The Index Effect: Evidence from the Option Market*

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Abstract

We document a significantly positive response of delta-hedged option positions on companies entering or leaving the S&P 500 index. Our findings (i) hold for both call and put options, (ii) are robust to placebo- and risk-adjustments, and (iii) are stronger for companies that are likely subject to more demand pressure from stock index investors. The inclusion effect is permanent, while the exclusion effect is transitory. We explore various mechanisms to explain these results, including leading theories of benchmarking, investor recognition, noise trading, and dispersion trading. We find that these explanations cannot individually account for all our novel results.

JEL classification: G12, G11, G17

Keywords: Delta-Hedged Options, Event Study, Index Effect, Placebo Group

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I Introduction

Cite the paper by Dew-Becker, Giglio and Kelly (Hedging Macroeconomic and Financial Uncertainty and Volatility)

- Include the gamma vega decomposition
- Motivate each channel (look at the slides CMES):
  - Gamma: directional movement in the underlying, or perhaps feedback from delta-hedging activity of the market maker. Perhaps call it the jump channel or the hedging error (better if want to spin a story about the market maker)
  - Vega channel: Inventory/order flow and/or noise This can also be motivated by showing that the IV reacts.
- Perhaps emphasize more in the paper that the vega channel also matters. Looking back at the discussion by Caio and participants at the CMES, they expected the gamma channel. So it's cool to show that the vega channel reacts. Think about how to flesh it out in the abstract and introduction.

  Improve intro, the idea is to show that there is a big literature on index recomposition on spot. Massive studies show a significant impact etc. We also know that informed investors tend to trade in option markets since it gives leverage and enables bets on directional and volatility too The impact is predictable and presumably investor would want to take leverage bets on these positions. This is even more important as we have more armchair investors playing in the option market. Raises the question on what is happening to the option market? This paper comes in and sheds new light. We show that the effect goes beyond just the spot but also the options In intro go directly to the option results, skip spot results. Talk about investment performance (economic value)

Contribution could be to show the feedback mechanism induced by option market makers activities... Literature does not give a holistic view of the announcement effect as we do since they focus on spot... Additional analysis:

Subsample analysis: connected to either a decline in transactio costs or more passive investors.

How do bid ask spread behave? Might be important to show if MM are protecting themselves by widening the spread? Check the literature on earning news/macro news (perhaps one to contribiute to?) to see what mechanism they have

Have a look at Jun Pan's resolution of FOMC

For Tables 5 and 6, truncate/make it simpler to read. Nobody cares about the EW, so perhaps remoe it.

Possible mechanisms

–Addition:

Investors want to be long the CALL option so MM is short. As a result he delta-hedges exacerbating any movement. If prices go up, he buys even more, thus exacerbating the move, but also making the stock more volatile. This is the feedback mechanism

This generates a gamma effect which is common to both put and call btw.

Also, the MM receives a lot of buying orders meaning he has a lot of vega risk (part of which is offset with people selling put) but still I expect the MM to be net short and to hedge he needs to charge a higher IV.

Recall this effect should be stronger for OTM calls. Question: What about volume? Do we see a higher bid-ask spread, indicating an inventory management concern? For exclusions,

Demand for puts, still same feedback mechanism since the MM is net short puts.

He will also want to charge a higher IV

Questions: Should effect be same for call and puts? No depends on relative demand pressure

Consider options that expire only at the ED so you can do delta hedging daily or once/

In explanation always highlight the preference of end users for one direction as opposed to the other, i.e. Call vs. Put

- Effect of news on volatility. Joel Peress JF paper. News coverage of the events could trigger surge in volatility. Good point, to look into the paper. This would be gamma effect though, not the vega effect…

- With more noise trading, the premium for asymmetric information/adverse selection might decline (as the share of informed traders decreases). Implication for the bid ask spread of the stock and option. Both should narrow. Furthermore, if the option contains a premium for illiquidity, then we should see a decline in the

- Effect on the stock market disappeared in the last 10 years. What about the option market?

Good question, worth exploring….

- Why not use IV directly?

For the transaction costs analysis, we could do this: –Use the 75/25 and 25/75 weighted average of the bid/ask as in the Maturity Driven Mispricing of Options.

If our story is true about delta-hedging effect, then we should look at the implications for • First order autocorrelation motivated by the paper of Zhi Da • When the effect is strongest: It should be even stronger for less liquid stocks because of the microstructure. So the buy will move quickly through the order book. • At some point bid-ask spreads of options would need to move to help the market maker manage the inventory/vega risk…

Look at the Muravyev paper to get an idea of transactions costs!

Feedvack from University of Bremen (Chardin: Make sure you thank them in acknowledgement) 1) Of course the question on the predictability of the events. 2) One of them did not like the use of the word "permanent", since we only examine the period until half a year out. 3) One comment was that we should examine whether the systematic or idiosyncratic part of the volatility increase after inclusion. 4) One PhD student was interested in the further decomposition of the effect in moneyness and time-to-maturity. 5) That same guy complained a lot about our usage of the Black—Scholes model. He had a lengthy monologue on its inaccuracies…

The HVX factors seem to kill the results beyond ED. Actually the FF9 model does that too. It seems the effect is very strong for OTM options. That is, for PUTS 0.8–0.95 and 1.05–1.2

The before/after analysis is fun. Cool analysis of Bid, ask, 75% bid and so on.

What is happening to Bid–Ask spread

Let's focus on impact on sum of squared return. Let's do the same for the change in IV. Stulz shows a decline in the index effect. Same for Kappou et al. Argue tjhat the underlying efect is not permanent. This seems Similar to Patel and Welch. Note we start our sample a bit late 1996 compared to them. End date of sample is more recent though.

Note that the channels are computed each day and compounded to ge tto the decomposition effect.

Gamma effect: True even without further order flow pressure on the option side. This is because the hedge needs to be adjusted.

Vega: Inventory management so indirectly, we can look at Bid/ask spread or volume.

Feedback from the ACFR Derivatives cocnference:

- Exclusions might be a lot more predictable than inclusions. Intuitively, Chardin seems to agree. One thing to do is look at say 1 year of data, and see if the financial press, e.g. the FT, correctly identifies these excluded firms. If this is true, then the announcement is merely confirming a rumor and as such, the effect of the announcement should be small. This would also mean by the way very little (abnormal) option trading volume and thus, the MM needs not adjust the IV. ==> the vega channel becomes muted and all of the action is via gamma. Again this helps understand the difference in the permanent vs temporary dimensions as well as the magnitude of the announcements.

- Asset managers tend to drop companies that are thought to be excluded from the index ahead . Hence, there would be little abnormal trading ahead.

- Analysis of the time-variations in the effects: For instead for the noise trader, you would expect the effect to be strong during the more recent sample. The dispersion trade was hot in 2007 ish so this period may be more relevant then.

From Chardin's reading of the literature, papers that focus on the order imbalance, e.g. the Poteshmann types of paper (esp with Ni) or the Weinbaun paper, are cast in an event study. So they tell us how end users trade around the event. Fabian points out that some papers that use both inventory and flow interpret the former as level and the latter as innovation (Golez and Goyenko (2021) paper which references the Banerjee and Kremer (2010)).

Looking at Reddit, it seems the market maker always tries to keep the vega risk within some specific risk limit. How does she do this? Suppose she is long the individual stock call. To hedge, she can short the index option or instead the option of a similar securities. Generally, this works well unconditionally. However, during times of stress or event, the position and the hedging instruments do not react the same way. This is important for two reasons:

- The inventory metric probably only gives us a partial look (to be confirmed following the LQG seminar of 14 Sept 2021)
- The market maker will probably get spooked if she perceives a strong order flow. To deal with this, she will change the IV that she prices in the option market since she knows her hedge will be imperfect. Conceptually, I guess it's the same story for the gamma pricing effect.
- The hedge did not work from pre-AD to ED. Question: what effect does this have on the behaviour?

We agreed to focus on ED+5 max. And then to have a subsection where we look at the longer horizon, e.g. say ED+63. This choice is motivated by the fact that from ED+21, the significance of the effect depends critically on the risk model that we use.

We want to change the motivation. Start with the large literature on index recomposition and stock market. Then connect with the notion that options provide leverage, allow to lockin prices etc. Thus it is natural to look at the response of option markets to recomposition events. In particular, we focus on delta-hedged options to analyze effects other than those linked to directional moves. Furthermore, we shed light on how end users actually trade around these important events (this is a big difference from the Dash and Liu paper).

So the new paper will be about documenting the evidence of a response, showing how end users trade around this, and then discussing potential explanations for the effect.

Explore if the index tracker can trade the options to lock in prices. So the motivation would be ok, the index effect has declined recently, presumably because rebalancers use options to lock-in prices. So the question is how does this trading affect the option market? We need anecdotal evidence to suggest that this is how they mitigate the impact of recomposition news.

We need to improve the definition of the ED. For inclusion, it is the day before the one where the stock is officially included. This is because index trackers can start trading at the end of the day before. For exclusions, it is the last day when the stock is inside the index. This way, our exclusion and inclusion dates are well-aligned. A better definition is to say that it is the date of the last market close prior to the index recomposition change being reflected in the SP500.

- Chardin to think about the best way to present the results on trading. Idea is to look at the work of Augustin in Man Sci and the recent paper by Muravyev.
  - We want to present the data for different maturity buckets: first expiration after the ED, Second expiration after the ED, and may be last expiration before AD. We feel that presenting the data in event time, as opposed to calendar time, is probably the best way forward.
- We want to use data on Robinhood traders to show that these agents actually trade

the stocks and if so is that a popular thing they do?

After speaking with Max, it transpires that the market maker might take a directional view too. Of course one might object that they are supposed to be inventory neutral but they can hide behind the pre-hedging argument which goes along the lines of: we expect a lot of client flows, so we will do this and that in anticipation of this trade, thus giving them some directional exposures. See the flagged email from Zillow Matt Levine of November 06 "Early discussions of the Volcker Rule, which forbids banks from doing “proprietary trading” but allows them to do “market making,” placed some emphasis on this distinction: If your desk makes most of its money from price moves, that’s bad prop trading; if it makes most of its money from spreads, that’s good market making. The Financial Stability Oversight Council, for instance, said in 2011 that “Understanding the source of a market maker‘s profits would ordinarily provide a strong indication of whether the firm is profiting from bona fide market making or proprietary trading. Market making activities should be characterized by rapid inventory turnover and minimal profits on inventory held, while proprietary trading activities should evidence more modest turnover with the bulk of profits derived from inventory appreciation.” (The council added that this is hard to measure, and the actual Volcker Rule as ultimately implemented is not especially dogmatic about it.) "

Idea of a plan

- There is a big literature on the stock index effect. This is because of forced buying by index providers etc.
- However, we also know that iShares, and Vanguard for instance allow the trading of derivatives contracts. Naturally, one may wonder whether derivatives markets react to these events. Another reason may be that retail traders trade the derivatives because of its embedded leverage.
  - **In the literature, they assume that index providers mainly rebalance at the ED due to concerns about their tracking errors. For example the Blume and Edelen (2004) paper offers a good discussion of the issue. Recent papers, though, argue that index providers appear to be a bit more flexible in their rebalancing "around the ED". Some hints to this can be found, e.g., in Blitzer (2005), Kappou (2018). [Alternative explanations can also be found here:** `https://jii.pm-research.com/content/11/1/17andinPrestonandSoe(2021)`
  - **The SPDR indeed cannot use any derivatives. However, things are different for Blackrock (iShares), which may invest up to 20% in derivatives and Vanguard, which invests "to a limited extent, in derivatives, including equity futures". I have uploaded the highlighted prospectuses to our Dropbox folders (**`Bird'sEye$\protect\T1\textdollar02-Recompositions$\protect\T1\textdollarETFs`**).**
  - **Front running is a big topic in the index literature. To measures whether this is profitable, they examine whether there are abnormal returns between AD and ED (since that is when you could profitably**

trade on it). Kappou (2017), for example, shows that this is not profitable anymore in the recent period. Far as I know, it is also not profitable on options markets to invest between AD and ED. Hence, I agree that we should hint at this channel. But I would not make it too big.

- So the question is: do we see evidence of trading in the derivatives market? This is important because it is clean and more direct evidence of people front-running the index trackers. So we could show the abnormal trading volume/pattern in options. The next thing we can do is to basically shed light on whether they trade calls or puts and what kind of maturity, moneyness. I think this is an important contribution that sets us apart from the literature. **Ok. Will have to run the code from an early stage again to get the volume for different maturities and moneyness levels. This should be easy**.

- Then we can ask, given the evidence of trading, what is the effect on option prices? In particular, we can compute option P&L, i.e. just the change in option price (so only the first term on the right of the equality sign in Eqn 1 of our paper- the rf*Option price), which we normalize by the cost of a delta-hedged portfolio at inception (Yes, delta-hedged! It is just a scaling thing but in the next bullet it should be obvious why) . **Ok. If I do not find a nice tweak, I will have to run the code again from the very start, though, which I expect will take weeks...**: Updated to green

- We can next hedge out the directional effect to ask the question: is this simply a directional effect or is there more to it? So essentially, the return in the previous bullet point can be decomposed into the delta-hedged option return and the directional effect...

- Then we can dissect the gamma/vega channels and see which mechanisms are most consistent or not with our pattern of results. **The overall flow sounds good to me.**

It is interesting to note that there are no exclusions in 2006 (based on Figure A.1) One possibility is to think about stock lending.

If bad news, investors want to buy puts. So MM is short Puts, i.e. positive delta. To hedge, he short sells the stocks. But lending fees will be high. So he charges a bit more than expected, making the put more expensive. But Fabian argues that the Calls should be cheaper.

Short-term action points

- Clarify the computation of Delta: is it really Black and Scholes (1973)?
  - So these are the Deltas from OptionMetrics. Chardin to doublecheck from the OptionMetrics whitepapaer.
- Get the RA to explore newswires linked to exclusions.
  - The V18 version of the file suggests you get abnormal returns prior to exclusions (on the stock side of things). However, the results for delta-hedged options suggests there is nothing abnormal. To explore further
- The idea
  - We follow Augustin et al. (2019) to compute the abnormal volume. Fabian to double check the issue about whether we model the log(1+volume) as the paper by Augustin et al. (2019) is a bit misleading. [Update: They seem to use the log form for the abnormal volume]

- The idea of the paper now is to focus on inclusions and sell the narrative of Garleanu and Pedersen or perhaps the Ranaldo. Exclusions are simply a side show results
- The narrative of the paper is as follows:
  1. Show that there is option trading volume at the announcement date (without any distinction between the put and the call). This is intriguing because, strictly, the effect should be in the underlying only.
  2. Show that the option volume is actually much larger (in equivalent shares) than what is happening in the underlying. Suggesting some speculation? One issue I can think of is that we assume a Delta of 1. I wonder if we need to account for this.
  3. Show that the bulk of the action arises from the call options rather than the put options. This further confirms this kind of speculation hypothesis. We can follow the visualisation of Augustin et al. (2019). The evidence suggests that there is a significantly positive impact on call volume and OI on a placebo and abnormal basis (perhaps talk throughout the paper about abnormal rather than risk-adjusted quantities). For puts, there is no significant OI effect. Interestingly, the bid-ask of both option types do not react significantly.
  4. Study the impact of this announcement on the price of raw option prices: show that both calls and puts react. Document that the effect is particularly strong for short-term options that are out-of-the money. (**May be we should also include the trading activity data for this cut of data, i.e. first by maturity and then by moneyness.Update of 18 Jan: May be we do not need this for now!**) The question is whether

there is an effect beyond delta!

5. Study the delta-hedged option positions and show a positive response. This is surprising for two reasons. First, the options are not in fixed supply so there is no reason to expect them to react? That's my reading of the downward sloping curve. Second, the put also reacts. This is puzzling since there is little evidence of abnormal trading. The answer is that there is an unhedgeable component in the option that comoves with that of the call a la Garleanu et al. (2008).

6. Dissecting the effect: Gamma and Vega. Gamma can be thought of as the cost of hedging. As the market maker is short gamma, any time the stock price increases, as will be the case given the news, the hedge gets costlier and costlier, i.e. the market maker is locking in more losses. This cost is then passed on to end users. Furthermore, this is a common effect for both puts and calls. Vega is all about the unhedgeable component for me and thus how expensive it is to keep the position on the books.

   * This effect might be stronger when funding is tight (**test using the hybrid setting**)!
   * The effect should also be stronger the bigger the order imbalance.
   * The effect should also be stronger when capital is scarce, e..g the intermediary capital variable.
   * The effect should also be stronger when sentiment is low, e..g the baker wurgler index.
   * The effect should also be stronger when the risk aversion is bigger, i.e. when VIX might be high.

7. We will use the evidence of short-term effects on inclusion to rule out most

of the other explanations of inclusions, which predict a permanent effect (it is a good idea to summarize all these explanations in a table). Then we can show additional evidence showing how trading activity, e.g. order imbalance, open interest and volume evolve around ED. If they decline quickly, then we are safe.

8. For the test relted to the order imbalance etc, we could rely on the 1-sided test. But be careful, since it is a placebo distribution, it needs not be symmetric.

9. We need to clarify who might trade in the option market around that time. One option is to simply use the quotes from Fabian, showing that ETFs can use derivatives, though it is not clear which one. Blume and Edelen (2004) write that "*Some index fund may lend securities to enhance return, and some may use derivatives.*" and "*As practitioners interviewed for this study suggest [...], many indexers enter into bilateral agreements with providers of liquidity to trade at the closing price and are "paid" to enter into such agreements".*[1] One may wonder how they can fund these activities; one possibility is that they use the income say from stock lending. Also, you could cite investors who want to front run the index trackers and make big money, hence the interest in an asset providing leverage.Another option is to use the call order imbalance and compute it separately for the customer and firm. At the moment, the joint measure works but if we break down the numerator into a customer only and a firm only, we can shed light on

[1] Vanguard states in its prospectus that it will use derivatives when "favorably priced," and it presumably utilizes "smart" trading techniques as well." Such lends itself to derivatives (sounds like some type of swap contract: receive stock, pay P_t minus 0.15%). Derivatives markets are likely affected?!

where does the imbalance come from:

$$OI_t^{i,j} = \frac{OB^{i,j} - OS^{i,j}}{OB^{i,firm} + OB^{i,customer}} \qquad (1)$$

where $OI^{c,j}$ is the option i, where i can be the call or put, order imbalance associated with player j, which can either be a firm or a customer. OB and OS stand for the open buy and open sell, respectively.

10. Present the exclusion results in the what about section. We do not emphasize this set of results because the sample size is potentially problematic and exclusions may be anticipated (GET THE EVIDENCE! HiWi ready (Arjan Sohrab, arjan.sohrab@stud.uni-hannover.de)).

    * Some documents to look at that indicate there might be predictability:
    https://insight.factset.com/through-the-looking-glass-predicting-sp-50
    https://www.wsj.com/articles/tesla-to-replace-real-estate-stock-in-s-p-
    https://www.sciencedirect.com/science/article/abs/pii/S1062976909001318

    * Furthermore, the timing of voluntary deletions is also more predictable, because much will happen in the more or less regular quarterly rebalancing dates (60% of the exclusions in our sample are in March, June, September, or December; although it becomes clear that not all are on the month-ends; 26% in December, 15% in June; inclusions only 46% in these months). On the other hand, for inclusions the timing is much less predictable since most are triggered by a forced exclusion event. Not sure, though, whether we want to discuss this much.

11. Include the time trend analysis in the paper:

    * Strongest effect in the stock market in the first couple of years

    * Pretty clear downward trend
    * For calls no clear downward trend (but also strongest the first 5 years or so)
    * Only 2012, 2014, and 2019 no significant raw effect; placebo adjusted 1996, 2002, 2004, 2012, 2014, 2019, 2020 missing; risk-adjusted (not placebo, Model 2): only 2014 and 2019 missing
    * Gamma part negative trend (mirroring the movement in the underlying); Vega more noisy, trend seems to be there but not as clear [To check this, we look at $Results_hybrid_inclusion$ particularly the results by 5-year period. There we should think about why the declining trend. Is it due to declining OIB, is it due to more dealers in the market? Think about htis.]

1. Chardin to email OptionMetrics to understand how they compute delta
2. Check the Garleanu paper amd see how it could inform our hybrid analysis:
    - Inspired by the work of Garleanu et al. (2008), we simply do a panel estimation of the things of interest on the demand. One suggestion is to compute a measure of option expensiveness. This can be done by following the authors in computing the difference between the ATM excess implied volatility and the GARCH (1,1) forecast. [we agree to put it on the backburner as a fall-back mechanism.]
    - We like the interaction of demand with the option volume as in Table 5.
    - It might be interesting to try and explain our variable of interest with the TED, intermediary capital ratio, the VIX (level), LIBOR–OIS, Order imbalance and the market return. Fabian makes a good point that it is a good idea to keep

the list of the variables broad. Let's do this to better understand what is happening and then we can consider whether we want to fine-tune things or not.

3. Do more research to understand the difference between customers and firms.

Chardin to go through the results of V21. There seems to be a story whereby the firm and customers react at different levels.

For the raw option price, use the **plain with denominator results**: these are DOI weighted.

For liquidity discussions (in v21, these are 1-sided for the OIB): let's focus on $Results_inclusion_aroundA$ or either inclusion adjusted. Call open interest: First set of results are just the raw data and second is abnormal liquidity and placebo adjustment. The way to read the data is to talk about the average over windows: AD, and then AD to ED (both inclusive).

Be careful the model for abn OI is not necessarily accurate. We use the Augustin et al. (2019) model but it is for volume rather than open interest.

Volume open interest:

A potentially neat story from Fabian:

1. The speculator anticipates the demand from the index tracker in the future and agrees to sell him the underlying at a small rebate around the ED. To capitalise, the speculator sets up the option portfolio today.

2. SO the bank is net short the synthetic stock and therefore has a need to buy the stock in short run to hedge, hence she ends up pushing the spot price higher and carries the other risk, gamma and vega.

3. Index tracker buys from the speculator at a small discount from the spot.

Another idea is to look at stocks that move from the midcap to the SP500. The idea is that there is less room for speculation because you know that the demand from index trackers is going to be much smaller and therefore the effect on delta-hedged options will be smaller.

Meeting of January 2022

During that meeting, we did the following:

- We looked at the new results 22 01 18 file. Generally the results are qualitatively consistent with Garleanu et al. (2008). The only question mark relates to the inclusion of the Call OIB. It is significant in the raw regression but not when we do placebo adjustments. A possible way out is to:
  - Combine the put and call OIB: Theoretically, the market maker does not make a distinction between the two.
  - Include the OIB of the put as additional regressor
  - Use the total OIB as a measure and see how far we go with this
- We could present the explanation of the demand based option pricing as the main and have a different section where we talk about other explanations and discuss why we think they may not work.

Feedback from SGF: The paper is well-written and well-executed, no problems here. I am not sure about the ultimate contribution. Why especially delta-hedged call option returns should be interesting? Why not some specific moments of a stock return? I do not see much motivation except for the ability of the authors to carry out such an analysis.

Chardin to build on the paper: Informed Trading around Stock Split Announcements: Evidence from the Option Market to see how to frame the discussion based on O/S and the related plots.

For the regression results, Chardin to take a look at the new results 22 02 02 matfile. It is important to stress out that the results based on CALL OIB adj seem to work really well. In particular, this is the placebo adjusted OIB. Chardin to also think a bit more about why the total OIB takes negative values. This is the delta-weighted OIB. The right set of results to look at, for the time being, is results hybrid inclusion 31, 2 row 8!

$\Rightarrow$ We agreed to do a global optimization. It is likely that the earlier results hold for most of specifications of adjusted model. What we can do is start from the hybrid regression results and work backwards.

Think about whether we need all the columns for the basic tables in terms of AD to ED+X

For our plots of liquidity, we want to build on the work of Gharghori et al. (2017).

Check how our decomposition relates to the work of Carr and Wu (2020)

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1. Liquidity Effects: The discussion revolves around the matfile ResultsV22volume in Levels

   - The volume in calls spikes clearly on the graph. Interestingly, most of the volume occurs at the AD date. This is quite different from the stock volume which spikes more on the ED date. Quite interesting indeed.
   - I wonder if we could get the positions aggregated across put and calls too: volume and open interest.
   - It is clear that the volume spikes to up 3,000 contracts in the call, suggesting an effect! Open interest increases by about 50% too and remains at high levels until at least the ED
   - For puts, we see a spike in volume and this seems to be more modest than what we observed in calls. Furthermore, we see a quick mean reversion. Generally, the volume and OI look weird! I wonder if we should present the aggregate and then show the call to hammer home the message that it is this segment that drives the effect. Please note: v21 is log (level) and the volumeinlevel is proper level.
   - Regarding the computation and related reference to the call/stock metric? This is the stock equivalent, taking into account the number of shares and adjustments such as stock splits etc. . . .

2. Stock effect: Results inclusion adjusted (2,5)

   Unadjusted: It seems the effect is significant at AD (3.36%), ED (4.46%) and at ED+63 (3.22%)

Adjusted: It seems the effect is significant at AD (3.13%), ED (3.81%) and becomes insignificant at ED+63 (1.49%)

3. Options

   Unadjusted Raw Call : It seems the effect is significant at AD (4.83%), ED (2.21%) and at ED+63 (8.4825e-4)

   Unadjusted delta-hedged Call: It seems the effect is significant at AD (0.96%), ED (1.05%) and at ED+63 (2.45%)

   ⇒ Unhedgeable risk account for a sizeable chunk of the announcement effects. Weird result at ED+63 though (2.45%). It seems this weird result disappears with the placebo adjustment! Placebo adjusted Raw Call: It seems the effect is significant at AD (4.60%), ED (1.95%) and becomes insignificant at ED+63 (2.5637e-4)

   Placebo adjusted Delta-hedged Call: It seems the effect is significant at AD (0.92%), ED (0.91%) and becomes insignificant at ED+63 (8.1629e-4)

   ⇒ Clearly, the placebo adjustment makes a huge difference at the long horizon!

   Unadjusted Raw put: The effect is significant at AD (-2.26%), ED (-0.93%) and at ED+63 (-4.3385e-4). With the delta-hedging, we find significant effect at AD (0.59%), ED (0.79%), and insignificant t ED+63 (0.5%)

   Placebo adjusted delta-hedged put: The effect is significant at AD (0.60%), ED (0.71%) and insignificant at ED+63 (-0.0012e-4)

   We note that using the DOI, VOLUME, EW yield similar economic conclusions!

4. Where is the effect more dominant?

   - It seems short-term options of up to 60 days have a stronger effect

- For calls, the effect is stronger for options that are Out-of-the-money (let's chck that the **S for the moneyess is from AD-1 not AD**) then ATM then ITM
- For puts, the effect is stronger for moneyness 0.8 to 0.95. First, I thought that it makes sense that the investors sells these options. Then I became sceptical. If you want to be synthetically long the stock, would you not focus on the same moneyness as the call?

One potential explanation is that out-of-money options might have lower margin requirements than in-the-money options. **Think about it further and get back to Fabian**

5. The effect seems robust to delta.
    - We use the adjusted delta (I guess this is the one of Carol Alexander)?
    - I wonder if we can do the derivative of the delta-hedged option return with respect to delta to study the impact it may have? Based on the results, I still believe that it does not materially affect our main results.
6. The effect seems robust to the choice of execution price. In particular, the 75%/25% mix seems to yield similar findings.
7. We can repackage the gamma and vega part as associated with jump risk and stochastic vol and tightly connect to Garleanu and Pedersen.
8. The focus could be on finding the right spec and dealing with the news story search for RA.
    - Correlation matrix: TED VIX Call OIBadj

- The total OIB variable needs to be clarified. Is it the sum of C OIB and P OIB? Or is it the sum of numerators divided by the sum of denominators? This matters for the interpretation of negative sign. **To redo: Chardin remembers that the total OIB is based on the OOI measure (see Fabian's email of Sept 2021)**
- If anything, I would focus on Placebo adjusted and row 8.

To present the results of the panel regression, focus on Results hybrid inclusion. In particular, look at the inclusion results (2,2). There you can present the results of univariate regressions as well as those of the multivariate model in column 16. Following this, we can present the results of the placebo adjusted findings (3,3) where we only report column 16. Next is the the Placebo adjusted Model 3 results where we only show column 16! Fabian makes a good point that column 16 contains all the variables that we are mostly interested in. Price relates to the magnitude of the stock price. Penny stocks would likely attract more noise traders.

Clarification: the CHZT comes from the Cao et al model! When looking at the new results 22 02 02, Raw is the delta-hedged option return (with no placebo adjustment and no risk-factor correction).

Look at v23. It contains the volume for different moneyness and maturity buckets.

So we look at the regression results in Results hybryid inclusion 31,2. Column 15 is for the full sample whereas Column 17 is only for the ISE period.

- We can see that the CALL OIB ADJ and SP midcap are significant
- A good question to ask is whether the difference wrt column 15 is due to sample change or the fact that CALL OIB adj is an endogeneous variable? FH to look into this.[FH drew attention to this endogeneous vs exogeneous variables.]

Chardin to look at spec, in particular incl or excl to see the list of affected firms. Use this to think of framework for research assistant. Fabian has also added it in the SPX Constituents CRSP mat file.

We agreed to look at windows Ad-10 to AD-1, ad-1 to AD, AD-1 to ED and then AD-1 to ED+63

For the plots, we present volume, and abnormal volume for the days between AD-10 (or 9) to ED+63 aand we have nothing in-between AD and ED.

The risk adjustment is based on the CHTZ factor model.

We will show the liquidity plot for put/call combined. Then based on maturity and moneyness separately! We only show total and then call volume. The gap being driven by put!

We are doing a pooled OLS regression rather than a full-blown panel. In the panel setting, it seems that some of the results disappear. This is worth checking further to better understand the implications.

Discuss the free-float adjustment results and see if we can spin it or not!?

For the slides, I have removed the open interest plot! It does not make our point I think

For the delta-hedged options, should we change the denominator

Clarify exactly what is in the risk factor model of CHTZ. **The CHTZ factor model includes the the market factor, the idiosyncratic vol factor, and the illiquidity factor. The HVX model has: market, size, ivol and VRP.**

Feedback from St Andrews:

- Can we control for skewness and kurtosis **In an earlier version, we also include the volatility and jump factors of Cremers et al. (2015). Jumps matter for skewness and kurtosis**

- Should the speculator not buy the call and delta-hedge at the same time? **Typically, the literature on news-driven trading in the option market focuses on directional view and the search for leverage. This is consistent say with the Augustin et al. (2019) and also the various news articles from Matt Levine. perhaps take a look at the 10 laws of insider trading articles**

- If the market maker is increasing the price, does that mean she is losing money relative to her last sale?

- One suggestion is to see if we can have the data on individual traders from Wikifolio or robinhood? This could shed a revealing light on who actually trades and when.

- Ioannis points out that There is also a small literature on earnings pre-earnings announcement drift: `https://seekingalpha.com/article/4038768-pre-earnings-annoucement-s` The implication is we should also discard recomposition announcements that occur during a pre-earnings announcement window.

- If our story is correct, should we not see a correction in the price as the option becomes overpriced? I argue that this is precisely why we see the reversal at ED+63! The pressure is temporary. **In the paper, we should admit that once the pressure disappears, the price comes back down, consistent with what we observe on ED+63. We need not make a big deal of this in the paper but it's something nice to explain in a sentence or not.**

- Ruslan wonders if we should not just link our results to the vol risk premium literature. On average, you lose on the delta-hedged options. But for this unexpected event (since it is difficult to predict this event), the insurance contract pays off! He links it to the work of Gao et al. (2018). This is precisely what we pay insurance for. Intuitively, this is correct. However, it does not say why the stock becomes more volatile thus leading to the insurance payoff. Furthermore, this approach cannot explain the spike in volume. The middle ground is that before the AD-1, you have the natural hedgers trading and from there on, we have our speculators. They disappear shortly after ED? But it is tentative to me and I am not sure that having a conversation about a tale of two players helps strengthen our narrative.

- Does the sign of intermediary capital ratio makes sense? **This is Broker-dealer equity divided by broker dealer equity plus debt. When the ratio is high, it means funding is tight and therefore the adjustment needs to be stronger than when the intermediary capital ratio is low. So yes, it makes sense!**is Price 1 for low priced stocks? **No! Price is a continuous variable that captures the price of the spot and is standardized. Expensive stocks are less subject to call option demand (too expensive to trade) and therefore, the reaction of delta-hedged options is less.**

- Ozge Senay was wondering if the VIX should not be more important than the TED?

- You are proposing a very interesting idea in your paper, so keep pushing forward and I am sure you have every chance to publish it in a top journal. I have really enjoyed your presentation, especially the part with a mechanism - it is crystal clear. When you get the next paper draft complete, I would appreciate if you could please send it to me.

- Discuss in a footnote (in the data section) that the exclusion sample is small and that is why we do not focus mostly on this.

For the paper we keep the alternative risk factor models for robustness checks and not in th main body of the paper.

We stick to the exact periods as in the St Andrews slides

For the volume, present only the plot and not the table.

Compare also the results to those of Dash and Liu (2008)

To be actioned Feedback from Lei

- Move the discussion of the short-term options, out-of-money options to the section where we discuss the demand based story. May be we can even show the order imbalance...

- For the plots on volume around the event dates, think of doing a similar plot for the placebo.

- Build on the paper that he recommended. Chardin to update the paper with his notes and send a copy to Fabian.

- Include the footnote relative to the S&P index committee member `https://www.justice.gov/usao-edny/pr/queens-man-charged-insider-trading-scheme`. Spin it to show that people are actually trading on options side. Chardin to dig deeper to check if we can get an insight into what positions he took...

- One idea coming from the paper by Fleckenstein and Longstaff (2020) is to look at events where the announcement day is in one quarter and the effective date in another quarter. In this case, the incentive for the market maker to increase this is even bigger.

Check the paper by Jun Pan on uncertainty resolution

Could it be informed trading by firms' exec? Check that S&P does not communicate with firms. Should the volume not be permanently higher?

One idea coming from the paper by is to look at events where the announcement day is in one quarter and the effective date in another quarter. In this case, the incentive for the market maker to increase this is even bigger.

A large literature studies the response of volatility instruments to informative events such as earnings announcements (Dubinsky et al., 2018; Gao et al., 2018). While these papers enable us to better understand the response of volatility traders to events that convey new information about the fundamentals of firms, it is quite surprising that we know very little about the impact of non-fundamental news on volatility assets.

This paper analyzes the impact of S&P 500 index recomposition news for volatility traders. These index recompositions constitute major non-fundamental news events for companies.[2] We seek to answer the following questions: do volatility traders respond to index recomposition news? If yes, what is the sign and magnitude of the announcement effect? Is the announcement response permanent or transitory? Are existing explanations of the index effect consistent with the new empirical findings?

Answering these questions is important because, while existing theoretical models agree on the impact of index recomposition news on stock prices, they yield conflicting predictions regarding the impact of these news on volatility. For instance, Cuoco and Kaniel (2011) develop a model to study the impact of delegated portfolio management on asset prices. Under the assumption that portfolio managers are rewarded based on asymmetric performance fees, the authors show that stocks added to the benchmark index witness a decrease in the conditional volatility of their stock returns. In contrast, the institutional benchmarking model of Basak and Pavlova (2013) predicts an increase in the conditional volatility of the returns of stocks added to the benchmark index.

We use a large sample of S&P 500 inclusion and exclusion announcements between 1996 and 2015 to examine the impact of index recomposition news on (i) stock prices and (ii) delta-hedged call option positions. Analyzing the short-term event window, which

[2]We view index recomposition events as non-fundamental news events in the sense that, unlike earnings announcements and mergers and acquisitions, for instance, index recompositions do not convey material new information about the fundamentals of the included and excluded firms.

starts from the day of the announcement to the following trading day, we confirm that the short-term inclusion (exclusion) effects on stock prices are positive (negative). We compare the short-term announcement responses of stocks added to the S&P 500 index, while they were previously (i) outside of the S&P 400 mid-cap index (outsider) and (ii) inside the S&P 400 mid-cap index (insider). On a placebo and risk-adjusted basis, the equity response is, with 2.19 percentage points, significantly stronger for the outsider stocks than for the insider stocks.

Turning to delta-hedged call options, the main focus of our paper, we document several novel findings. First, the delta-hedged call options of companies added to the S&P 500 index display a significantly positive response (1.10 %) over the short event window. This positive announcement response is significantly higher than the unconditional average daily delta-hedged call option return over our sample. We carry out a placebo and risk-adjustment to evaluate the robustness of the announcement effect. We find a placebo and risk-adjusted average return (1.04 %) that is very similar to the average raw short-term announcement effect (1.10 %). Comparing the responses of the delta-hedged call options of insider and outsider firms, we establish that the delta-hedged call options of outsider firms exhibit a short-term response that is, with 0.65 percentage points, significantly stronger than that of the insider stocks.

Second, we compare the responses of the delta-hedged call options to inclusion and exclusion news. Similar to the response of delta-hedged call options to inclusion news, we find a significantly positive, though smaller (0.46 %), placebo and risk-adjusted short-term response to exclusion news. Analyzing the long-horizon event window that spans the period from the day of the announcement to 126 trading days after the effective date, we find a significant placebo and risk-adjusted long-term response to inclusion news (2.87 %, p-value=0.0 %) and an insignificant long-term effect for exclusion news (−0.34 %,

p-value=72.4 %). We thus conclude that the inclusion effect is permanent while the exclusion effect is transitory.

We perform several tests to evaluate the robustness of our results. To begin with, we document similar results for delta-hedged put options. Next, we show that the main findings hold for near at-the-money options and options of short maturity. Following Coval and Shumway (2001), we perturbate our Black and Scholes (1973) delta hedge ratio to analyze the impact of potential measurement errors in the hedge ratio and reach qualitatively similar conclusions. Finally, we show that our results are distinct from the earnings announcement effect of Gao et al. (2018).

To rationalize the joint announcement responses of the equity and delta-hedged call option prices, we separately consider explanations based on investor awareness (Merton, 1987), noise trading (Black, 1986; Ben-David et al., 2018), dispersion trading (Driessen et al., 2009), and benchmarking by institutional investors (Basak and Pavlova, 2013). While most of these theories have been proposed in the literature to explain the response of equity prices to index recomposition news, they might have implications for the joint response of equity and delta-hedged call option prices, which we explore in this paper. The investor awareness explanation does not predict an increase in the conditional volatility of stock returns of firms added to the index. All the remaining theories posit that the response of the conditional volatility of stock returns of included firms is positive while that of excluded firms is negative. In the data, we observe a positive response of the delta-hedged options of both included and excluded firms. Overall, we conclude that the aforementioned explanations are difficult to reconcile with our key findings.

Our work relates to the growing literature that analyzes changes in option-implied volatility in event studies. Kelly et al. (2016) analyze the response of the option-implied volatility to political news. Dubinsky et al. (2018) use option prices to study the uncertainty associated with earnings news. A common theme among these studies is that they focus on events that are expected to materially affect the fundamentals of a company. To the best of our knowledge, we are the first to document the impact of non-fundamental news on delta-hedged option returns.

Our research is linked to the literature that analyzes volatility changes around index recomposition news. Harris (1989) analyzes the impact of S&P 500 index inclusion and exclusion news on the realized volatility of stock returns. Ben-David et al. (2018) and Coles et al. (2020) exploit changes in the composition of equity indices to study the impact of index investing on various quantities, including the realized volatility of stock returns. Different from the aforementioned studies, we focus on the response of delta-hedged option portfolios to index recomposition news. This difference is important because delta-hedged options are forward looking and informative about the market's pricing of the expected future volatility. To the best of our knowledge, we are the first to jointly study the impact of the index recomposition news on the risk premia associated with the first two moments of the return distribution.

Dhillon and Johnson (1991) and Dash and Liu (2008) study the response of outright option positions to index recomposition news. When interpreting their empirical results, it is important to stress that the outright option position is sensitive to (i) the directional movement in the underlying and (ii) the volatility effects. Thus, the authors finding of a negative response of the outright put option on the included firm simply indicates that the directional movement in the underlying dominates the volatility effects. It does not shed light on the existence and importance of the volatility effects, the goal of our paper.

Finally, our paper adds to the large literature that analyzes the impact of index recomposition events on asset prices. Harris and Gurel (1986), Shleifer (1986), Lynch and Mendenhall (1997), Chen et al. (2004), and Chang et al. (2014) are some important studies in the literature. Generally, these studies document a significantly positive (negative) inclusion (exclusion) effect on stock returns. We update and confirm the findings of this stream of the literature. Our study goes one step further by providing the first analysis of the announcement impact on the pricing of volatility which we study through the lenses of delta-hedged options. By doing so, our paper raises the bar for explanations of the index effect since any satisfactory explanation should jointly explain the responses of equity and delta-hedged option prices.

The remainder of this paper is organized as follows. Section II presents the data and methodology. Section III summarizes the results of our analysis of the impact of index recomposition events on the equity and delta-hedged option returns. Section IV provides various robustness checks. Section V presents and tests several economic mechanisms to jointly explain the responses of equity and delta-hedged options. Finally, Section VI 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).[3] Standard and Poors (S&P) has a detailed set of eligibility criteria related to the domicile, exchange listing, organizational structure, and share type of

[3]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.

securities added to the S&P 500 index.[4] Accordingly, we only include stocks with CRSP share codes of 10, 11, 12, 18, or 48 in our analysis.

Option Data We match the stock data with the option dataset retrieved from OptionMetrics. The OptionMetrics dataset spans the period starting in January 1996 and ending in December 2015.[5] It includes the daily bid and ask option prices, the option trading volume, the open interest, and the Black and Scholes (1973) option sensitivities.[6] It is worth pointing out that, as a result of the matching of the equity and option datasets, our effective sample period starts in January 1996 and ends in December 2015.

We process the option dataset as follows. First, we discard options with time-to-maturity (i) smaller than 8 calendar days or (ii) greater than 120 calendar days since they are likely illiquid and noisy (Bollerslev et al., 2015).[7] Second, we only retain options with (i) positive bid and ask prices, (ii) positive volume and (iii) a mid-quote price that is at least equal to $0.125 (Cao and Han, 2013). Third, we only keep options with a moneyness range, defined as the ratio of the strike price over the spot price, between 0.80 and 1.20. By taking this step, we ensure that we are analyzing option contracts that are likely liquid.[8] Fourth, 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 security 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.

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

[5] 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 2015, which is the latest observation available to us at the time we started the research project.

[6] Please double check that these deltas are not the Cox, Ross and Rubinstein deltas, which are adjusted for early exercise etc.

[7] As a robustness check, we repeat our analysis while focusing on options of maturity up to 60 days only (see Section IV.B). The results are qualitatively similar.

[8] As an additional analysis, we focus on options with moneyness between 0.90 and 1.10. The economic conclusions are qualitatively similar (see Section IV.B).

$C_{j,t}$ and $P_{j,t}$ denote the time-t call and put option prices of strike price K written on the stock j, respectively.[9] In order to avoid the bid-ask bounce from daily closing option prices, we use the mid-quote as representative of the option price (Gao et al., 2018).

Index Recomposition Events The S&P 500 index has a fixed number of constituents (500) that are selected at the discretion of the index committee.[10] The committee only considers firms that satisfy some inclusion criteria such as a minimum market capitalization, currently of $8.2 billion, 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 Standard & Poors (S&P) press releases on PR

[9] 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.

[10] Although the members of the committee are full-time employees working for S&P Dow Jones Indices, their identities are kept anonymous. 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 address: https://us.spindices.com/documents/methodologies/methodology-sp-us-indices.pdf. It is worth pointing out that the criteria relate to the inclusion of stocks. They are not criteria 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 by Li et al. (2021).

[12] The index committee's decision to include a firm in the S&P 500 index is 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. The case of Tesla illustrates this point. In July 2020, the company reported its fourth consecutive quarter of profitability, raising expectations that it will be included in the S&P 500 index in September 2020. Even though the company met all the requirements, it was not added to the S&P 500 index in September 2020. In November 2020, S&P announced that Tesla will be added to the index in December 2020.

[13] A growing number of studies analyze the recomposition of the Russell 2000 index using a regression discontinuity design. Cao et al. (2019) is an example along these lines. We do not analyze that index because doing so would restrict our focus to fairly small firms, for which the option contracts are likely not liquid enough to carry out a robust analysis.

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. It is worth emphasizing that 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 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 the goal of our paper is to study the impact of index recomposition events on stock and delta-hedged option returns. Overall, our final sample consists of 393 inclusion and 93 exclusion events.[14] Figure A1 of the Online Appendix shows the number of index inclusions and exclusions over time. As can be seen, these events occur quite frequently each year. Indeed, our untabulated analysis reveals that, on average, there are 18 (76) days between two consecutive inclusion (exclusion) events.

B Methodology

Overview S&P publicly announces the changes to the index composition at 05:15 PM Eastern Time. Since the press release occurs after the regular trading hours, the impact of the index recomposition announcements can only be seen on the next trading day. Similar to Patel and Welch (2017), we refer to that day as the announcement date (AD). The public announcement by S&P also specifies the date when the index recomposition

[14]Intuitively, one would expect the samples of inclusion and exclusion events to be of similar size. Yet, our results reveal that 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 bankruptcy, 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 difference between the sample sizes of included and excluded firms is also apparent in existing studies. For instance, Chen et al. (2004) study 760 additions and 235 deletions for the period beginning from July 1962 and ending in December 2000. Barberis et al. (2005) study 455 inclusions and 76 deletion events between September 22, 1976 and December 31, 2000.

takes effect. We call this date the effective date (ED). On average, there are 6 trading days between the AD and ED during our sample period.[15] Figure 1 illustrates our timing convention. Throughout the paper, we use the expression short event window to denote the window starting at $AD-1$ and ending at AD. We also analyze the event window beginning at $AD-1$ and ending 126 trading days after the effective date, i.e., $ED+126$. Similar to Patel and Welch (2017), we refer to this window as the long-term window.[16]

Delta-hedged Option Returns In order to carry out our analysis, we need to compute the delta-hedged option returns.[17] For each optionable stock and trading day, we create a delta-hedged position in each option. We then calculate the daily profit and loss of the corresponding position (Bakshi and Kapadia, 2003):

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

[15]Generally, the announcement and effective days are well spread across the week. For inclusion events in our sample, the minimum number of days between the AD and ED is 1 and the maximum is 71 trading days. The standard deviation amounts to 6 trading days. For exclusions, the minimum is 2 and the maximum is 18 trading days. The standard deviation amounts to 2 trading days.

[16]If a trader is able to accurately predict the decision of the S&P index committee, our analysis of the short and long event windows is informative about the gross profitability of the event-driven trading strategy that seeks to exploit the index recomposition events. Since it is difficult to accurately predict the decision of the index committee (Li et al., 2021), this strategy may not be easy to implement. Therefore, we also consider the event window starting at AD, i.e. after the release of the information, and ending at $ED+126$. Generally, we find that it yields conclusions that are similar to those of the long event window.

[17]One may be tempted to study the dynamics of the variance swap rate 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, such analysis is artificial in that it assumes the existence of options of a fixed time-to-maturity every day and does not take into account the decreasing time-to-maturity of option contracts. Third, the market for variance swaps on single names has dried up since the crisis of 2008 (Hollstein and Wese Simen, 2020). In contrast to the variance swap approach, our focus on delta-hedged options is consistent with the market practice of trading volatility risk through delta-hedged options. As such, our strategy can be easily implemented in the market.

where $\Pi_{j,t}$ is the profit and loss, at time t, of the delta-hedged option written on security j. For our main analyses, we focus on call options.[18] $O_{j,t}$ is the price at time t of the option contract written on security j. $\delta_{j,t-1}$ is the Black and Scholes (1973) delta of the option at time $t-1$.[19] $r_{f,t-1}$ is the 1-day interest rate, expressed on a per day basis, which we base on the 1-month Treasury Bill from Kenneth French's data library.

The profit and loss computed using Equation (2) is not well-suited for our empirical analysis because the option price is homogeneous of degree one in the underlying price. Consequently, the profit and loss amounts are not comparable across stocks that have different underlying prices, making it difficult to aggregate the profit and loss amounts across firms. To address this issue, we follow Cao and Han (2013) and compute the return associated with each delta-hedged option position as:[20]

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

$R_{Option,j,t}$ is the return at time t on the delta-hedged option written on security j.[21]

For each trading day and firm in our sample, we use Equation (3) to calculate the daily delta-hedged option returns of all options.[22] Next, we aggregate the returns on all

[18] As a robustness check, we repeat our analysis using put instead of call options and obtain qualitatively similar results. See Section IV.A for further details.

[19] One concern may be that the Black and Scholes (1973) delta hedge ratio is not accurate. Section IV.D explores this possibility and shows that the results are robust to measurements errors in the hedge ratio.

[20] There are alternative ways to normalize the profit and loss of the delta-hedged option position. For instance, Huang et al. (2019) use the underlying price in the denominator. We also consider this alternative choice and reach qualitatively similar conclusions. These findings are not tabulated for brevity.

[21] This statement needs to be qualified. 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 formula in Equation (2) already takes 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 delta-hedged option return (Cao and Han, 2013).

[22] By rebalancing the delta-hedged option portfolio at the daily frequency, we ensure that the effect we document in this paper does not merely reflect the directional movement in the underlying stock. Our interest in the daily rebalancing scheme is also consistent with the literature, e.g. Bakshi and Kapadia (2003) and Cao and Han (2013).

the delta-hedged options 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).[23] By using this weighting scheme, we aim to assuage the concern that our results may be driven by option contracts that are of limited interest to market participants.[24] We repeat these steps every day, thus obtaining the time series of daily delta-hedged option returns aggregated at the company level. In order to obtain long-horizon delta-hedged option returns, we simply compound the daily return series.

Risk-Adjusted Delta-hedged Option Returns We compute the risk-adjusted delta-hedged option returns, defined as the difference between the delta-hedged option returns and the expected delta-hedged option returns. Although intuitive, the computation of the risk-adjusted return is challenging since the expected delta-hedged return is not directly observable. Unfortunately, the existing literature offers little guidance regarding the model for the expected delta-hedged option returns. In light of this, we cast our net wide and use 9 variables drawn from the literature on the cross-section of equity returns and that of option returns to construct our benchmark model. To be more specific, our benchmark model consists of the 6-factor model of Fama and French (2018), which we augment with the 1-day change in the S&P 500 volatility index (VIX), and the aggregate volatility and jump factors of Cremers et al. (2015).[25] The data related to the Fama and French (2018)

[23] It is worth emphasizing that the option positions that underpin the aggregation at the firm level may differ in terms of strike prices and/or maturity dates.

[24] Section IV.C 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.

[25] We assess the robustness of our main results to the specification of the benchmark model. In one robustness check, we replace our benchmark model with that of Goyal and Saretto (2009) and obtain qualitatively similar results. We also analyze the sensitivity of our results to the choice of equity factors in the benchmark model. To be specific, we separately replace the Fama and French (2018) factors with (i) the 4-factor model of Carhart (1997), (ii) the Fama and French (2015) 5-factor model, (iii) the factor model of Hou et al. (2015), and (iv) the Stambaugh and Yuan (2016) factors. Overall, the actual choice of the equity factor model makes little empirical difference to our key findings. We do not tabulate these results for brevity.

factors come from Kenneth French's website. We obtain the time series of the VIX from Bloomberg. Finally, we compute the aggregate volatility and jump factors exactly as in Cremers et al. (2015).

Equipped with this empirical model, we can now compute the risk-adjusted delta-hedged option returns associated with security j as:

$$AR_{Option,j,t} = R_{Option,j,t} - \sum_{k=1}^{9} \hat{\beta}_{j,k} f_{k,t} \quad (4)$$

where $AR_{Option,j,t}$ is the risk-adjusted return at time t of the delta-hedged option written on firm j. $\hat{\beta}_{j,k}$ is the estimated sensitivity of the delta-hedged return on the options written on firm j with respect to the risk factor k. $f_{k,t}$ is the value at time t of the risk factor k. We estimate the factor sensitivities by pooling together the return data from (i) 202 to 11 days before the announcement date and (ii) from 127 trading days after the effective date to 318 trading days after the effective date.[26]

Control Group Patel and Welch (2017) documented that a group of placebo firms exhibits an economically large positive risk-adjusted return of more than 1.9 % over the long event window. Thus, 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. Given our interest in ascertaining whether the index effect is permanent or transitory, it is prudent to carry out a placebo-adjustment.

Our approach is similar to that of Patel and Welch (2017). For each stock entering or leaving the S&P 500 index, we randomly select another stock that could have been

[26] Hollstein et al. (2019) show that an estimation window of roughly one year and a half of daily observations performs well for the beta estimation. As a robustness check, we repeat our main analyses based on a shorter estimation window of the parameters. Specifically, we estimate the factor sensitivities based on return data from (i) 111 days to 11 days before the announcement date and (ii) from 127 trading days to 227 trading after the effective day. The related results are slightly stronger than our baseline findings.

but was not selected by S&P. For each inclusion (exclusion), we draw a control firm from the list of companies (i) that are outside (inside) 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.[27] We then compute the raw and risk-adjusted delta-hedged option return associated with the drawn firm. We repeat this experiment 1,000 times, thus obtaining the placebo distribution of the raw and risk-adjusted delta-hedged option 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-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 stock excess returns, we find an overall daily average of 0.082 %. For constituent stocks, the average return (0.036 %) is markedly lower than that of non-constituent stocks (0.114 %). Turning to the delta-hedged option returns, we observe negative average values for both constituent and non-constituent stocks. This finding is in line with the work of Bakshi and Kapadia (2003) and Cao and Han (2013) to name but a few. The cross-sectional distribution of the option returns displays positive skewness

[27] One may think of an alternative matching algorithm. Such approach could involve making a list of variables that are thought to accurately predict the decision of S&P. We refrain from this approach because the selection of the index committee is discretionary (see Section II.A). Thus, this approach would lead to noisy matches. See as well the discussion in Patel and Welch (2017).

and high kurtosis, indicating that it is non-normal.

As is standard in the literature, we view long positions in delta-hedged options as instruments to trade volatility. In order to better understand the link between delta-hedged option returns and volatility trading, it is useful to analyze a simple Taylor approximation of the daily profit and loss of delta-hedged options:

$$\begin{aligned}\Pi_{j,t} &= \underbrace{\frac{1}{2}\Gamma_{j,t-1}S_{j,t-1}^2\left(\frac{S_{j,t}-S_{j,t-1}}{S_{j,t-1}}\right)^2+\nu_{j,t-1}(\sigma_{j,t}-\sigma_{j,t-1})+\theta_{j,t-1}\Delta t+\rho_{j,t-1}(r_{f,t}^a-r_{f,t-1}^a)+\epsilon_{j,t}}_{O_{j,t}-O_{j,t-1}-\delta_{j,t-1}[S_{j,t}-S_{j,t-1}]} \\ &\quad -r_{f,t-1}\left[O_{j,t-1}-\delta_{j,t-1}S_{j,t-1}\right] \qquad (5)\end{aligned}$$

where $\Gamma_{j,t-1}$ is the Black and Scholes (1973) gamma at time $t-1$, i.e., the second-order sensitivity of the option price written on firm j to the underlying price at time $t-1$. $\nu_{j,t-1}$ denotes the Black and Scholes (1973) vega at time $t-1$, defined as the sensitivity of the option price to changes in the implied volatility. $\theta_{j,t-1}$ is the sensitivity of the price of the option written on firm j to the change in time to maturity at time $t-1$. $\rho_{j,t-1}$ is the time $t-1$ sensitivity of the option price to the change in the riskless rate. $r_{f,t}^a$ and $r_{f,t-1}^a$ denote the annualized risk-free rate of the same maturity as the option at times t and $t-1$, respectively. The residual $\epsilon_{j,t}$ captures other terms, including the higher-order components.

Combining Equations (3) and (5), we can show that:

$$\begin{aligned}R_{Option,j,t} &= \frac{1}{2}\frac{\Gamma_{j,t-1}S_{j,t-1}^2}{|O_{j,t-1}-\delta_{j,t-1}S_{j,t-1}|}\left(\frac{S_{j,t}-S_{j,t-1}}{S_{j,t-1}}\right)^2+\frac{\nu_{j,t-1}}{|O_{j,t-1}-\delta_{j,t-1}S_{j,t-1}|}(\sigma_{j,t}-\sigma_{j,t-1}) \\ &+ \frac{\theta_{j,t-1}\Delta t+\rho_{j,t-1}(r_{f,t}^a-r_{f,t-1}^a)+\epsilon_{j,t}-r_{f,t-1}\left[O_{j,t-1}-\delta_{j,t-1}S_{j,t-1}\right]}{|O_{j,t-1}-\delta_{j,t-1}S_{j,t-1}|} \qquad (6)\end{aligned}$$

Equation (6) enables us to understand the drivers of the daily delta-hedged option returns.[28] The first term to the right-hand side of the equality sign highlights the impact of the realized variance of the underlying.[29] If the underlying moves by large amounts as is the case in the presence of jumps, then this channel will lead to a higher delta-hedged option return. The second term of the summation depends on the revision in the implied volatility. If the implied volatility increases, then we will observe a higher delta-hedged option return. The third component of the summation captures the time-decay, the interest rate contribution, and all other effects, respectively.

Several points are worth discussing. First, the formula shows that the response of delta-hedged options does not merely reflect the directional movement of the underlying. This is to be expected since we focus specifically on delta-hedged call options, rather than outright call options. Second, the delta-hedged call option positions benefit from option traders revising upwards their estimate of the implied volatility. In an untabulated analysis, we empirically find that the implied volatility channel accounts for 94.09 % (102.67 %) of the unconditional average delta-hedged option return of firms added to (excluded from) the S&P 500 index over our sample period.[30] Economically, this finding confirms that the delta-hedged options are mostly informative about the pricing of the expected volatility.

[28]It is important to emphasize that the decomposition is exact for the daily return. It does not naturally extend to the long-horizon returns. This problem arises because the long-horizon return is obtained by compounding daily returns.

[29]Our use of the expression "realized variance" is an 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.

[30]In order to calculate this statistic, we proceed as follows. For each firm, we compute the ratio of the value of the channel of interest (see Equation (6)) on a given day over the daily delta-hedged option return of the same day. Next, we average these results in the time-series dimension to obtain our estimate at the firm level. Finally, we compute the equal-weighted average of the estimates across firms.

III The Impact of S&P 500 Index Recompositions on...

This section presents our main empirical findings regarding the impact of S&P 500 index recomposition news on asset prices. We begin by analyzing the response of the individual stock prices. In so doing, we revisit and update the findings of the extant literature that mostly focuses on the response of equities to S&P 500 index recomposition news. We then study the response of delta-hedged options to index recomposition news, the main research goal of our paper. We average the raw and placebo-adjusted announcement responses across all stocks. The statistical inference for the average raw returns is based on the asymptotic distribution, while that of the placebo-adjusted findings is couched on the placebo distribution.[31] Throughout this paper, we use the 5 % significance level.

A Stock Prices

Inclusions Panel A of Table 2 documents the response of equity prices to the announcements of index inclusions. Starting with the raw average return, we observe a significantly positive effect of 3.96 % and 5.71 % over the short- and long-term windows, respectively.[32,33] Analyzing the placebo- and risk-adjusted returns, we find significantly positive average returns of 4.03 % and 4.96 % for the short- and long-term event windows, respectively. The short run positive announcement response is consistent with the existing

[31] By using the placebo distribution, we aim to deal with the non-normal features of the return distribution. As a further robustness check, we implement the winsorization scheme of Patel and Welch (2017). Specifically, we winsorize the (i) excess and (ii) risk-adjusted returns of each stock at $5\% \times \sqrt{T}$ and $-4.74\% \times \sqrt{T}$, where T denotes the length of the event window in trading days. The empirical results are qualitatively similar to our benchmark findings. We do not tabulate these findings for brevity.

[32] Interestingly, the short-term raw announcement return (3.96 %) is similar to the placebo-adjusted average response (3.99 %). This similarity indicates that, for the 1-day horizon, the control group exhibits very little drift. However, at the long-horizon, we notice a large difference between the two sets of estimates (5.71 % vs. 2.85 %), indicating that the control group displays a sizable drift over the long horizon (see also Patel and Welch (2017)).

[33] It is worth noting that the inclusion effect is smaller during our sample period compared to earlier studies. This finding is consistent with the recent observation of Patel and Welch (2017) who document a declining inclusion effect.

literature, e.g., Harris and Gurel (1986) and Shleifer (1986). Furthermore, the significant result obtained over the long event window echoes the finding of Chen et al. (2004) of a permanent inclusion effect for individual equities.

Exclusions Panel B of Table 2 reports the results associated with the exclusion events. Contrary to the inclusion events, the placebo- and risk-adjusted returns point to a short-term negative announcement response to exclusion events ($-3.82\,\%$). This finding is congruent with the existing literature, e.g., Patel and Welch (2017). We can see that the short-term response to the exclusion news is similar, in magnitude, to that of the inclusion news ($4.03\,\%$). Turning to the long event window, we do not find a significant placebo- and risk-adjusted average return. This observation leads us to the conclusion that the exclusion announcements have a transitory effect on stock prices.

Overall, our empirical findings are consistent with the research of Chen et al. (2004), who document an asymmetry between the long-term inclusion and exclusion effects on stocks.

B Delta-Hedged Option Prices

Inclusions We now turn our attention to the response of delta-hedged call option positions to the announcements of index inclusions. Panel A of Table 3 summarizes the results. We observe a positive and significant average response ($1.10\,\%$) over the short event window.[34,35] This result is interesting for a number of reasons. To begin with, the average short-term announcement return of the delta-hedged call options of companies added to the index is positive, whereas their unconditional average daily return is negative (−0.006 %).[36] Moreover, the inclusion effect observed over the short event window is at least an order of magnitude larger than the unconditional average. This finding further confirms that index inclusion news significantly moves the market price of the delta-hedged call option positions.

Turning to the placebo- and risk-adjusted excess returns, we find a positive and significant inclusion effect of 1.04 % and 2.87 % over the short and long event windows,

[34] 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 is an order of magnitude smaller than theirs. To understand the difference in the empirical results, it is important to note that the authors analyze the impact of index recomposition news on outright option positions, whereas we focus on delta-hedged option positions. Given their focus, they compute the option return as follows:

$$R_{Dash\&Liu,j,t} = \frac{O_{j,t} - O_{j,t-1}}{O_{j,t-1}} \tag{7}$$

Since their object of interest (see Equation (7)) is different from ours (see Equation (3)), the two sets of results are not directly comparable. To verify this, we compute option returns as in Dash and Liu (2008) and repeat our main analysis. Table A1 of the Online Appendix summarizes the findings. We find a short-term announcement effect of 48.34 %, which is an order of magnitude larger than the result based on delta-hedged option returns (1.10 %).

[35] One may wonder whether the strong equity price reaction around the news announcement date materially affects our understanding of the drivers of the delta-hedged option return. Specifically, if the underlying price jumps around the announcement time, then the contribution of the implied volatility channel to the delta-hedged option return might decline, while that of the realized variance channel might increase. To shed light on this, we implement the decomposition suggested by Equation (6). Our untabulated analysis reveals that, on average, the revision in the implied volatility channel still accounts for 88.21 % of the short-term announcement effect. The upshot of this analysis is that most of the delta-hedged option response arises from revisions in the implied volatility.

[36] 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.

respectively.[37,38] Economically, our results suggest that a good explanation of the inclusion effect needs to rationalize the positive announcement effects on (i) the underlying equity and (ii) the delta-hedged call option position. We shall return to this point in Section V. Furthermore, the positive response of delta-hedged options points to an increase in the implied volatility of stock returns. This finding is difficult to reconcile with the prediction of the model of Cuoco and Kaniel (2011) under asymmetric performance fees discussed in the introduction.

Exclusions Panel B of Table 3 focuses on the response of delta-hedged call options to the news of index exclusion. We observe a significantly positive response (0.44 %) over the short event window.[39] Our untabulated analysis suggests that the unconditional average delta-hedged call return of firms in our exclusion sample is −0.05 %. Keeping this in mind, it is clear that the short-term announcement response to the exclusion news is both economically and statistically significant.

It is also worth noting that the short-term announcement response of the delta-hedged call option is positive whereas that of the underlying asset is negative. Not sure we need this as it gives the impression we are developing a new explanationThis result may be explained by the leverage effect (Black, 1976), namely the empirical observation that

[37] As a further analysis, we consider another event window that starts from AD and ends at $ED+126$. We find a placebo- and risk-adjusted return of 1.82 %. This untabulated result is interesting because it suggests that part of the inclusion effect on delta-hedged call options might be exploitable in practice. We leave a thorough analysis of the formulation and implementation of such trading strategy to future research.

[38] Similar to our findings for the stock prices, we find little to distinguish between the average raw (1.10 %) and placebo-adjusted (1.08 %) responses over the short event window. This result may explain why the prior literature, e.g., Dash and Liu (2008), does not carry out any placebo adjustment when analyzing short event windows.

[39] Similar to the inclusion events, there is very little difference between the raw and placebo-adjusted mean returns over the short window, indicating that the delta-hedged call options written on firms belonging to the control group show little movement around the exclusion announcements. However, the results related to the long event window point to a negative wedge of −1.10 % between the two groups of firms.

equity returns become more volatile as the underlying price decreases.[40]

Comparing the results for the inclusion and exclusion effects, we can see that the placebo and risk-adjusted short-term response of delta-hedged call options associated with exclusion news (0.46 %) is less than half that of inclusion events (1.04 %). Turning to the long event window, we observe a significant inclusion effect (2.87 %) and an insignificant exclusion effect (−0.34 %). The finding of a transitory exclusion effect is in sharp contrast with the permanent inclusion effect. This conclusion extends that of Chen et al. (2004), who document a similar asymmetry for individual equities, to delta-hedged call option positions.

IV Are the Findings Robust to ...

In this section, we evaluate the robustness of our findings to the various methodological choices discussed in Section II. In particular, we repeat our analysis of the response of delta-hedged option prices using put options only. We then study the robustness of our results with respect to at-the-money options. Relatedly, we evaluate the sensitivity of the results to the maturity of the options. Additionally, we consider different methods to aggregate the option returns at the firm level. Next, we assess the potential impact of measurement errors in the hedge ratio. Finally, we analyze the possibility that our main results may be affected by the concurrent release of earnings news.

[40] It is worth highlighting that the leverage explanation of Black (1976) is just one potential mechanism. An alternative explanation is that higher expected volatility should be accompanied by high expected returns. As a result of the high expected returns, prices must fall, thus giving rise to the negative correlation between equity returns and expected volatility. For more details, we refer the interested reader to Ait-Sahalia et al. (2013) and the references therein.

A The Option Type?

Up to this point, our main analysis has focused on delta-hedged call options. To the extent that our results reflect volatility effects, our findings should also hold for delta-hedged put options.

Table 4 summarizes the response of delta-hedged put options to index recomposition news. Panel A of that table focuses on inclusion news. It documents a significant placebo- and risk-adjusted reaction of the delta-hedged put options of 0.62 % and 1.60 % for the short- and long-term event windows, respectively. These estimates are qualitatively similar, although slightly lower, to those of the call option contracts. It is worth mentioning that our finding of a significantly positive response of delta-hedged put option prices to inclusion news is not necessarily inconsistent with the significantly negative response of put option prices documented by Dhillon and Johnson (1991) and Dash and Liu (2008).[41] To understand why, it is useful to recall that the put option prices decrease with the underlying price and increase with volatility. Thus, their finding should be viewed as indicating that the underlying channel dominates the volatility effects. It does not necessarily imply that the volatility effects are non-existent. Turning to exclusion events, the placebo- and risk-adjusted average return (see Panel B of Table 4) points to a significant short-term reaction (0.48 %) that is not discernible over the long event window.

Taken as a whole, these results are qualitatively consistent with those based on delta-hedged call options. The inclusion effect is significantly positive and permanent, whereas the exclusion effect is smaller and transitory.

[41] As a robustness check, we use the same definition of returns as Dash and Liu (2008) (see Equation (7)) to compute the put option returns. Panel A of Table A2 of the Online Appendix documents a significantly negative response of −23.25 % and −67.32 % for the short- and long-term event windows, respectively. Our short-term result is qualitatively consistent with that of Dash and Liu (2008) who document a positive response (34.75 %) of the short put position.

B The Illiquidity of Options?

Our analysis involves options that cover a wide moneyness range. However, options that are near the at-the-money range are more liquid than other options (Carr and Wu, 2020). This observation motivates us to focus on call options that are near the at-the-money range, i.e., with moneyness range between 0.90 and 1.10. Panel A of Table 5 shows that the placebo- and risk-adjusted delta-hedged returns display a significantly positive inclusion effect at both the short (1.07 %) and long (2.81 %) horizons, respectively. Panel B of Table 5 confirms that the impact of exclusion news on delta-hedged option positions is transitory. Taken together, these results are aligned with our benchmark findings.

Up to this point, we have focused on options of time to maturity up to 120 days. One may be concerned that the prices of options of longer maturity are noisier than those of short-term options. It is thus interesting to repeat our analysis for short-term options, defined as options with time to maturity shorter than 60 days. Table 5 confirms that the inclusion effect is significantly positive and permanent, whereas the exclusion effect is weaker and transitory. This set of results is consistent with our benchmark results.

C 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. As previously discussed, the motivation for this weighting scheme is to give more prominence to options that attract more open interest. It is, however, interesting to analyze the extent to which the results are sensitive to the method of aggregation.

Accordingly, we repeat our main analysis after separately implementing (i) a volume-weighting scheme, which gives more prominence to options that attract more trading volume and (ii) an equal-weighting scheme, which treats all option contracts in the same manner. If the obtained results are very different from our benchmark findings, then we can infer that the weighting scheme significantly affects our main results.

Panel A of Table 5 documents an average placebo- and risk-adjusted inclusion effect based on the volume-weighting scheme equal to 1.21 % and 2.15 % over the short and long windows, respectively. Turning to the equal-weighting scheme, we obtain 1.42 % and 2.82 % over the short and long event windows, respectively. Overall, these numbers are comparable to the benchmark estimates of 1.04 % and 2.87 % over the short and long event windows (see Table 3), respectively. Turning to exclusion events, Panel B of Table 5 confirms that the results are qualitatively similar to our benchmark findings. We thus conclude that the method of aggregation does not materially influence our main findings.

D Measurement Errors in the Hedge Ratio?

Our empirical analysis requires the estimation of the hedge ratio to create the delta-hedged option positions. Unfortunately, the "true" hedge ratio is not directly observable but instead needs to be estimated using a specific option pricing model. Since different models can lead to different estimates, it is likely that the hedge ratio used for our main analysis is computed with errors arising from model misspecification. If the "true" hedge ratio differs from the Black and Scholes (1973) hedge ratio, our analysis will be affected by measurement errors.

There are several approaches to analyzing the sensitivity of the results to the estimation of the delta hedge ratio. One possibility is to formulate and estimate an empirical model for the delta. That is, we can assume that the delta of an option depends on several characteristics. We can then empirically estimate the sensitivity of delta to the various characteristics and use 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. A seemingly better alternative approach used in the literature, e.g. Coval and Shumway (2001) and Huang et al. (2019) consists in perturbating the Black and Scholes (1973) hedge ratio. More specifically, we assume that the "true" hedge ratio is equal to 90 % or 110 % of the Black and Scholes (1973) delta and repeat the analysis using these new hedge ratios.[42,43] Table 5 presents the results for the delta-hedged call options based on the new hedge ratios. Starting with inclusion events in Panel A, we can see that the announcement effect is still discernible over both the short and long event windows. Turning to the exclusion events, we observe that the index exclusion news has a transitory effect on the delta-hedged call option position (see Panel B of Table 5). Overall, these results are aligned with our main findings.

E 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 were the case, the effect we document around index recomposition news would be the same as that of Gao et al. (2018).

To shed light on this hypothesis, we remove from the treated and control groups all stocks for which either the earnings announcement date or the day after correspond to

[42] Huang et al. (2019) assume values of 95 % and 105 %. We use a wider range, 90 % to 110 %, in order to carry out a more conservative analysis.

[43] 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 these returns is non-linear. This is because the hedge ratio affects both the numerator and the denominator.

an index recomposition announcement day.[44] The last row of Panel A of Table 5 repeats our analysis of inclusion events. We observe a statistically significant placebo- and risk-adjusted delta-hedged call return of 1.03 % and 2.92 % over the short- and long-term event windows, respectively. These results are very similar to the significant benchmark estimates of 1.04 % and 2.87 % observed over the short and long windows, respectively.[45] We also repeat a similar analysis for the announcements of index exclusions. Panel B of Table 5 documents a significant response over the short event window (0.48 %) that is no longer discernible over the long event window. Taken together, these results are qualitatively similar to our benchmark findings. We thus conclude that the effect we document is distinct from the earnings announcement findings of Gao et al. (2018).

V Potential Explanations

We now assess the ability of several mechanisms to jointly explain the responses of the stock and delta-hedged option prices. In particular, we present and evaluate explanations based on (i) investor recognition, (ii) noise trading, (iii) dispersion trading, and (iv) benchmarking by institutional investors.

A Investor Recognition

Merton (1987) develops a theoretical model to study asset prices in an informationally incomplete market. In that model, the investor is only aware of a subset of the securities available in the economy. Because the investor includes a security in her portfolio only if she is aware of it, she holds an incompletely diversified portfolio. In equilibrium, the

[44] In the data, we find that there are 13 (5) inclusion (exclusion) events where the announcement day or the day after the announcement day corresponds to an earnings news date or the following day.

[45] We have also repeated the analysis for stocks. Table A3 of the Online Appendix presents placebo- and risk-adjusted results that are similar to those of Table 2.

stocks with low investor recognition offer high returns to compensate the stock holder for the limited risk-sharing. As the recognition increases, the equilibrium required rate of return of that stock falls and its price rises. Chen et al. (2004) argue that index inclusions increase the awareness of investors. The authors also point out that, to the extent that the investor does not become "unaware" of a stock following news of its exclusion from the index, exclusion announcements should not affect equity prices over the long event window.

Motivated by this argument, we analyze the impact of S&P 500 index recomposition news on firms with different levels of analyst coverage. Since the argument of Chen et al. (2004) is that inclusion to an index raises investor's awareness, we would expect the inclusion effect to be weaker for companies with higher analyst coverage before the announcement. This is because the high analyst coverage would have already raised the awareness of investors to the stock. We obtain data on the number of analysts covering each stock from the Institutional Brokers Estimate System (IBES) database. For the S&P 500 recomposition announcements, we sort the treated stocks into two categories below and above the median, namely high and low, based on the number of analysts covering them prior to the announcement date. We then compute and report the placebo- and risk-adjusted results for each of these two categories. Starting with Panel A of Table 6, which focuses on short-term inclusion events, we can see that there is no significant difference between the equity response of the two groups. Panel A of Table 7, which focuses on the long-term effect of inclusion news, documents that the response of stocks is significant (7.70 %, p-value=0.3 %) for companies that already had a high number of analysts. In contrast, we observe an insignificant (3.12%, p-value=15.2 %) effect for stocks that have low analyst coverage. This result is diametrically opposed to the prediction of an explanation based on investor recognition.

Overall, the cross-sectional test reveals that the response of equities is difficult to reconcile with an explanation based on investor recognition. Moreover, in the original model of Merton (1987), the increased awareness of investors towards a stock does not increase the volatility of its returns. Consequently, the model cannot shed light on the response of delta-hedged options to index recomposition news (see Panel A of Tables 3 and 4).

B Noise Trading

Index-related products, such as index futures and exchange traded funds, are highly liquid products. 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 product is linked to the constituent stocks by the absence of arbitrage, the high-frequency trading of noise traders in the index product essentially impounds non-fundamental volatility into the stock prices of index constituents. Although this noise trading argument does not speak to the issue of the directional response of equity prices to index recomposition news, it has some potential to explain our volatility results.[46] Consistent with this mechanism, Ben-David et al. (2018) find that an increase in ETF ownership is associated with more volatile

[46]It is important to point out that the noise trader that we consider here is primarily interested in trading the index product, rather than the underlying index constituents. Obviously, one can think of a framework where noise trading risk affects the price of individual equities. For instance, De Long et al. (1990) develop a theoretical model to study the impact of noise trader risk on individual asset prices. In the model, the arbitrageur is deterred from betting against the noise trader as she may be forced to close the arbitrage trade before the asset price converges to its fundamental price. We do not believe that noise trader risk can help explain our results. If the stock price reaction of included firms were the result of noise trading risk, we would expect an opposite effect for the stocks of excluded firms. This prediction is inconsistent with the transitory exclusion effect documented in the literature and our own empirical evidence (see Panel B of Table 2).

stock returns.[47] If option traders account for this increased volatility, we expect to see a positive and permanent placebo- and risk-adjusted response of the delta-hedged options of included firms. Moreover, this response should be stronger during periods of high noise trading activity. Turning to exclusions, the noise trading explanation counterfactually predicts a permanently negative response of the delta-hedged options of excluded firms (see Panel B of Tables 3 and 4). Additionally, the magnitude of the negative response should be high during periods of high noise trading activity.

The preceding discussion motivates two cross-sectional tests of the noise trading explanation that focus on the long event window. To understand our interest in the long event window, it is useful to recall that, in the case of index inclusions, the no-arbitrage link between the index product and the index constituents hinges on the stock being in the index, i.e., it holds only after the effective date. If one considers the short rather than the long event window, the transmission mechanism of the noise trader shock from the index product to the soon-to-be stock becomes somewhat tenuous.[48]

The first test builds on the Baker and Wurgler (2006) measure of investor sentiment. Assuming that noise traders are more active during periods of high sentiment, we expect the inclusion effect to be stronger for delta-hedged options during times of high sentiment compared to low sentiment. We orthogonalize the sentiment measure with respect to business cycle variables following Sibley et al. (2016). Next, we compute the average of the orthogonalized measure over the event window. We then sort all recomposition events into two groups, high and low, based on the size of the orthogonalized sentiment measure.

[47] 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.

[48] Nonetheless, we present the results linked to the short-term window in Table 6.

We repeat our analysis separately for each of these two groups. Panel A of Table 7 shows that there is no significant difference in the response of delta-hedged call options observed during periods of high and low investor sentiment. This finding is difficult to reconcile with an explanation based on the impact of noise trading in the index products. Turning to exclusion events, the spread between the high and low groups yields a result that has a sign opposite to that predicted by the noise trading explanation.

The second test is motivated by the work of Baltussen et al. (2019) who show that the rise of indexing has lowered the autocorrelation of the returns of index stocks. We turn this argument on its head. If a stock has witnessed a meaningful decline in its autocorrelation since joining the index, it likely is the result of noise trading in the index product that gets transmitted to the stock via arbitrage trading. In this case, we expect to see a stronger inclusion effect for the delta-hedged options linked to companies with a larger fall in the autocorrelation of their stock returns. We compute the multi-period autocorrelation (MAC) of order 5 as in Baltussen et al. (2019) for each treated stock:[49]

$$MAC(5) = r_t(4r_{t-1} + 3r_{t-2} + 2r_{t-3} + 1r_{t-4})/5\sigma^2 \tag{8}$$

where $MAC(5)$ is the multi-period autocorrelation of order 5. r_t, r_{t-1}, r_{t-2}, r_{t-3}, and r_{t-4} denote the stock return at times t, $t-1$, $t-2$, $t-3$, and $t-4$, respectively. σ^2 is the unconditional variance of the returns.

We estimate the change in the autocorrelation dynamics (ΔMAC) as the difference between (i) the MAC computed over the 126-trading-day period starting immediately after ED and (ii) the MAC related to the 126-trading-day period that ends on $AD - 1$. We sort all the inclusion event windows into two groups, namely high and low, based on

[49] As a robustness check, we use the simple $AR(1)$ autocorrelation estimate and obtain qualitatively similar results. These findings are not tabulated for brevity.

the median ΔMAC. We analyze the index effect for each of these two groups. Panel A of Table 7, which focuses on inclusions, shows a significantly positive effect (4.05 %, p-value=0.0 %) for the delta-hedged call options of companies in the low ΔMAC and a positive (1.60 %) but insignificant response for the group with the high ΔMAC. However, the difference between the two groups is not statistically significant. Turning to exclusion events, we do not detect any significant response for any of the two groups (Panel B of Table 7). Again, this finding is difficult to reconcile with the noise trading hypothesis.

C Dispersion Trading

Several studies document a sizable correlation risk premium in the S&P 500 index option market (Driessen et al., 2009; Hollstein and Wese Simen, 2020). In order to capture this premium, the dispersion trader takes a short position in the index options and long positions in the options of all the index stocks. If a large amount of money is passively invested in this dispersion strategy, then the inclusion of a stock in the S&P 500 index will trigger an excess demand for its options from dispersion traders. In turn, this excess demand will raise the price of options written on the included firm(s) and lead to a positive announcement response of their delta-hedged options. The empirical evidence of Panel A of Tables 3 and 4 lends support to this argument.

There are, however, several reasons to be skeptical of this explanation. To begin with, the dispersion trading argument is silent on the announcement response of the underlying stock. Thus, it can at best serve as a partial explanation for the reaction of delta-hedged options. Additionally, this explanation predicts that the delta-hedged options of firms are expensive as long as they remain in the index. If a company is excluded from the index, we should observe a negative and permanent exclusion effect since its options would no longer be affected by the excess demand of dispersion traders. This prediction is not borne out by the data. Panel B of Tables 3 and 4 documents a positive and transitory exclusion effect on delta-hedged options. 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 on all 500 constituent stocks. Instead, practitioners only trade the options of a subset of large and very liquid firms.[50] Consequently, it is unlikely that dispersion traders take positions in the derivatives of the newly included and excluded stocks. To verify this, we analyze the abnormal volume and open interest of the call options of excluded firms.[51] On a placebo-adjusted basis, we do not find evidence of a significant average abnormal volume and open interest. We do not tabulate these findings for brevity.[52]

D Benchmarking and Institutional Investors

Basak and Pavlova (2013) develop a theory to understand the response of stocks to index recomposition news. The theoretical model features an institutional investor alongside a retail investor. The institutional investor is evaluated relative to a benchmark

[50] For instance, the CBOE S&P 500 implied correlation index does not use the option contracts on all 500 constituent stocks. Instead, the index is based on the 50 largest stocks in the S&P 500 index. 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.

[51] Our model for the abnormal volume (open interest) is similar to that of Augustin et al. (2019). The main independent variables are the median call option trading volume (open interest) taken across the call options of all S&P 500 constituent firms, the S&P 500 implied volatility index, the return on the S&P 500 index, and the stock return of the company being analyzed. We also include the 1-period lag of the aforementioned independent variables as well as that of the dependent variable of our model. We use the same windows as for the risk-adjustment to estimate the loadings.

[52] As an additional analysis, we also analyze the abnormal open interest and trading volume of the call options of firms added to the S&P 500 index. On a placebo-adjusted basis, we observe a significantly positive and permanent abnormal open interest and trading volume. The significantly positive abnormal option trading volume is congruent with the research of Dash and Liu (2008). While this finding may lend credence to the explanation based on dispersion traders, the absence of a negative exclusion effect on trading activity casts doubt on the plausibility of this mechanism.

index and, thus, has an incentive to do well when the benchmark index performs well. In order to hedge against the fluctuations in the benchmark index, the institutional investor demands additional holdings of index stocks. This hedging incentive creates an excess demand for the index stocks (Brennan, 1993), thus raising the stock price of added firms. This positive inclusion effect is consistent with the findings of the literature, e.g. Harris and Gurel (1986), Shleifer (1986), Patel and Welch (2017), and our own evidence (see Panel A of Table 2).

The theoretical model has an implication for the conditional volatility of index stock returns. Specifically, the model posits that the conditional volatility of index stock returns is higher in the economy with the institutional investor. This is the result of market clearing. Given that stocks are in limited supply and institutional investors generate an excess demand for index stocks, the higher conditional volatility of index stock returns makes these stocks less attractive to retail investors who will cede part of their holdings to institutional investors.[53] To the extent that derivatives traders account for this volatility effect in their pricing on the announcement-day, we should observe a positive response of the delta-hedged options of added stocks over the short window. The empirical evidence of Panel A of Tables 3 and 4 is congruent with this implication. Turning to exclusion news, the model predicts a decline in the volatility of the returns of excluded stocks. Essentially, this lower volatility incentivises retail investors to acquire the stocks sold by institutional investors. Alas, this prediction is not supported by the data (see Panels B of Tables 3 and 4). Instead, our finding of a positive return to the volatility strategy may be consistent with the leverage effect.

Notwithstanding this limitation, we find it interesting to further explore the implica-

[53] The authors emphasize that the predictions *"concern only the announcement date"* and that they *"cannot make finer predictions which separate announcement-date returns and inclusion-date returns"* (Basak and Pavlova, 2013, p. 1752). Accordingly, our empirical tests mostly focus on the short event window.

tions of the model of Basak and Pavlova (2013). In particular, the model also predicts that the index effect increases with benchmarked institutional investors. This motivates us to carry out a simple cross-sectional test. We compare the addition effect for stocks included in the S&P 500 index that were previously (i) inside the S&P 400 mid-cap index and (ii) outside of the S&P 400 mid-cap index.[54,55] When a stock transitions from the S&P 400 mid-cap 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 mid-cap index. The net result is that the effect of benchmarking is likely weaker for a stock that transitions from the S&P 400 mid-cap index to the S&P 500 index compared to a stock that joins the S&P 500 index from outside the S&P 400 mid-cap index.

If the mechanism of Basak and Pavlova (2013) holds in the data, we should observe a short-term positive inclusion effect for both the stock and the delta-hedged options. Moreover, the effect should be stronger for stocks that were not previously in the S&P 400 mid-cap index. Consistent with the model, Panel A of Table 6 documents a positive inclusion effect for both groups of companies. Furthermore, it reveals that the short-term inclusion response is 2.19 percentage points (p-value = 0.0 %) stronger for added stocks that were outside the S&P 400 mid-cap index compared to those that were in the S&P 400 mid-cap index. Repeating this analysis for delta-hedged call options, we find a

[54] Overall, 215 of the 393 added stocks come from the S&P 400 mid-cap index. Conversely, 43 out of the 93 stocks excluded from the S&P 500 index in our sample go to the S&P 400 mid-cap index.

[55] 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 mid-cap index to the S&P 500 index, its weight in the new index is quite 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 mid-cap index. Saglam et al. (2019) empirically show that the combined ownership of ETF and index funds generally increases as a stock transitions from the S&P 400 mid-cap index to the S&P 500 index. Interestingly, their detailed analysis also reveals that the ownership of ETFs decreases when a stock moves from the S&P 400 mid-cap index to the S&P 500 index.

qualitatively similar result, though of a smaller magnitude (0.65 percentage points, p-value $= 0.0\,\%$). The short-term reaction to exclusion news is 4.36 percentage points (p-value $= 0.0\,\%$) stronger for stocks that are excluded from the S&P 500 index to outside of the S&P 400 mid-cap index compared to those that ended up in the S&P 400 mid-cap index. Turning to the delta-hedged call options, we can see a positive response to exclusion news, which is at odds with the negative response predicted by the model.

VI Conclusion

We analyze the impact of S&P 500 index recomposition news on both equity and delta-hedged option returns. Consistent with the earlier literature, we document a significantly positive (negative) inclusion (exclusion) short-term announcement response of equity prices.

Our novel finding is that the delta-hedged options of included and excluded firms exhibit a significantly positive announcement response. This result holds for both call and put options and is robust to placebo- and risk-adjustments. Analyzing a long event window, we establish that the inclusion effect is permanent, whereas the exclusion effect is temporary. We explore potential explanations for the documented announcement effects and find that, existing theories of the index effect cannot individually explain the joint responses of equity and delta-hedged option prices.

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Figure 1: Event Study: Timeline

This figure illustrates the timeline used in the paper. AD indicates the announcement date. Essentially, this is the first trading day after the announcement, which is made after the regular trading hours of day $AD-1$. ED is the effective date, i.e., the date when the recomposition event actually takes effect. Time differences are expressed in trading days. For example, $ED+126$ denotes the date 126 trading days after the ED.

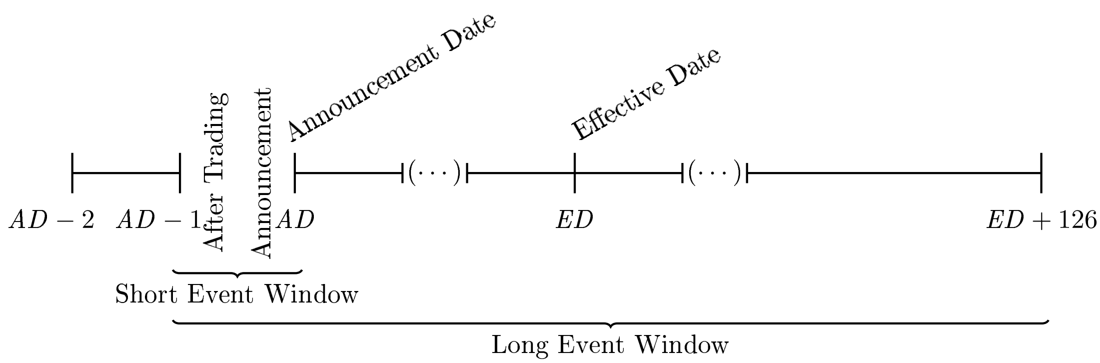

Table 1: Summary Statistics

This table presents the summary statistics of daily stock, delta-hedged call, and delta-hedged put returns. At each point in time, we compute the summary statistics using the returns related to the stocks ranked between #200 and #800 by market capitalization. We then compute and present the time-series average of these summary statistics. We do this separately for the stocks and for the delta-hedged calls and puts. Avg reports the average of the *[name in row]* returns. All returns are expressed in percentage points per day. Med, $Skew$, $Kurt$, $Q_{0.10}$, and $Q_{0.90}$ report the median, skewness, kurtosis, as well as the 10% and 90% quantiles, respectively. The subscripts C and nC indicate that the calculation relate 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	0.082	0.036	0.114	−0.006	0.027	2.196	1.953	2.303	0.697	20.53	−2.116	2.325
Calls	−0.009	−0.006	−0.012	−0.042	−0.051	0.860	0.716	0.920	2.185	59.49	−0.659	0.643
Puts	−0.019	−0.021	−0.018	−0.055	−0.067	0.779	0.628	0.847	2.703	62.25	−0.586	0.547

Table 2: Announcement Effect: Stocks

This table summarizes the response of stocks to index recomposition news. Panels A and B summarize the results associated with inclusion and exclusion news, respectively. AD and ED denote the announcement and effective dates, respectively. We present the results for different event windows with the length of the window expressed in trading days. For each panel, we analyze the (i) raw and (ii) placebo-adjusted returns. The placebos for the inclusion events are based on stocks not currently included in the S&P 500 index. For exclusion events, the placebo stocks are drawn from the constituents of the S&P 500 index. $\overline{R}$ denotes the average excess return. $\overline{AR}$ is the average risk-adjusted excess return. In order to carry out the risk-adjustment, we use a model that includes the 6 factors of Fama and French (2018), the daily innovation to the VIX, and the aggregate volatility and jump factors of Cremers et al. (2015). In parentheses, we report the p-values based on the Newey and West (1987) standard errors with 4 lags for the raw results or the placebo distribution for the placebo-adjusted results. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Inclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	0.0011	0.0396***	0.0529***	0.0406***	0.0379***	0.0449***	0.0571***
	(0.595)	(0.000)	(0.000)	(0.000)	(0.000)	(0.007)	(0.010)
$\overline{AR}$	0.0029	0.0408***	0.0508***	0.0406***	0.0296***	0.0406***	0.0692***
	(0.106)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.004)
				Placebo-Adjusted			
$\overline{R}$	0.0006	0.0399***	0.0489***	0.0386***	0.0299***	0.0283***	0.0285**
	(0.742)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.049)
$\overline{AR}$	0.0008	0.0403***	0.0494***	0.0391***	0.0298***	0.0371***	0.0496***
	(0.624)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)

Panel B: Exclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	−0.0149	−0.0391***	−0.0745***	−0.0166	0.0250	0.1160*	0.1541
	(0.164)	(0.000)	(0.000)	(0.458)	(0.412)	(0.059)	(0.125)
$\overline{AR}$	−0.0123	−0.0379***	−0.0702***	−0.0160	0.0011	0.0182	0.0009
	(0.194)	(0.000)	(0.000)	(0.564)	(0.968)	(0.600)	(0.984)
				Placebo-Adjusted			
$\overline{R}$	−0.0137***	−0.0388***	−0.0693***	−0.0182***	0.0118	0.0797***	0.0767***
	(0.000)	(0.000)	(0.000)	(0.006)	(0.177)	(0.000)	(0.000)
$\overline{AR}$	−0.0128***	−0.0382***	−0.0693***	−0.0156**	0.0025	0.0193	−0.0017
	(0.000)	(0.000)	(0.000)	(0.017)	(0.799)	(0.177)	(0.932)

Table 3: Announcement Effect: Delta-Hedged Call Options

This table summarizes the response of delta-hedged call options to index recomposition news. Panels A and B summarize the results associated with inclusion and exclusion news, respectively. AD and ED denote the announcement and effective dates, respectively. We present the results for different event windows with the length of the window expressed in trading days. For each panel, we analyze the (i) raw and (ii) placebo-adjusted returns. The placebos for the inclusion events are based on stocks not currently included in the S&P 500 index. For exclusion events, the placebo stocks are drawn from the constituents of the S&P 500 index. $\overline{R}$ denotes the average excess return. $\overline{AR}$ is the average risk-adjusted excess return. In order to carry out the risk-adjustment, we use a model that includes the 6 factors of Fama and French (2018), the daily innovation to the VIX, and the aggregate volatility and jump factors of Cremers et al. (2015). In parentheses, we report the p-values based on the Newey and West (1987) standard errors with 4 lags for the raw results or the placebo distribution for the placebo-adjusted results. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Inclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	−0.0014*	0.0110***	0.0084***	0.0092***	0.0084**	0.0105*	0.0246***
	(0.059)	(0.000)	(0.000)	(0.000)	(0.011)	(0.052)	(0.009)
$\overline{AR}$	−0.0011	0.0105***	0.0094***	0.0109***	0.0120***	0.0218***	0.0437***
	(0.103)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
				Placebo-Adjusted			
$\overline{R}$	−0.0012*	0.0108***	0.0080***	0.0066***	0.0055**	0.0099**	0.0242***
	(0.081)	(0.000)	(0.000)	(0.003)	(0.046)	(0.029)	(0.000)
$\overline{AR}$	−0.0011	0.0104***	0.0073***	0.0062***	0.0057*	0.0123**	0.0287***
	(0.121)	(0.000)	(0.000)	(0.006)	(0.051)	(0.010)	(0.000)

Panel B: Exclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	0.0004	0.0044**	0.0018	−0.0011	0.0000	−0.0038	−0.0233
	(0.837)	(0.021)	(0.698)	(0.834)	(0.995)	(0.770)	(0.348)
$\overline{AR}$	0.0001	0.0050***	0.0044	0.0032	0.0061	0.0046	−0.0037
	(0.959)	(0.009)	(0.257)	(0.474)	(0.332)	(0.660)	(0.868)
				Placebo-Adjusted			
$\overline{R}$	−0.0004	0.0043***	0.0022	−0.0028	−0.0004	−0.0032	−0.0110
	(0.718)	(0.000)	(0.273)	(0.441)	(0.927)	(0.620)	(0.222)
$\overline{AR}$	−0.0007	0.0046***	0.0032	−0.0013	0.0025	−0.0012	−0.0034
	(0.548)	(0.000)	(0.130)	(0.726)	(0.591)	(0.861)	(0.724)

Table 4: Announcement Effect: Delta-Hedged Put Options

This table summarizes the response of delta-hedged put options to index recomposition news. Panels A and B summarize the results associated with inclusion and exclusion news, respectively. AD and ED denote the announcement and effective dates, respectively. We present the results for different event windows with the length of the window expressed in trading days. For each panel, we analyze the (i) raw and (ii) placebo-adjusted returns. The placebos for the inclusion events are based on stocks not currently included in the S&P 500 index. For exclusion events, the placebo stocks are drawn from the constituents of the S&P 500 index. $\overline{R}$ denotes the average excess return. $\overline{AR}$ is the average risk-adjusted excess return. In order to carry out the risk-adjustment, we use a model that includes the 6 factors of Fama and French (2018), the daily innovation to the VIX, and the aggregate volatility and jump factors of Cremers et al. (2015). In parentheses, we report the p-values based on the Newey and West (1987) standard errors with 4 lags for the raw results or the placebo distribution for the placebo-adjusted results. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Inclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	0.0007	0.0068***	0.0066***	0.0032	0.0009	0.0016	0.0019
	(0.404)	(0.000)	(0.000)	(0.133)	(0.763)	(0.770)	(0.836)
$\overline{AR}$	0.0010	0.0065***	0.0073***	0.0047**	0.0036	0.0098*	0.0170*
	(0.202)	(0.000)	(0.000)	(0.030)	(0.217)	(0.097)	(0.094)
				Placebo-Adjusted			
$\overline{R}$	0.0012**	0.0065***	0.0071***	0.0028	0.0013	0.0074*	0.0143**
	(0.045)	(0.000)	(0.001)	(0.138)	(0.589)	(0.093)	(0.026)
$\overline{AR}$	0.0011*	0.0062***	0.0070***	0.0026	0.0012	0.0080*	0.0160**
	(0.070)	(0.000)	(0.001)	(0.183)	(0.639)	(0.092)	(0.021)

Panel B: Exclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	0.0001	0.0049***	0.0043	0.0021	−0.0032	−0.0168	−0.0342*
	(0.955)	(0.009)	(0.340)	(0.624)	(0.531)	(0.124)	(0.083)
$\overline{AR}$	−0.0002	0.0048***	0.0057	0.0037	−0.0030	−0.0139	−0.0278
	(0.926)	(0.008)	(0.184)	(0.349)	(0.532)	(0.198)	(0.148)
				Placebo-Adjusted			
$\overline{R}$	0.0004	0.0050***	0.0063***	0.0042	0.0025	−0.0010	0.0001
	(0.605)	(0.001)	(0.009)	(0.126)	(0.443)	(0.839)	(0.993)
$\overline{AR}$	−0.0001	0.0048***	0.0065***	0.0042	0.0007	−0.0026	−0.0009
	(0.956)	(0.001)	(0.009)	(0.136)	(0.840)	(0.606)	(0.902)

Table 5: Robustness: Placebo- and Risk-Adjusted Delta-Hedged Option Returns

This table presents various robustness checks regarding the placebo- and risk-adjusted responses of delta-hedged call options to S&P 500 index recomposition news. Panels A and B summarize the results associated with inclusion and exclusion news, respectively. AD and ED denote the announcement and effective dates, respectively. We present the results for different event windows with the length of the window expressed in trading days. The placebos for the inclusion events are based on stocks not currently included in the S&P 500 index. For exclusion events, the placebo stocks are drawn from the constituents of the S&P 500 index. $\overline{AR}$ is the average risk-adjusted excess return. In order to carry out the risk-adjustment, we use a model that includes the 6 factors of Fama and French (2018), the daily innovation to the VIX, and the aggregate volatility and jump factors of Cremers et al. (2015). In parentheses, we report the p-values relative to the placebo distribution. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Inclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				At-the-Money Calls			
$\overline{AR}$	−0.0009	0.0107***	0.0073***	0.0062***	0.0062**	0.0151***	0.0281***
	(0.206)	(0.000)	(0.000)	(0.001)	(0.019)	(0.000)	(0.000)
				Short-Term Options			
$\overline{AR}$	−0.0008	0.0132***	0.0086***	0.0080***	0.0077**	0.0145***	0.0260***
	(0.256)	(0.000)	(0.000)	(0.001)	(0.010)	(0.003)	(0.002)
				Volume-Weighting			
$\overline{AR}$	−0.0006	0.0121***	0.0083***	0.0043	0.0050	0.0113*	0.0215**
	(0.530)	(0.000)	(0.001)	(0.157)	(0.210)	(0.089)	(0.038)
				Equal-Weighting			
$\overline{AR}$	−0.0010	0.0142***	0.0100***	0.0092***	0.0085***	0.0150***	0.0282***
	(0.179)	(0.000)	(0.000)	(0.000)	(0.002)	(0.003)	(0.001)
				Perturbation: Delta × 0.9			
$\overline{AR}$	−0.0012	0.0168***	0.0147***	0.0118***	0.0103***	0.0181***	0.0412***
	(0.145)	(0.000)	(0.000)	(0.000)	(0.004)	(0.002)	(0.000)
				Perturbation: Delta × 1.1			
$\overline{AR}$	−0.0010*	0.0053***	0.0016	0.0016	0.0021	0.0078*	0.0201***
	(0.091)	(0.000)	(0.266)	(0.415)	(0.413)	(0.069)	(0.001)
				Excluding Earnings Announcements			
$\overline{AR}$	−0.0005	0.0103***	0.0075***	0.0062***	0.0057**	0.0120**	0.0292***
	(0.460)	(0.000)	(0.000)	(0.004)	(0.045)	(0.020)	(0.000)

Table 5: Robustness: Placebo- and Risk-Adjusted Delta-Hedged Option Returns (continued)

Panel B: Exclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				At-The-Money Calls			
$\overline{AR}$	-0.0013	0.0041***	0.0054***	0.0021	0.0092**	0.0091	0.0127
	(0.164)	(0.000)	(0.005)	(0.507)	(0.029)	(0.165)	(0.173)
				Short-Term Options			
$\overline{AR}$	-0.0017	0.0031***	0.0017	-0.0027	-0.0002	-0.0089	-0.0060
	(0.177)	(0.007)	(0.401)	(0.480)	(0.962)	(0.229)	(0.550)
				Volume-Weighting			
$\overline{AR}$	-0.0009	0.0044***	0.0025	-0.0041	0.0012	0.0001	0.0231
	(0.552)	(0.000)	(0.360)	(0.380)	(0.838)	(0.984)	(0.106)
				Equal-Weighting			
$\overline{AR}$	-0.0013	0.0052***	0.0045**	0.0005	0.0051	0.0004	-0.0008
	(0.261)	(0.000)	(0.029)	(0.856)	(0.237)	(0.964)	(0.948)
				Perturbation: Delta $\times$ 0.9			
$\overline{AR}$	-0.0012	0.0015	-0.0032	-0.0066*	-0.0002	-0.0022	-0.0084
	(0.357)	(0.127)	(0.136)	(0.097)	(0.980)	(0.781)	(0.440)
				Perturbation: Delta $\times$ 1.1			
$\overline{AR}$	-0.0002	0.0070***	0.0083***	0.0030	0.0048	-0.0002	0.0005
	(0.812)	(0.000)	(0.000)	(0.364)	(0.246)	(0.981)	(0.959)
				Excluding Earnings Announcements			
$\overline{AR}$	-0.0007	0.0048***	0.0040*	-0.0012	0.0033	-0.0018	-0.0026
	(0.543)	(0.000)	(0.056)	(0.751)	(0.475)	(0.771)	(0.751)

Table 6: Testing Potential Explanations: Short-Term Evidence

This table summarizes the results of tests of the investor's recognition, noise traders, and benchmarking hypotheses. Panels A and B summarize the results associated with inclusion and exclusion news, respectively. We report placebo- and risk-adjusted results. The returns relate to the short-term event window, i.e., from $AD-1$ to AD. The placebos for the inclusion events are based on stocks not currently included in the S&P 500 index. For exclusion events, the placebo stocks are drawn from the constituents of the S&P 500 index. $\overline{AR}$ is the average risk-adjusted excess return. In order to carry out the risk-adjustment, we use a model that includes the 6 factors of Fama and French (2018), the daily innovation to the VIX, and the aggregate volatility and jump factors of Cremers et al. (2015). The first set of results relates to sorts based on the number of analysts following each stock. The second set of results compares the index effect during periods of high and low investor sentiment. The third set of results focuses on the impact of the change in autocorrelation. Finally, the last set of findings relate to stocks promoted from or relegated to the S&P 400 mid-cap index. In parentheses, we report the p-values based on the placebo distribution. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Inclusions

			Analyst Coverage			
	Low		High		High − Low	
Equity $\overline{AR}$	0.0418***	(0.000)	0.0391***	(0.000)	−0.0027	(0.305)
Delta-Hedged Call $\overline{AR}$	0.0132***	(0.000)	0.0072***	(0.000)	−0.0061***	(0.000)
			Sentiment			
	Low		High		High − Low	
Equity $\overline{AR}$	0.0438***	(0.000)	0.0367***	(0.000)	−0.0071***	(0.003)
Delta-Hedged Call $\overline{AR}$	0.0104***	(0.000)	0.0104***	(0.000)	−0.0000	(0.968)
			Δ Autocorrelation			
	Low		High		High − Low	
Equity $\overline{AR}$	0.0412***	(0.000)	0.0400***	(0.000)	−0.0012	(0.642)
Delta-Hedged Call $\overline{AR}$	0.0113***	(0.000)	0.0096***	(0.000)	−0.0017	(0.118)
			Inter-Index Transfer			
	No		Yes		Yes − No	
Equity $\overline{AR}$	0.0523***	(0.000)	0.0303***	(0.000)	−0.0219***	(0.000)
Delta-Hedged Call $\overline{AR}$	0.0140***	(0.000)	0.0074***	(0.000)	−0.0065***	(0.000)

Table 6: Testing Potential Explanations: Short-Term Evidence (continued)

Panel B: Exclusions

	Analyst Coverage					
	Low		High		High − Low	
Equity $\overline{AR}$	−0.0472***	(0.000)	−0.0292***	(0.000)	0.0180***	(0.000)
Delta-Hedged Call $\overline{AR}$	0.0069***	(0.000)	0.0022**	(0.048)	−0.0048**	(0.018)
	Sentiment					
	Low		High		High − Low	
Equity $\overline{AR}$	−0.0377***	(0.000)	−0.0388***	(0.000)	−0.0011	(0.743)
Delta-Hedged Call $\overline{AR}$	0.0034**	(0.019)	0.0059***	(0.000)	0.0024	(0.153)
	Δ Autocorrelation					
	Low		High		High − Low	
Equity $\overline{AR}$	−0.0301***	(0.000)	−0.0477***	(0.000)	−0.0176***	(0.000)
Delta-Hedged Call $\overline{AR}$	0.0023*	(0.083)	0.0067***	(0.001)	0.0044**	(0.029)
	Inter-Index Transfer					
	No		Yes		Yes − No	
Equity $\overline{AR}$	−0.0551***	(0.000)	−0.0115***	(0.000)	0.0436***	(0.000)
Delta-Hedged Call $\overline{AR}$	0.0076***	(0.000)	0.0013	(0.106)	−0.0063***	(0.001)

Table 7: Testing Potential Explanations: Long-Term Evidence

This table summarizes the results of tests of the investor's recognition, noise traders, and benchmarking hypotheses. Panels A and B summarize the results associated with inclusion and exclusion news, respectively. We report placebo- and risk-adjusted results. The returns relate to the long-term event window, i.e., from $AD - 1$ to $ED + 126$. The placebos for the inclusion events are based on stocks not currently included in the S&P 500 index. For exclusion events, the placebo stocks are drawn from the constituents of the S&P 500 index. $\overline{AR}$ is the average risk-adjusted excess return. In order to carry out the risk-adjustment, we use a model that includes the 6 factors of Fama and French (2018), the daily innovation to the VIX, and the aggregate volatility and jump factors of Cremers et al. (2015). The first set of results relates to sorts based on the number of analysts following each stock. The second set of results compares the index effect during periods of high and low investor sentiment. The third set of results focuses on the impact of the change in autocorrelation. Finally, the last set of findings relate to stocks promoted from or relegated to the S&P 400 mid-cap index. In parentheses, we report the p-values based on the placebo distribution. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Inclusions

	Analyst Coverage					
	Low		High		High − Low	
Equity $\overline{AR}$	0.0312	(0.152)	0.0770***	(0.003)	0.0459	(0.179)
Delta-Hedged Call $\overline{AR}$	0.0221**	(0.031)	0.0379***	(0.002)	0.0159	(0.286)
	Sentiment					
	Low		High		High − Low	
Equity $\overline{AR}$	0.0160	(0.404)	0.0836***	(0.002)	0.0677**	(0.033)
Delta-Hedged Call $\overline{AR}$	0.0250**	(0.016)	0.0325***	(0.004)	0.0076	(0.617)
	Δ Autocorrelation					
	Low		High		High − Low	
Equity $\overline{AR}$	0.0583**	(0.013)	0.0434**	(0.048)	−0.0149	(0.645)
Delta-Hedged Call $\overline{AR}$	0.0405***	(0.000)	0.0160	(0.144)	−0.0245	(0.103)
	Inter-Index Transfer					
	No		Yes		Yes − No	
Equity $\overline{AR}$	0.0553**	(0.020)	0.0450**	(0.036)	−0.0103	(0.747)
Delta-Hedged Call $\overline{AR}$	0.0406***	(0.000)	0.0188*	(0.065)	−0.0217	(0.137)

Table 7: Testing Potential Explanations: Long-Term Evidence (continued)

Panel B: Exclusions

	Analyst Coverage					
	Low		High		High − Low	
Equity $\overline{AR}$	−0.0423	(0.136)	0.0396	(0.109)	0.0818**	(0.029)
Delta-Hedged Call $\overline{AR}$	−0.0144	(0.292)	0.0085	(0.461)	0.0229	(0.214)
	Sentiment					
	Low		High		High − Low	
Equity $\overline{AR}$	0.0918***	(0.000)	−0.0966***	(0.002)	−0.1884***	(0.000)
Delta-Hedged Call $\overline{AR}$	−0.0239	(0.115)	0.0190*	(0.090)	0.0429**	(0.027)
	Δ Autocorrelation					
	Low		High		High − Low	
Equity $\overline{AR}$	0.0079	(0.774)	−0.0312	(0.268)	−0.0391	(0.325)
Delta-Hedged Call $\overline{AR}$	−0.0275*	(0.067)	0.0152	(0.274)	0.0427**	(0.035)
	Inter-Index Transfer					
	No		Yes		Yes − No	
Equity $\overline{AR}$	0.0381	(0.179)	−0.0645**	(0.012)	−0.1026***	(0.008)
Delta-Hedged Call $\overline{AR}$	−0.0351**	(0.024)	0.0312***	(0.005)	0.0663***	(0.002)

The Index Effect: Evidence from the Option Market

Online Appendix

JEL classification: G12, G11, G17

Keywords: Delta-Hedged Options, Event Study, Index Effect, Placebo Group

Figure A1: Inclusions and Exclusions Over Time

This figure presents the number of inclusions (dashed red) and exclusions (solid black) per month in our final sample. The shaded areas indicate business cycle contractions as identified by the NBER.

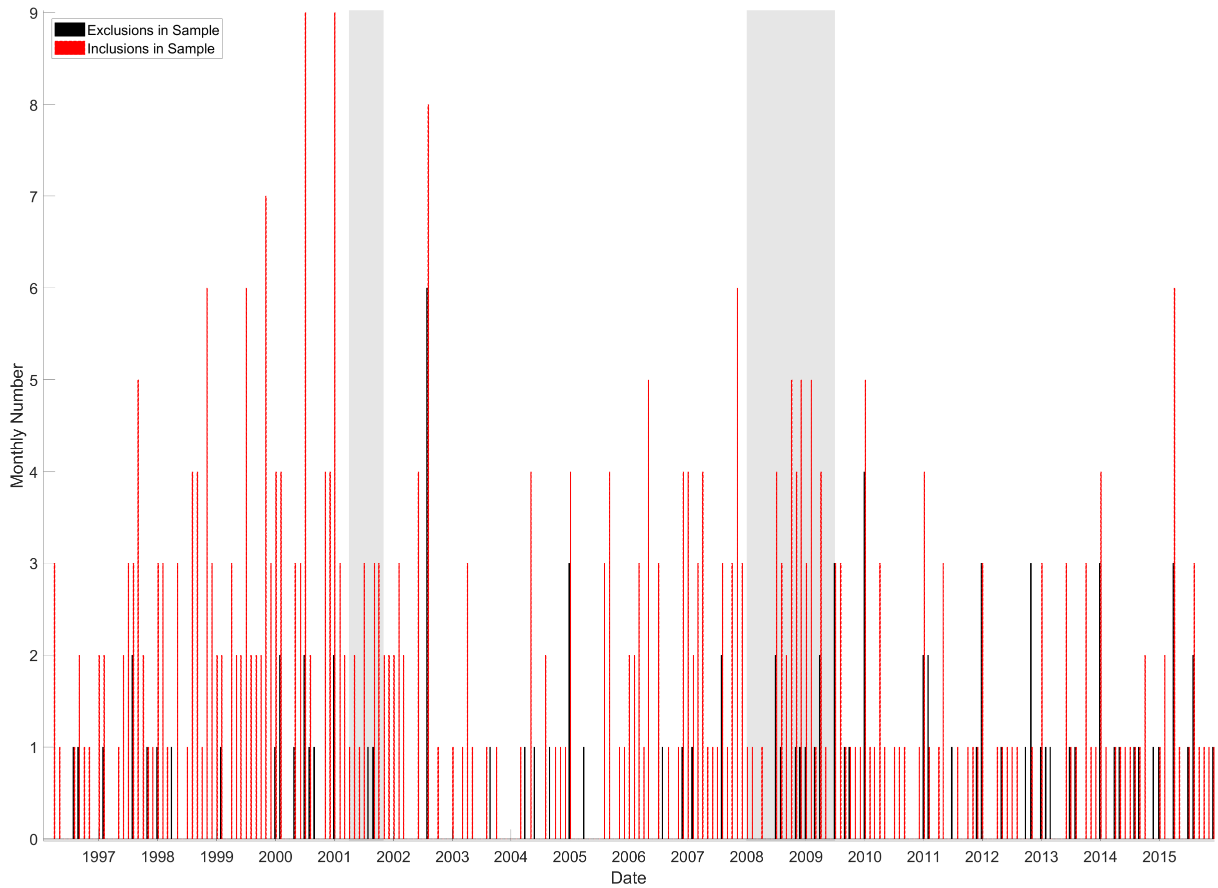

Table A1: Announcement Effect: Call Options (Dash and Liu, 2008)

This table summarizes the response of outright call options to index recomposition news. Panels A and B summarize the results associated with inclusion and exclusion news, respectively. AD and ED denote the announcement and effective dates, respectively. We present the results for different event windows with the length of the window expressed in trading days. We calculate the daily option returns as in Dash and Liu (2008). $\overline{R}$ denotes the average excess return. $\overline{AR}$ is the average risk-adjusted return. In order to carry out the risk-adjustment, we use a model that includes the 6 factors of Fama and French (2018), the daily innovation to the VIX, and the aggregate volatility and jump factors of Cremers et al. (2015). In parentheses, we report the p-values based on the Newey and West (1987) standard errors with 4 lags for the raw results or the placebo distribution for the placebo-adjusted results. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Inclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	−0.0064	0.4834***	0.6169***	0.5270***	0.3657***	0.2662**	0.7219
	(0.674)	(0.000)	(0.000)	(0.000)	(0.004)	(0.048)	(0.228)
$\overline{AR}$	0.0126	0.4834***	0.6372***	0.4452***	0.3790***	0.6153**	2.0309**
	(0.357)	(0.000)	(0.000)	(0.000)	(0.001)	(0.022)	(0.034)
				Placebo-Adjusted			
$\overline{R}$	−0.0078	0.4808***	0.5657***	0.4802***	0.2754***	0.0094	0.3173
	(0.622)	(0.000)	(0.000)	(0.005)	(0.005)	(0.955)	(0.340)
$\overline{AR}$	−0.0074	0.4736***	0.5888***	0.3532***	0.2753***	0.3348	0.4089
	(0.642)	(0.000)	(0.000)	(0.005)	(0.006)	(0.105)	(0.943)

Panel B: Exclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	−0.0448	−0.1483***	−0.2667***	−0.1271	0.1345	0.7426*	0.1895
	(0.161)	(0.000)	(0.000)	(0.255)	(0.432)	(0.084)	(0.598)
$\overline{AR}$	−0.0079	−0.1414***	−0.2598***	−0.1920**	−0.0127	0.7063	−0.0111
	(0.807)	(0.000)	(0.000)	(0.027)	(0.924)	(0.176)	(0.972)
				Placebo-Adjusted			
$\overline{R}$	−0.0191	−0.1509***	−0.2700***	−0.2121**	0.0233	0.3403	−0.7830
	(0.465)	(0.000)	(0.000)	(0.037)	(0.834)	(0.227)	(0.252)
$\overline{AR}$	−0.0159	−0.1527***	−0.2904***	−0.2619*	−0.0435	0.5106*	−0.2841
	(0.552)	(0.000)	(0.000)	(0.056)	(0.674)	(0.053)	(0.577)

Table A2: Announcement Effect: Put Options (Dash and Liu, 2008)

This table summarizes the response of outright put options to index recomposition news. Panels A and B summarize the results associated with inclusion and exclusion news, respectively. AD and ED denote the announcement and effective dates, respectively. We present the results for different event windows with the length of the window expressed in trading days. We calculate the daily option returns as in Dash and Liu (2008). $\overline{R}$ denotes the average excess return. $\overline{AR}$ is the average risk-adjusted return. In order to carry out the risk-adjustment, we use a model that includes the 6 factors of Fama and French (2018), the daily innovation to the VIX, and the aggregate volatility and jump factors of Cremers et al. (2015). In parentheses, we report the p-values based on the Newey and West (1987) standard errors with 4 lags for the raw results or the placebo distribution for the placebo-adjusted results. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Inclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	0.0053	−0.2325***	−0.2953***	−0.2644***	−0.3180***	−0.3291***	−0.6732***
	(0.747)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\overline{AR}$	−0.0082	−0.2396***	−0.2817***	−0.2834***	−0.2306***	−0.1958***	−0.3697***
	(0.530)	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	(0.002)
				Placebo-Adjusted			
$\overline{R}$	−0.0011	−0.2388***	−0.2722***	−0.2350***	−0.2469***	−0.3213	−0.9937*
	(0.928)	(0.000)	(0.000)	(0.002)	(0.009)	(0.107)	(0.056)
$\overline{AR}$	−0.0022	−0.2394***	−0.2641***	−0.2643***	−0.2152**	−0.1926	−0.4847
	(0.862)	(0.000)	(0.000)	(0.000)	(0.015)	(0.219)	(0.142)

Panel B: Exclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	0.0646*	0.2423***	0.7131*	0.3768	0.1247	0.1587	−0.1079
	(0.073)	(0.001)	(0.084)	(0.107)	(0.546)	(0.749)	(0.798)
$\overline{AR}$	0.0289	0.2358***	0.4819**	0.3384**	0.2383	0.0720	−0.0962
	(0.340)	(0.000)	(0.012)	(0.044)	(0.266)	(0.804)	(0.637)
				Placebo-Adjusted			
$\overline{R}$	0.0408	0.2409***	0.6462***	0.4294***	0.3295***	0.4572**	0.1421
	(0.120)	(0.000)	(0.000)	(0.001)	(0.005)	(0.047)	(0.855)
$\overline{AR}$	0.0305	0.2427***	0.5047***	0.3459***	0.2817**	0.1306	−0.0797
	(0.211)	(0.000)	(0.000)	(0.002)	(0.013)	(0.491)	(0.908)

Table A3: Announcement Effect (Without Earnings Announcements): Stocks

This table summarizes the response of stocks to index recomposition news. We discard all companies for which either the earnings announcement date or the day after correspond to an index recomposition announcement day. Panels A and B summarize the results associated with inclusion and exclusion news, respectively. AD and ED denote the announcement and effective dates, respectively. We present the results for different event windows with the length of the window expressed in trading days. For each panel, we first analyze the raw returns. Then, we focus on the placebo-adjusted results. The placebos for the inclusion events are based on stocks not currently included in the S&P 500 index. For exclusion events, the placebo stocks are drawn from the constituents of the S&P 500 index. $\overline{R}$ denotes the average excess return. $\overline{AR}$ is the average risk-adjusted return. In order to carry out the risk-adjustment, we use a model that includes the 6 factors of Fama and French (2018), the daily innovation to the VIX, and the aggregate volatility and jump factors of Cremers et al. (2015). In parentheses, we report the p-values based on the Newey and West (1987) standard errors with 4 lags for the raw results or the placebo distribution for the placebo-adjusted results. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Inclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	0.0009	0.0406***	0.0542***	0.0417***	0.0387***	0.0435**	0.0589***
	(0.665)	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)	(0.009)
$\overline{AR}$	0.0025	0.0417***	0.0518***	0.0420***	0.0309***	0.0409***	0.0718***
	(0.149)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.003)
				Placebo-Adjusted			
$\overline{R}$	0.0005	0.0410***	0.0502***	0.0395***	0.0306***	0.0265**	0.0299*
	(0.794)	(0.000)	(0.000)	(0.000)	(0.000)	(0.024)	(0.054)
$\overline{AR}$	0.0006	0.0413***	0.0505***	0.0405***	0.0313***	0.0377***	0.0533***
	(0.727)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.003)

Panel B: Exclusions

	$AD-2$ to $AD-1$	$AD-1$ to AD	$AD-1$ to ED	$AD-1$ to $ED+10$	$AD-1$ to $ED+21$	$AD-1$ to $ED+63$	$AD-1$ to $ED+126$
				Raw			
$\overline{R}$	−0.0142	−0.0397***	−0.0751***	−0.0159	0.0263	0.1130*	0.1584
	(0.200)	(0.000)	(0.000)	(0.487)	(0.398)	(0.075)	(0.128)
$\overline{AR}$	−0.0119	−0.0383***	−0.0707***	−0.0155	0.0027	0.0162	0.0025
	(0.223)	(0.000)	(0.000)	(0.590)	(0.921)	(0.652)	(0.956)
				Placebo-Adjusted			
$\overline{R}$	−0.0131***	−0.0391***	−0.0686***	−0.0162**	0.0138	0.0794***	0.0823***
	(0.001)	(0.000)	(0.000)	(0.017)	(0.116)	(0.000)	(0.000)
$\overline{AR}$	−0.0126***	−0.0385***	−0.0693***	−0.0138**	0.0054	0.0187	0.0018
	(0.000)	(0.000)	(0.000)	(0.041)	(0.512)	(0.196)	(0.923)