The Effect of Stock Market Indexing on Option Market Quality*

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Abstract

Using Russell index reconstitution as the identification strategy, we examine how the option market quality is affected by the indexing in stock market. Evidence from regression discontinuity design shows that the option liquidity and trading continuity, measured by the number of zero trading days, is significantly lower if the firm is at the top of Russell 2000 index, compared with a similar sized firm that is at the bottom of Russell 1000 index. The drop in number of zero trading days in option is likely to be due to the increased trading from transient institutional investors who benchmark their performance to indexes and trade option as part of their strategies.

JEL Classification: G12, G13, G14, G32

Keywords: Option, Indexing, Liquidity, Zero trading day, Institutional investors

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1. Introduction

Stock market indexing has been a popular research area since decades ago. Some papers examine the price effect of stock market indexing, which has been traditionally focused on the Standard and Poor's (S&P) 500 index addition effect. Earlier papers such as Shleifer (1986) and Harris and Gurel (1986) find a positive risk-adjusted return for stocks added into S&P 500 or other major indexes. Beneish and Whaley (1996), Lynch and Mendenhall (1997), and Wurgler and Zhuravskaya (2002) show an abnormal stock return of 3% to 7% in the month after the firm is added into the S&P 500 index and a significant proportion of the price effect is permanent. These traditional studies argue that the price effect is due to forced buying from indexing and benchmarking from institutional investors.

However, it is difficult to separate indexing effect from potential confounding factors such as the increased investor attention and recognition on firms newly added into S&P 500 index. Chang, Hong, and Liskovich (2015) show recent evidence using Russell 1000/2000 index reconstitution to address this issue and find that additions (deletions) to Russell 2000 result in price increases (decreases). With the clean setting of Russell reconstitution, Boone and White (2015) find that firms at the top of Russell 2000 index have discontinuously higher institutional ownership than firms at the bottom of Russell 1000 index, and higher institutional ownership is associated with higher stock liquidity and lower information asymmetry. In this paper, we examine the indexing effect on option market instead.

Nowadays, option market has become a significant and popular venue to trade, especially for informed investors. Easley, O'Hara, and Srinivas (1998) argue that informed investors tend to capitalize their private information in option market when its implicit leverage is high and its trading is more liquid. Other empirical studies show evidence on the return predictability of informed option trading in general (such as Pan and Poteshman (2006), Cremers and Weinbaum (2010), Xing, Zhang, and Zhao (2010), Johnson and So (2012), and Ge, Lin, Pearson (2016)) and around major corporate events (such as Cao, Chen, and Griffin (2005), Jin, Livnat, and Zhang (2012), Chan, Ge, and Lin (2015), and Augustin, Brenner, and Subrahmanyam (2016)).

When investors determine the venue to trade, option trading cost or liquidity is certainly a key factor to consider. Thus, it is interesting and important to investigate how option market quality, such as the trading cost or liquidity, can be improved. In this paper, we focus on the indexing effect in option market which has been overlooked.

The number of zero trading days is an important measure for market quality. We can observe zero trading if there is no new information or any liquidity demand, which tends to be unlikely, or if the trading cost is larger than what the investors can profit from their information. According to Lesmond, Ogden, and Trzcinka (1999), informed investors will trade only if the trading cost is lower than what they can profit from their private information. Similarly, liquidity traders will stop trading if the trading cost is too high. Thus, incidence of no trading indicates higher trading cost and lower liquidity, all else equal. Since a trading decision is endogenously determined, as a function of trading cost which cannot be directly observed, we can only infer the trading cost from the ex post observation that whether trades occur. Lin, Singh, and Yu (2009) show that number of zero trading volume days decreases after stock splits and they interpret it as lower latent trading cost.

In our paper, we examine how option market quality, measured by number of zero trading days, is affected by indexing. The zero trading day measure has been widely used in stock market when the stock market has not been as liquid as it is now. However, in recent years we still observe a significant number of days with zero trading volumes in options. The zero trading day measure is thus more applicable to option market as option trading cost is way larger than stock trading cost and there are more non-trading days in options than in stocks.

To separate indexing from potential confounding effects, we conduct regression discontinuity analysis around the annual Russell 1000/2000 index reconstitution as the identification strategy. We hypothesize that the option number of zero trading day is significantly lower if the firm is at the top of Russell 2000 index, compared with a similar-sized firm that is at the bottom of Russell 1000 index. The drop in number of zero trading day in option is likely to be due to the increased trading from transient institutional investors who benchmark their performance to indexes and trade option as part of their strategies.

Empirically, we construct number of zero trading days as the standardized turnover-adjusted number of zero trading volume days (NZVD) over 12 months after each Russell 1000/2000 index reconstitution. On average, there are 13.07 days without trading for stocks, however, this measure is much higher for options (60.15 days). Put options have more non-trading days than call options in general.

Using the regression discontinuity methodology, we find that firms close to the threshold but at the top of Russell 2000 index exhibit significantly fewer zero trading days in options, compared with firms at the bottom of Russell 1000 index. We show a significant and negative treatment effect (denoted as τ) of Russell 2000 index inclusion, with τ = –54.8237 (z-statistic = –5.16) with the rule of thumb bandwidth described in Calonico, Cattaneo, and Titiunik (2014). The results are consistent across call options and put options, with a larger magnitude for the latter. Choice of bandwidths does not alter the results qualitatively. We then randomly select pseudo thresholds and find insignificant treatment effects for option zero trading day measure.

As an additional evidence, we implement the two-stage least squares regression approach with instrumental variables. Consistent with Boone and White (2015), we find that institutional ownership ratio is discontinuously higher for firms at the top of Russell 2000 index than for firms at the bottom of Russell 1000 index. As in Prado, Saffi, and Sturgess (2016), we use Russell 2000 dummy, rank distance and its square term, as well as their interactions as the instrumental variables in stage one. In stage two, the measure for option zero trading day is then regressed on instrumented institutional ownership ratio (IOR). As expected, we show that higher IOR leads to lower option NZVD. We further break down the IOR according to the classification in Bushee and Noe (2000) and Bushee (2001), as IOR for quasi-indexer, transient investor, and dedicated investor. We find that only transient IOR is significantly and negatively correlated with option NZVD. This is consistent with our conjecture that most of the indexing effect is probably due to more trading from transient investors who benchmark their performance to indexes and trade options as part of their complicated strategies.

Our main results are robust to the alternative construction of option NZVD where we calculate the standardized number of zero trading volume days without adjusting for turnover. Besides, we find qualitatively similar results using shorter horizons of NZVD.

Our paper contributes to the asset pricing literature of indexing and to our best knowledge this is the first paper to study indexing effect on option market. Given literature showing that option market is an important venue for informed trading, this matters for how information is revealed and transmitted. We find that the number of option zero trading day is significantly lower for firms at the top of Russell 2000 index than for those at the bottom of Russell 1000 index.

The remaining of the paper is organized as follows. The next section describes data and methodology, focusing on the measure of zero trading day, identification strategy, and regression discontinuity approach. Section 3 first presents the main finding of the stock market indexing effect on option market quality, using regression discontinuity design. Then we use pseudo test to confirm that the discontinuity only exists around the true cutoff point. In section 4, we adopt two-stage regressions with instrumental variables as an alternative approach, and report several other robustness tests. Section 5 briefly concludes the paper.

2. Data and methodology

This section first discusses construction of our measure for option market quality. We then describe the identification strategy using the setting of Russell 1000/2000 index reconstitution and regression discontinuity design used in the main analysis.

2.1. Zero trading day measure

We obtain daily option data from OptionMetrics, daily stock price and volume data from Center for Research in Security Prices (CRSP), accounting information from Compustat, and institutional ownership data from SEC 13F filings. We gather yearly Russell 1000/2000 index membership list from Russell. Our sample period is from 1998 to 2006, with 3585 unique firms with listed options. We end our sample period in 2006 because of the banding policy implemented by Russell starting from 2007, where stocks switch from their current index only if their market capitalizations move beyond 5% range of the threshold. This banding policy mitigates index turnover and potentially reduces local continuity of firm assignment around the threshold (Chang, Hong, and Liskovich (2015), Boone and White (2015)).

We use the number of zero-volume days (NZVD) as the proxy for option market quality. Following Liu (2006), we define NZVD as the standardized turnover-adjusted number of zero trading volume days over x months, that is,

$$NZVD_x = \left[No.\ of\ zero\ daily\ volumes\ in\ x\ months + \frac{1/(x\text{–}month\ turnover)}{Deflator}\right] \times \frac{21x}{NoTD}. \quad (1)$$

In our main analysis, we choose x = 12, so that NZVD measures the option market quality for the next 12 months. Our robustness tests show the results using other horizons. The x-month turnover is the sum of daily turnover for that period, where option daily turnover is calculated as the daily option trading volume (converted into the number of shares) divided by shares outstanding. NoTD is the number of trading days for that period. Deflator is chosen so that

$$0 < \frac{1/(x\text{–}month\ turnover)}{Deflator} < 1.$$ [1]

For each firm, we calculate NZVD for all options with that underlying stock. We also calculate NZVD for call options and put options separately for each firm. Options are then classified into different moneyness groups following Bollen and Whaley (2004). A call option is defined to be out-of-the-money (OTM) if 0.02 < delta = 0.375; at-the-money (ATM) if 0.375 <delta = 0.625; and in-the-money (ITM) if 0.625 < delta = 0.98. A put option is defined to be out-of-the-money (OTM) if –0.375 < delta = –0.02; at-the-money (ATM) if –0.625 < delta = –0.375; and in-the-money (ITM) if –0.98 < delta = –0.625. Then NZVD is calculated for each moneyness group for options with each underlying stock. We also construct NZVD for stock which measures the number of non-trading days in stock market for that firm.

[Table 1 about here]

[1] Our deflators are different from those in Liu (2006), as our option volume and turnover are in different magnitude compared with those for stocks in his paper. For 12-month NZVD, deflator equals to 4,000,000.

Table 1 shows summary statistics for yearly NZVD. We keep all stocks with available exchange-traded options. On average, within a year, there are 13.07 days with zero trading volume for a stock, while this number is much higher for an option which is 60.15 days. Call options NZVD is lower than that for put options, implying that call options tend to be more liquid and with higher trading continuity than put options. Intuitively, ATM options are the most liquid one with the lowest NZVD.

As the NZVD for an option is much larger than that for a stock in general, we believe this measure is more pronounced in option market. Any improvement in option market liquidity and reduction in the number of zero trading day would be important to investors.

2.2. Identification strategy

To examine the indexing effect, earlier papers commonly focus on firms added to major indexes such as S&P 500 index, and argue that the price impact is due to the buying pressure from passive index funds and active institutional investors who benchmark their performance to indexes. A downward sloping demand curve is assumed. However, the potential confounding effect questions the plausibility of the above argument. Those findings could be potentially due to fundamental change in the firm production and performance, and the increased investor recognition as a result of index inclusion, etc.

Recent literature has adopted a clean setting using Russell 1000/2000 index reconstitution as the identification strategy. Each year, the Russell 1000 index and Russell 2000 index are constructed based on a set of rules where firm ranking is largely determined by the market capitalization at the end of May. The addition and deletion of member firms are released in June and the reconstitution date is the last Friday of June when the exact portfolio weights are allocated. The final membership list is then published at the beginning of July.

The difference between the market capitalizations for firms ranked just above and below the cutoff is quite small. As the cutoff varies from year to year, it is unlikely for firms to know the exact value of the threshold in advance. Thus firms should not be able to control their market capitalizations and determine on which side of the threshold they are to be located. In this setting, the market capitalizations for Russell 1000/2000 index firms are continuous. Firms around the threshold exhibit similar characteristics. However, there is sharp discontinuity in portfolio weights across the cutoff, and as a result firms at the top of Russell 2000 index have much higher institutional ownership than those at the bottom of Russell 1000 index, due to indexing and benchmarking from institutional investors (Boone and White (2015)). In addition to the literature of indexing effect on asset prices, some other studies show evidence in corporate finance. For example, Crane, Michenaud, and Weston (2016) argue that firms with higher institutional ownership pay more dividends and repurchase more shares. Prado, Saffi, and Sturgess (2016) examine how ownership structure leads to limits to arbitrage through it impact on short-sale constraints.

2.3. Regression discontinuity design

Following Boone and White (2015), Calonico, Cattaneo, and Titiunik (2015), and Chang, Hong and Liskovich (2015), we implement regression discontinuity (RD) design to estimate the treatment effect of Russell 2000 index inclusion, by fitting a local third-order polynomial estimate using a triangular kernel to the left and right of the index cutoff. We investigate different fixed bandwidths and also the rule of thumb bandwidth described in Calonico, Cattaneo, and Titiunik

(2014) which corrects for non-negligible bias in the distributional approximation in the bandwidth choice.

We also use the regression discontinuity plots representing local sample means using ten non-overlapping evenly spaced bins on each side of the threshold. The lines represent a third-order polynomial regression curve. Before we analyze the indexing effect on option zero trading days, we first show graphs for the discontinuity in institutional ownership. Figure 1 Panel A reveals the large discontinuity in institutional ownership ratio (IOR) for firms within ± 200 bandwidth of the Russell 1000/2000 threshold. Firms located on the right-hand side of the cutoff point exhibit much higher levels of IOR compared with those on the left-hand side of the cutoff.

Following Bushee and Noe (2000) and Bushee (2001), we define quasi-indexer as the passive funds and those actively managed funds but mimic an index closely. They tend to have low turnover, high diversification and a long-term investment horizon. Transient institutional investors benchmark their performance to indexes and tend to have high turnover, high diversification and short-term investment horizon. Dedicated institutional investors have low turnover and long-term trading strategy in information opaque firms which they have direct engagement and private information. The total IOR is decomposed for the three types of institutional investors. As shown in Figure 1, most of the effects are from quasi-indexers (Panel B) and transient institutional investors (Panel C) defined as in. Dedicated IOR does not differ much between firms on both sides. These patterns are consistent with Boone and White (2015).

[Figure 1 about here]

3. Empirical results

In this section, we examine the indexing effect on number of option zero trading days using RD approach. We then randomly select pseudo cutoffs and repeat the test to see whether our treatment effect only exists around the true threshold of Russell 1000/2000 index.

3.1. The indexing effect on number of option zero trading day

We analyze the effect of stock market indexing on our measure of option market quality. Using the option NZVD defined in equation (1), we plot the third-order polynomial regression curve around the Russell 1000/2000 threshold for all options (Figure 2), call options (Figure 3), and put options (Figure 4). For each Russell 1000 and Russell 2000 member firm with exchange-traded options, NZVD is measured during 12 months following Russell index reconstitution, i.e., July through next June, for all options, call options, and put options with the firm's stock as underlying asset. In addition to the fixed bandwidths of ± 200, ± 300, and ± 400, we also calculate the respective optimal bandwidth following Calonico, Cattaneo, and Titiunik, (2014). Comparing the sample mean for firms at the bottom of Russell 1000 and firms at the top of Russell 2000, there is a significant discontinuity in option NZVD, implying that firms at the top of Russell 2000 have much smaller number of zero trading volume days, and thus a much lower implied trading cost and better liquidity. The magnitude of the sharp decrease in NZVD for put option is slightly larger than that for call option.

[Figure 2 about here]

[Figure 3 about here]

[Figure 4 about here]

Table 2 presents the bias-corrected RD treatment coefficient, τ, which indicates the average treatment effect of assignment to the Russell 2000 index on 12-month option NZVD. The RD coefficient, τ, is estimated by fitting a local third-order polynomial estimate using a triangular kernel to the left and right of the Russell 1000/2000 cutoff based on the bias-correction methodology in Calonico, Cattaneo, and Titiunik (2015). We first present the RD coefficient of τ for three fixed bandwidths around the Russell 1000/2000 threshold, i.e., ± 200, ± 300, and ± 400. We also follow the selection procedures in Calonico, Cattaneo, and Titiunik (2014) to estimate the rule of thumb bandwidth, and present the RD coefficient of τ for the optimal bandwidth. *z*-statistics are in parentheses.

[Table 2 about here]

Consistent with the RD plots, we find that firms at the top of Russell 2000 exhibit discontinuously lower NZVD in options than firms at the bottom of Russell 1000. The treatment effect of assignment into Russell 2000 is negative and statistically significant. With the optimal bandwidth, the treatment effect for all options is –54.8237 (z-statistic = –5.16), indicating that the average number of zero trading days is about 55 days less if the firm is at the top of Russell 2000 index, compared with a similar sized firm that is at the bottom of Russell 1000 index. This difference is quite close to the mean NZVD for all options, which is 60 days, suggesting that the implied trading cost is significantly mitigated with indexing and option liquidity is highly improved.

We also confirm the finding that number of zero trading days in put options are affected more, given the larger magnitude of treatment τ, –72.0492 using optimal bandwidth (z-statistic = –5.71), compared with that for call options, –58.7474 (z-statistic = –5.14).

3.2. Pseudo-threshold

In order to show that the change in option NZVD is due to index inclusion, we validate that the sharp discontinuity only exists around the cutoff point, which is the firm with market capitalization ranked at 1000th in our setting.

Table 3 shows regression discontinuity analysis of option NZVD around pseudo-thresholds, where we use 950th ranked firm as the cutoff point. Clearly, none of the treatment effect is statistically significant. This confirms that our finding of the sharp discontinuity in NZVD only exists around the true Russell 1000/2000 cutoff. Firms ranked below but near 1000th ranked firm have discontinuously fewer zero trading days as a result of more trading from transient institutional investors. However, firms around pseudo-cutoff do not exhibit this discontinuity.

[Table 3 about here]

4. Additional analyses and robustness tests

In this section, we confirm our main finding using an alternative methodology of two-stage least squares regression, followed by several robustness tests.

4.1. Instrumental variables

In this subsection, we adopt a two-stage least squares regression approach with instrumental variables as an alternative methodology. It helps to resolve the concern that other unobserved variables may be different for firms near the cutoff, thus leading to a violation of the assumption for the RD approach.

Following Prado, Saffi, and Sturgess (2016), we run a first stage regression within ± 300 bandwidth around the cutoff point that instruments for total IOR based on the specification

$$IOR_{it} = \alpha_i + \alpha_t + \tau_0 D_{it} + \sum_{j=1}^{2} \tau_i R_{it}^{j} + \sum_{j=1}^{2} \kappa_i D_{it} R_{it}^{j} + X'\delta + \xi_{it} \quad (2)$$

where R_{it} is the rank distance from the Russell 1000/2000 threshold based on the June reconstitution (centered at zero around the threshold), and D_{it} is a dummy variable which equals to one if the firm *i* is included in Russell 2000 at time *t*. The superscript j takes the value of one and two to take into account the non-linear relationship between ranking distance and the institutional ownership.

The second stage below shows the proxy for option market quality, i.e., NZVD, as a function of instrumented IOR.

$$Y_{it} = \theta_i + \theta_t + \gamma_1 \widehat{IOR_{it}} + X'\beta + \varepsilon_{it} \tag{3}$$

We conduct two-stage least squares regressions with a set of control variables *X* as used in Lin and Lu (2015) and Roll, Schwartz, and Subrahmanyam (2010). Size is the natural logarithm of previous fiscal year-end market capitalization and B/M is the book-to-market ratio. We define the 12 months after each Russell reconstitution as Ryear, i.e., July through next June. For each Ryear, implied volatility is the open-interest weighted average option implied volatility. Delta is open-interest weighted average option delta, where put option delta is reversed in sign. Stock bid-ask spread is the average of daily stock spread calculated as the difference between best-offer and best-bid price divided by the mid-point of the two, in percentage. Stock return is the compounded daily return. VIX is the average daily VIX. S&P500 index return is the compounded daily return on S&P500 index. We also include lag stock return, lag stock return volatility, and lag stock return skewness for the previous Ryear. All regressions are estimated for the 12 months after each Russell index reconstitution, with year fixed effect and industry fixed effect.

We report the first stage regression coefficients in Panel A of Table 4. Column 1 shows that firms ranked close to the cutoff but in Russell 2000 index have higher level of total IOR than similar-sized firms in Russell 1000. IOR decreases (increases) as the firm moves away from the threshold into Russell 2000 (1000). In the second stage, we find that instrumented total IOR is negatively correlated with option NZVD for all options, call options and put options, as shown in columns 1, 3, and 5 in Panel B. This is consistent with the finding in Table 3 that higher institutional ownership is associated with fewer non-trading days.

We further break down the total IOR into quasi-indexer IOR, transient IOR, and dedicated IOR, and then repeat the two-stage regressions. Consistent with our RD plots for IOR in Figure 1, dedicated IOR in stage one is not significantly different for firms on the two sides of the threshold. Thus only quasi-indexer IOR and transient IOR are adopted as the instrumented variables in stage two, as reported in columns 2, 4, and 6 in Panel B of Table 4. Instrumented transient IOR is significantly negatively correlated with option NZVD, while instrumented quasi-indexer IOR shows no significance. This is in line with our conjecture that the effect of indexing on the number of option zero trading days is mostly due to the trading from actively managed funds and hedge funds who tend to incorporate options into their strategies.

[Table 4 about here]

4.2. Robustness

As the time-to-expiration of traded options are normally several months, we first check whether our results hold using shorter horizons of the option zero trading day measure. Table 5 shows the RD treatment effect on 6-month NZVD and 3-month NZVD, which are consistently negative and significant, with smaller magnitude compared with the τ in Table 2

[Table 5 about here]

In Table 6, we repeat the RD analysis using a different construction of NZVD measure as in equation (4), which is the standardized number of zero volume trading without adjustment of turnover. This gives very similar results to our main results, with only slight difference in treatment τ.

$$NZVD_x = [No.\ of\ zero\ daily\ volumes\ in\ x\ months] \times \frac{21x}{NoTD}. \quad (4)$$

[Table 6 about here]

Another robustness is on a different measure of liquidity such as turnover. Table 7 shows significantly positive treatment effect on option turnover using the RD approach, which is consistent with our expectation.

[Table 7 about here]

5. Conclusion

Past literature on asset pricing effect of indexing focuses on the stock market price impact. We are the first, to the best of our knowledge, to examine the indexing effect on option market quality. In particular, we are interested in the number of option zero trading days. Option trading cost is way higher than that for stock, and this measure has a much larger magnitude in option market than in stock market, thus the concept of zero trading day is even more pronounced in option market.

Using RD design in the setting of annual Russell 1000/2000 index reconstitution, we resolve the confounding effect of index inclusion which have been questioned in other papers. Following Boone and White (2015), Chang, Hong, and Liskovich (2015), and Crane, Michenaud, and Weston (2016), we find a negative and significant RD treatment effect, which indicates a much fewer option zero trading days for firms at the top of Russell 2000 index, compared with similar-sized firms at the bottom of Russell 1000 index.

We also show supporting evidence using an alternative methodology with instrumental variables, as in Prado, Saffi, and Sturgess (2016). We find that instrumented total IOR is negatively correlated with option zero trading day measure. The IOR from transient institutional investors shows strong relationship, which is consistent with our expectation that these institutional investors actively trade options as part of their strategies. Our main results also hold for other time horizons and the alternative construction of the zero trading day measure.

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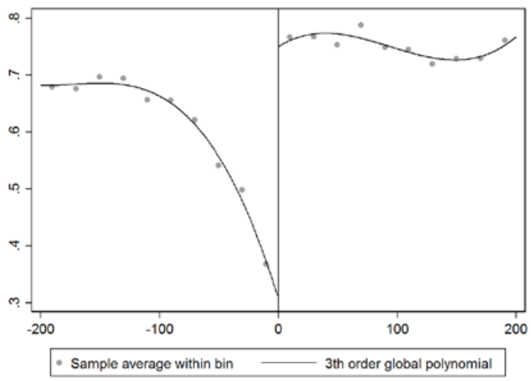
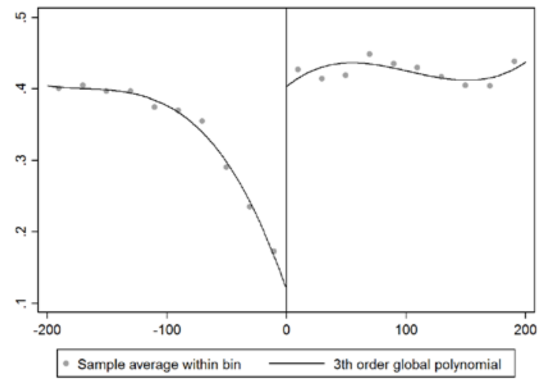
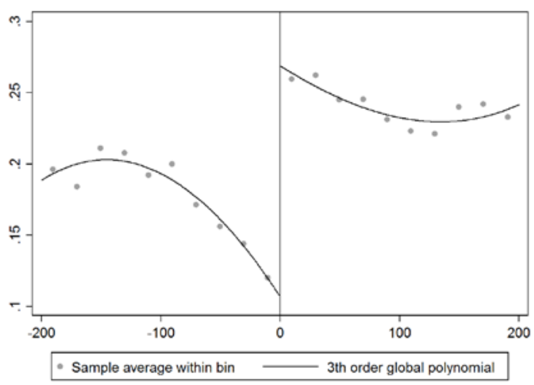
Panel A: Fixed bandwidth of ± 200 for IOR



Panel B: Fixed bandwidth of ± 200 for Quasi IOR



Panel C: Fixed bandwidth of ± 200 for Transient IOR



Panel D: Fixed bandwidth of ± 200 for Dedicated IOR

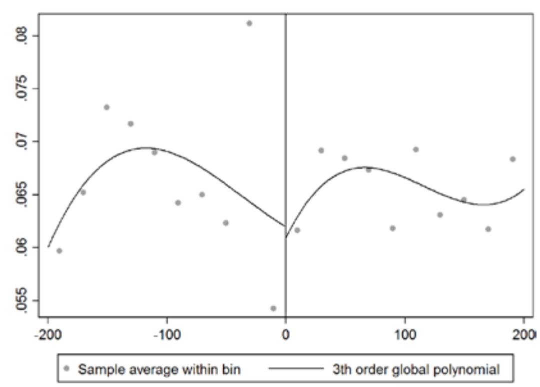
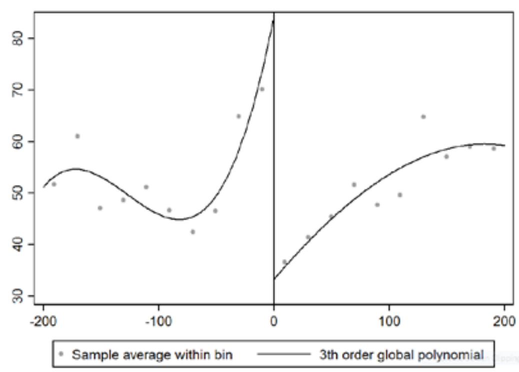


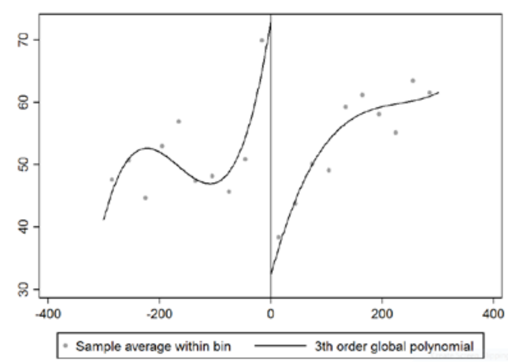
Fig 1: Percentage institutional ownership ratio around the Russell 1000/2000 threshold

This graph displays the function form and fitted regression curves of institutional ownership ratios for firms around the Russell 1000/2000 threshold for our sample period with a fixed bandwidth of ± 200. In Panel A, the y-axis represents the institutional ownership ratio, which is computed as the total institutional ownership scaled by total shares outstanding. In Panel B, the x-axis represents the quasi-indexers ownership ratio, which is computed as the quasi-indexers ownership scaled by total shares outstanding. In Panel C, the x-axis represents the transient institutional ownership ratio, which is computed as the transient institutional ownership scaled by total shares outstanding. In Panel D, the x-axis represents the dedicated institutional ownership ratio, which is computed as the dedicated institutional ownership scaled by total shares outstanding. The x-axis is the distance, which represents the relative position of a firm to the cutoff point (the 1,000th firm), centered at zero, between the Russell 1000 index and the Russell 2000 index each year based on the end-of-May market capitalization. Negative values represent the Russell 1000, and positive values represent the Russell 2000. The regression discontinuity plots represent local sample means using ten non-overlapping evenly spaced bins on each side of the threshold. The lines represent a third-order polynomial regression curve (Calonico, Cattaneo, and Titiunik (2015)).

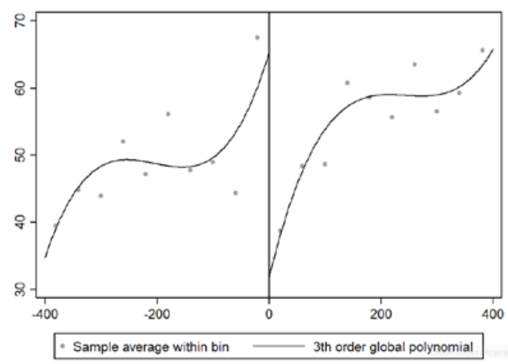
Panel A: Fixed bandwidth of ± 200



Panel B: Fixed bandwidth of ± 300



Panel C: Fixed bandwidth of ± 400



Panel D: Optimal bandwidth of ± 337

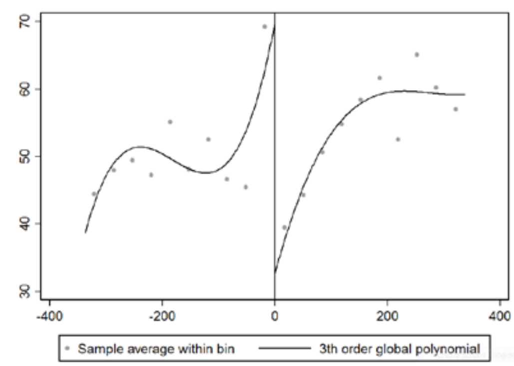
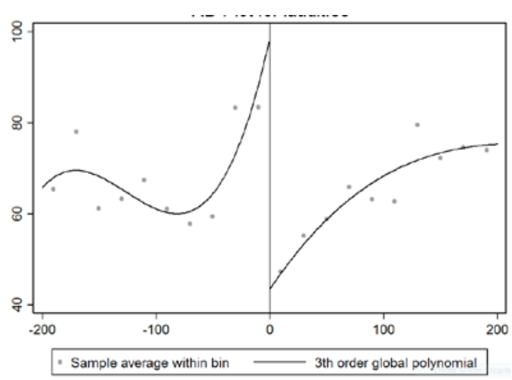


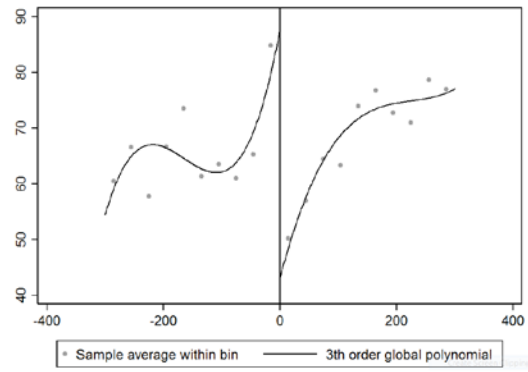
Fig 2: Number of zero volume days around the Russell 1000/2000 threshold (all options)

This graph displays the function form and fitted regression curves of the number of zero volume days (NZVD) of all options for firms around the Russell 1000/2000 threshold for our sample period. The x-axis is the distance, which represents the relative position of a firm to the cutoff point (the 1,000th firm), centered at zero, between the Russell 1000 index and the Russell 2000 index each year based on the end-of-May market capitalization. Negative values represent the Russell 1000, and positive values represent the Russell 2000. In Panel A, we present the graph for the fixed bandwidth of ± 200. In Panel B, we present the graph for the fixed bandwidth of ± 300. In Panel C, we present the graph for the fixed bandwidth of ± 400. In Panel D, we present the graph based on the rule of thumb bandwidth of ± 337 (Calonico, Cattaneo, and Titiunik (2014)). The regression discontinuity plots represent local sample means using ten non-overlapping evenly spaced bins on each side of the threshold. The lines represent a third-order polynomial regression curve (Calonico, Cattaneo, and Titiunik (2015)).

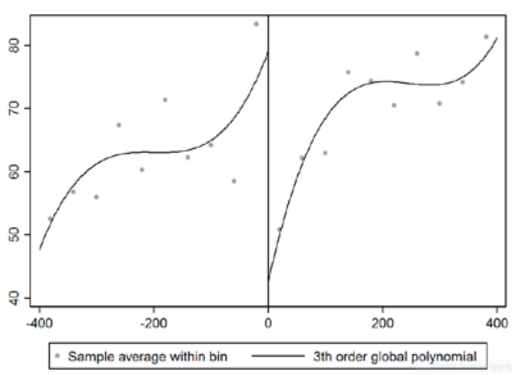
Panel A: Fixed bandwidth of ± 200



Panel B: Fixed bandwidth of ± 300



Panel C: Fixed bandwidth of ± 400



Panel D: Optimal bandwidth of ± 342

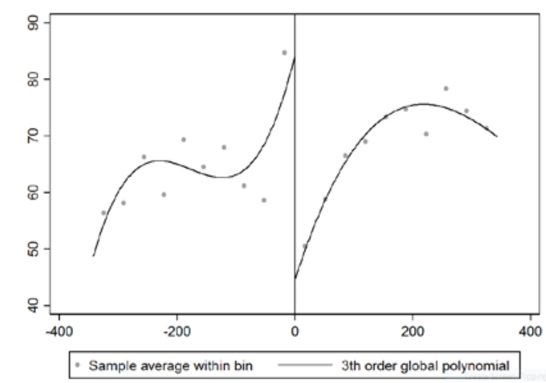
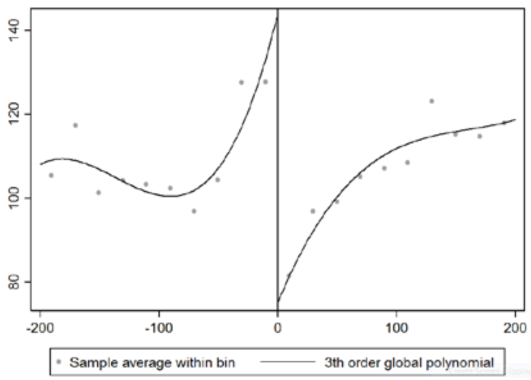


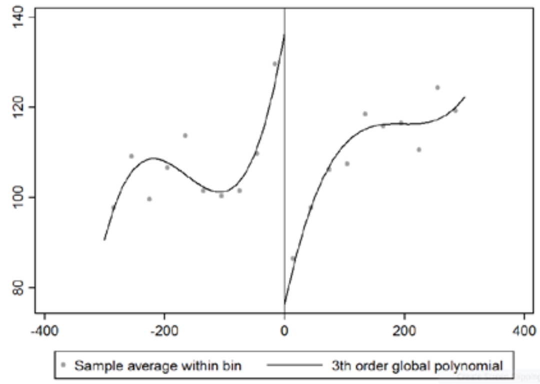
Fig 3: Number of zero volume day around the Russell 1000/2000 threshold (call options)

This graph displays the function form and fitted regression curves of the number of zero volume days (NZVD) of call options for firms around the Russell 1000/2000 threshold for our sample period. The x-axis is the distance, which represents the relative position of a firm to the cutoff point (the 1,000th firm), centered at zero, between the Russell 1000 index and the Russell 2000 index each year based on the end-of-May market capitalization. Negative values represent the Russell 1000, and positive values represent the Russell 2000. In Panel A, we present the graph for the fixed bandwidth of ± 200. In Panel B, we present the graph for the fixed bandwidth of ± 300. In Panel C, we present the graph for the fixed bandwidth of ± 400. In Panel D, we present the graph based on the rule of thumb bandwidth of ± 337 (Calonico, Cattaneo, and Titiunik (2014)). The regression discontinuity plots represent local sample means using ten non-overlapping evenly spaced bins on each side of the threshold. The lines represent a third-order polynomial regression curve (Calonico, Cattaneo, and Titiunik (2015)).

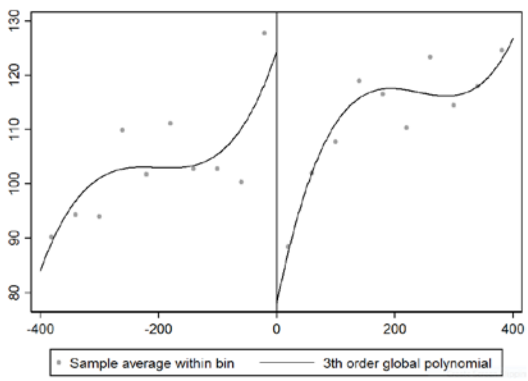
Panel A: Fixed bandwidth of ± 200



Panel B: Fixed bandwidth of ± 300



Panel C: Fixed bandwidth of ± 400



Panel D: Optimal bandwidth of ± 313

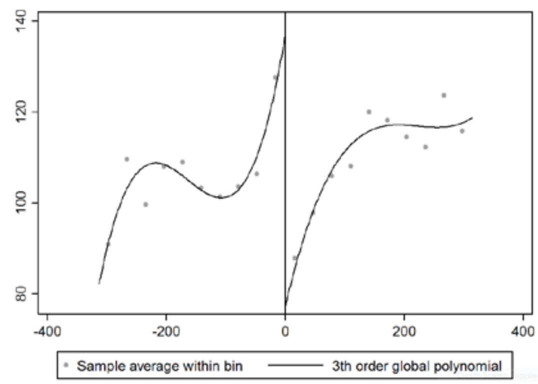


Fig 4: Number of zero volume day around the Russell 1000/2000 threshold (put options)

This graph displays the function form and fitted regression curves of the number of zero volume days (NZVD) of put options for firms around the Russell 1000/2000 threshold for our sample period. The x-axis is the distance, which represents the relative position of a firm to the cutoff point (the 1,000th firm), centered at zero, between the Russell 1000 index and the Russell 2000 index each year based on the end-of-May market capitalization. Negative values represent the Russell 1000, and positive values represent the Russell 2000. In Panel A, we present the graph for the fixed bandwidth of ± 200. In Panel B, we present the graph for the fixed bandwidth of ± 300. In Panel C, we present the graph for the fixed bandwidth of ± 400. In Panel D, we present the graph based on the rule of thumb bandwidth of ± 337 (Calonico, Cattaneo, and Titiunik (2014)). The regression discontinuity plots represent local sample means using ten non-overlapping evenly spaced bins on each side of the threshold. The lines represent a third-order polynomial regression curve (Calonico, Cattaneo, and Titiunik (2015)).

Table 1: Summary statistics

This table reports the summary statistics for the number of zero trading volume days (NZVD) for stocks, all options, call options, put options, and for different moneyness, i.e., ITM, OTM, and OTM, respectively.

	Moneyness	No. of Obs.	Mean	Std	Q1	Median	Q3
Stock		73,703	13.07	32.63	0	0	4.89
All Option		24,021	60.15	69.43	1	29	106
Call Option		23,882	69.6	71.96	3	44.71	124
Call Option	*ATM*	23,316	101.59	76.06	27.44	98.39	168.3
Call Option	*ITM*	23,053	131.6	78.94	61	145.46	201.71
Call Option	*OTM*	23,126	124.39	82.75	43	135.69	200.57
Put Option		23,762	114.09	83.53	27.44	119.33	192
Put Option	*ATM*	22,868	156.93	75.39	104.81	180.6	220.5
Put Option	*ITM*	22,350	183.63	70.8	152.82	213.23	236.7
Put Option	*OTM*	22,674	146.72	83.36	75.8	171	220.93

Table 2: Regression treatment effect analysis of option NZVD

This table presents the bias-corrected regression discontinuity (RD) treatment coefficient, τ, which indicates the average treatment effect of assignment to the Russell 2000 index on 12-month option NZVD. The RD coefficient, τ, is estimated by fitting a local third-order polynomial estimate using a triangular kernel to the left and right of the Russell 1000/2000 index cutoff based on the bias-correction methodology in Calonico, Cattaneo, and Titiunik, (2015). In columns (1), (2), and (3), we present the RD coefficients of τ for three fixed bandwidths around the Russell 1000/2000 threshold, i.e., ± 200, ± 300, and ± 400. In columns (4), we follow the selection procedures in Calonico, Cattaneo, and Titiunik (2014) to estimate the rule of thumb bandwidth, and present the RD coefficient of τ for the optimal bandwidth. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. *z*-statistics are in parentheses.

	(1)	(2)	(3)	(4)
		ALL OPTION		
Bandwidth	± 200	± 300	± 400	Rule of Thumb
Treatment τ	-56.7191***	-50.1908***	-43.1070***	-54.8237***
z-Statistics	(-4.81)	(-5.45)	(-5.55)	(-5.16)
		CALL OPTION		
Bandwidth	± 200	± 300	± 400	Rule of Thumb
Treatment τ	-60.7506***	-53.7515***	-46.6161***	-58.7474***
z-Statistics	(-4.82)	(-5.39)	(-5.51)	(-5.14)
		PUT OPTION		
Bandwidth	± 200	± 300	± 400	Rule of Thumb
Treatment τ	-72.8104***	-69.2665***	-61.5023***	-72.0492***
z-Statistics	(-5.25)	(-6.24)	(-6.45)	(-5.71)

Table 3: Pseudo-threshold for regression discontinuity analysis

This table presents the bias-corrected regression discontinuity (RD) treatment coefficient, τ, which indicates the average treatment effect of assignment to the Russell 2000 index on NZVD for pseudo-thresholds of 950th ranked firm. The RD coefficient, τ, is estimated by fitting a local third-order polynomial estimate using a triangular kernel to the left and right of the Russell 1000/2000 cutoff based on the bias-correction methodology in Calonico, Cattaneo, and Titiunik, (2015). We also present the RD coefficient of τ for three fixed bandwidths around the Russell 1000/2000 threshold, i.e., ± 200, ± 300, and ± 400. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. *z*-statistics are in parentheses.

	(1)	(2)	(3)
		ALL OPTION	
Bandwidth	± 200	± 300	± 400
Treatment τ	-1.1113	6.8711	5.5130
z-Statistics	(0.12)	(0.88)	(0.82)
		CALL OPTION	
Bandwidth	± 200	± 300	± 400
Treatment τ	2.1273	7.6406	5.5017
z-Statistics	(0.20)	(0.88)	(0.74)
		PUT OPTION	
Bandwidth	± 200	± 300	± 400
Treatment τ	3.7130	6.9570	2.9024
z-Statistics	(0.29)	(0.67)	(0.33)

Table 4: The two stage regressions with instrumental variables

This table presents the results of two-stage least squares (2SLS) regressions using an instrumental variable estimation during our sample period for the fixed bandwidth of ± 300 around the Russell 1000/2000 threshold. In Panel A, we include the results of the first-stage least squares regression. We examine the effect of the Russell index inclusion on total institutional ownership ratio (IOR), quasi-indexer IOR, transient IOR, and dedicated IOR, respectively. Dum2000 is a dummy variable, which equals one if firm *i* is included in the Russell 2000 index in year *t*. Distance is the rank distance from the Russell 1000/2000 cutoff, which is centered at zero around the threshold. The quadratic power of distance is also included to control for any non-linear relationship between ranking distance and IOR. We also include interaction terms. In Panel B, we present the second stage results of regressing number of zero volume days (NZVD) on instrumented total IOR (InstrumentedIOR), instrumented quasi-indexer IOR (InstrumentedQXIOR) and instrumented transient IOR (InstrumentedTRANIOR). In Panel B columns (1) and (2), we report the results for all options. In columns (3) and (4), we report the results for call options. In columns (5) and (6), we report the results for put options. IOR is in percentage. We multiply size, implied volatility, delta with 100 and multiply lag return volatility with 1000, so that the coefficients are in a reasonable magnitude. All of the regressions include year and industry fixed effects and standard errors are clustered at the industry level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The *t*-statistics are in parentheses.

Panel A: Stage One				
	(1)	(2)	(3)	(4)
	IOR	QUASI IOR	TRANSIENT IOR	DEDICATED IOR
Dum2000	38.1042***	23.5140***	13.3641***	0.0122
	(11.72)	(12.46)	(10.25)	(0.49)
Distance	32.4669***	20.8571***	11.4448***	0.0040
	(8.69)	(9.66)	(8.76)	(0.13)
Dum2000×Distance	-37.9703***	-25.3693***	-12.6876***	-0.0040
	(-8.74)	(-9.98)	(-7.21)	(-0.12)
Distance^2	-7.3053***	-4.7858***	-2.4634***	-0.0015
	(-7.56)	(-8.14)	(-6.34)	(-0.21)
Dum2000×Distance^2	7.8687***	5.6069***	2.3974***	0.0005
	(6.98)	(7.87)	(4.53)	(0.07)
Size	-1.6105***	-1.1492***	-0.7681***	0.0028
	(-3.66)	(-5.54)	(-5.72)	(0.70)
Implied Vol	0.2113***	-0.0440	0.1896***	0.0006*
	(2.61)	(-1.01)	(4.75)	(1.95)
Delta	-0.2845***	-0.1651***	-0.0784**	-0.0003
	(-4.39)	(-4.34)	(-2.40)	(-0.67)
B/M	0.3184	1.5613***	-1.7711***	0.0056
	(0.42)	(3.45)	(-4.62)	(1.05)
Stock Bid-ask Spread	-1.3441*	-0.0109	-0.6421	-0.0052*
	(-1.74)	(-0.03)	(-1.62)	(-1.84)
Lag Stock Ret	-1.2227**	-2.5582***	1.7203***	-0.0046**
	(-2.05)	(-7.85)	(4.92)	(-2.30)
Lag Ret Volatility	-4.3228***	-2.5702***	-1.3568***	-0.0055***
	(-7.66)	(-8.42)	(-4.11)	(-3.09)

Lag Ret Skewness	-0.4090	-0.2307	-0.3052*	0.0009
	(-1.31)	(-1.12)	(-1.90)	(0.61)
VIX	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
S&P Ret	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
Stock Ret	-0.0040	-0.2484	-0.3186	0.0039
	(-0.01)	(-0.57)	(-0.75)	(1.30)
Year Fixed Effect	Y	Y	Y	Y
Industry Fixed Effect	Y	Y	Y	Y
No. Obs.	3,177	3,177	3,177	3,177
R^2	0.4235	0.7025	0.4733	0.1694

Panel B: Stage 2						
	ALL OPTION		CALL OPTION		PUT OPTION	
	(1)	(2)	(3)	(4)	(5)	(6)
InstrumentedIOR	-1.0326***		-1.1565***		-1.2687***	
	(-6.70)		(-6.85)		(-6.81)	
InstrumentedQXIOR		1.6442		1.0083		1.5425
		(1.63)		(1.11)		(1.22)
InstrumentedTRANIOR		-5.5114***		-4.8404***		-6.0006***
		(-3.41)		(-3.31)		(-3.00)
Size	-4.8978***	-5.4242***	-5.7541***	-6.2666***	-6.8432***	-7.4799***
	(-11.03)	(-11.69)	(-12.47)	(-12.96)	(-13.56)	(-13.96)
Implied Vol	-1.6771***	-0.7932**	-1.8967***	-1.1920***	-2.8038***	-1.8867***
	(-8.75)	(-2.03)	(-8.81)	(-3.13)	(-14.72)	(-4.02)
Delta	0.7997***	0.9345***	-0.0931	0.0253	0.5470***	0.6768***
	(4.33)	(4.95)	(-0.56)	(0.15)	(3.61)	(4.26)
B/M	2.0155	-10.0890**	3.7716**	-6.2877	6.4895***	-6.3361
	(1.29)	(-2.20)	(2.16)	(-1.50)	(3.23)	(-1.11)
Stock Bid-ask Spread	1.8885	-0.3510	-0.3844	-1.9875	6.5118***	4.1953*
	(1.07)	(-0.17)	(-0.19)	(-0.88)	(3.56)	(1.87)
Lag Stock Ret	-2.5002**	11.9221**	-2.6670**	9.3030*	-2.5028*	12.4236*
	(-2.19)	(2.30)	(-2.18)	(1.93)	(-1.68)	(1.91)
Lag Ret Volatility	-3.5993***	-2.3877*	-5.0590***	-4.0369***	-7.5073***	-6.1220***
	(-2.77)	(-1.83)	(-3.72)	(-3.02)	(-4.93)	(-3.91)
Lag Ret Skewness	-0.2349	-1.0554	-0.6743	-1.3980*	0.6653	-0.1957
	(-0.34)	(-1.43)	(-0.86)	(-1.72)	(0.79)	(-0.22)
VIX	3.6252***	3.6567***	4.5798***	4.6214***	6.0672***	6.1143***
	(13.14)	(13.29)	(15.44)	(15.61)	(18.29)	(18.42)
S&P Ret	21.3368	19.6351	13.3106	11.2302	6.0327	4.3084
	(1.22)	(1.11)	(0.66)	(0.55)	(0.25)	(0.18)
Stock Ret	-22.3395***	-23.9075***	-26.9958***	-28.4284***	-14.5778***	-16.5807***
	(-12.97)	(-13.59)	(-10.83)	(-11.29)	(-6.03)	(-6.83)
Year Fixed Effect	Y	Y	Y	Y	Y	Y
Industry Fixed Effect	Y	Y	Y	Y	Y	Y
No. Obs.	3,176	3,176	3,175	3,175	3,167	3,167
R^2	0.4350	0.4375	0.4719	0.4732	0.5404	0.5424

Table 5: Regression treatment effect on different horizons

This table presents the bias-corrected regression discontinuity (RD) treatment coefficient, τ, which indicates the average treatment effect of assignment to the Russell 2000 index with different horizons of option zero trading day measure. In Panel A, option NZVD is measured for the 6 months after annual Russell reconstitution, and Panel B is for 3-month option NZVD. The RD coefficient, τ, is estimated by fitting a local third-order polynomial estimate using a triangular kernel to the left and right of the Russell 1000/2000 index cutoff based on the bias-correction methodology in Calonico, Cattaneo, and Titiunik, (2015). We present the RD coefficients of τ for three fixed bandwidths around the Russell 1000/2000 threshold, i.e., ± 200, ± 300, and ± 400. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. *z*-statistics are in parentheses.

Panel A: 6-month option NZVD			
	(1)	(2)	(3)
ALL OPTION			
Bandwidth	± 200	± 300	± 400
Treatment τ	-28.0336***	-24.6937***	-21.7356***
z-Statistics	(-4.65)	(-5.20)	(-5.41)
CALL OPTION			
Bandwidth	± 200	± 300	± 400
Treatment τ	-30.7466***	-27.0500***	-24.3432***
z-Statistics	(-4.73)	(-5.23)	(-5.52)
PUT OPTION			
Bandwidth	± 200	± 300	± 400
Treatment τ	-36.3376***	-34.6153***	-31.0036***
z-Statistics	(-5.15)	(-6.11)	(-6.37)

Panel B: 3-month option NZVD			
	(1)	(2)	(3)
ALL OPTION			
Bandwidth	± 200	± 300	± 400
Treatment τ	-10.7183***	-10.7829***	-9.8691***
z-Statistics	(-3.53)	(-4.55)	(-4.93)
CALL OPTION			
Bandwidth	± 200	± 300	± 400
Treatment τ	-12.9019***	-12.4630***	-11.6284***
z-Statistics	(-3.90)	(-4.74)	(-5.20)
PUT OPTION			
Bandwidth	± 200	± 300	± 400
Treatment τ	-15.8907***	-16.1871***	-14.6829***
z-Statistics	(-4.28)	(-5.50)	(-5.84)

Table 6: Variation of option NZVD

This table presents the bias-corrected regression discontinuity (RD) treatment coefficient, τ, which indicates the average treatment effect of assignment to the Russell 2000 index on a variation of NZVD in the main result. As defined in equation (4), we calculate the standardized number of zero volume days without adjusting for turnover. This measure is quite close to the NZVD in equation (1) in magnitude. The RD coefficient, τ, is estimated by fitting a local third-order polynomial estimate using a triangular kernel to the left and right of the Russell 1000/2000 index cutoff based on the bias-correction methodology in Calonico, Cattaneo, and Titiunik, (2015). We present the RD coefficients of τ for three fixed bandwidths around the Russell 1000/2000 threshold, i.e., ± 200, ± 300, and ± 400. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. *z*-statistics are in parentheses.

	(1)	(2)	(3)
		ALL OPTION	
Bandwidth	± 200	± 300	± 400
Treatment τ	-56.9886***	-50.6552***	-44.2339***
z-Statistics	(-4.84)	(-5.51)	(-5.70)
		CALL OPTION	
Bandwidth	± 200	± 300	± 400
Treatment τ	-60.8885***	-54.6645***	-48.2075***
z-Statistics	(-4.84)	(-5.50)	(-5.71)
		PUT OPTION	
Bandwidth	± 200	± 300	± 400
Treatment τ	-72.2348***	-68.9182***	-61.7568***
z-Statistics	(-5.21)	(-6.21)	(-6.49)

Table 7: Regression treatment effect of option turnover

This table presents the bias-corrected regression discontinuity (RD) treatment coefficient, τ, which indicates the average treatment effect of assignment to the Russell 2000 index on option turnover, for 6 months after each Russell reconstitution. Turnover is calculated as the trading volume in options (in number of shares) divided by shares outstanding. The RD coefficient, τ, is estimated by fitting a local third-order polynomial estimate using a triangular kernel to the left and right of the Russell 1000/2000 index cutoff based on the bias-correction methodology in Calonico, Cattaneo, and Titiunik, (2015). We present the RD coefficients of τ for three fixed bandwidths around the Russell 1000/2000 threshold, i.e., ± 200, ± 300, and ± 400. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. *z*-statistics are in parentheses.

	(1)	(2)	(3)
		ALL OPTION	
Bandwidth	± 200	± 300	± 400
Treatment τ	0.0006*	0.0006***	0.0006***
z-Statistics	(1.94)	(2.60)	(3.17)
		CALL OPTION	
Bandwidth	± 200	± 300	± 400
Treatment τ	0.0004**	0.0004***	0.0004***
z-Statistics	(2.18)	(2.72)	(3.22)
		PUT OPTION	
Bandwidth	± 200	± 300	± 400
Treatment τ	0.0002	0.0002**	0.0002***
z-Statistics	(1.57)	(2.32)	(2.93)