

Intraday and Night Index Arbitrage

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The changes to the S&P 500 index provide a unique laboratory for assessing the degree to which institutional versus individual investors capitalize on available arbitrage opportunities. We provide new evidence on the S&P 500 game using intraday data and examining the role of institutional versus individual investors in both open hours and after-hours trading. Using a sample of 135 changes to the S&P 500 index, we find the highest returns from the S&P game are obtained by investors who enter the game at the beginning of the after-hours session of the announcement date. Profits from arbitrage remain even after accounting for the bid-ask spread.

Introduction

The “S&P game,” a term coined by Beneish and Whaley (1996, 1997, 2002), represents the arbitrage that occurs in response to addition of stocks in the S&P 500 index.¹ It is conducted by both index fund managers and other traders. When changes in an index are announced, index fund managers rebalance their portfolio by buying the added firms. Traditionally, the index fund managers attempted to time the market by jamming the close—buying the stock during the last hour of trading on the day prior to the effective date. More recently, traders attempt to game the index fund managers by getting in the game earlier (on the announcement date) and selling higher to index fund managers on the effective date (Luskin, 2000). Thus, the added stocks may experience price effects at the time of the announcement and around the effective date.

¹A recent paper by Beneish and Whaley (2002) examines index deletions as well and argues that the S&P game profits occur with deletions as well as additions.

The S&P game serves as a unique laboratory to assess arbitrage gains for the following reasons. First, the event (since October 1989) is anticipated fully, as the announcement occurs in advance of the effective date when the index officially is changed. Therefore, it allows some time for arbitrageurs to capitalize on the potential discrepancy in prices, which easily could be done by individual investors. Since 1989, Standard & Poor's has announced the change in the index shortly after the market closes. The effective date commonly is set for five days from the time of the announcement, but has ranged from one day to 20 days. Risk arbitrageurs anticipate that index funds will need to rebalance their portfolios accordingly and take positions in advance of the index funds. While there is strong evidence of gains by risk arbitrageurs, there is limited information about the flow of trading activity in response to the change in the index.

Second, because these events have occurred over time, they allow us to test whether time-varying conditions have altered the price adjustment process. Given that arbitrage has been documented in the past, the arbitrage returns in recent years should be reduced as a result of the increased participation by individual investors. Third, the increasing use of after-hours trading over time may have caused a shift in the proportion of the arbitrage returns that occur in that market versus during normal trading hours.

In particular, our paper differs from previous research in that we assess the impact of the index changes from a microstructure perspective to address the following questions:

- What is the timing of the price adjustment? How long does it take for prices to adjust? Because the announcement occurs after hours, what is the degree of price adjustment in the first after-hours market session versus the subsequent normal day market? Has the proportion of total arbitrage returns that occurs in the after-hours market increased recently in response to the increased trading activity of the night market? If so, this is the first evidence that investors should transact after the close of the day session of the announcement of the change in the S&P Index.
- Are arbitrage profits still possible even after considering the actual spread between bid and ask prices? If so, retail investors should operationalize these trading strategies to take advantage of index funds' participation.
- What is the proportion of total arbitrage activity that is attributed to institutional versus individual investors? Has this proportion changed over time? If so, retail investors successfully are taking advantage of information technology increasingly available to them in order to generate trading profits.

Based on a sample of additions to the S&P 500 index from 1999 to 2002, we are able to address the microstructure-related questions surrounding the arbitrage process. We find that the largest arbitrage profits are earned by investors who enter the

game at the beginning of the after-hours session of the announcement date. The arbitrage is profitable even after accounting for the bid-ask spread.

Theoretical and Empirical Implications

Timing of Price Adjustment

Previous studies find that semi-strong market efficiency is violated due to index arbitrage. Index funds would like to reduce their purchase price by rebalancing before the effective date, such as the night session following the announcement date. Participating too early in the game (such as during the night session on the announcement date), however, could result in a larger tracking error, which is especially a concern if the strategy results in a larger downside error relative to the index and when there is a long time delay between the announcement and effective dates. Nonetheless, if the returns from the game are available in the pre-opening session or at the open on the day prior to the *effective* date, index funds would be able to avoid tracking error. If index funds are attempting to rebalance before the effective date, the price adjustment is expected to occur more rapidly.

We also test whether any evidence of market inefficiency is isolated in the after-hours markets or also persists during normal trading hours. According to Barclay and Hendershott (2003), the after-hours market has become more popular over time. Therefore, the participants in the after-hours market may accrue a larger proportion of the arbitrage return than in the past. We hypothesize that most of the arbitrage will occur in the first session that traders can use the public information, which is the night session of the announcement date.

Evidence on Changes to Indices

Jain (1987) and Dhillon and Johnson (1991) document positive and significant changes in the stock prices of firms that are added to the S&P 500 index. Lynch and Mendenhall (1997) assess 71 changes in the S&P 500 index over the period from October 1989 to 1995. During this period, the additions to, or deletions from, the index are announced by S&P before they become effective, which may allow some time for risk arbitrageurs to accumulate shares of the added stock before the index funds respond. The authors document positive and significant returns following the announcements. Beneish and Whaley (1995) and Beneish and Whaley (1997) document adjustments in trading volume of firms that are added to a stock index.

Beneish and Whaley (1996) find that arbitrageurs earn significant abnormal returns prior to the effective date, though these returns subsequently are reversed, indicating that index funds are being front run by gamblers. Beneish and Whaley (2002) examine the role of after hours trading and find that significant returns still can be made and are increasing over time, despite their conjecture that such abnormal returns would be driven away. Beneish and Whaley (2002) also examine trading firms deleted from the S&P 500, and find that this new game in town also generates

significant abnormal returns. Their papers, however, do not investigate the role of individual versus institutional investors in generating gaming returns, nor do they assess whether significant abnormal returns are possible after accounting for transactions costs.

Data and Methodology

Data

The list of firms added to the S&P 500 Index from January 1999 to December 2002 is obtained from the Standard & Poor's (hereafter, S&P). During this four-year period, there are a total of 151 firms that were added to the S&P 500 index.² Daily returns are obtained from the CRSP to calculate the abnormal and cumulative abnormal returns. To analyze the trading and price movements during various intraday periods, the trade-by-trade price and quotes data are utilized. These trades and quotes data are obtained from the NYSE TAQ database. Of the 151 firms, the final sample consists of 135 firms that have available the necessary daily and intraday information. Of the 135 sample firms, more than half result from the deleted firms being acquired.

We find that the time lag between the announcement and the effective dates is relatively small. Twenty-two (16 percent) of the changes become effective the next day. Thirty (22 percent) of the announced changes become effective four days later. Only 13 (10 percent) of the changes take effect in more than ten days after the announcements.

Methodology

We examine intraday returns surrounding the announcement of an addition to the S&P index. The intraday return of any period under consideration is calculated as the logarithm of the ratio between the ending price and the beginning price of the period. To account for the risk, we calculate abnormal returns. We use the exchange traded fund, the American Stock Exchange's SPDR as the proxy for the market. In order to risk-adjust our abnormal returns, we use three months' intraday returns (-4 month to -1 month before the event) for the firms, and the corresponding returns for the SPIDER ETF (i.e., S&P 500 Exchange Traded Fund) to estimate the alpha and beta of the market model for each firm. The risk-adjusted returns then are calculated using the estimated alpha and beta.

We also incorporate the bid-ask spread in the entire analysis.

²Three of the of the 154 changes reported on the S&P website involve separate announcements—one for the deletion and one for the addition—for the same change. Hence, after removing these announcements, we have a sample of 151.

Results

Abnormal Returns around the Announcement and Effective Dates

Using daily close price data, the market response to the 135 sample index additions is shown in Table 1 for both the announcement date (Panel A) and the effective date (Panel B).

Table 1—Abnormal Returns Upon Index Addition Announcement^a

Days	N	Mean Cumulative Abnormal Return	Mean Value Weighted CAAR	Median Cumulative Abnormal Return	Positive: Negative	Z	Generalized Sign Z
Panel A: Announcement Date							
(-1,0)	135	0.52%	0.15%	-0.27%	65:70	0.468	-0.073
(-1,+1)	135	5.29%	4.41%	3.86%	111:24	11.485***	7.881***
(0,0)	135	0.44%	0.13%	0.22%	71:64	0.606	0.965
(0,+1)	135	5.21%	4.40%	4.58%	117:18	14.027***	8.918***
(-10,+10)	135	7.35%	5.86%	6.55%	89:46	5.794***	4.077***
Panel B: Effective Date							
(-1,0)	134	2.53%	2.05%	1.35%	86:49	6.498***	3.563***
(-1,+1)	134	1.83%	1.40%	1.40%	81:54	3.673***	2.698**
(0,0)	134	1.36%	1.20%	1.20%	79:56	5.398***	2.352*
(0,+1)	134	0.66%	0.56%	1.17%	80:55	1.809\$	2.525*
(-10,+10)	134	5.21%	4.09%	4.21%	84:51	4.081***	3.217**

a. This table provides the results over several windows of abnormal returns to firms that are being added to the S&P 500 on the announcement date and effective date, respectively. *, **, and *** represent significance at the 10, 5, and 1 percent levels

Panel A indicates that during the three-day (-1, +1) event period, the mean cumulative abnormal returns (CAR) is 5.29 percent, statistically significant at the 1 percent level. Most of the adjustment occurs in the first day after the announcement. The abnormal returns of the day prior to the announcement, (-1,0), and the day of the announcement (0,0) are both insignificant, suggesting no leakage of the news regarding impending announcements by S&P.

Panel B provides the cumulative abnormal returns around the effective day. The one-day abnormal return on the day preceding the effective date (-1, 0), is 2.53 percent and is significant at 1 percent level. The (-1, +1) abnormal return is 1.83 percent, also significant at the 1 percent level. The abnormal return on the day of the effective date (0, 0) is 1.36 percent, significant at the 1 percent level, while the two day (0, +1) abnormal return of 0.66 percent is significant at the 10 percent level. The results in Table 1 are consistent with previous studies using daily close prices that indicate a significant positive abnormal return at the announcement of an index addition as traders incorporate the news of the addition, and on the effective date as index funds rebalance their portfolios.

We are more interested, however, in various intraday and interday activities to determine the timing and the source of price adjustments in response to index changes. We next investigate arbitrage profits using intraday data.

Intraday Risk Adjusted Abnormal Returns around the Announcement Date After Accounting for the Bid-Ask Spread

Table 2 provides risk adjusted intraday abnormal returns around the announcement date taking into account transaction costs, i.e., the bid ask spread. For the announcement date, six following intraday periods are assessed. We use the subscript c to represent the close of a given session, o to represent the open of a given session, and d to represent the day session. We use -1 to denote the day prior to the announcement or effective date, 0 to denote the day of the announcement or addition, and +1 to denote the day following the announcement or effective date.

1. $R_{ACD0:AOD+1}$: the close of the market on the day of the announcement to the open of the market on the day following the announcement,
2. $R_{ACD0:ACD+1}$: the close of the day session on announcement date to the close of the day session on the day after the announcement,
3. $R_{EDC-1:EOD0}$: the close of the effective day session the day prior to the effective date to the open of the effective day,
4. $R_{ECD-1:ECD0}$: the close of the effective day prior to the effective date to the close of the day session on the effective day,
5. $R_{ECD-1:EOD+1}$: the close of the day session on the day prior to the effective day to the open of the day session on the day following the effective date,
6. $R_{ACD0:EOD+1}$: the close of the day session on the announcement date to the open of the day session on the day following the effective date.

Net of transactions costs, and once risk is taken into account, is the trading strategy profitable? We examine returns taking into account bid-ask spreads.³ To account for the bid-ask spread, we use the ask quote for the purchase price (as dictated by the implied strategy of buying the beginning and selling at the end of the period) as the beginning price and the bid quote associated with the selling price (as dictated by the implied strategy) as the ending price. Results of this analysis are reported in Table 2.

Returns from the close of the day session on the day of the announcement to the open of the day session on the day following the announcement, $R_{ACD0:AOD+1}$, are a statistically significant 5.65 percent and 4.35 percent from the beginning of the night session on announcement date to the close of the day session on the day after the announcement, $R_{ACD0:ACD+1}$, also significant at the 1 percent level. It is clear that although bid-ask spread reduces the profitability, investors still can earn statistically significant returns by responding to the index announcements.

³Results using returns unadjusted for spreads yield similar results and are available upon request.

Table 2—Market Adjusted Daily and Intraday Risk-Adjusted Returns Accounting for Bid Ask Spreads^a

Panel A: Announcement Day									
	$R_{ACD-I-ACD0}$	$R_{ACD0-ACN0}$	$R_{ACN0-AOD-I}$	$R_{AOD-I-ACD-I}$	$R_{ACD0-AOD-I}$	$R_{ACD0-ACD-I}$			
Mean	0.0034	0.0435	0.0147	-0.0123	0.0565	0.0435			
Median	-0.0005	0.0338	0.0013	-0.0118	0.0549	0.0408			
T-Statistic	1.16	10.58***	3.82***	-4.51***	16.26***	10.33***			
Signed Rank	56	3687***	1201***	-2126***	3958***	3656***			
Positive:Negative	64:69	105:28	72:59	38:95	123:8	119:12			
Max	0.1524	0.1904	0.1289	0.1313	0.1716	0.2949			
Min	-0.0888	-0.0244	-0.0635	-0.1112	-0.0459	-0.1570			
Panel B: Effective Day									
	$R_{CD-I-CN-I}$	$R_{CN-I-OD0}$	$R_{OD0-CD0}$	$R_{CD0-ON0}$	$R_{ON0-OD-I}$	$R_{OD-I-CD-I}$	$R_{CD-I-OD0}$	$R_{CD-I-CD0}$	$R_{CD-I-OD-I}$
Mean	0.0103	0.0047	-0.0033	0.0009	-0.0050	-0.0028	0.0102	0.0106	0.0045
Median	0.0019	0.0017	-0.0046	-0.0004	-0.0026	-0.0033	0.0053	0.0064	0.0051
T	4.30***	2.22**	-0.72	0.68	-2.75***	-0.96	1.91*	1.99**	0.89
Signed Rank	1893***	990**	-419	92	-1274***	-53	779*	894**	522
Positive:Negative	86:46	84:45	59:73	62:70	52:79	58:76	77:52	81:48	76:53
Max	0.1541	0.0958	0.1741	0.0535	0.0505	0.1410	0.2632	0.2532	0.2481
Min	-0.0303	-0.0635	-0.1597	-0.0472	-0.1418	-0.1502	-0.1558	-0.1648	-0.1684

a. This table provides market-adjusted daily and intraday returns taking into account bid-ask spreads. A: Announcement date. E: Effective date. C: Close of trading. O: Opening of trading. D: Normal trading hours during the day. -1 and 1: One day before and one day after the announcement/effective date, respectively. *, **, and *** represent significance at the 10, 5, and 1 percent level

Table 2 also provides evidence on spread and market-adjusted returns around the effective date. The mean (median) return from the close of the day prior to the effective date to the open of the day session of the effective date ($R_{ECD-1:EOD0}$) is 0.47 percent (0.17 percent), which is statistically significant at the 1 percent (5 percent) level. The signed rank S statistic indicates that more firms had positive returns than negative returns, significant at the 5 percent level. Returns for the close of the day prior to the effective date to the close of the day session on the effective date ($R_{ECD-1:ECD0}$), and from the close of the day session the day prior to the effective date to the open of the day session on the day following the effective date ($R_{ECD-1:EOD+1}$) are 1.065 percent and 0.45 percent, respectively, and insignificant. The returns for the whole period from the close of day session of the announcement date to the open of the day session on the day following the effective date (not shown in Table 2), $R_{AC0:EOD+1}$ —taking into account risk and transactions costs—are 5.23 percent on average, which is statistically significant at the 1 percent level.

Proportion of Profits During the Night

To determine whether the proportion of profits accruing from night trading activity has increased over time, Table 3 provides mean and median percent of total trading profits from night trading by year and by semiannual period for both the announcement and effective dates.

Table 3—Night Trading Profits as a Percent of Total Profits By Year^a

Panel A: Announcement by Year								
	Total	1999	2000	2001	2002			
N	133	36	52	24	21			
Mean	42.55	36.11	46.60	37.70	49.13			
Median	13.82	2.38	29.30	1.65	47.09			
Announcement, by Semiannual Period								
	1999-I	1999-II	2000-I	2000-II	2001-I	2001-II	2002-I	2002-II
N	16	20	24	28	11	13	10	11
Mean	48.29	26.37	42.45	50.15	29.61	44.56	51.67	46.82
Median	33.94	1.46	12.02	55.95	0.00	5.22	53.69	16.50
Panel B: Effective by Year								
	Total	1999	2000	2001	2002			
N	124	31	49	24	20			
Mean	33.16	31.90	29.21	34.80	42.85			
Median	10.07	0.00	11.21	0.00	13.79			
Effective by Semiannual Period								
	1999-I	1999-II	2000-I	2000-II	2001-I	2001-II	2002-I	2002-II
N	13	18	24	25	10	14	9	11
Mean	35.15	29.54	28.73	29.66	28.76	39.12	47.48	39.06
Median	0.00	5.04	8.83	16.83	0.00	7.17	47.64	10.05

a. This table provides information on night-trading profit as a percentage of total profit from the close of day 0 to open of day +1 for announcement dates and day -1 to day 0 for effective dates. The number of observations may differ from 135 because there are days when both the total profit and night profit are zero and days when total profit and night profit are zero. Both scenarios are excluded, resulting in total observations of less than 135

Surprisingly, no clear pattern emerges between 1999 and 2002; while the percentage of profits from night trading increases from 1999 to 2000, it declines in 2001, reaching a high of 49.13 percent in 2002. Results by semiannual periods from 1999 to 2002 are comparable. Thus, these results indicate that despite improvements in information technology and access to trading after hours and despite the evidence in Table 2 that the highest returns from the S&P game are obtained after the close on the announcement date, the percentage of profits from night trading is not increasing over time.

Decomposition of Trading by Institutional vs. Individual Investors

We classify trades into either trades by institutions or individual investors and examine the ratios of institutional trades around the announcement and effective days.

To classify the source of the trades, we follow Lee (1992). If the total value of the trade is over \$10,000, it is assumed to be done by institutional investors. For trades with the value of \$10,000 or less, the trade is assumed to be done by an individual investor. We use the Lee (1992) approach, given that Lee and Radhakrishana (2000) find that measures based on the dollar value can classify trades better than alternative measures. The results of this analysis are reported in Table 4.

Panel a(i) provides information on mean and median proportion of trades that are institutional investor trades during the pre-open, day, and post-close session for the day prior to the announcement, the day of the announcement, and the day following the announcement for the full 1999 to 2002 sample period. The results show an apparent increased trading by institutional traders in the normal day session on the day of the announcement and the day after. There is a large decline in the proportion of institutional trades (from a median of 83.3 percent to 66.5 percent and a mean of 71.5 percent to 63.5 percent) in the post-close session on the announcement date, which is the most lucrative window to profit from the index changes. These changes between days around the announcement date are clearer by looking at the differences between day -1 and day 0 and between day 0 and day +1. Panel a(ii) shows the former. There is no significant difference in the proportion of institutional trades during the normal day session of the announcement date versus the day before. On the other hand, the difference in the post-close session between day -1 and day 0 is significant. As indicated by the negative and significant t-statistic and S test statistic, the proportion of institutional trades declines from day -1 to day 0, which suggests more trading by individual investors in response to the news announcement on day 0. On day +1, however, both day and post-close sessions have a higher proportion of institutional trades than on day 0. This suggests that trading by individual investors subsides, perhaps because they already had participated in the game the night before (i.e., after the market closed on day 0).

Table 4—Decomposition of Trades by Institutional vs. Individual Investors

Panel A: Announcement Date by Percent by Session and Day

	D-1			D			D+1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.600	0.524	0.833	0.613	0.554	0.665	0.610	0.667	0.796
Mean	0.516	0.487	0.715	0.578	0.491	0.635	0.514	0.585	0.756
t-statistic	9.62***	20.40***	25.20***	11.7***	20.9***	26.7***	11.1***	24.7***	38.6***
S:Sign-rank	315***	4590***	3691***	333***	4590***	4128***	390***	4590***	4590***

Announcement Date Change over Event Period by Session

	Day -1 – Day 0			day 0–Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.000	0.000	0.029	0.000	-0.090	-0.090
Mean	-0.070	0.000	0.064	-0.010	-0.090	-0.120
t-statistic	-1.90*	-0.87	2.68***	-0.18	-10.00***	-5.50***
S:Sign-rank	-73	-88	960***	-4.50	-3000***	-2000***

Panel B: Effective Date, Percent by Session and Day

	D-1			D			D+1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.571	0.612	0.791	0.602	0.713	0.837	0.626	0.630	0.800
Mean	0.501	0.560	0.738	0.545	0.640	0.789	0.580	0.568	0.755
t-statistic	10.2***	24.9***	31.7***	12.9***	30.6***	53.2***	13.1***	26.2***	35.2***
S:Sign-rank	352***	4590***	4258***	495***	4590***	4590***	452***	4590***	4323

Effective Date, Change over Event Period by Session

	Day -1 - Day 0			Day 0–Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.000	-0.070	-0.020	-0.020	0.060	0.021
Mean	-0.040	-0.080	-0.050	-0.040	0.071	0.036
t-statistic	-1.30	-7.90***	-2.70***	-1.70*	12.70***	2.04***
S:Sign-rank	-86*	-4000***	-987***	-98*	3875***	852***

Panel B provides the results of the analysis for the effective date. The results indicate that there are more institutional trades on day 0 during the day and post-close sessions than on day -1, as indicated in Panel B by the significantly negative difference between day -1 and day 0 for both day and post-close session. This increased institutional trading carries over to the pre-open session on day +1, as indicated by the significantly negative difference between day 0 and day +1. These results are consistent with institutional traders being more active—due to the necessary portfolio rebalancing—on the effective date starting from the day session, and that the activity carries over to post-close and even next morning's pre-open session. Their participation subsides after these windows, as indicated by the significant positive difference in the day and post-close sessions between day 0 and day +1. Thus, institutions attempt to avoid tracking error by buying on the effective date.

Table 5A—Breakdown by Year of Institutional trades on Announcement Date

Panel A: 1999 Percent by Session and Day

	Day -1			Day 0			Day 1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.000	0.104	0.333	0.000	0.117	0.333	0.025	0.182	0.540
Mean	0.041	0.137	0.374	0.102	0.141	0.421	0.110	0.220	0.555
t-stat	1.54	6.08***	6.38***	1.71	6.54***	8.02***	2.45**	16.00***	12.10***
S:Sign-rank	1.50	371***	176***	3.00	371***	264***	10.50**	371***	371***

Change over Event Period by Session

	Day -1 - Day 0			Day 0 - Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	-0.030	-0.000	-0.080	-0.02	-0.08	-0.12
Mean	-0.040	-0.000	-0.070	-0.070	-0.080	-0.130
t-stat	-1.60	-0.64	-1.10	-1.70	-5.50***	-2.50**
S:Sign-rank	-1.50	-39	-78	-400	-292***	-147***

Panel B: 2000 Percent by Session and Day

	Day -1			Day 0			Day 1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.714	0.682	1.00	0.754	0.685	0.750	0.650	0.753	0.883
Mean	0.711	0.688	0.852	0.785	0.691	0.755	0.685	0.752	0.846
t-stat	12.90***	26.90***	27.20***	17.20***	28.20***	25.90***	13.60***	33.80***	34.80***
S:Sign-rank	127***	689***	638***	116***	689***	663***	95.0***	689***	689***

Change over Event Period by Session

	Day -1 - Day 0			Day 0 - Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	-0.010	0.000	0.012	0.100	-0.040	-0.040
Mean	0.084	-0.00	0.087	0.084	-0.060	-0.090
t-stat	1.46	-0.27	2.98***	1.46	-3.70***	-3.00***
S:Sign-rank	22.50	37.50	177***	22.50	-325***	-213**

Panel C: 2001 Percent by Session and Day

	Day -1			Day 0			Day 1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.363	0.511	0.817	0.400	0.561	0.662	0.627	0.684	0.870
Mean	0.361	0.509	0.803	0.483	0.540	0.658	0.556	0.675	0.848
t-stat	4.06***	17.10***	19.50***	8.87***	18.30***	16.10***	10.30***	21.70***	24.10***
S:Sign-rank	14.0**	150***	150***	22.5***	150***	150***	27.5***	150***	150***

Change over Event Period by Session

	Day -1 - Day 0			Day 0 - Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	-0.090	-0.020	0.100	0.000	-0.130	-0.180
Mean	-0.150	-0.030	0.145	-0.070	-0.130	-0.190
t-stat	-1.90*	-2.10**	4.53***	-0.92	-7.0***	-4.40***
S:Sign-rank	-7.500	-78***	84***	-4.0	-132***	-99***

Panel D: 2002 Percent by Session and Day

	Day -1			Day 0			Day 1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.658	0.615	0.857	0.571	0.583	0.714	0.687	0.775	0.800
Mean	0.588	0.596	0.849	0.527	0.576	0.702	0.713	0.727	0.794
t-stat	4.27***	21.30***	22.00***	10.7***	20.9***	19.8***	10.50***	25.70***	24.60***
S:Sign-rank	3.00	116***	116***	3.00	116***	116***	5.00	116***	116***

Change over Event Period by Session

	Day -1 - Day 0			Day 0 - Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.135	0.025	0.150	-0.300	-0.170	-0.030
Mean	0.190	0.020	0.147	-0.220	-0.150	-0.090
t-stat	1.69	1.53	2.96***	-2.20**	-8.20***	-1.80*
S:Sign-rank	3.00	61.5***	73.0***	-3.00	-113**	-44*

Table 5B—Breakdown by Year of Institutional trades on Announcement Date

Panel A: 1999 Percent by Session and Day

	Day -1			Day 0			Day 1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.000	0.216	0.528	0.083	0.329	0.571	0.077	0.230	0.446
Mean	0.076	0.240	0.513	0.150	0.323	0.589	0.124	0.245	0.547
t-stat	1.67	7.16***	9.00***	3.01***	11.20***	26.60***	2.25**	9.46***	10.3***
S:Sign-rank	3.00	352***	281***	14.00**	352***	352***	18***	352***	315***

Change over Event Period by Session

	Day -1 - Day 0			Day 0 - Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.000	-0.070	-0.070	-0.020	0.059	0.110
Mean	-0.050	-0.080	-0.07	-0.050	0.078	0.049
t-stat	-1.60	-2.70**	-1.2	-0.67	6.67***	0.96
S:Sign-rank	-8	-279***	-89	-3	332***	56

Panel B: 2000 Percent by Session and Day

	Day -1			Day 0			Day 1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.267	0.415	0.690	0.300	0.568	0.767	0.443	0.431	0.673
Mean	0.370	0.407	0.636	0.297	0.533	0.771	0.486	0.431	0.665
t-stat	3.06***	15.80***	12.4***	3.77***	20.1***	33.2***	6.75***	20.9***	14.9***
S:Sign-rank	18**	352***	315***	18**	352***	352***	18**	352***	352***

Change over Event Period by Session

	Day -1 - Day 0			Day 0 - Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.033	-0.12	-0.12	-0.18	0.106	0.106
Mean	0.122	-0.13	-0.14	-0.22	0.102	0.112
t-stat	0.97	-9.90***	-2.80***	-1.70	8.10***	2.64**
S:Sign-rank	6	-352***	-150***	-8	337	143

Panel C: 2001 Percent by Session and Day

	Day -1			Day 0			Day 1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.626	0.716	0.892	0.738	0.816	0.899	0.731	0.743	0.841
Mean	0.645	0.724	0.853	0.742	0.788	0.905	0.741	0.736	0.847
t-stat	11.0***	34.0***	35.0***	19.1***	43.2***	77.0***	17.8***	36.6***	41.3***
S:Sign-rank	116***	689***	663***	150***	689***	689***	116***	689***	638***

Change over Event Period by Session

	Day -1 - Day 0			Day 0 - Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	-0.050	-0.050	0.000	0.000	0.051	0.026
Mean	-0.110	-0.060	-0.050	-0.20	0.052	0.056
t-stat	-2.10**	-6.50***	-2.50**	-0.49	6.52***	2.75***
S:Sign-rank	-43	-471***	-153***	-3	465***	216***

Panel D: 2002 Percent by Session and Day

	Day -1			Day 0			Day 1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	0.123	0.298	0.500	0.204	0.425	0.624	0.188	0.359	0.493
Mean	0.155	0.320	0.541	0.221	0.413	0.641	0.246	0.341	0.568
t-stat	4.97***	13.6***	12.8***	9.79***	14.50***	22.9***	7.29***	14.80***	14.10***
S:Sign-rank	86***	689***	663***	150***	689***	689***	116***	689***	613***

Change over Event Period by Session

	Day -1 - Day 0			Day 0 - Day +1		
	Pre-Open	Day	Post-Close	Pre-Open	Day	Post-Close
Median	-0.070	-0.080	-0.140	-0.030	0.070	0.111
Mean	-0.070	-0.09	-0.10	-0.030	0.072	0.080
t-stat	-1.70*	-8.40***	-3.30***	-0.71	6.77***	2.47**
S:Sign-rank	-54***	-654***	-328***	-21	585***	238***

While the technology in the post-1999 time period enabled individual investors easier access to the S&P game after hours, the index gaming after hours mainly is being executed by institutional investors for both the announcement and effective dates. As shown in Panels A and B, the mean percent of trades done by institutional traders ranges from 58 percent to 78.9 percent. By contrast, the pre-open and day sessions have less institutional participation; the percentage of institutional trade for the pre-open and day sessions is closer to 50 percent on average.

In order to examine whether individual investors increasingly are participating in the S&P game over time, we perform the same analysis reported in Table 4 for each year separately; the results of the year by year analysis are reported in Table 5A for the announcement date and Table 5B for the effective date, respectively. Panels A through D provide the percentage of institutional trades by session for the day prior to, day of, and day following the announcement date or effective date over different time periods. The results suggest that the lowest institutional participation occurs in 1999; surprisingly, less than 25 percent of the trades are by institutions in 1999. For 1999, tests of day -1–day 0 indicate no significant change in all sessions on the announcement date and the day before. The tests for day 0–day +1, however, indicate more institutional trades on day +1 in the day and post-close sessions. These results suggest that the increased individual trading in the post-close session on the announcement date subsides the day after. Other than this variation, the results in Table 5 for years 2000, 2001, and 2002 are similar to the full sample results in Table 4.

Conclusions

In contrast to prevailing academic paradigms of semi-strong form market efficiency, evidence suggests that profitable trading strategies based on public information exist, even after they have been documented. This study provides additional evidence on the S&P game. Using a sample of 135 changes to the S&P 500 index, we find that a profitable trading strategy of buying firms included in the S&P 500 index after the close on the date of the announcement, and selling before the market open on the effective date yields significant positive abnormal returns. The highest returns from the S&P game are generated by investors who enter the game at the beginning of the after-hours session of the announcement date.

There is evidence of profitability from arbitrage even after accounting for transactions costs. Institutional investors, hedge funds, and speculators still can use index gaming ahead of the index fund portfolio rebalancing.

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