility, either before or after trading in index futures became well established. Third, the increase in variance became significant starting in 1986 and remained significant in most of the following years after. These findings are compatible with the result of Harris (1989), documenting a positive difference between S&P 500 stock and non-S&P 500 stock return volatilities, beginning in the year 1985.

Fourth, we find strong evidence that turnover changes are positively related to changes in volatility. Finally, we find weak evidence that a small beta increase is associated with the added firms during the second subperiod. The small shift in beta of 0.04 is statistically, but not economically, significant. Furthermore, our results are independent of the methodologies we employ in estimating return volatility.

We offer the following explanations for the empirical results. Trade in index derivative contracts has a fundamental effect (not a temporary effect) on the stock return distribution of a security being included in the S&P 500 Index. Firms removed from the index experience no significant change in trading volume and return variance because the market capitalization of these stocks generally becomes extremely small as they exit the index. As a result, they are not (or perhaps minimally) affected by index trading.

This study contributes to two groups of literature. First, it documents an increase in return volatility associated with index addition. This result is particularly useful to option traders and risk management programs. Additionally, this new evidence supports Shleifer's (1986) imperfect substitute hypothesis. Second, this study adds additional support that derivatives trading may "fundamentally" destabilize the underlying cash securities.

RESULTS

The empirical results are divided into three parts. We begin with abnormal trading volume. Then we consider the volatility effect associated with Index additions and deletions. Finally, we find that there is no significant alteration of the stock's systematic (market) risk. Complete information about data and methodology are available in the Appendix.

TRADING VOLUME EFFECT

We use the abnormal turnover ratio methodology similar to Harris and Gurel (1986) and Chen, Noronha, and Singal (2004). In the turnover ratio approach, volume turnover is simply individual firm trading volume divided by total shares outstanding. The ratio is then divided by overall market volume measured by the total trading volume of the New York Stock Exchange (NYSE).[3] The market-adjusted turnover ratio tests whether post-inclusion (deletion) volume is different from pre-inclusion (deletion) volume. If there is abnormal trading around Index changes, the mean turnover ratio (MTR) will deviate significantly from unity.

Table 2 provides results of our trading volume analysis. For stocks added to the Index, the turnover ratios in post-1986 periods are significantly different from those prior to the year 1986. We use the year 1986 as the cutoff year as Vijh (1994) shows that the total (implied) dollar volume related to S&P 500 Index-based trading strategies for the year 1986 is almost twice as much as that for the year 1985 (Table 1). As a result, we compare the turnover ratios of two distinct periods: (1) September 1976 to December 1985, when Index-based trading was less important, and (2) January 1986 to December 2005, after trading in index derivatives had become well established.

For the first period, the mean turnover around the effective day of inclusion is not significantly different from the ‘‘normal’’ turnover, which is measure using trading volume before the actual event day. In fact, our result indicates that during this period when Index component stocks are less likely to be affected by trading in the derivative markets, there is no abnormal trading volume associated with the company being included in the S&P 500. In other words, an entry to the Index portfolio did not change the trading volume of the addition during this period.

In the period 1986–2005, though, the mean turnover around the effective day is 1.093. The p-value of the t-test is less than 0.001, indicating that the post-inclusion volume is significantly higher than the volume during normal trading days, by almost 10%. This provides evidence that index additions are likely to experience an increase in trading volume following their entry into the Index, coinciding with the underlying cash securities becoming directly linked to the trading in the Index derivative products. We obtain similar abnormal volume results when we extend our ‘‘event’’ period longer, up to 150 trading days after the effective. The result suggests that there is permanent change in volume for 1986–2005 portion of the data. Our results

Table 1. S&P 500 Index Trading Strategies and Trading Volume.

Year	S&P 500 Trading Volume							S&P 100 Trading Volume		NYSE Trading Volume	
	Index futures		Index options		Futures options		Total dollars	Index Options		Stocks	
	Contracts	Dollars	Contracts	Dollars	Contracts	Dollars		Contracts	Dollars	Round lots	Dollars
1982	2,935	161	–	–	–	–	161	–	–	16,670	495
1983	8,069	678	14	1	281	24	703	10,595	177	21,845	775
1984	12,364	947	12	1	673	52	1,000	64,288	977	23,309	773
1985	15,056	1,444	8	1	1,090	105	1,550	90,805	1,686	27,774	981
1986	19,505	2,446	1,683	42	1,886	237	2,725	113,151	2,684	36,010	1,389
1987	19,045	2,895	6,205	187	1,877	285	3,367	101,827	3,044	48,143	1,889
1988	11,354	1,553	4,817	132	735	101	1,786	57,433	1,503	41,118	1,366
1989	10,560	1,679	6,274	199	1,162	185	2,063	58,371	1,721	42,022	1,556

Source: Reproduced from Vijh (1994, RFS).

are generally in line with those reported in previous studies (a review of the literature follows later in this work).

Next, we examine the trading volume around the time when an S&P 500 component stock is removed from the Index. We expect that there should be no abnormal volume around the deletion event, even during the period of heavy index-based trading. This is because the deletions typically represent an extremely small fraction of the Index at the time of removal. Most of the deletions that survived the sample screening procedure are removed for lack of representation. These stocks are usually the smallest firms in the S&P 500, in terms of market capitalization. As a result, derivatives trading would have little or no impact on the volume of these "beaten-down" shares. Hence, there should be no abnormal volume surrounding the removal day.

In Table 2, the MTRs during both periods are not significantly different from one, which means that subsequent to the removal, the trading volume of the deleted stocks are close to the normal volume (pre-deletion volume). In the period 1976–1985, the MTR is 0.935% or 93.5% of the normal volume. Although the volume is lower following the deletion, the decrease in volume is not statistically or economically different than the trading volume in the pre-removal period of (−31, −91). Similarly, for the period covering 1986–2005, the MTR of 0.974 is close to unity and is not statistically different from unity. Our results remain unchanged if we extend the event period up to 150 trading days after the effective day. This indicates that there is no abnormal trading volume around the time a company is taken

Table 2. Index Changes and Volume Effects.

S&P 500 Index Changes: Volume Effect		
Additions	197609-198512	198601-200512
Initial sample		
Final sample	96	247
Turnover ratio	0.994	1.093*
p-value	0.901	<.001
Deletions	197609-198512	198601-200512
Initial sample		
Final sample	18	60
Turnover ratio	0.935	0.974
p-value	0.533	0.714

*Significance at the 1% level.

out of the S&P 500 Index in the full sample period September 1975 to December 2005 or in the subperiods – September 1975 to December 1985 as well as January 1986 through December 2005.

In sum, we find significant increase in trading volume for stocks added to the S&P 500, but only during the period when dollar volume in S&P 500 Index-based derivatives (e.g., index futures and index options) is considered important. The excess volume is close to 10% of the normal trading volume in days before the actual inclusion. In the period from 1976 to 1985, index additions are not associated with trading volume change. As for index deletions, we find results supporting our hypotheses that there is no abnormal trading volume when a company is removed from the Index. Upon further investigation, we document similar results when extending the event period from 120 to 150 trading days following the effective day. Thus, it can be argued that the volume effect associated with index membership changes is permanent.

VOLATILITY EFFECT

We employ various measures of stock return volatility and find that our results are independent of the methods used for estimating return variance. We investigate whether volatilities change as firms enter or leave the S&P 500 Index, in periods before and after 1986 when the dollar volume in S&P Index derivative products became significant. First, simple stock return variances are computed using daily return series. The post-change (pre-change) return variance is estimated using 60 trading days in the interval from day +61 (day −31) to day +120 (day −90). These time intervals correspond to the intervals in the volume effect analysis.

Second, we look at a measure of idiosyncratic volatility – residual return variance (see Elliott, Van Ness, Walker, & Warr, 2006). The residual variance measures a "stock's idiosyncratic risk and is the variance of the difference between the return on the firm's stock and the return on the market portfolio." The CRSP AMEX-NYSE-NASDAQ equally weighted index is used as a proxy of the market index.[4]

The final measure of volatility is based on Nelson's (1991) exponential GARCH model. We estimate the conditional variances for each additions and deletions using stock returns from day −150 to day +150. After the return variances are calculated, we compare the distribution of variances before and after the actual S&P 500 Index changes. The Wilcoxon Signed Ranks test and paired *t*-test are used to determine whether there is a change

Table 3. Volatility Effect – Return Variance Measure.

S&P 500 Index Changes: Volatility Effect				
	Return variance			
	Pre-inclusion	Post-inclusion	Paired t	Wilcoxon signed ranks (Z)
Additions sample				
September 1976 to December 1985 % positive = 44.12%	0.000514	0.000459	−1.09	−1.527
January 1986 to December 2005 % positive = 63.75%	0.000875	0.00114	4.41***	4.873***
Deletions sample				
September 1976 to December 1985 % positive = 28.57%	0.000611	0.00090	0.584	−1.527
September 1976 to December 1985 % positive = 47.27%	0.00135	0.00132	−0.196	−0.31

***Significance at the 1% level.

in return variance around the time a company is included in or removed from the Index.

Tables 3–5 assess the volatilities of additions and deletions surrounding the effective day. We obtain the same results regardless of the methods we use to estimate volatilities. The daily return variances for added firms average 0.00088 and 0.0011 before and after the S&P 500 changes for the period 1986–2005, and average 0.00051 and 0.00046 before and after the effective day during 1976–1985. Both Wilcoxon Signed test and paired t-test indicate that added companies experience significant increase in return variance [Wilcoxon Z-statistic (p-value) 4.87 (<0.01); paired t-statistic (p-value) 4.41 (<0.01)], but only over the period when index-based trading achieves record volume in 1986. Similar results are obtained in the analysis of residual return variance and EGARCH conditional variance. Both residual return variance and EGARCH conditional variance are significantly higher after a stock is added to the S&P 500 over the period 1986 to 2005.

Tables 3–5 also report the percentage of stocks that experience higher volatility. The percentage ranges from over 60% to about two-thirds of the additions. Thus, our results do not appear to be driven by a few outliers.

Table 4. Volatility Effect – EGARCH Conditional Variance.

S&P 500 Index Changes: Volatility Effect – EGARCH Conditional Variance				
	EGARCH conditional variance			
	Pre-inclusion	Post-inclusion	Paired t	Wilcoxon signed ranks (Z)
Additions sample				
September 1976 to December 1985 % positive = 46.60%	0.000490	0.000465	−1.12*	−0.21
January 1986 to December 2005 % positive = 66.53%	0.000914	0.00111	4.70***	6.23***
Deletions sample				
September 1976 to December 1985 % positive = 42.86.57%	0.00055	0.00080	0.776	−0.19
January 1986 to December 2005 % positive = 44.07%	0.00148	0.00195	1.39	−0.249

*Significance at the 10% level.
***Significance at the 1% level.

Table 5. Volatility Effect – Residual Return Variance.

S&P 500 Index Changes: Volatility Effect – Idiosyncratic Risk				
	Residual return variance			
	Pre-inclusion	Post-inclusion	Paired t	Wilcoxon signed ranks (Z)
Additions sample				
September 1976 to December 1985 % positive = 43.14%	0.00044	0.00041	−0.62	−0.986
January 1986 to December 2005 % positive = 60.58%	0.000766	0.000985	4.24***	4.450***
Deletions sample				
September 1976 to December 1985 % positive = 38.10%	0.000505	0.000883	0.809	−0.678
January 1986 to December 2005 % positive = 46.67%	0.00121	0.00153	1.15	−0.375

***Significance at the 1% level.

In the period from September 1976 to December 1985, both Wilcoxon Signed test and paired *t*-test fail to reject the null hypothesis of no change in volatility for added firms. In addition, it is shown that volatility actually decreases for more than half of the added firms in this period. In general, the results indicate that for added firms, volatility does not change in this period before 1986. The results lend additional support to the notion that trading in the index derivative markets may lead to an increase in the volatility of the underlying shares as we find dramatically different results in the two subperiods.

Figs. 1 and 2 further show that post-inclusion volatility is higher following the introduction of index futures and option contracts. These show mean squared daily returns (MSDRs) from 150 days before index inclusion until 150 days after, for each of the stocks in the samples. Fig. 1 gives a clear picture that during the time prior to index derivatives trading becoming well established, there was no shift in volatility of returns from the time before the time after inclusion (the inclusion event is day 0). Fig. 2 gives a clear picture of an upward shift in volatility upon inclusion in the index, during the period after index derivatives trading becoming well established.

To further understand how return volatility is influenced by trading volume in the derivative markets, we examine the observed volatility

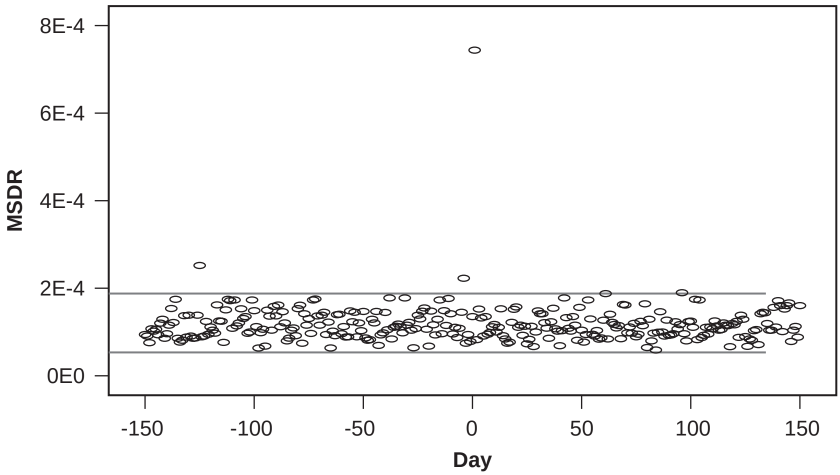

Fig. 1. S&P 500 Index Additions (September 1976–1985). This Chart Shows the Median Squared Daily Returns, Surrounding the Effective Date, for Stocks Added to the S&P 500 Index During the Period September 1976 to December 1985.

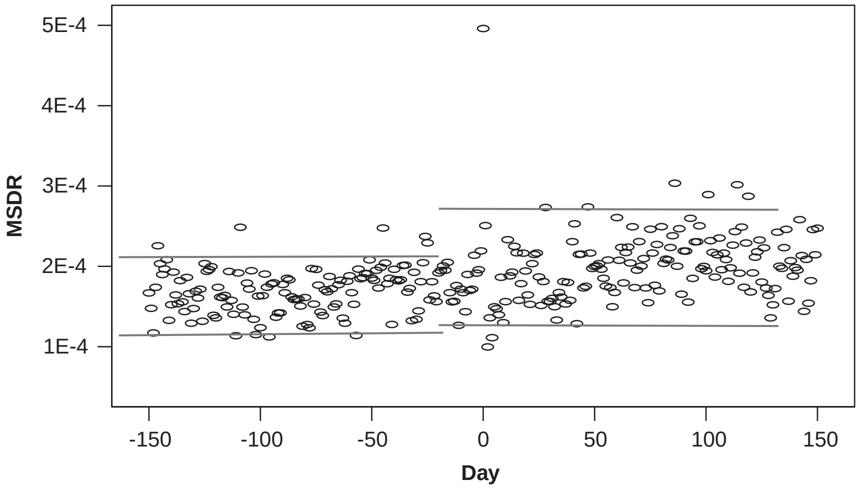

Fig. 2. Index Additions (January 1986–December 2005). This Chart Shows the Median Squared Daily Returns, Surrounding the Effective Date, for Stocks Added to the S&P 500 Index During the Period January 1986 to December 2005.

dynamics around index additions by breaking down the two periods further. Table 6 illustrates shows the detailed year-to-year volatility comparisons for index additions, beginning with the year 1981, which is the full year before the introduction of S&P 500 Index futures contracts. Return volatility is not significantly different before and after index additions, generally from 1981 to 1985. Tests of volatility change for these five years indicate that there is no change in return variance for additions. Except the year 1981, the remaining four years in this period are associated with more firms that have higher post-inclusion volatilities. In fact, more than 55% of added firms have higher post-inclusion volatilities, comparing with 34% of added firms in the period from 1976 to 1981.

Immediately Around the Crash of 1987

Note that, in Table 6, the year 1986 is the first year in the sample period that we find higher return volatility (significant at the 5% level) in the post-inclusion period.[5] There were a total of 14 additions in the final sample and more than 70% of the added firms (10 of 14) experience higher post-change volatility. The EGARCH conditional (daily) variance for included stocks average 0.00048 and 0.0006 before and after the S&P500 changes for the year.

Table 6. Volatility Changes around 1982 and 1983 (EGARCH Volatility).

Year (Positive/ Negative)	Pre-Inclusion Volatility	Post-Inclusion Volatility	Change in Volatility	Wilcoxon Signed Ranks
1976–1980 (14/22)	0.000491	0.000407	−0.000084	−1.82**
1981 (3/11)	0.000446	0.000401	−0.000045	−1.60
1982 (10/8)	0.000509	0.000600	0.000091	1.07
1983 (3/2)	0.000580	0.000612	0.000032	1.21
1984 (9/9)	0.000540	0.000500	−0.000040	−0.54
1985 (9/6)	0.000411	0.000405	−0.000006	0.63
1986 (10/4)	0.000483	0.000600	0.000117	1.92**
1987 (3/1)	0.000560	0.000850	0.000290	1.10
1988 (4/5)	0.000267	0.000234	−0.000033	−1.00
1989 (14/4)	0.000320	0.000362	0.000042	1.98**
1990 (6/3)	0.000478	0.000662	0.000184	1.84**
1986–1990 (37/17)	0.000398	0.000488	0.000090	3.00***
1991–1995 (17/15)	0.000490	0.000571	0.000081	1.57*
1996–2005 (107/53)	0.001150	0.001400	0.000250	5.13***

*Significance at the 10% level.
**Significance at the 5% level.
***Significance at the 1% level.

To examine years immediately following 1986, we must deal with the crash of 1987. Consistent with previous research, we removed firms with effective day that is 120 trading days around the crash. There are 14 index additions excluded from our sample for this reason. For the year 1987, there were only four added firms available for statistical analysis. We still report Wilcoxon signed test results, but we must interpret the results carefully. In 1987, three of the four newly included stocks show higher post-change volatility. The average pre- and post-inclusion variance are 0.00056 and 0.00085, however, the change in volatility is not statistically significant probably due to small sample size. We did not find volatility change in 1988, but find significant increases in return variance in 1989 and 1990. For the period 1986–1990, the post-inclusion volatility of 0.000488 is significantly higher that the pre-inclusion volatility of 0.000398 at the 1% significance level. The result supports our hypothesis that post-inclusion volatility is higher for index addition in this period when index trading volume reached record highs.

It is interesting to note that in the period preceding 1982, the post-inclusion volatility is actually lower than the pre-inclusion volatility. The

Wilcoxon test shows that the negative change in volatility is statistically significant. Table 6 also indicates significantly higher post-change volatility for added firms in periods following 1990. Both periods 1991–1995 and 1996–2005 show increases in conditional variances with the later period providing more significant increase. Despite the activation of circuit breakers and other forms of exchange trading curbs following the crash of 1987, we continue to find higher post-inclusion volatility in our sample of S&P 500 additions.

For companies deleted from the Index, we find evidence in support of our hypotheses that no change in volatility is associated with deletions. As we expect, in a market value-weighted index like the S&P 500, firms being excluded from the Index typically represent an extremely small fraction of the Index, as a result volatility should not change around removal days regardless of whether or not there is significant trading in the index derivative markets.

We find no significant change in volatility of the firms that were removed from the S&P 500. Less than 50% (ranging from 28.57% in the period 1976–1985 to 47.27% in the 1986–2005 period) of the deleted firms experience an increase in return volatility although the average post-deletion volatilities are generally higher than pre-deletion volatilities. Figs. 3 and 4 gives clear

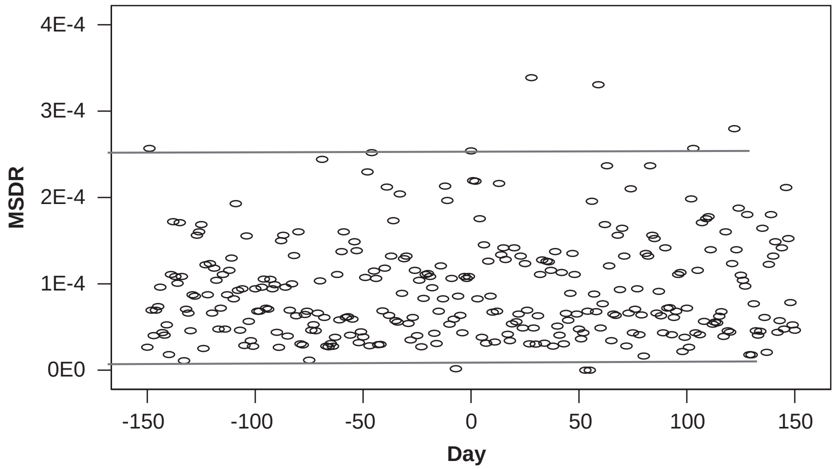

Fig. 3. Index Deletions (1976–1985). This Chart Shows the Median Squared Daily Returns, Surrounding the Effective Date, for Stocks Deleted from the S&P 500 Index During the Period January 1976 to December 1985.

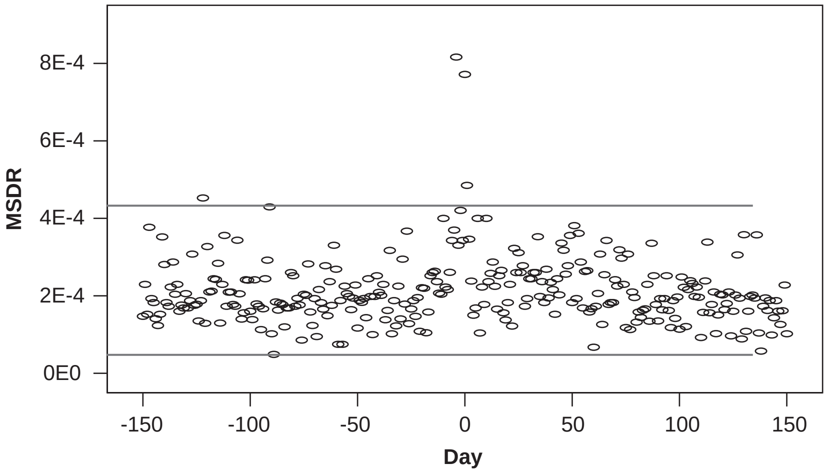

Fig. 4. Index Deletions (1986–2005). This Chart Shows the Median Squared Daily Returns, Surrounding the Effective Date, for Stocks Deleted from the S&P 500 Index During the Period January 1986 to December 2005.

pictures that return volatility does not change after a firm is removed from the S&P 500 Index.

Additionally, we examine the relationship between turnover (percentage) change and change in volatility. We calculate percentage turnover change by subtracting pre-inclusion turnover from post-inclusion turnover and divide this ratio by the pre-inclusion turnover. The "most active" group consists of the top decile of firms experiencing highest turnover change. The second group includes firms that experience no change in turnover, and the third group includes firms that experience strongest turnover decline. Table 7 reports the results, indicating that there is a positive relationship between turnover and return variance. The higher the percentage turnover, the greater the volatility increase.

MARKET RISK MEASURE

The results concerning total variability of returns raise the question of whether there is any change in systematic (market) risk surrounding Index composition changes. We estimate stock betas around the effective day using the methodology specified in Scholes and Williams (1977), to cope

Table 7. Linking Turnover and Volatility.

S&P 500 Index Changes				
Portfolio group	Mean % turnover change	Pre-inclusion volatility	Post-inclusion volatility	Paired *t*-statistic
Group 1 turnover increase	114.60	0.001047	0.001953	4.04*
Group 2 turnover no change	3.53	0.000688	0.000794	1.13**
Group 3 turnover decrease	–25.84	0.00116	0.00124	0.64

*Significantly different from zero at the 1% level.
**Significantly different from zero at the 5% level.

Table 8. Market Risk.

S&P 500 Index Changes Stock Beta				
	Pre-inclusion beta	Post-inclusion beta	Change in beta	Wilcoxon signed ranks
Additions				
1976–1985	1.28	1.23	−0.05	−0.705
1986–2005	1.25	1.29	0.04	1.35*
Deletions				
1976–1985	0.72	0.65	−0.07	−0.487
1986–2005	1.05	0.89	−0.16	−0.715

*Significance at the 10% level.

with the issue of non-synchronous trading. The Scholes and Williams beta has been shown to outperform ordinary least squares (OLS) beta in a number of empirical studies. For additions, we estimate pre- and post-change betas using daily returns in the [−31, −150] and [+31, +150] windows around the effective day. But for deletions, we begin with day −16 and day +16 and estimate betas using 120 trading day returns, due to data limitations of the deleted companies. The Wilcoxon Signed test is used to determine whether there is beta shift around the actual Index inclusion or deletion.

Table 8 presents the results regarding beta. The mean pre-inclusion beta is not significantly different from the post-inclusion beta for the sample of Index additions in the period covering 1976–1985. But, over the period

1986–2005 we find a small increase in beta, statistically (not economically significant) significant at the 10% level.[6] This finding is similar to results documented in Vijh (1994) and Barberis, Shleifer, and Wurgler (2005). The analysis of beta adds to our understanding of risk change associated with index additions. On the contrary, we find no change in beta around the event of index removals.

EXCHANGE TRADING COMPARED WITH OVER-THE-COUNTER

Furthermore, Table 9 shows the volatility tests for the NYSE and Nasdaq stocks being added to the S&P 500 Index. The results show that both groups of stocks experience significant increase in return volatility following inclusion. The results indicate that Nasdaq-based firms experience even higher increase in volatility than NYSE-listed companies.[7]

Table 10 shows the analysis of monthly return variance. The monthly return volatility of an added firm increases from 0.0177 to 0.021 [Wilcoxon Z-statistic (p-value) 3.31 (<0.01)]. The results indicate that index inclusions experience significant increase in long-interval return volatility measure. This finding is consistent with the hypothesis that derivative trading fundamentally destabilizes the underlying securities (see Harris, 1989).[8]

RELATED RESEARCH

Harris (1989) discusses two paradigms describing the impact derivative markets have on the volatility of the spot markets. First, large transactions

Table 9. NYSE vs NASDAQ.

Index Additions					
Exchange or market	No. of Firms	Pre-inclusion Volatility	Post-inclusion Volatility	Paired t-statistic	Wilcoxon Z
NYSE % positive = 63.40%	153	0.00058	0.00071	3.63***	3.79***
Nasdaq % positive = 77.03%	74	0.0014	0.00194	5.53***	5.26***

Table 10. Monthly Return Variance.

Index Additions				
Monthly return variance				
Period	Pre-inclusion volatility	Post-inclusion volatility	Paired *t*-statistic	Wilcoxon *Z*
197609|198512	0.0111	0.0106	−0.54	−0.29
198601|200512	0.0177	0.0210	2.47*	3.31*

*Significantly different from zero at the 1% level.

in the derivatives markets may result in transaction spillover to the underlying spot markets, inducing liquidity pressure. In other words, trade in the derivative contracts may cause related transactions in the cash markets that are often too large to be absorbed by the market (i.e., order imbalances). Such transactions, according to Harris (1989) and Vijh (1994) may be associated with mechanical arbitrage activities, portfolio insurance operations, and program trading. The notion of price pressure suggests that price changes are transitory and may be attributed to temporary trading imbalances, induced by index-based trading programs. This argument implies that return volatility measured over short intervals (such as daily) will be greater for the added stocks subsequent to the effective day, but that return volatility estimated over longer intervals (i.e., weekly and monthly) will be the same. This prediction is consistent with the price pressure hypothesis in that stock prices revert close to pre-announcement levels (see Harris & Gurel, 1986).

The second paradigm asserts that trading in futures and options markets fundamentally destabilizes the value formation process in cash markets. Under this framework, both short- and long-interval measures of return volatility should be larger after a stock is officially included in the index portfolio. In other words, large ongoing transactions resulting from arbitrage, program trading, and portfolio insurance operations cause permanent changes in prices of the underlying securities. The change in long-interval volatility measures may be associated with long-run demand shift of the component stocks.[9]

There are two main lines of reasoning to account for the change in volume and volatility, resulting from index derivatives transactions. One interpretation is that stock return variability is positively related to the information arrivals accompanied by trading volume. This argument is based on how information is incorporated into security prices. As the market digests new information, prices are adjusted to reflect a new set of available information. The other is based on how market makers respond to large block trades caused by arbitrage. This is a market microstructure perspective, looking at the volatility of price changes as market makers adjust prices based on their portfolio risk and inventory risk. Prices may also change in response to liquidity demand requiring market makers to provide immediate transactions when large transactions come to the marketplace. Both interpretation suggest also a positive relationship between trading volume and return volatility.

SPILLOVER

Stoll and Whaley (1987) look at market-wide trading activities and stock price changes around derivative expiration days. They find that trading volume and volatility of the S&P 500 Index increase significantly around expiration days. These volume and price effects, though, are not associated with non-S&P stocks. French and Roll (1986) have investigated how stock return volatility varies in response to different levels of trading. They document higher stock volatilities when the stock market is open for trading, with non-market session hours are linked to lower volatility. Their findings are consistent with the positive volume–volatility relationship.

In the information framework, an increase in trading is typically accompanied by additional information that is being priced in the marketplace. Ross (1989) suggests that the volatility of prices is directly related to the rate of information flowing into the market. Similarly, Cox (1976), Copeland (1976), Epps and Epps (1976), Tauchen and Pitts (1983), and Jennings and Barry (1983) provide insights as to whether price changes are linked to information arrivals. These models provide insights as to how information production is related to price volatility. Derivative markets offer additional channels for information to be disseminated, implying that information is more likely to be discovered and transmitted between the markets. Security prices are adjusted to reflect new information, and thus, price movements may directly correspond to information arrivals.

Cox (1976) investigates the information effect of futures trading and whether there is a relationship between information production and the prices of the spot assets. Cox demonstrates that futures trading activities are associated with an increase in information production of the underlying securities and prices of the spot assets respond quickly to the updated information set. Vijh (1994) points out that the large trading in S&P 500 products may affect prices because, "Simply by chance the buy orders will dominate sell orders on certain days while the sell orders will dominate buy orders on other days."

In addition, Duffie, Kupiec, and White (1990) argue that index arbitrage may cause price changes as large transactions are executed in the spot markets, resulting in reduced liquidity. Stoll and Whaley (1987) and French and Roll (1986) show that stock variance is strongly related to trading activities. Moreover, derivative trading is also subject to margin calls that at times of order imbalance may trigger additional price pressure.

Santoni (1987) documents an inverse relation between S&P 500 Index futures trading volume and volatility of the S&P 500 market index, suggesting that an increase in futures trading activities leads to a reduction in spot market volatility. Moreover, Bessembinder and Seguin (1992) provide evidence that stock market volatility is negatively correlated to (total) trading volume in the cash markets. Trades in the futures markets are directly related to the trading volume in the underlying spot securities. However, when the authors decompose trading activities, they find that only "unexpected" trading volume in the spot securities is positively correlated with volatility. Expected changes in volume do not affect volatility. Moreover, Edwards (1988a, 1988b) finds that the introduction of futures contracts is not related to volatility changes in the underlying cash markets.

DESTABILIZATION

Stein (1987) contends that fewer informed traders may be attracted to derivative markets. The increase in the number of noise traders may reduce the information content of the market prices, resulting in price destabilization.[10] Index derivative transactions are likely to increase information production and the rate of information transmitted to the market. As a result, trading in the derivative markets may be related to volatility changes in the spot assets.

Pruitt and Wei (1989) provide further evidence supporting the short-term price effect (price pressure). Their study shows that institutional ownership increases following a firm's inclusion in the S&P 500 Index. As institutional investors are associated with larger trading transactions, it is more likely to cause temporary order imbalances, which in turn lead to higher price changes. Jones, Kaul, and Lipson (1994) decomposes daily trading volume into number of trades and average trade size and examines their impact on the volatility of stocks traded in the NASDAQ national market. They find that number of transactions is the most important measure of trading activity that explains volatility changes although size of trade is also an influencing factor.

Ho and Macris (1984) suggest that the market makers adjust bid-ask spreads when they face large order flows. Market makers, in response to liquidity constraints, often carry additional inventory to cope with possible order imbalances, resulting in suboptimal inventory holdings. This inventory cost is then reflected in security prices resulting in short-term price changes. Several other studies have also argue that large transactions tend to increase costs associated with market making services and these costs are associated with stock prices being deviated from their intrinsic (fundamental) values.

THIS STUDY'S RESULTS IN PERSPECTIVE

Previous studies investigating the effects of index composition changes suggest that the volatility of the added or deleted firm does not change around the announcement or effective date, and thus, the observed price response to the event of index changes cannot be attributed to change in risk.[11] Dhillon and Johnson (1991) study the prices of options for companies added to the S&P 500 Index, during the period 1984–1988. The results indicate that, around the announcement date, call prices increase but put prices decline, leading to inconclusive evidence as to whether return variances for the added firms change. Studies in index composition changes, following Dhillon and Johnson (1991), have generally regarded index change announcements as non-volatility induced events.

Our study is closely related to a body of literature investigating the impact of index trading strategies on the volatility of the underlying securities. Traditional finance theory suggests that derivative markets are linked to the underlying spot market by mechanical arbitrage trading (see Grossman, 1988). When cash securities are overpriced (underpriced) relative to the derivative markets, arbitrageurs could sell (buy) the cash assets and take long (short) positions in the derivatives. These arbitrage transactions continue to take place until both markets converge to equilibrium. Arbitrage transactions tend to create additional large order flows in the underlying market as the arbitrage mechanism works to correct prices. Previous empirical studies have examined the relationship between trading volume and volatility. Karpoff (1987) and Gallant, Rossi, and Tauchen (1992) have shown a positive relation between volume and the absolute value of price changes. Thus, it can be argued that arbitrage transactions may result in abnormal trading, which in turn causes price movements.

In this study, we build on the work of Harris (1989) and Vijh (1994) and directly examine trading volume and security return volatility for firms that are added to and deleted from the S&P 500 Index from September 1976 to December 2005. We are particularly interested in the trading volume and volatility of index additions and deletions around effective date, the first day when the actual change is reflected in the index composition. To investigate the impact of index derivatives, the full sample period is partitioned into two subperiods, covering the period September 1976–1985 and 1986–2005. This first subperiod is related to a period of relative lower index derivative dollar volume since the S&P index futures (options) were not available until 1982 (1983). Subsequent to the first subperiod, the dollar volume on the index derivatives contracts reached record highs. Thus, the second subperiod focuses on the effects of transactions (such as index arbitrage, portfolio insurance, and program trading). Our main goal is to determine whether the index trading volume affects the turnover and return volatility of the underlying stocks. Unlike earlier studies, we employ a list of index additions and deletions to study the impact of index trading strategies.[12]

CONCLUSION

This study investigates the trading volume and volatility of companies added to and deleted from the S&P 500 Index, in the period following the introduction of S&P 500 Index futures and options (1986–2005). Following the empirical framework of Vijh (1994), we find significant increase in both trading volume and return volatility after a firm is included in the index. This result is not found during the period prior to the introduction of index derivative securities. To our best knowledge, we are the first to document an increase in return volatility associated with index addition.

Upon further investigation, we find that both daily and monthly return variances increase for the added firms, indicating that the price effect due to index changes is not solely due to short-term price pressure. The empirical evidence supports a long-term downward sloping demand curve for stocks. We ascribe the change in risk to index arbitrage transactions although we cannot rule out other factors (such as portfolio insurance operations and program trading) influencing the volatility of the added firms.

Furthermore, we document a positive relationship between turnover change and volatility change – the greater the change in turnover, the higher the change in return volatility following inclusion. This provides evidence that volatility of the added firms is affected by trading volume resulting from index trading strategies. Our result is consistent with Karpoff (1987).

For the deleted stocks, no significant changes in trading volume and return volatility are found for deleted firms. We argue that the market value of these firms relative to the market value of the index become extremely small at the time they are removed. Since the S&P 500 Index is a market value-weighted portfolio, the deleted firms are not significantly affected by index trading as their index weights become trivial.

NOTES

1. The quote is from Harris (1989, p. 1155).
2. The introduction of the S&P 500 ETF in 1993 allows index arbitrageurs to trade the index portfolio more easily. Before 1993, most index arbitrage transactions are carried out using program trading.
3. We use the NYSE market volume, consistent with earlier studies.
4. We obtain similar results using the CRSP AMEX-NYSE-NASDAQ value-weighted index.
5. We were able to confirm Dhillon and Johnson's (1991) results, using index inclusion data from 1984–1988. Volatility of the added firms does not change during this period.
6. We obtained similar results with regard to systematic risk, using the conventional OLS approach.
7. Elliott and Warr (2003) document that Nasdaq-based firms experience much higher excess returns than NYSE-based companies upon their inclusion into the S&P 500. They argue that the result may be related to the unique specialist program of the NYSE.
8. Harris (1989) supports the price pressure hypothesis as he finds that daily (not weekly) volatility measures are higher for S&P 500 stocks.
9. See Shleifer (1986). In general, previous studies investigating the S&P Effect support the long-term downward sloping demand curves for stock hypothesis.
10. The question whether trade in index derivatives destabilizes the underlying has been debated in the literature. Previous studies have also found that derivatives trading decreases the return volatility of the spot securities. Leading examples include Edwards (1988a, 1988b), Conrad (1989), and Bessembinder and Seguin (1992).
11. In the current literature, change in risk is not found to be associated with index additions and deletions. There are several competing hypotheses explaining the market reactions to the announcement (effective) of index compositions. They include price pressure, imperfect substitutes, liquidity, information content, and investor recognition. A recent analytical review of the related studies can be found in Elliott et al. (2006).
12. Harris (1989) compares S&P 500 stock return volatilities to the volatilities of a matched set of stocks, after controlling for cross-sectional differences in firm attributes such as size, beta, and liquidity.

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APPENDIX. SAMPLE AND DATA

The initial sample consists of all additions and deletions occurring between September 1976 and December 2005. We gathered information about these changes from two sources. First, we obtained index changes for the period September 1976 through December 2000 from Jeffrey Wurgler. This dataset was used in two earlier S&P Index studies – Wurgler and Zhuravskaya (2002) and Barberis et al. (2005). The remaining data on index changes were collected from the Standard and Poor's company website. The sample period begins in September 1976 because before that time, S&P did not publicly announce index changes.

The initial sample consists of 181 additions for the September 1976 to December 1985 period and 515 additions for the January 1986 to December 2005 period. For the entire sample period September 1976 to December 2005), there are 696 additions and 696 deletions. There are, on average, between 20 and 25 stocks added to (deleted from) the S&P 500 Index each year.

Since S&P index additions and deletions are often associated with other contemporaneous corporate events (e.g., spin-offs, merger and acquisition, and restructuring), we use the following set of criteria to screen out firms that are not pure cases of inclusion or deletion. First, we exclude index changes resulted from merger, acquisition, or restructuring. Second, we remove index additions involving merger/acquisition transactions that do not actually include a new company to the index portfolio. For instance, when a non-index company acquires an S&P 500 firm and is subsequently added to the index, we exclude such addition from our sample.

To make certain that we have a clean sample in the analysis of trading volume and return volatility, we search the LexisNexis Academic database for confounding events (such as earnings, dividend, split, financing/investment announcements during the period from three days before the announcement date to seven days subsequent to the effective date (see Denis, McConnell, Ovtchinnikov, & Yu, 2003).

In addition, we require that the there must be sufficient stock returns, trading volume, and shares outstanding data around the effective day. For the trading volume analysis, the post-change (event) period covers the interval [+61, +120]. We also extend the post-inclusion turnover ratio up to 150 trading days after the effective. No index additions in our sample survive less than 150 days. For our volatility and market risk tests, the required daily returns span 300 trading day surround the effective day. The final (clean) sample includes 364 additions and 90 deletions.

The Center for Research in Security Prices (CRSP) database is used to obtain daily returns, daily trading volume, and shares outstanding for the firms used in the analysis. We obtain NYSE trading volume from the historical data archive library on its website.

Methodology

Abnormal Volume Measurement

We analyze trading volume around the effective date of S&P 500 Index changes using procedure similar to those in Harris and Gurel (1986), Elliott and Warr (2003), and Chen et al. (2004). Our purpose is to determine whether excess turnover is associated with index changes, before and after the introduction of S&P 500 Index-based trading strategies. Following Chen et al. (2004, p. 1907), we use turnover (trading volume divided by shares outstanding) instead of trading volume, so that unusually high volume in a few large stocks does not disproportionately affect the market volume.

The volume turnover is calculated by Eq. (A2). The denominator is the market-adjusted volume during the "estimation" period. The estimation period covers the interval, [−61, −120]. The market-adjusted turnover is the ratio of individual stock volume divided by market volume. The numerator is the "event" period turnover adjusted by total market volume during the post-change interval of [+61, +120]. In Eq. (A2), T_{it} is the volume turnover for stock i at time t, the subscript m refers to the market index. Consistent with previous studies, we use the NYSE trading volume as a proxy for market level volume. The pre- (post-change) turnover ratio is the 60-day average trading turnover (with a minimum of 30 days) beginning 61 trading days before (after) the effective date. Thus, trading before (after) the effective date must last for at least 90 days. We calculate the pre- and post-change turnover ratio for each index change in our sample and test whether the MTR across all index changes is significantly different from unity.

$$T_{it}(\text{Turnover}) = \frac{V_{it}}{S_{it}}, \tag{A1}$$

$$TR_i(\text{Turnover Ratio}) = \frac{\sum_{t=61}^{ED+120} \frac{T_{it}}{T_{mt}}}{\sum_{t=-61}^{ED-120} \frac{T_{it}}{T_{mt}}}, \tag{A2}$$

$$MTR = \sum_{i=1}^{N} TR_i \tag{A3}$$

Volatility Measurement

We investigate four measures of stock return volatility surrounding the event – variance of daily stock returns, residual standard deviation, and EGARCH conditional variance. For each index change, we calculate variance of stock returns from the period prior to (subsequent) the effective day. We use Elliott et al. (2006) idiosyncratic expression to measure residual variance: "the residual standard deviation measures the stock's idiosyncratic risk and is the standard deviation of the difference between the return on the firm's stock and the return on the CRSP Equally-weighted portfolio." For the pre-change (normal) period we measure this difference over the [−61, −120] window, and for the post-change period we use the period [+61, +120]. We then compare each pair of pre- and post-change return variances in our sample.

The autoregressive conditional heteroscedasticity (ARCH) was first developed by Engle (1982). Later, the generalized (GARCH) form of ARCH, proposed by Bollerslev (1986), allows for "lagged variances and the further lagging of the error term." Nelson (1991) further extends the GARCH form to incorporate "volatility clustering" and the "leverage effect" that exists in financial data. The specification proposed, known as exponential GARCH (EGARCH), allows for an asymmetric response to positive and negative price changes.

The general EGARCH model begins with a simple univariate framework where no other variables (except past values of returns) can be used in predicting mean returns. The mean return process can generally be expressed as

$$r_t = \mu + \phi(L)r_{t-1} + \varepsilon_t, \quad t = \rho + 1, \ldots, T \tag{A4}$$

where $\phi(L)$ is a polynomial in the lag operator L, that is, $\phi(L) = \phi_1 + \phi_2 L + \ldots + \phi_p L^{p-1}$. The error term ε_t describes the unpredictable component of the returns. A common assumption about its behavior is that it follows a GARCH-type process, namely that

$$\varepsilon_t | I_{t-1} \sim N(0, \sigma_t^2)$$

where I_{t-1} is the information available at time $t-1$ and σ_t^2 follows a process

$$\sigma_t^2 = \alpha_0 + \alpha_t \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

in the GARCH (1, 1) representation (Bollerslev, 1986), and

$$\log\left(\sigma_t^2\right) = \omega + \beta \log\left(\sigma_{t-1}^2\right) + \alpha \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} - \sqrt{\frac{2}{\pi}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \tag{A5}$$

in the Nelson (1991) exponential GARCH [EGARCH(1, 1)] representation.

The variance equation shows that the model is basically a "weighted moving average" of past volatility (one-period lag) and residuals from the mean regression estimations.

"A typical characteristic of asset returns is volatility clustering where one period of high volatility is followed by more of the same and then successive periods of low volatility ensue" (Bollerslev, Chou, & Kroner, 1992). The EGARCH model offers several advantages over other ARCH models.

First, the EGARCH model can deal with volatility clustering and the leverage effect. Second, unlike GARCH, the EGARCH model "imposes no positive constraints on estimated parameters and explicitly accounts for asymmetry in asset return volatility, thereby avoiding possible misspecification in the volatility process" (Glosten, Jaganathan, & Runkle, 1993).

Furthermore, Nelson (1991) points out that the "EGARCH model also allows for a general probability density function (i.e., generalized error distribution, GED), which allows for distributions involving non-normality." This approach makes fewer assumptions about the distribution of the measured volatility series. As Bollerslev et al. (1992) and several others suggest "imposing the normality assumption could bias the estimates."

We use both the Berndt-Hall-Hall-Hausman (hereafter, BHHH) and Marquardt optimization algorithms in the iteration process. The BHHH method outperforms the Marquardt approach, in terms of the percentage of processes that were successfully converged. In our experiments, all of our EGARCH conditional variances converged using the BHHH approach, however, less than 75% successfully converged under the Marquardt algorithm. However, our significance level for the documented increase in variance does not change using either procedure. We thus report only the results of the BHHH optimization algorithms.

Market Risk

Following Scholes and Williams (1977), we estimate stock betas by adjusting for nonsynchronous trading (infrequent trading). This methodology has been shown to outperform the conventional OLS technique. Scholes and Williams (1977) propose a model to incorporate nonsynchronous trading. Infrequent trading may cause a bias in beta estimation procedure. Lo and MacKinlay (1990) contend that "thin trading induces a negative autocorrelation in stock returns, an overstatement of the return variance, and a downward bias in the market risk." To deal with the problems, Scholes and Williams (1977) derive a consistent estimate for beta:

$$\hat{\beta}_i = \frac{\hat{b}_i^{+} + \hat{b}_i + \hat{b}_i^{-}}{1 + 2\hat{\rho}_m} \quad \text{(A6)}$$

where $\hat{b}_i^{+}$, $\hat{b}_i$, and $\hat{b}_i^{-}$, respectively, are the OLS estimates of the slopes of regression of asset i's returns on one-period lag, concurrent, and one-period ahead of the market index; $\hat{\rho}_m$ is the first-order autocorrelation of the index return.