The Index Effect: Evidence from the Option Market*

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Abstract

Equity option markets react significantly to S&P 500 index inclusion news. We document a strong and temporary increase in call option trading volume shortly after the announcement. In the one-day event window, delta-hedged call options yield a statistically significant placebo- and risk-adjusted return of 0.90%. Increases in implied volatility account for a large part of the announcement effect. The effect is stronger for options that provide more leverage and reverses over time. Overall, the results are consistent with the demand-based theory of option pricing.

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I Introduction

Standard and Poors (S&P) regularly announces changes to the membership of its flagship S&P 500 index. Each announcement specifies the name of the new index member as well as the date when the change becomes effective.[1] A large literature, dating back to Harris and Gurel (1986) and Shleifer (1986), documents a significant positive reaction in the stock price of the soon-to-be index member and a sizeable trading volume in the stock around the effective date.[2]

A common interpretation of this result is that, because index trackers aim to minimize their tracking error, they generally purchase the stock of the incumbent index member around the effective date (Bessembinder et al., 2016).[3] Essentially, the S&P announcement makes the rebalancing trades of index trackers and the associated stock price pressure somewhat predictable. In order to efficiently exploit this predictability, an investor can engage in "risk arbitrage" and open positions in call option contracts as soon as the news is public.[4] This insight raises a number of questions: Do investors trade in the option market around the recomposition news? If so, which options are most in demand? What are the pricing implications of this option demand-pressure? To date, these questions have received very little attention from the literature.

We use a large sample of S&P 500 inclusion announcements between 1996 and 2020

[1]Over our sample period, there are on average 6 trading days between the date of the announcement and the effective date.

[2]For an overview of this literature, we refer the reader to Patel and Welch (2017) and the references therein.

[3]It is worth pointing out that the demand for the new index member does not solely stem from index trackers. Indeed, theoretical work by Cuoco and Kaniel (2011) and Basak and Pavlova (2013) shows that institutional investors who are benchmarked against the index allocate a fraction of their wealth to the index constituents. Pavlova and Sikorskaya (2022) document that this result applies to both active and passive institutional investors.

[4]Beneish and Whaley (1996) coin the expression "risk arbitrage" to denote the strategy whereby the investor purchases the stock of the soon-to-be index member immediately after the S&P index recomposition announcement and sells it, presumably at a higher price, around the effective date. Implementing the risk arbitrage trade via option securities is attractive due to the embedded leverage.

to examine the impact of index inclusion news on individual equity options. We begin by characterizing the trading activity in individual equity options around the news announcements. We find that the trading volume in the options associated with the soon-to-be index member more than doubles immediately after the announcement. 76% of the announcement effect stems from increases in the call, rather than the put, option volume. The trading activity declines by the effective date and subsequently returns to its pre-announcement level.

Next, we analyze the impact of the index inclusion news on the price of outright call options. We find a positive and statistically significant announcement response in event windows extending to the effective date. These results hold up to placebo- and risk-adjustments. Our findings are reminiscent of the response of stocks to inclusion news, e.g., Patel and Welch (2017), raising the possibility that delta, i.e., the sensitivity of option prices to the underlying price, may explain the effects. This insight motivates us to analyze delta-hedged option positions, which neutralize the effect of underlying shocks on option prices. We find that, on a placebo- and risk-adjusted basis, the delta-hedged call option exhibits a positive (0.90%) and significant short-term response to inclusion news. This announcement response is significant in every 5-year subsample and reverses over the long event window, which ends 63 days after the effective date.

In order to rationalize our empirical findings, we build on the demand-based option pricing model of Garleanu et al. (2009). The intuition is as follows: Once S&P makes its announcement, the risk arbitrageurs purchase call options. By doing this, they enter a leveraged trade to benefit from the expected stock price pressure arising from the trading of benchmarked institutional investors. The option market maker absorbs the option demand shock and hedges the delta risk by trading the underlying security. However, she is exposed to unhedgeable risks that arise from jump risk and stochastic volatility, among others. As the option demand intensifies, the market maker, who has limited risk-bearing capacity, raises the price of the option contracts to account for the increase in unhedgeable risks. This mechanism explains why the option trading volume peaks immediately after the announcement, while the stock trading volume peaks at the effective date. More importantly, it helps connect the positive and temporary response of the (i) option trading volume and (ii) delta-hedged option prices.

We test and validate several predictions of the model. First, we show that, consistent with the theory, the option-implied volatility responds positively to the inclusion announcements. In fact, 42% of the short-term placebo- and risk-adjusted response of the delta-hedged options can be traced back to the revision in the implied volatility.

Second, we document that the announcement effect is stronger for options that are likely subject to more demand pressure owing to their greater embedded leverage. For instance, short-term delta-hedged call options react more than long-term delta-hedged options. Similarly, the announcement effect monotonically declines as we move from the out-of-the-money to the in-the-money delta-hedged call options.

Third, we estimate a pooled regression of the short-term placebo- and risk-adjusted announcement return on a constant and several variables that are informative about the option demand pressure and the constraints faced by the financial intermediary. We find that the announcement effect is stronger for the delta-hedged call options of companies with low-priced stocks and increases with the funding cost of the intermediary. Furthermore, the announcement effect is stronger for stocks that were not part of the S&P 400 midcap index prior to the announcement than for stocks that came from that index.

Fourth, the theory predicts that the demand-pressure in a particular option affects the pricing of all other options which unhedgeable risk comoves with that of the in-demand option. By documenting a similar announcement effect for put options, which attract considerably lower trading volume around the inclusion announcement, we show that this prediction is also borne out by the data.

We perform several additional tests. To begin with, we sort companies into high and low portfolios based on the growth in their call option trading volume over the short event window. We document that the high portfolio displays a significantly higher short-term response than the low portfolio. This analysis thus confirms that there is a link between the trading volume and the announcement response. Next, we show that, consistent with the demand-based explanation, there is long-term reversal of the announcement effect at the firm level. Additionally, we establish that our results are robust to the methodology underpinning the choice of placebo firms. Moreover, we establish that the potential noise in the option prices does not materially affect our results. We further evaluate the impact of potential biases in the delta-hedge ratio and reach similar conclusions. Finally, we show that our results are distinct from the earnings announcement effect of Gao et al. (2018).

Our paper contributes to the extensive literature that quantifies the index effect. Most of this literature focuses on the response of stock prices. Harris and Gurel (1986), Shleifer (1986), Chen et al. (2004), Baker et al. (2010), Chang et al. (2014), and Patel and Welch (2017), among others, document a significantly positive response of stocks to inclusion news. Brennan (1993), Cuoco and Kaniel (2011), Basak and Pavlova (2013), and Pavlova and Sikorskaya (2022) develop theoretical models that rationalize the empirical evidence. We complement these studies by showing that S&P 500 index inclusion news affects financial markets much more broadly than previously thought. In particular, we show that equity options react to inclusion news, even after accounting for the underlying response, i.e., the delta effect. Thus, a comprehensive analysis of the index effect should go beyond individual equities and account for the response of related securities.

Our research is directly related to the small number of studies that analyze the impact of S&P recomposition news on the option market. Dhillon and Johnson (1991) and Dash and Liu (2008) document the positive (negative) response of outright call (put) options to index inclusion news. To the best of our knowledge, we are the first to document that the response of outright options is not solely due to the directional response of the underlying. We show that there is another channel through which recomposition news moves option prices. This new channel is related to the change in the implied volatility and accounts for more than 20% of the response of outright options. Furthermore, we broaden our understanding of the index effect in the option market by identifying, in the cross-section, the characteristics that affect the strength of the announcement response.

Our main findings are consistent with the insights from the literature analyzing the impact of demand-pressure shocks on constrained intermediaries. Garleanu et al. (2009) develop a demand-based option pricing model that sheds light on how the demand pressure of an option affects its price and that of related options. Fournier and Jacobs (2020) present a related model. Bollen and Whaley (2004) empirically study the effect of the option demand pressure on the implied volatility. Lemmon and Ni (2014) analyze the impact of investor sentiment on the demand and pricing of stock options. Ramachandran and Tayal (2021) study the impact of short-sale constraints in individual equities on the demand and pricing of put options. To the best of our knowledge, we are the first to document the impact of index inclusion news on the demand and pricing of (delta-hedged) options. We find that the impact of the option demand pressure is economically large and consistent with the demand-based theory of option pricing.

The remainder of this paper proceeds as follows. Section II presents the data and methodology. Section III summarizes our main results. Section IV discusses the mechanism underpinning our results. Section V evaluates alternative explanations for our main findings. Section VI provides various additional analyses and robustness checks. Finally, Section VII concludes.

II Data and Methodology

A Data

Stock Data We obtain daily data on stock prices, the associated returns, and shares outstanding from the Center for Research in Security Prices (CRSP). We download this information for all stocks traded on the New York Stock Exchange (NYSE), the American Stock Exchange (AMEX), and the National Association of Securities Dealers Automated Quotations (NASDAQ).[5] Standard and Poors (S&P) has a detailed set of eligibility criteria related to the domicile, exchange listing, organizational structure, and share type of securities added to the S&P 500 index.[6] Accordingly, we only include stocks with CRSP share codes 10, 11, 12, 18, or 48 in our analysis.

Option Data We retrieve the option data for the period starting in January 1996 and ending in December 2020 from OptionMetrics.[7] The dataset includes the daily bid–ask option prices, the option trading volume, the open interest, and the option sensitivities.

We discard options that are likely illiquid and noisy. First, we remove options with (i) AM settlement (Boyer and Vorkink, 2014) and (ii) time-to-maturity smaller than 8 calendar days or greater than 120 calendar days (Bollerslev et al., 2015). Second, we only retain regular options (Baltussen et al., 2018) with (i) standard settlement (Boyer

[5]One may ask: why do we cover a broad range of companies, irrespective of whether they belonged to the S&P 500 index at any point in time? Our decision is motivated by the need to have a large pool of companies from which we can draw firms that will form the placebo group.

[6]For more details about these criteria, we refer the interested reader to the following webpage: `https://us.spindices.com/indices/equity/sp-500`.

[7]The beginning of our sample period is driven by the fact that the OptionMetrics dataset starts in January 1996. In a similar vein, our sample ends in 2020, which is the latest observation available to us at the time we downloaded the data.

and Vorkink, 2014), (ii) positive bid–ask prices, (iii) positive bid–ask spread that ranges from the minimum tick size (Goyal and Saretto, 2009) to \$5 (Boyer and Vorkink, 2014), and (iv) positive open interest. Third, we discard options with missing implied volatility (Driessen et al., 2009). Fourth, we expunge all call options with deltas outside of the interval starting at 0 and ending at 1. Similarly, we discard put options with deltas outside of the interval beginning at −1 and ending at 0. Fifth, we only keep options with a moneyness level, defined as the ratio of the strike price over the spot price, between 0.80 and 1.20. By taking this step, we focus on option contracts that are likely liquid. Sixth, we discard observations that violate the no-arbitrage conditions: $\max(S_{j,t} - PV(K), 0) \leq C_{j,t} \leq S_{j,t}$ and $\max(PV(K) - S_{j,t}, 0) \leq P_{j,t} \leq K$, where $S_{j,t}$ is the ex-dividend stock price of company j at time t. $PV(K)$ is the present value of the strike price K computed using the term-structure of interest rates available from OptionMetrics. $C_{j,t}$ and $P_{j,t}$ denote the time-t call and put option prices of strike price K associated with company j, respectively.[8]

In order to avoid the bid–ask bounce from daily closing option prices, we use the mid-quote price as representative of the option price (Gao et al., 2018).[9] Following Boyer and Vorkink (2014), we eliminate any option with a price below 50% of the intrinsic value or \$100 above the intrinsic value. Finally, we aim to mitigate the impact of early exercise by implementing the approach of Pool et al. (2008). Specifically, we follow Shafaati et al. (2021) and remove all options for which early exercise might be profitable on the ex-dividend day.

[8]Although the option price depends on the strike price K, we have decided to not reflect this in the notation. This decision is motivated by our desire to make the notation as simple as possible.

[9]As a robustness check, we follow Eisdorfer et al. (2022) and assume that the option price is either the 75%/25% or the 25%/75% weighted average of the bid–ask prices. As Section VI.D shows, our results are robust to this alternative approach.

Index Recomposition Events The S&P 500 index consists of 500 companies selected at the discretion of the index committee.[10] The committee only considers firms that satisfy the index inclusion criteria such as a minimum market capitalization, of $14.6 billion as of January 2023, positive earnings in the most recent quarter, as well as positive average earnings over the past 4 quarters, to name but a few.[11,12] The index committee pays close attention to sector balance in the selection of companies for the index.

We hand-collect information on the changes in the composition of the S&P 500 index, the announcement dates, the effective dates, and the reason for the index changes.[13] We extract this information from the official S&P press releases on PR Newswire. Following Barberis et al. (2005), we exclude all index changes that are related to firm-specific corporate events, such as acquisitions, bankruptcies, mergers, or spinoffs. We only focus on companies that have an associated option market prior to, on, and after the announcement date. To be more specific, for each company included in our analysis, either as a treated firm or in the placebo group, we require at least 100 option return observations during the period starting from 10 trading days before the announcement date until 252 trading days after. This filter is necessary because our main goal is to study the impact of index recomposition events on the option market.

[10] The index committee meets on a monthly basis and consists of full-time employees working for S&P Dow Jones Indices. It is important to stress that the identity of the index members is kept confidential. See https://www.wsj.com/articles/gamestop-stocks-possible-return-to-s-p-500-in-hands-of-anonymous-committee-11630494001?mod=hp_lead_pos4.

[11] The complete list of inclusion criteria is available at the following webpage: https://us.spindices.com/documents/methodologies/methodology-sp-us-indices.pdf. It is worth pointing out that these are criteria for inclusion and not for continued membership in the index. For a detailed discussion of the evolution of the inclusion criteria over time, we refer the interested reader to the study of Li et al. (2021).

[12] The index committee's decision to include a firm in the S&P 500 index is based on a combination of both art and science. A company's stock may be among the largest firms in terms of market capitalization and meet all the eligibility criteria and still not be immediately included in the S&P 500 index, as the decision of the index committee is discretionary.

[13] Some studies, e.g., Cao et al. (2019), analyze the recomposition of the Russell 2000 index using a regression discontinuity design. It is tempting to analyze this index. However, we caution that such analysis would involve fairly small firms, for which the option contracts are likely not liquid enough to carry out a robust analysis.

Overall, the filtered sample consists of 497 inclusion, but only 133 exclusion events. The limited number of exclusion events makes it difficult to conduct a robust statistical analysis of index deletions.[14] Consequently, we focus solely on the inclusion events. Figure A1 of the Online Appendix depicts the number of index inclusions over time. We can see that these events take place throughout the sample period. Our untabulated analysis reveals that, on average, there are 18 days between two consecutive inclusion events.

B Methodology

Overview S&P publicly announces the changes to the index composition at 05:15 PM Eastern Time, after the regular trading hours. As a result, the impact of the index recomposition announcements can only be seen on the next trading day. Throughout the paper, we refer to that day as the announcement date (AD). We denote the effective date (ED), the last trading day before the change becomes effective.[15,16]

Figure 1 illustrates our timing convention. We focus on three event windows: short, medium, and long. The short window starts at $AD-1$ and ends at AD. It is mostly informative about the immediate response of asset prices to news. The medium window, which spans the period from $AD-1$ to ED, is useful to assess the response of financial markets until the change becomes effective. Finally, the long event window begins at

[14] Intuitively, one would expect the samples of inclusion and exclusion events to be of comparable size. Yet, the final exclusion sample is much smaller than the inclusion sample. This finding arises from the fact that (i) we discard recomposition events that occur around firm-specific corporate events, including bankruptcies, mergers, takeovers, and exchange delisting and (ii) we require the availability of market data several days after the announcement date. These requirements are more demanding for the exclusion events. The imbalance between the sample sizes of included and excluded firms is also apparent in the literature. For instance, Chen et al. (2004) find 760 additions and 235 deletions for the period beginning from July 1962 and ending in December 2000. Barberis et al. (2005) obtain 455 inclusion and 76 deletion events between September 22, 1976 and December 31, 2000.

[15] The index tracker who purchases the stock of the incumbent firm at the close of this day will perfectly track the index.

[16] Generally, the AD and the ED are well spread across the week. The minimum number of calendar days between AD and ED is 0 and the maximum is 99 calendar days. The standard deviation amounts to 7 calendar days.

$AD-1$ and ends at $ED+63$. It sheds light on the long-term effects of the news.

Option Returns In order to carry out our analysis, we need to compute the option returns. We distinguish between the (i) outright and (ii) delta-hedged option return. The outright option return involves a long position in the option, whereas the delta-hedged option return consists of a long option position that is delta-hedged by trading the underlying security every day.[17] By studying the response of the delta-hedged option position, we are able to strip out the effect of shocks to the underlying stock price.[18]

For each optionable stock and trading day, we calculate the daily profit and loss of the outright and delta-hedged option strategies as follows:

$$\Pi_{j,t}^{outright} = \underbrace{O_{j,t} - O_{j,t-1}}_{\text{Option Gain/Loss}} - \underbrace{(e^{r_{f,t-1}} - 1)O_{j,t-1}}_{\text{Interest Rate Component}} \tag{1}$$

$$\Pi_{j,t}^{hedged} = \underbrace{O_{j,t} - O_{j,t-1}}_{\text{Option Gain/Loss}} - \underbrace{\delta_{j,t-1}\left[S_{j,t} - S_{j,t-1}\right]}_{\text{Delta-hedging Gain/Loss}} - \underbrace{(e^{r_{f,t-1}} - 1)\left[O_{j,t-1} - \delta_{j,t-1}S_{j,t-1}\right]}_{\text{Interest Rate Component}} \tag{2}$$

where $\Pi_{j,t}^{outright}$ and $\Pi_{j,t}^{hedged}$ denote the time-t profit and loss of the outright and delta-hedged option position associated with company j, respectively. $O_{j,t}$ is the price at time t of the option contract written on company j. $\delta_{j,t-1}$ is the delta of the option at time $t-1$.[19] $r_{f,t-1}$ is the continuously compounded interest rate, expressed on a per day basis, of the same maturity as the option. The interest rate data come from OptionMetrics.

Unfortunately, the profit and loss formulas described above are not well-suited for our

[17] Our interest in the daily rebalancing scheme is consistent with the literature, e.g., Bakshi and Kapadia (2003) and Cao and Han (2013).

[18] An alternative approach might be to study the variance swap rate, proxied with the model-free implied variance as in Carr and Wu (2008), of constant time-to-maturity around S&P 500 recomposition events. We refrain from pursuing this analysis for several reasons. First, such analysis introduces a number of issues linked to the numerical method used to compute the variance swap rate. Second, the market for variance swaps on single names has dried up since the crisis of 2008 (Hollstein and Wese Simen, 2020).

[19] One concern may be that the delta-hedge ratio is not accurate. Section VI.E explores this possibility and shows that the main results are robust to measurement errors in the hedge ratio.

empirical analysis, because the option price is homogeneous of degree one in the underlying price. An upshot of this is that the profit and loss amounts are not comparable across stocks that have different underlying prices, making it difficult to aggregate the figures across firms. To address this issue, we follow Cao and Han (2013) and compute the option return as:[20]

$$R_{Option,j,t} = \frac{\Pi_{j,t}}{|O_{j,t-1} - \delta_{j,t-1} S_{j,t-1}|} \tag{3}$$

where $R_{Option,j,t}$ is the return at time t on the option associated with company j.[21] $\Pi_{j,t}$ is the profit and loss, at time t, of the option on company j. To calculate the return of the outright (delta-hedged) option position, we use the profit and loss of the outright (delta-hedged) option position.

For each firm and trading day in our sample, we use Equation (3) to calculate the daily returns of each option contract. Next, we aggregate the returns on all the option positions by weighting them by the U.S. Dollar open interest, defined as the product of the option price and the open interest of the option (Gao et al., 2018).[22] By using this weighting scheme, we give more weight to option contracts that are of greater economic interest to market participants. We repeat these steps every day, thus obtaining the time

[20] The reader may wonder: Why do we use the same denominator when computing the returns on the outright and delta-hedged option positions? This approach enables us to decompose the return of the outright position into a component that solely depends on the directional movement of the underlying and a component related to other sources of risk, e.g., jump and volatility risks. There are alternative ways to normalize the profit and loss of the option position. For instance, Huang et al. (2019) use the underlying price in the denominator. We also consider this alternative and reach qualitatively similar conclusions. As an additional check, we only use the option price in the denominator and obtain similar results. These findings are not tabulated for brevity.

[21] To be precise, Equation (3) is the formula for the excess return on the delta-hedged option. This can be seen from the fact that the profit and loss formulas in Equations (1) and (2) already take into account the cost of funding the position. Throughout this paper, we commit a slight abuse of terminology by referring to this quantity as the option return (Cao and Han, 2013).

[22] Note that the option positions that underpin the aggregation at the firm level may differ in terms of strike prices and/or maturity dates. Section VI.F discusses the results based on two alternative weighting schemes, namely the volume-weighting and the equal-weighting schemes. Overall, the weighting scheme has very little bearing on the main results.

series of daily option returns aggregated at the firm level. We compound the daily return series to obtain returns for longer horizons.

Risk-Adjusted Option Returns We compute the risk-adjusted return as the difference between the observed option return and the expected return generated from a benchmark model. Although intuitive, this computation is challenging, since there is no consensus in the literature about the correct model for expected option returns. We build on Zhan et al. (2022) and use a 3-factor model. The 3 factors are the S&P 500 index option return and the market-capitalization weighted returns of option portfolios sorted on the stock (i) idiosyncratic volatility (IVOL) and (ii) illiquidity (ILLIQUIDITY) characteristics.[23]

Equipped with this empirical model, we compute the risk-adjusted option return associated with company j as:

$$AR_{Option,j,t} \quad = \quad R_{Option,j,t} - \sum_{k=1}^{3} \hat{\beta}_{j,k} f_{k,t} \tag{4}$$

where $AR_{Option,j,t}$ is the risk-adjusted return at time t of the option associated with firm j. $\hat{\beta}_{j,k}$ is the estimated sensitivity of the option return with respect to the risk factor k. $f_{k,t}$ denotes the factor k at time t. We estimate the factor sensitivities by pooling together the return data from (i) 130 to 11 days before the AD and (ii) from 64 trading days after

[23] Our methodology follows closely that of Zhan et al. (2022). For each stock and month, we use all daily data to regress the time series of the stock excess returns on the 3 factors of Fama and French (1993). We compute the idiosyncratic volatility of the stock as the standard deviation of the regression residuals. We also compute the illiquidity measure as the monthly average of the daily ratio of the absolute value of the stock return over the dollar trading volume. For each end-of-month date, we sort the relevant option positions into decile portfolios based on the characteristic of interest and create a high-minus-low spread portfolio of market capitalization weighted option positions. The upshot of this is that when we compute the risk-adjusted returns of outright (delta-hedged) option positions, the factors are based on outright (delta-hedged) option positions.

the ED to 183 trading days later.[24]

Control Group Patel and Welch (2017) caution that the positive risk-adjusted long-term return of added stocks reported in the literature does not necessarily shed light on the magnitude of the inclusion effect. Indeed, the authors show that a group of placebo firms exhibits an economically large positive risk-adjusted stock return of more than 1.9 % over a longer event window. Given this finding, it is prudent to carry out a placebo adjustment.

Our approach is similar to that of Patel and Welch (2017). For each stock added to the S&P 500 index, we draw a control firm from the list of companies (i) that are outside the S&P 500 index and (ii) have a market capitalization rank between #200 and #800 on the day before the announcement of the index recomposition.[25] We then repeat our main analyses on this pseudo-sample. We perform this experiment 1,000 times, thus obtaining the placebo distribution of returns.

C Summary Statistics

It is useful to look at the key descriptive statistics contained in Table 1. All returns are expressed in percentage points per day. For each day, we compute the summary statistics based on the cross-section of companies ranked between #200 and #800 by market capitalization. We then average these results in the time series. In order to shed light on whether there are systematic differences between the constituent and non-

[24]Hollstein et al. (2019) show that an estimation window of roughly 1 year of daily observations performs well for the beta estimation. As a robustness check, we also consider shorter or longer estimation windows and obtain similar results. We do not tabulate these findings for brevity.

[25]As a robustness check, we implement the often-used matching algorithm of Barber and Lyon (1997). Section VI.C shows that this alternative approach does not materially affect our results. One may also consider a more complicated matching algorithm that involves a list of variables that accurately predict the decision of the index committee. In principle, this approach is appealing. However, if the forecasting power is limited, the matches will be very noisy. Li et al. (2021) empirically document that it is difficult to predict the additions to the index. This is consistent with the knowledge that the decision of the index committee is discretionary (see Section II.A). Given this finding, we do not pursue this approach. See also the discussion in Patel and Welch (2017).

constituent stocks, we divide the firms into two groups. The first is made up of constituent firms, i.e., the firms that belonged to the S&P 500 index at that point in time, while the second contains the non-constituent firms.

Starting with the excess return of stocks, we find a daily average of 0.083 %. The average returns of the outright call and put options are positive and negative, respectively. Turning to the delta-hedged option returns, we observe negative average estimates for both constituent and non-constituent firms. This finding is in line with the work of Bakshi and Kapadia (2003) and Cao and Han (2013), to name only a few. Interestingly, there is very little to distinguish between the delta-hedged option returns of both constituent and non-constituent firms. The cross-sectional distribution of the option returns displays positive skewness and high kurtosis, indicating that it is non-normal.

III The Impact of S&P 500 Index Inclusion News on...

This section focuses on the impact of S&P 500 index recomposition news on financial markets. We begin by analyzing the trading activity around inclusion news. By taking this step, we shed light on whether, and if so how, market participants trade around inclusion news. Next, we study the price response to the announcements.

A Trading Activity

Figure 2 characterizes the dynamics of stock trading volume for the included firms. The trading volume more than doubles from $AD-1$ to the AD, suggesting that market participants react to inclusion news. Moreover, the trading activity continues to rise at the ED, where it peaks. The peak trading volume observed at the ED is consistent with the notion that index funds trade the stocks of included firms at the ED in order to minimize tracking error (Bessembinder et al., 2016).

Figure 3 repeats this analysis for the option market. For ease of exposition, we report the stock equivalent numbers rather than the number of option contracts.[26] We can see a rapid increase in option trading volume from $AD-1$ to its peak observed at the AD. This finding is interesting for several reasons. First, it suggests that market participants trade in the option market following inclusion news. Second, the finding that the option trading volume peaks at the AD, whereas that of the stock peaks at the ED, raises the prospect that the option traders may have different trading motives from the stock traders. Possibly, the option traders are risk arbitrageurs who position themselves in the option market as soon as the information is public to take advantage of the predictable trading of benchmarked institutional investors.

While the graphs suggest that market participants react to inclusion news, they do not speak directly to the impact of these news events on the price of financial securities. To shed light on this, we begin by analyzing the response of the individual stock prices. In so doing, we revisit and update the findings of the existing literature. We then study the response of option prices to index recomposition news, the main novelty of our paper.

B Stock Prices

Table 2 documents the response of equity prices to inclusion news. Throughout this paper, we follow Patel and Welch (2017) and winsorize the (i) return and (ii) risk-adjusted return associated with each company at $-4.74\%\sqrt{T}$ and $5\%\sqrt{T}$, where T denotes the length of the event window in trading days.[27] We use the 5 % significance level for all statistical tests. The statistical inference for the average (i) return and (ii) risk-adjusted

[26]For each option contract, the stock equivalent number corresponds to the contract size, i.e., the number of stocks associated with an option contract, adjusted to account for stock splits.

[27]The winsorization scheme does not affect our main conclusions.

return is based on the asymptotic distribution, while that of the average placebo- and risk-adjusted return is based on the placebo distribution.[28]

Starting with the average return, we observe a significantly positive announcement effect of 3.21 % over the short window. While this result is economically congruent with the literature, the magnitude of the announcement effect is somewhat smaller than that documented in earlier studies. This finding echoes the conclusion of Kappou (2018), Bennett et al. (2020), and Greenwood and Sammon (2022), who document a weaker index effect in the more recent sample. Looking at other horizons, we can see that the cumulative announcement effect continues to grow from 3.21% at the AD to 4.72% at the ED before falling to 4.56% by ED+63.

Next, we examine the average risk-adjusted return. As benchmark model for equity returns, we use the 6-factor model of Fama and French (2018). Table 2 shows that the average risk-adjusted return is highly significant and comparable to the average return. This is true for all horizons, suggesting that the factor model cannot explain the pattern of announcement responses.

Finally, we study the impact of the placebo adjustment. This analysis is important to rule out the possibility that the results stem from a force unrelated to the inclusion announcement that affects both the treated and placebo firms. The last set of results of Table 2 shows that, at the short horizon, the average placebo- and risk-adjusted return (3.21%) is significant and very similar to the average stock return (3.21%). Over the medium horizon, the average placebo- and risk-adjusted return remains positive and significant (3.85%). Turning to the long-horizon, we can see that the placebo- and risk-adjustment result in an economically smaller and insignificant average return (1.49%).

Our placebo- and risk-adjusted results confirm that there is an inclusion effect. This

[28] By using the placebo distribution, we aim to deal with the non-normal features of the return distribution.

finding is particularly discernible at both the short and medium horizons.[29] The analysis also reveals that the announcement response reverses over the long event window. Taken as a whole, the pattern of results associated with both the stock trading volume and the stock price response appears to be consistent with an explanation of the index effect based on price pressure in the equity market (Harris and Gurel, 1986).

C Call Option Positions

We now turn our attention to the price response of options. We focus specifically on call options, since they represent an attractive way to trade on the inclusion news using option contracts.[30] Indeed, a risk arbitrageur who anticipates an increase in the stock price of the soon-to-be index member will likely open a long call, rather than a short put, option position. This is because a long call option position has limited downside and provides more leverage than a short put position (Augustin et al., 2022). Christoffersen et al. (2017) document that, on average, most of the stock option trading takes place in call options. We verify that this result holds around inclusion news. Figure 4 depicts the trading volume in the call options around the inclusion announcements. This plot is comparable to that of the total option trading volume (see Figure 3). By comparing Figures 3 and 4, we deduce that 76% of the increase in the total option trading volume observed at the AD relates to call options.

Outright Call Option Positions Panel A of Table 3 summarizes the results associated with the outright call options position. Several findings are worth highlighting. First, the call options react strongly to inclusion news, as evidenced by the significant announcement

[29] This positive inclusion effect is consistent with the findings of the literature, see Patel and Welch (2017) and the references therein.

[30] We repeat our analysis using put instead of call options and obtain qualitatively similar results. See Section IV.D for further details.

response of 4.55% observed over the short window.[31] Implementing the placebo- and risk-adjustment does not materially change the estimate of the inclusion effect, as evidenced by the significant short-term response (4.50%). A similar result holds for the medium window. Second, the inclusion effect weakens over the long window, as evidenced by the smaller placebo- and risk-adjusted average return (2.89%).

Overall, our analysis reveals that the positive response of call options to inclusion news is strongest over the short window and declines over the long window. This pattern is reminiscent of the response of stocks, and raises the possibility that the response of the outright call option may mechanically mirror that of the underlying. We next study the response of delta-hedged call options, which neutralize the effect of a shock in the underlying security on the option price.

Delta-Hedged Call Option Positions Panel B of Table 3 is instructive regarding the response of delta-hedged options. We can see a positive and significant average response (0.95 %) over the short event window. This announcement response is interesting for a number of reasons. To begin with, it is positive, whereas the unconditional average daily delta-hedged option return is negative (−0.006 %).[32] Moreover, the short-term announce-

[31] Analyzing a short event window, Dhillon and Johnson (1991) and Dash and Liu (2008) report that option prices rise by 26.22 % and 83.87 %, respectively. Clearly, our estimate of the short-term inclusion effect (4.55%) is noticeably smaller than theirs. To understand the difference in the empirical results, it is important to consider how the authors compute option returns:

$$R_{Dash\&Liu,j,t} = \frac{O_{j,t} - O_{j,t-1}}{O_{j,t-1}} \tag{5}$$

Since their object of interest (see Equation (5)) is different from ours (see Equation (3)), the two sets of results are not directly comparable. As an additional analysis, we compute option returns as in Dash and Liu (2008) and repeat the analysis. Table A1 of the Online Appendix documents a short-term announcement effect of 39.9 %, which is of similar order of magnitude to the estimates of Dhillon and Johnson (1991) and Dash and Liu (2008).

[32] In order to calculate this unconditional average, we take the complete time series of delta-hedged option returns associated with all companies added to the S&P 500 index. We calculate the U.S. Dollar open interest weighted average daily delta-hedged option return first at the company level and then take the mean of the resulting estimates across all companies added to the index during that period. These findings are not tabulated for brevity.

ment response is at least an order of magnitude larger than the unconditional average delta-hedged option return. Collectively, these observations lead us to the conclusion that index inclusion news significantly impacts on the delta-hedged call option return over the short window. We analyze the extent to which the announcement effect is stable over our sample period. Table 4 documents a significant short-term announcement response in every 5-year subsample. Unlike the findings for stocks documented in Greenwood and Sammon (2022), we do not find any evidence to suggest a declining announcement effect in the recent sample for delta-hedged call options.

Intuitively, we can think of the 1-period outright option return as the sum of the delta-hedged option return and other terms that depend on the current and past stock prices. More formally, we decompose the average short-term outright option return as follows:

$$E\left(R_{j,t}^{outright}\right) = E\left(R_{j,t}^{hedged}\right) + E\left(\frac{\delta_{j,t-1}\left[S_{j,t} - S_{j,t-1}\right] - (e^{r_{f,t-1}} - 1)\delta_{j,t-1}S_{j,t-1}}{\left|O_{j,t-1} - \delta_{j,t-1}S_{j,t-1}\right|}\right) \quad (6)$$

where $E(\cdot)$ denotes the expectation operator. $R_{j,t}^{outright}$ and $R_{j,t}^{hedged}$ denote the return at time t of the outright and delta-hedged options associated with firm j, respectively.

The expression above enables us to quantify the extent to which the response of the outright option is solely driven by a directional shock to the stock price. If all of the response relates to the delta effect, we should observe that the average return on the delta-hedged option accounts for a negligible fraction of the average response of the outright option return. A comparison of the average short-term announcement response of the outright option position (4.55%) with that of the delta-hedged call option (0.95%) in Table 3 reveals that more than 20% of the response of the outright call option is due to forces different from the directional movement in the underlying. We thus conclude that the shock to the spot price is not the only conduit through which inclusion news impacts the pricing of options.

In summary, we confirm that equity prices respond positively to inclusion news and most of the stock trading volume takes place on the ED. This pattern of trading activity is consistent with the notion that, in order to minimize their tracking error, benchmarked institutional investors, such as index trackers, wait until the ED to purchase the stock of the added firm. Interestingly, trading activity in the option market peaks earlier (at the AD), and most of the trading volume is in call options. This pattern raises the possibility that risk arbitrageurs open long call option positions as soon as possible to position themselves ahead of the trading of benchmarked institutional investors, who mostly trade at the ED. The next section focuses on the impact of the call option demand pressure on the pricing of options.

IV An Explanation of the Response of the Option Market

Garleanu et al. (2009) develop a demand-based theory of option prices that features two players: the option market maker and the option end-user. In our setting, the option end-user purchases call option i possibly to take advantage of the predictable demand for stocks by the index trackers around the ED. Since options are in zero net supply, the option market maker facilitates the trade by absorbing the end-user's option demand. As a result, she faces two types of risk: hedgeable risk and unhedgeable risk. She manages the hedgeable risk by trading δ units of the underlying. In contrast, she cannot eliminate the unhedgeable risk which may arise from several sources – among others, jumps, or stochastic volatility. Since the option market maker (i) cannot perfectly hedge the risk inherent in her inventory and (ii) has limited risk-bearing capacity, she increases the price and implied volatility of the call option i.[33]

There are several reasons to think that this theory is consistent with our results. First, we document a significant increase in call option trading volume at the AD. This increase in volume likely reflects the demand pressure that the option market maker faces.[34] Second, we observe a significantly positive announcement response of delta-hedged call options over the same event window. Third, the announcement effect subsides over the long event window, where trading activity returns to its pre-announcement level. The remainder of this section tests the demand-based option pricing theory further.

A Evidence from the Implied Volatility Channel

The demand-based theory of Garleanu et al. (2009) posits that a positive option demand pressure results in a higher implied volatility. This prediction is consistent with the empirical evidence of Bollen and Whaley (2004), and suggests that the revision in the implied volatility may help explain the announcement response of the delta-hedged option portfolios. To see this, consider a simple Taylor approximation of the 1-period daily profit and loss of a delta-hedged option:

$$\Pi_{j,t}^{hedged} \approx \frac{1}{2}\Gamma_{j,t-1}S_{j,t-1}^2\left(\frac{S_{j,t}-S_{j,t-1}}{S_{j,t-1}}\right)^2 + \nu_{j,t-1}(\sigma_{j,t}-\sigma_{j,t-1}) \tag{7}$$

where $\Gamma_{j,t-1}$ is the second-order sensitivity of the option price associated with firm j to the underlying price at time $t-1$. $\nu_{j,t-1}$ denotes the sensitivity at time $t-1$ of the option

[33] There is growing evidence that market-makers in derivatives markets face a broad range of frictions, including regulatory capital and liquidity requirements, shareholder costs arising from debt overhang (Andersen et al., 2019), and desk-specific risk limits to name a few. For more details on these frictions, we refer the interested reader to the work of Andersen et al. (2019), Fleckenstein and Longstaff (2020), and Hazelkorn et al. (2023).

[34] We acknowledge that an increase in trading volume does not necessarily imply an order imbalance. Section VI.A shows that the increase in call option trading volume around the AD appears to be a good proxy for the call option demand pressure.

price to changes in the implied volatility of the option associated with firm j.

Combining Equations (3) and (7), it is straightforward to show that the 1-period delta-hedged option return is approximately equal to:[35]

$$R^{hedged}_{Option,j,t} \approx \underbrace{\frac{\frac{1}{2}\Gamma_{j,t-1}S^2_{j,t-1}\left(\frac{S_{j,t}-S_{j,t-1}}{S_{j,t-1}}\right)^2}{|O_{j,t-1}-\delta_{j,t-1}S_{j,t-1}|}}_{\text{Realized Variance Channel}} + \underbrace{\frac{\nu_{j,t-1}}{|O_{j,t-1}-\delta_{j,t-1}S_{j,t-1}|}(\sigma_{j,t}-\sigma_{j,t-1})}_{\text{Implied Volatility Channel}} \quad (8)$$

Equation (8) reveals that we can decompose the 1-period delta-hedged return into the (i) realized variance and (ii) implied volatility channels. The realized variance channel depends on the square of the 1-period return of the underlying, among others.[36] Since the underlying moves by a large amount following the inclusion news (see Table 2), we expect this channel to make a meaningful contribution to the delta-hedged option return. The implied volatility channel depends on the change in implied volatility. If the option market maker faces a transitory demand pressure and temporarily adjusts the implied volatility upwards, as predicted by Garleanu et al. (2009), then the implied volatility channel will have a positive effect on the delta-hedged option return.[37] This intuition motivates us to focus specifically on the response of the implied volatility channel to inclusion news.

Each trading day, we use all market data to compute the realized variance and the implied volatility channels. We then analyze the placebo- and risk-adjusted response of the two channels to index recomposition news. Table 5 summarizes the results. Consistent with our intuition, the realized variance channel exhibits a positive and significant response

[35]Note that the approximation is most accurate for the 1-period delta-hedged return. It does not naturally extend to longer horizons. This problem arises because the long-horizon returns are obtained by compounding daily returns.

[36]Our use of the expression "realized variance" is a slight abuse of terminology. The literature on high-frequency financial econometrics typically uses the term "realized" variance to indicate the variance computed based on intraday data. If we were to delta-hedge the option positions at the intraday (rather than daily) frequency, our use of the expression would be entirely consistent with this literature.

[37]The implied volatility may react for a number of other reasons. Section V explores some of these alternative explanations, and shows that they are unlikely to explain our main results.

(0.55%) over the short window. More interestingly, the implied volatility channel exhibits an economically large (0.38%) and statistically significant response over the same window. The magnitude of the effect is noteworthy: it accounts for 42% of the placebo- and risk-adjusted response of delta-hedged call options observed over the same window. We thus conclude that the innovation in the implied volatility is an important conduit through which the index recomposition news moves the delta-hedged call options over the short window.

We also study the response of the 30-day model-free implied volatility of Bakshi et al. (2003) to index recomposition news. Our analysis reveals a positive and statistically significant response over the short and medium windows. Consistent with the intuition that the demand pressure weakens over the long window, we observe a reversal. This pattern is consistent with the demand-based option pricing theory. We do not tabulate these results for brevity.[38]

B Evidence from Options of Different Moneyness and Maturity Levels

It is plausible that the option end-user exhibits a stronger preference for some options than for others. For instance, out-of-the-money and short-maturity options are particularly attractive to the option end-user since they provide "*more bang for the buck*" (Augustin et al., 2019, p. 5703). Accordingly, the demand pressure and ensuing pricing effects should be stronger for these options than for others.

Moneyness Motivated by this insight, we repeat our main analyses for options of different moneyness levels. Specifically, we distinguish between the out-of-the-money

[38]Given the discussion in Footnote 18, please note that the results of the analysis of the response of the 30-day model-free implied volatility should be interpreted cautiously.

($1.05 \leq K/S < 1.2$), at-the-money ($0.95 \leq K/S < 1.05$), and in-the-money call options ($0.8 \leq K/S < 0.95$). Because of their high embedded leverage, the out-of-the-money options are likely the most attractive to the option trader. They are then followed by the at-the-money and in-the-money options, respectively. Accordingly, we expect the direct demand pressure and thus the announcement effect to ease as we transition from the out-of-the-money options to the at-the-money and then the in-the-money options.

Table 6 characterizes the placebo- and risk-adjusted response of delta-hedged call options of different moneyness levels. The out-of-the-money options react strongly to the inclusion news at the short horizon, as evidenced by a significant announcement effect of 1.87%. Consistent with our intuition, the strength of the short-term announcement effect declines as we move to at-the-money (0.84%) and then in-the-money (0.35%).[39] We notice a similar pattern over the medium window too. We also analyze the long horizon, where the demand pressure likely disappears. Based on the model of Garleanu et al. (2009), we expect to find little to distinguish between the response of options of different moneyness levels. Table 6 documents precisely this result. The delta-hedged options do not display a significant placebo- and risk-adjusted return at the long horizon. This is true for all moneyness levels.

Maturity We also anticipate that the option end-user has a preference for short-term options due to their high embedded leverage. This insight motivates us to separately repeat our analysis for short- and long-term options. Specifically, we identify options of maturity less (more) than 60 days as short (long) maturity options.

Table 6 confirms that the placebo- and risk-adjusted response of the short-term options (1.06%) is stronger than that of the long-term options (0.73%). Using the relevant

[39] We also implement the monotonicity test of Patton and Timmermann (2010) with 1,000 bootstrap repetitions and a block size of 10. The test statistic leads us to reject the null hypothesis, indicating that the relationship is monotonic. We do not tabulate the results for brevity.

information in the table, we test and formally reject the null hypothesis that the two announcement effects are equal. This result holds for both the short and medium event windows. Since the demand pressure likely disappears over the long window, we expect to find little difference between the responses of short and long maturity options. Table 6 confirms this intuition.

As an additional analysis, we focus on out-of-the-money call options of short maturity. Our untabulated analysis reveals a significant announcement effect over the short (1.98%) and medium (1.18%) windows that reverses over the long horizon. Collectively, these results are consistent with the demand-based option pricing theory of Garleanu et al. (2009).

C Regression-Based Evidence

The logic of the demand-based explanation suggests that variables that affect the demand of option end-users and the ability of market makers to intermediate are both important drivers of the short-term response of the placebo- and risk-adjusted delta-hedged option returns. This insight motivates us to consider a broad range of variables. The first variable is the TED spread (TED), which is a proxy for the funding cost of the market maker. This variable is computed as the difference between the 3-month London Interbank Offered Rate (LIBOR) and the 3-month Treasury bill rate. Intuitively, a higher cost of funding makes it more difficult for the market maker to accommodate the customers' option demand (Lou et al., 2013). As a result, she will increase the option price more when the cost of funding increases.

The second variable (PRICE) is the stock price of the new index member on $AD-1$. As Boulatov et al. (2022) point out, investors may perceive options on low-priced stocks as cheap or "good deals". Accordingly, there will likely be more option demand pressure for low-priced companies, resulting in a higher price response by the option market maker.

The third variable (MIDCAP) is a dummy variable that takes the value 1 if the new index member is upgraded from the S&P 400 midcap index to the S&P 500 index. Our motivation stems from the model of Pavlova and Sikorskaya (2022). When a stock transitions from the S&P 400 midcap index to the S&P 500 index, it is subject to buying pressure from institutional investors benchmarked against the S&P 500 index. However, that buying pressure is partly offset by the selling pressure of institutional investors benchmarked against the S&P 400 midcap index.[40] The net result is that the response of the stock to the recomposition news is likely weaker for a company that transitions from the S&P 400 midcap index to the S&P 500 index compared to a company that joins the S&P 500 index from outside the S&P 400 midcap index.[41] To the extent that the option end-user accounts for the smaller expected stock response of firms that transition from the midcap index, she will exert less option demand pressure for companies that are upgraded from the S&P 400 midcap index. The upshot of this is that the MIDCAP variable should have a negative impact on the response of delta-hedged option positions.

The last two variables are DAYS and SENT. DAYS captures the number of trading

[40] The ownership of index investors is determined by the product of the weight of the company in the new index and the amount of money passively tracking that index. When a stock moves from the S&P 400 midcap index to the S&P 500 index, its weight in the new index is likely to drop. However, the drop in the index weight can be largely counteracted by the fact that the amount of money benchmarked against the S&P 500 index is significantly larger than that tracking the S&P 400 midcap index. Saglam et al. (2019) empirically show that the combined ownership of exchange traded funds (ETFs) and index funds generally increases as a stock transitions from the S&P 400 midcap index to the S&P 500 index.

[41] In our sample, there are 314 firms that transition from the S&P 400 midcap index to the S&P 500 index. We separately analyze the stock price response to index news when the dummy MIDCAP is equal to 0 and 1. Starting with the stocks that transition from outside the S&P 400 midcap index to the S&P 500 index (MIDCAP=0), we observe a placebo- and risk-adjusted announcement response of 5.01%, 7.67%, and 2.7% over the short, medium, and long window, respectively. Repeating the same analysis for added stocks that were part of the midcap index (MIDCAP=1), we obtain a placebo- and risk-adjusted stock announcement response of 2.16%, 1.63%, and 0.78%, respectively. We do not tabulate these results for brevity. In addition to the 314 upgrades from the S&P 400 midcap index to the S&P 500 index, there are 5 companies that moved from the S&P 600 smallcap index to the S&P 500 index. All other inclusions relate to firms outside the S&P indices. Our main results hold when we create an S&P dummy variable that takes the value 1 if the added firm was previously part of the S&P midcap or smallcap index.

days between the ED and the AD. When there is very little time between the two dates, option end-users are likely to trade with more intensity. SENT is based on the sentiment measure of Baker and Wurgler (2006). When sentiment is high, option end-users are likely to have a strong demand for options. In turn, this strong demand pressure leads to a stronger response of the delta-hedged options.

We perform a pooled regression of the (short-term) placebo- and risk-adjusted return of the delta-hedged option on a constant and the lagged observation of each of the aforementioned variables. For ease of comparison, we standardize all explanatory variables, except for the dummy, to have 0 mean and a unit standard deviation. Table 7 summarizes the regression results. Starting with the univariate specification, each slope parameter has the expected sign. Moreover, the results suggest that TED, PRICE, and MIDCAP have a statistically significant impact on the placebo- and risk-adjusted response of the delta-hedged option returns. The last column shows the results of the multivariate regression: the slope estimates associated with TED, PRICE, and MIDCAP remain highly significant. This set of results lends further support to the demand-based explanation.

D Evidence from Put Options

Up to this point, our main analysis has focused on call options. This choice was motivated by the observation that most of the option trading activity takes place in call, rather than put, options (see Figures 3 and 4). However, the theory of Garleanu et al. (2009) posits that the demand pressure associated with option i also affects the pricing of option j, for which the unhedgeable risk comoves with that of option i: the higher the comovement, the stronger is the effect on option j. Conceptually, a delta-hedged put option exposes the market maker to similar unhedgeable risks as does a delta-hedged call option. Thus, if our results are consistent with the demand-based option theory, we should observe qualitatively similar announcement effects for put options.

Table 8 documents a positive and significant average placebo- and risk-adjusted response over the short (0.60%) and medium (0.72%) windows. These estimates are smaller but qualitatively similar to the corresponding estimates for the call option. Similar to the call option results, the announcement effect reverses over the long horizon. Taken as a whole, these results lend further support to the demand-based option pricing model of Garleanu et al. (2009).

V Possible but not Probable Explanations

Although the demand-based option pricing theory explains our main empirical findings, the reader may wonder about alternative explanations. In this section, we consider and evaluate two potential mechanisms. The first builds on the dispersion trading strategy presented in Driessen et al. (2009), while the second relies on the noise trading insights of Black (1986). We show that these explanations make predictions that are at odds with the empirical evidence, leading us to conclude that they cannot explain our main findings.

A Dispersion Trading

Existing studies, e.g., Driessen et al. (2009) and Hollstein and Wese Simen (2020), document a sizeable correlation risk premium in the S&P 500 index option market. In order to capture this correlation risk premium, the authors implement a dispersion trade which consists of a short position in the index options and long positions in the options of all the index stocks. If a stock is added to the index, the dispersion trader will buy the options of the new index member. In turn, this permanent demand pressure of the dispersion trader will result in a permanent inclusion effect. Empirically, the prediction of a permanent addition effect is at odds with the temporary announcement response reported in Table 3.

Furthermore, conversations with market participants reveal that, in practice, the dispersion trading strategy typically does not involve positions in the options on all the S&P 500 constituent stocks. This is because of the high costs associated with trading the derivatives. Instead, practitioners only trade the options of a subset of large and very liquid firms. A case in point is the CBOE S&P 500 implied correlation index, which is based only on the 50 largest stocks in the S&P 500 index.[42] It is therefore unlikely that dispersion traders take positions in the derivatives of the newly included stocks.

B Noise Trading

Index-related products, such as index futures and ETFs, are liquid assets. In turn, the ease of trading these products attracts noise traders who have a high-frequency and non-fundamental demand (Black, 1986). Since the index is linked to the constituent stocks by the absence of arbitrage, the high-frequency trading of noise traders in the index product essentially imports non-fundamental volatility into the stock prices of index constituents. Consistent with this mechanism, Ben-David et al. (2018) find that an increase in ETF ownership is associated with more volatile stock returns.[43]

If option prices reflect this increased volatility, we expect to see a positive and perma-

[42] For further details on the construction of this index, we refer the reader to: https://www.cboe.com/micro/impliedcorrelation/impliedcorrelationindicator.pdf. For practical examples of dispersion strategies, see https://www.newconstructs.com/wp-content/uploads/2010/10/JP-Morgan-and-Correlation.

[43] Harris (1989) compares the volatility of the returns of stocks included in the S&P 500 index to that of a placebo group of firms. Analyzing the period after 1985, the author finds that stocks added to the index witness a significant increase in the short-term volatility of their returns of 14 basis points. Interestingly, there is no significant difference between the short-term volatility estimates of the included and placebo firms before 1983. Taken together, these results leave open the possibility that the higher short-term volatility of included firms in the post-1983 sample may be linked to the introduction of index products such as the S&P 500 index futures and option contracts.

nent placebo- and risk-adjusted response of the delta-hedged options of included firms. Clearly, this prediction is not borne out by the data, as Table 3 reports a temporary announcement response.

VI What About...

In this section, we conduct several additional checks to evaluate the robustness of our findings. We begin by examining the extent to which the increase in trading volume proxies for the demand pressure. We then analyze the evidence of reversal at the asset, rather than portfolio, level. Next, we select the placebo firms following a matching algorithm similar to that of Barber and Lyon (1997). Additionally, we assess the effect of measurement errors in the option price and the hedge ratio. We also analyze the sensitivity of our results to the weighting scheme used to aggregate option positions at the firm level. Finally, we show that our results are distinct from the earnings news effect documented by Gao et al. (2018).

A The Proxy for Demand Pressure?

So far, we have interpreted the increase in call option trading volume as indicative of the call option demand pressure. If this interpretation is valid, we expect to see a stronger announcement effect when there is a higher growth in the call option trading volume. Motivated by this insight, we sort the added firms into high and low portfolios based on the percentage change of the call option trading volume observed at the AD compared to the average volume over the 5 preceding days. For each firm, we calculate the placebo- and risk-adjusted response of the delta-hedged call options over the short-term event window. We then aggregate the results across all firms of each portfolio.

The first row of Table A2 of the Online Appendix presents the results of this analysis. We can see that the high portfolio of firms exhibits a stronger response (1.18%) than the low portfolio of firms (0.59%). This difference is statistically significant, as evidenced by the last column. As an additional check, we repeat the analysis after replacing the percentage change in volume with the logarithmic growth rate of the call option trading volume. As the last row of the table shows, the conclusion remains the same. Taken together, these findings reinforce our interpretation of the increase in option trading volume as evidence of option demand pressure.

B The Evidence of Reversal?

To the extent that the delta-hedged option positions respond to the temporary demand pressure of option end-users, the announcement effect should subside over the long event window. Up to this point, our evidence of reversal is based on the long-term results aggregated across firms. However, the reversal should also be discernible at the asset level and not just at the portfolio level. As pointed out by Patel and Welch (2017), the portfolio-level reversal is not necessarily evidence of reversal at the security level.

To assuage this concern, we follow Patel and Welch (2017) and estimate a cross-sectional regression of the placebo- and risk-adjusted returns of the delta-hedged options observed over the period from $AD+2$ to $ED+63$ on a constant and the 1-period placebo- and risk-adjusted return of the delta-hedged call option observed at (and around) the AD. Table A3 of the Online Appendix reveals that the AD return significantly predicts the return from $AD+2$ to $ED+63$ with a negative and economically large coefficient of -0.57. This result clearly points to reversal at the security level and lends further support to the demand-based theory of option pricing.

C The Control Group?

We analyze the robustness of our results to the selection of the control firms. Our approach broadly follows the matching algorithm of Barber and Lyon (1997). For each firm added to the index, we draw up a list of firms that are outside the S&P 500 index with an announcement day market capitalization corresponding to between 70% and 130% of that of the treated firm. Next, we separately sort the resulting firms based on how close their (i) book-to-market, (ii) investment, (iii) profitability, and (iv) momentum characteristics are to those of the treated firm. We then compute the average rank across all 4 sorts. We select the closest firm overall as control firm.

Armed with the control group, we re-compute the placebo- and risk-adjusted returns. Table A4 of the Online Appendix reports results that are similar to our benchmark estimates (see Table 3). We thus conclude that the main findings are not affected by the method of selecting the group of control firms.

D Noise in the Option Price?

Our main analysis focuses on the midpoint between the bid and ask option prices. It is, however, interesting to consider alternative approaches. We follow Eisdorfer et al. (2022) and use two specific alternative estimates of the option price. First, we assume that the option price corresponds to the sum of 75% of the bid and 25% of the ask prices. Second, we compute the option price as the sum of 25% of the bid price and 75% of the ask price. We then repeat our main analysis.

Table A4 of the Online Appendix summarizes the placebo- and risk-adjusted response of the delta-hedged call option. There is a positive and significant announcement response at the short and medium windows that reverses over the long window. The magnitude of the announcement effects is similar to our baseline estimates, leading us to conclude that the results are robust to noise in the option price.

E Measurement Errors in the Hedge Ratio?

Our construction of the delta-hedged option position requires accurate delta estimates. Unfortunately, the "true" delta is not directly observable but instead needs to be estimated using a specific option pricing model. It is possible that the delta estimates of Option-Metrics are affected by errors arising from model misspecification. To the extent that the "true" delta differs from the estimated delta, our analysis will be affected by measurement errors.

Smile Adjustment One concern may be that the delta should be adjusted to account for the implied volatility smile. Building on Alexander et al. (2012), we compute the smile-adjusted delta as the sum of the estimated delta and an adjustment term that corresponds to the product of the option vega with the sensitivity of the implied volatility to the underlying price. More formally, we have:

$$\delta_{j,t}^{adj} = \delta_{j,t} + \nu_{j,t}\sigma' \tag{9}$$

where $\delta_{j,t}^{adj}$ denotes the smile-adjusted delta, at time t, associated with option j. σ' is the sensitivity of the implied volatility to the underlying price.

Since the implied volatility depends on the strike price of the option, i.e., the smile effect, the last term on the right-hand-side of Equation (9) essentially adjusts the baseline delta for the smile effect. In order to characterize the sensitivity of the implied volatility to the underlying price, we implement the skew tilt in the same way as Alexander et al. (2012). We then compute the smile-adjusted delta and repeat our key analyses. Table A4 of the Online Appendix shows that, if anything, the adjustment slightly strengthens our main results.

Perturbation As an additional check, we follow Coval and Shumway (2001) in perturbating the computed delta.[44] More specifically, we assume that the "true" delta is equal to 95 % or 105 % (Huang et al., 2019) of the estimated delta and repeat the analysis using the new hedge ratio.[45] Table A4 of the Online Appendix presents the results for the delta-hedged call options based on the new hedge ratios. Generally, these results are consistent with our main findings. The delta-hedged call option positively reacts to inclusion news at the short and medium horizons and the announcement response reverses at the long horizon.

F The Method of Aggregation?

So far, we have used weights based on the U.S. Dollar open interest to aggregate the delta-hedged option returns at the firm level each day. We now consider alternative choices. Specifically, we repeat our main analysis after separately implementing (i) a volume-weighting scheme, which puts more emphasis on options that attract more trading volume, and (ii) an equal-weighting scheme (Christoffersen et al., 2017), which treats all option contracts in the same manner. By comparing the results based on these alternative weights with our benchmark estimates, we can evaluate the importance of the weighting scheme.

Table A4 of the Online Appendix reports estimates that are very similar to our bench-

[44] Another approach consists in formulating and estimating an empirical model for the delta. That is, one assumes that the delta of an option depends on several characteristics. One then empirically estimates the sensitivity of delta to the various characteristics and uses the parameter estimates to compute the model-implied hedge ratio. Huang et al. (2019) follow this approach, and document that the resulting hedge ratio is quite noisy. Given this conclusion, we refrain from pursuing this approach.

[45] It is worth pointing out that, given our formula for the delta-hedged option return (see Equation (3)), the impact of measurement errors in the hedge ratio on this return is non-linear. This is because the hedge ratio affects both the numerator and the denominator.

mark results. Over the short event window, we see a placebo- and risk-adjusted response of 1.20% and 1.18% when implementing the volume- and equal-weight schemes, respectively. This is comparable to our baseline estimate of 0.90% (see Table 3). The dynamics of the announcement response is consistent too: it is significantly positive over both the short and medium event windows and then reverses over the long window.

G Concurrent Earnings News?

Our finding of a significant positive short-term announcement response of the delta-hedged option market to index recomposition news is reminiscent of the work of Gao et al. (2018), who document that, while the straddle returns of individual stocks are negative on average, there is a significantly positive average straddle return around earnings announcements. Naturally, one may wonder if the index inclusion news coincides with the earnings announcements of the treated firms. If this is the case, the inclusion news effect we document could be driven by the earnings news effect of Gao et al. (2018).

To address this concern, we discard all observations associated with an AD that falls within 2 trading days of an earnings announcement. This criterion only affects 26 of the 497 inclusion events. Table A4 of the Online Appendix documents a statistically significant placebo- and risk-adjusted response of the delta-hedged call over the short and medium windows. This announcement effect disappears over the long window. Overall, these results are qualitatively and quantitatively similar to our benchmark findings. We thus conclude that our main results are distinct from the earnings announcement findings of Gao et al. (2018).

VII Conclusion

We study the impact of S&P 500 index inclusion news on equity options. There is a significant spike in option trading volume shortly after the announcement. The lion's share of this option trading volume relates to call options. We thus analyze the price impact of the inclusion news on delta-hedged call options. On a placebo- and risk-adjusted basis, the delta-hedged call options respond positively to the inclusion news over the short and medium event windows. This announcement effect subsides and becomes insignificant over the longer horizon.

The pattern of announcement effects in the options is consistent with the demand-based option pricing model of Garleanu et al. (2009). We find that revisions in the implied volatility account for 42% of the short-term response of delta-hedged call options. Additionally, the announcement response is stronger for call options that likely attract more demand from risk arbitrageurs and reverses at the long horizon as the option demand pressure subsides. Furthermore, we show that several well-motivated variables can explain the cross-sectional differences in the announcement response. Finally, we document that the delta-hedged put options, which attract considerably less trading volume, also react positively to the index inclusion news. Collectively, these results reveal that the impact of S&P index recompositions news extends from the equity market to the option market.

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Figure 1: Event Study: Timeline

This figure illustrates the timeline used in the paper. S&P publicly announces the changes to the index composition at 05:15 PM Eastern Time, after the regular trading hours. Thus, the impact of the index recomposition announcements can only be seen on the next trading day, which we denote the announcement date (AD). ED indicates the last trading day before the index recomposition event becomes effective. The difference in dates is expressed in trading days. For example, $ED + 63$ indicates 63 trading days after ED.

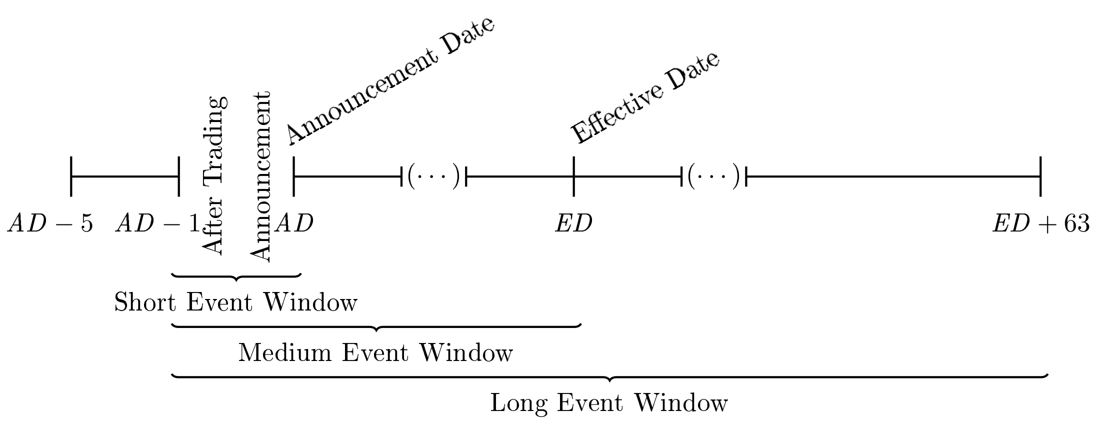

Figure 2: Stock Trading Volume around Inclusion News

This figure characterizes the average stock trading volume around key dates related to the inclusion events along with the corresponding 95% confidence interval. The horizontal axis shows different dates. AD denotes the first trading day after the index inclusion news is public. ED denotes the last trading day before the index inclusion becomes effective. The vertical axis shows the number of shares traded.

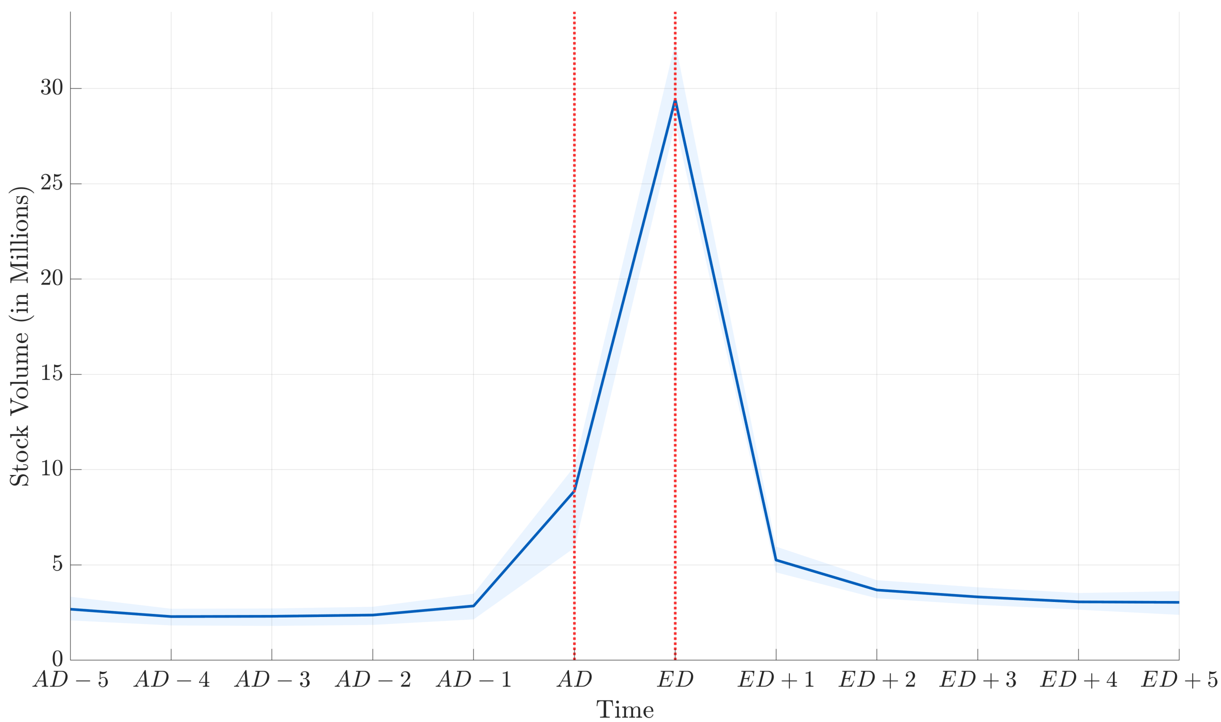

Figure 3: Option Trading Volume around Inclusion News

This figure characterizes the average option trading volume around key dates related to the inclusion events and the associated 95% confidence interval. The horizontal axis shows different dates. The *AD* denotes the first trading day after the index inclusion news is public. The *ED* denotes the last trading day before the index inclusion becomes effective. The vertical axis shows the option trading volume, expressed in stock equivalent.

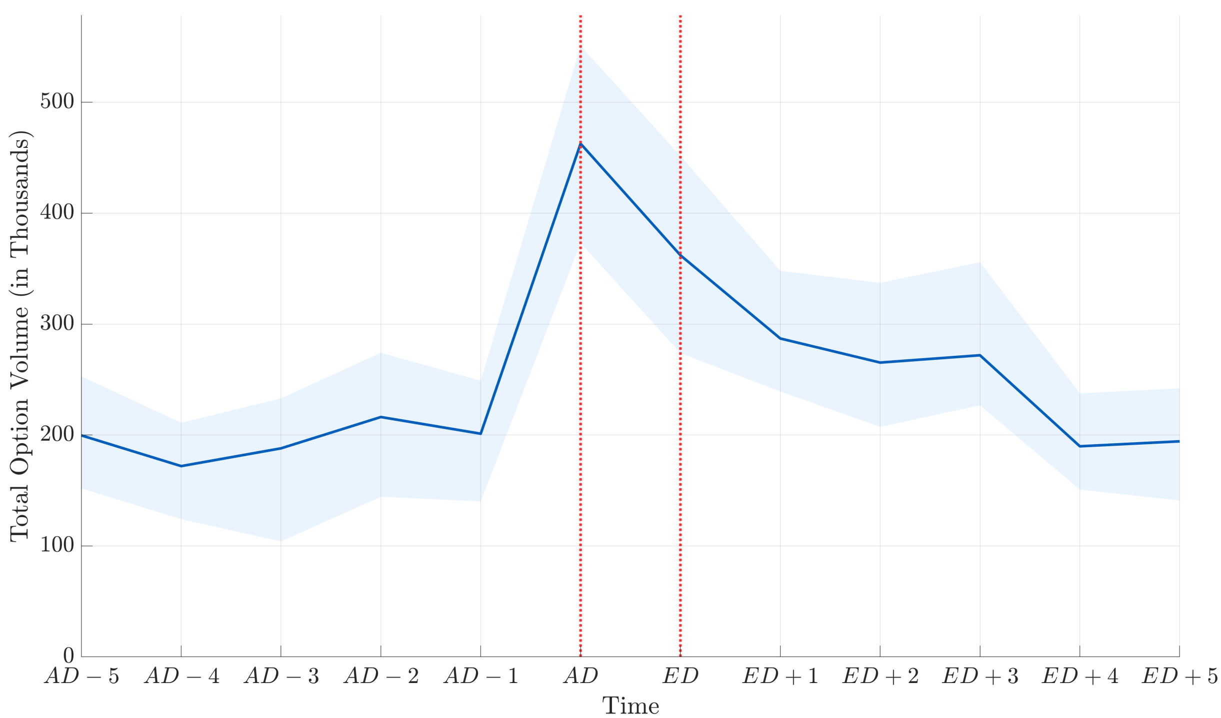

Figure 4: Call Option Trading Volume around Inclusion News

This figure characterizes the average call option trading volume around key dates related to the inclusion events and the associated 95% confidence interval. The horizontal axis shows different dates. The AD denotes the first trading day after the index inclusion news is public. The ED denotes the last trading day before the index inclusion becomes effective. The vertical axis shows the call option trading volume, expressed in stock equivalent.

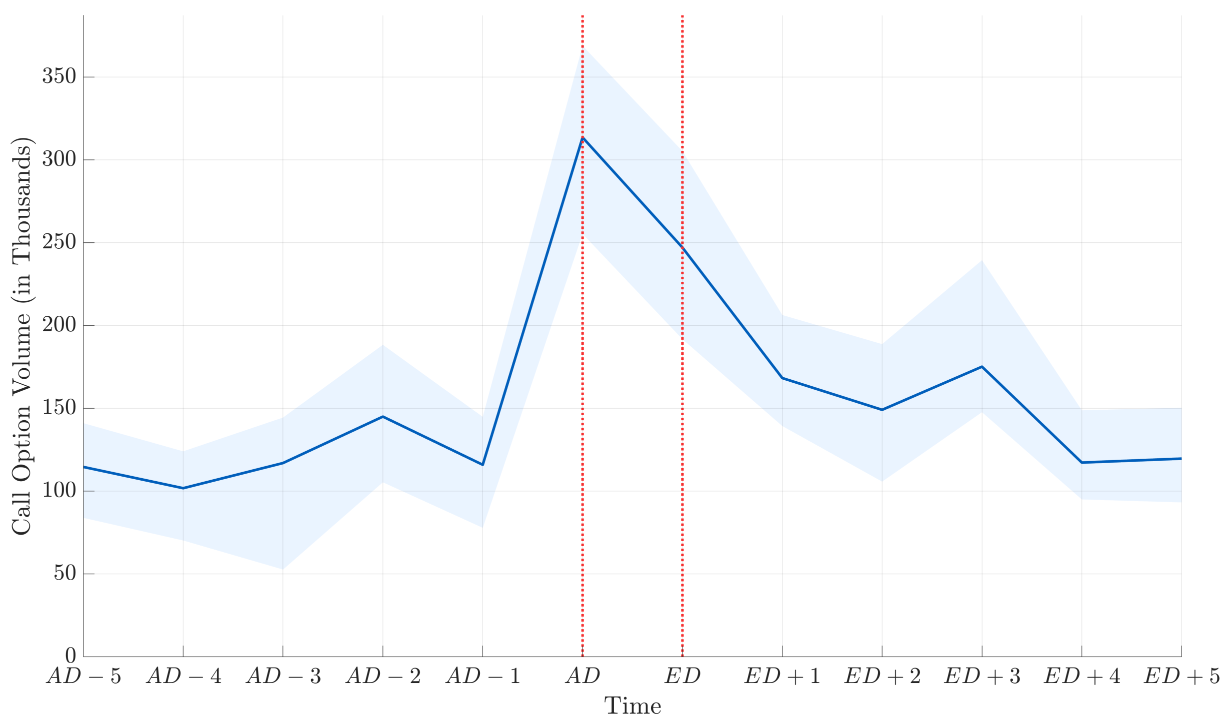

Table 1: Summary Statistics

This table presents the summary statistics of daily stock and (outright and delta-hedged) option returns. At each point in time, we compute the summary statistics using the returns related to the companies ranked between #200 and #800 by market capitalization. We then compute and present the time-series average of these summary statistics. *Avg* reports the average of the *[name in row]* returns. All returns are expressed in percentage points per day. *Med*, *Std*, *Skew*, *Kurt*, $Q_{0.10}$, and $Q_{0.90}$ report the median, standard deviation, skewness, kurtosis, as well as the 10% and 90% quantiles, respectively. The subscripts C and nC indicate that the calculation relates to S&P 500 index constituent and non-constituent stocks, respectively.

	Avg	Avg_C	Avg_{nC}	Med_C	Med_{nC}	Std	Std_C	Std_{nC}	$Skew$	$Kurt$	$Q_{0.10}$	$Q_{0.90}$
Stocks	0.083	0.042	0.119	0.010	0.039	2.089	1.872	2.208	0.716	21.53	−2.014	2.210
Outright calls	0.089	0.045	0.131	−0.075	−0.065	2.597	2.246	2.805	1.883	30.62	−2.366	2.610
Outright puts	−0.088	−0.055	−0.120	−0.115	−0.167	1.830	1.660	1.933	1.227	23.69	−1.939	1.764
Delta-hedged calls	−0.013	−0.010	−0.016	−0.040	−0.048	0.831	0.691	0.905	2.064	61.44	−0.630	0.601
Delta-hedged puts	−0.013	−0.013	−0.013	−0.047	−0.061	0.771	0.623	0.859	2.708	62.86	−0.566	0.544

Table 2: Announcement Effect: Stocks

This table summarizes the response of stocks to index inclusion news. The AD denotes the first trading day after the index inclusion news is public. The ED is the last trading day before the index inclusion becomes effective. We present the results for different event windows with the length of the window expressed in trading days. We report the average (i) raw ($\overline{R}$), (ii) risk-adjusted ($\overline{AR}$), and (iii) placebo- and risk-adjusted ($\overline{AR}^*$) excess return. In order to carry out the risk-adjustment, we use the 6-factor model of Fama and French (2018). In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	$AD-5$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+63$
$\overline{R}$	0.73***	3.21***	4.72***	4.56***
	(0.22)	(0.20)	(0.42)	(1.18)
$\overline{AR}$	0.77***	3.36***	4.46***	3.22***
	(0.20)	(0.19)	(0.36)	(0.97)
$\overline{AR}^*$	0.38*	3.21***	3.85***	1.49*
	(0.20)	(0.19)	(0.36)	(0.93)

Table 3: Announcement Effect: Call Options

This table summarizes the response of call options to index recomposition news. Panels A and B summarize the results associated with the (i) outright and (ii) delta-hedged option positions, respectively. The AD denotes the first trading day after the index inclusion news is public. The ED is the last trading day before the index inclusion becomes effective. We present the results for different event windows with the length of the window expressed in trading days. For each panel, we report the average (i) raw ($\overline{R}$), (ii) risk-adjusted ($\overline{AR}$), and (iii) placebo- and risk-adjusted ($\overline{AR}^*$) excess return. In order to carry out the risk-adjustment, we use the 3-factor model of Zhan et al. (2022). In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Outright Options

	$AD-5$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+63$
$\overline{R}$	0.71***	4.55***	6.28***	6.14***
	(0.23)	(0.26)	(0.53)	(1.48)
$\overline{AR}$	1.01***	4.74***	6.39***	8.00***
	(0.22)	(0.26)	(0.46)	(1.32)
$\overline{AR}^*$	0.52**	4.50***	5.32***	2.89**
	(0.22)	(0.26)	(0.46)	(1.23)

Panel B. Delta-Hedged Options

	$AD-5$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+63$
$\overline{R}$	−0.09	0.95***	0.91***	0.73*
	(0.08)	(0.09)	(0.14)	(0.38)
$\overline{AR}$	−0.02	0.95***	1.06***	2.24***
	(0.09)	(0.09)	(0.14)	(0.36)
$\overline{AR}^*$	−0.11	0.90***	0.92***	0.24
	(0.08)	(0.09)	(0.14)	(0.30)

Table 4: The Announcement Response of Delta-Hedged Call Options Over Time

This table summarizes the short-term, i.e., from $AD-1$ to AD, response of delta-hedged call options to index recomposition news. We present the results for different 5-year subsamples. Specifically, we report the average (i) raw ($\overline{R}$), (ii) risk-adjusted ($\overline{AR}$), and (iii) placebo- and risk-adjusted ($\overline{AR}^*$) excess return. In order to carry out the risk-adjustment, we use the 3-factor model of Zhan et al. (2022). In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	1996–2000	2001-2005	2006–2010	2011–2015	2016–2020
$\overline{R}$	2.07***	0.57***	0.51***	0.51***	0.36***
	(0.24)	(0.16)	(0.10)	(0.09)	(0.08)
$\overline{AR}$	2.03***	0.58***	0.52***	0.58***	0.40***
	(0.24)	(0.16)	(0.10)	(0.10)	(0.08)
$\overline{AR}^*$	1.95***	0.55***	0.49***	0.57***	0.33***
	(0.25)	(0.16)	(0.12)	(0.10)	(0.08)

Table 5: Realized Variance and Implied Volatility Channels

This table summarizes the placebo- and risk-adjusted response of the realized variance and implied volatility channels to index recomposition news. In order to carry out the risk-adjustment, we use the 3-factor model of Zhan et al. (2022). The AD denotes the first trading day after the index inclusion news is public. The ED is the last trading day before the index inclusion becomes effective. We present the results for different event windows with the length of the window expressed in trading days. In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	$AD-5$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+63$
Realized Variance Channel	-0.02	0.55^{***}	0.52^{***}	0.21
	(0.06)	(0.07)	(0.11)	(0.44)
Implied Volatility Channel	-0.05	0.38^{***}	0.42^{***}	0.16
	(0.06)	(0.06)	(0.08)	(0.20)

Table 6: Moneyness and Maturity Effects: Placebo- and Risk-Adjusted Delta-Hedged Option Returns

This table summarizes the average placebo- and risk-adjusted response of delta-hedged call options to index recomposition news. We separately analyze options of different moneyness and maturity as indicated in the first column. The AD denotes the first trading day after the index inclusion news is public. The ED denotes the last trading day before the index inclusion becomes effective. We present the results for different event windows with the length of the window expressed in trading days. In order to carry out the risk-adjustment, we use the 3-factor model of Zhan et al. (2022). In parentheses, we report the standard errors based on the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	$AD-5$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+63$
Moneyness				
Out-of-the-Money: $1.05 \leq K/S \leq 1.2$	-0.17	1.87^{***}	1.31^{***}	0.30
	(0.14)	(0.20)	(0.21)	(0.36)
At-the-Money: $0.95 \leq K/S < 1.05$	-0.05	0.84^{***}	0.81^{***}	0.53
	(0.08)	(0.07)	(0.12)	(0.30)
In-the-Money: $0.8 \leq K/S < 0.95$	-0.04	0.35^{***}	0.45^{***}	0.35
	(0.05)	(0.05)	(0.08)	(0.19)
Maturity				
Short-term: 8 to 60 days	-0.06	1.06^{***}	1.02^{***}	0.35
	(0.09)	(0.11)	(0.15)	(0.33)
Long-term: 61 to 120 days	-0.07	0.73^{***}	0.52^{***}	0.23
	(0.08)	(0.11)	(0.10)	(0.22)

Table 7: Announcement Effect: Regression

This table summarizes the results of a pooled regression of the short-term, placebo, and risk-adjusted announcement response of delta-hedged call options on a constant and 5 lagged explanatory variables. TED denotes the spread between the 3-month London Interbank Offered Rate (LIBOR) and the 3-month Treasury bill rate. PRICE is the stock price on $AD-1$ of the soon-to-be index member. MIDCAP is a dummy variable that takes value 1 if the new index member transitions from the S&P 400 midcap index to the S&P 500 index and 0 otherwise. DAYS indicates the number of trading days between the *ED* and the *AD*. Finally, SENT is the sentiment measure of Baker and Wurgler (2006). In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	(i)	*(ii)*	*(iii)*	*(iv)*	*(v)*	*(vi)*
α	0.90***	0.90***	1.34***	0.90***	0.90***	1.30***
	(0.09)	(0.09)	(0.18)	(0.09)	(0.09)	(0.17)
TED	0.20**					0.17**
	(0.09)					(0.08)
PRICE		−0.25***				−0.17***
		(0.07)				(0.06)
MIDCAP			−0.68***			−0.63***
			(0.21)			(0.20)
DAYS				−0.14		−0.13
				(0.09)		(0.08)
SENT					0.16	0.12
					(0.10)	(0.10)
Adj. R^2 (%)	0.77	1.23	2.34	0.28	0.40	4.09

Table 8: Announcement Effect: Put Options

This table summarizes the response of the delta-hedged put options to index recomposition news. The AD denotes the first trading day after the index inclusion news is public. The ED is the last trading day before the index inclusion becomes effective. We present the results for different event windows with the length of the window expressed in trading days. We report the average (i) raw ($\overline{R}$), (ii) risk-adjusted ($\overline{AR}$), and (iii) placebo- and risk-adjusted ($\overline{AR}^*$) excess return. In order to carry out the risk-adjustment, we use the 3-factor model of Zhan et al. (2022). In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	$AD-5$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+63$
$\overline{R}$	0.07	0.63***	0.76***	-0.00
	(0.08)	(0.08)	(0.12)	(0.29)
$\overline{AR}$	0.10	0.61***	0.80***	0.46*
	(0.08)	(0.08)	(0.12)	(0.26)
$\overline{AR}^*$	0.06	0.60***	0.72***	-0.02
	(0.08)	(0.08)	(0.12)	(0.24)

The Index Effect: Evidence from the Option Market

Online Appendix

JEL classification: G12, G11, G17

Keywords: Delta-Hedged Options, Demand Pressure, Index Effect, Placebo

Figure A1: Inclusions Over Time

This figure presents the number of inclusions for each month in our final sample. The horizontal axis shows the date. The shaded areas indicate business cycle contractions as identified by the National Bureau of Economic Research (NBER).

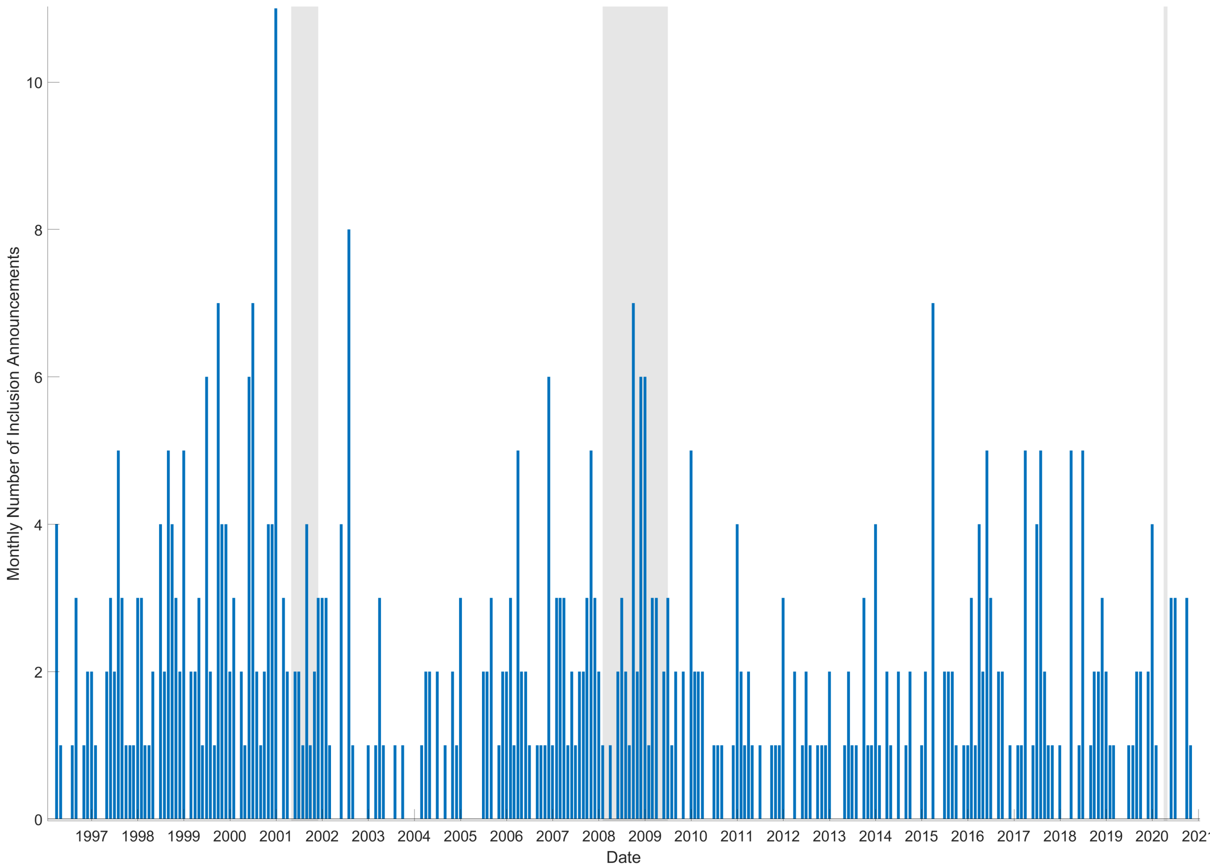

Table A1: Announcement Effect: Call Options (Dash and Liu, 2008)

This table characterizes the returns on call options around the index recomposition news. We calculate the daily option returns as in Dash and Liu (2008). The AD denotes the first trading day after the index inclusion news is public. The ED is the last trading day before the index inclusion becomes effective. We present the results for different event windows with the length of the window expressed in trading days. We report the average (i) raw ($\overline{R}$), (ii) risk-adjusted ($\overline{AR}$), and (iii) placebo- and risk-adjusted ($\overline{AR}^{*}$) excess return. In order to carry out the risk-adjustment, we use the 3-factor model of Zhan et al. (2022). In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	$AD-5$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+63$
$\overline{R}$	6.82***	39.9***	56.9***	38.9**
	(2.48)	(2.72)	(5.73)	(16.3)
$\overline{AR}$	7.64***	40.2***	54.8***	36.9***
	(2.46)	(2.71)	(4.65)	(14.2)
$\overline{AR}^{*}$	3.04	38.9***	47.2***	1.12
	(2.37)	(2.67)	(4.72)	(13.9)

Table A2: Announcement Effect: The Role of the Option Trading Volume

This table examines the impact of the change in the call option trading volume on the short-term placebo- and risk-adjusted response of delta-hedged call options. The response is measured over the period that starts at $AD-1$ and ends at the AD, where the AD denotes the first trading day after the index inclusion news is public. In order to carry out the risk-adjustment, we use the 3-factor model of Zhan et al. (2022). We sort firms into portfolios [*name in column*] based on the variable [*name in row*]. %ΔVolume indicates the percentage change in call option trading volume at the AD. As a reference volume level, we use the average volume computed using the 5-day period ending at $AD-1$. $\Delta\log$(Volume) denotes the logarithmic growth in call option trading volume. In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	Low		High		High-minus-Low	
%ΔVolume	0.59***	(0.13)	1.18***	(0.14)	0.59***	(0.19)
$\Delta\log$(Volume)	0.28***	(0.06)	1.50***	(0.16)	1.22***	(0.17)

Table A3: Analyzing Reversals

This table summarizes the results of the cross-sectional regression of the delta-hedged call option return for the period starting at $AD + 2$ and ending on $ED + 63$ on a constant and the delta-hedged call option return observed over the 1-period ending at [name in column]. γ denotes the slope coefficient. In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. The AD and the ED denote the announcement and effective dates, respectively. All the delta-hedged call option returns are placebo- and risk-adjusted. In order to carry out the risk-adjustment, we use the 3-factor model of Zhan et al. (2022). Mean and Std denote the average and volatility of the placebo- and risk-adjusted return observed at time [*name in column*], respectively. ρ_{AD} reports the correlation between the placebo- and risk-adjusted delta-hedged returns observed at times AD and [*name in column*].

	$AD-5$	$AD-4$	$AD-3$	$AD-2$	$AD-1$	AD	$AD+1$
Mean	0.02	−0.04	−0.02	0.01	−0.11	0.90	−0.00
Std	0.87	0.98	0.74	0.65	1.12	2.05	0.59
ρ_{AD}	−0.03	−0.05	0.02	−0.01	−0.25	1.00	0.07
γ	−0.29	−0.39*	0.58	0.30	−0.08	−0.57***	0.34
	(0.46)	(0.22)	(0.65)	(0.61)	(0.38)	(0.18)	(0.69)

Table A4: Robustness: Placebo- and Risk-Adjusted Delta-Hedged Call Option Returns

This table presents various robustness checks regarding the placebo- and risk-adjusted response of delta-hedged call options to S&P 500 index recomposition news. The first panel presents the results based on the control group of firms selected following the approach of Barber and Lyon (1997). The second panel uses the weighted average of the bid–ask option prices (Eisdorfer et al., 2022) to compute the option returns. The third panel adjusts the delta estimates to account for the smile effect (Alexander et al., 2012) or potential perturbations, as in (Coval and Shumway, 2001). The fourth panel presents the results based on different weighting schemes to aggregate the option returns at the firm level. The fifth panel reports the results based on a sample that excludes inclusion announcements that occur around earnings news. For each panel, we repeat the main analysis. The *AD* denotes the first trading day after the index inclusion news is public. The *ED* is the last trading day before the index inclusion becomes effective. We present the results for different event windows with the length of the window expressed in trading days. In order to carry out the risk-adjustment, we use the 3-factor model of Zhan et al. (2022). In parentheses, we report the Newey and West (1987) standard errors truncated at 4 lags. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	$AD-5$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+63$
		Alternative Control Group		
Barber and Lyon (1997)	−0.11	0.85***	0.90***	0.70
	(0.11)	(0.09)	(0.15)	(0.46)
		Noise in the Option Price		
75% Bid – 25% Ask Return	−0.12	0.86***	0.85***	0.20
	(0.08)	(0.09)	(0.14)	(0.29)
25% Bid – 75% Ask Return	−0.11	0.94***	0.83***	0.65
	(0.08)	(0.10)	(0.18)	(0.35)
		Different Delta Estimates		
Smile-Adjusted Delta	−0.03	1.09***	1.10***	0.54
	(0.09)	(0.11)	(0.16)	(0.42)
Perturbation: Delta×0.95	−0.08	1.15***	1.20***	0.27
	(0.09)	(0.10)	(0.15)	(0.32)
Perturbation: Delta×1.05	−0.13	0.68***	0.68***	0.21
	(0.08)	(0.09)	(0.13)	(0.30)
		Different Weighting Schemes		
Volume-weight	−0.04	1.20***	1.02***	0.29
	(0.09)	(0.10)	(0.15)	(0.36)
Equal-weight	−0.11	1.18***	1.24***	0.12
	(0.08)	(0.11)	(0.16)	(0.31)
		Earnings News		
$\overline{AR}^{*}$	−0.11	0.89***	0.92***	0.32
	(0.08)	(0.10)	(0.14)	(0.30)