The Passive-Ownership Share Is Double What You Think It Is*

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Abstract

Each time a stock gets added to or dropped from a benchmark index, we ask: "How much money would have to be tracking that index to explain the huge spike in rebalancing volume we observe on reconstitution day?" While index funds held 16% of the US stock market in 2021, we put the true passive-ownership share at 33.3%. Our headline number is twice as large because it reflects index funds as well as other kinds of passive investors, such as direct indexers and active managers who are closet indexing.

Keywords: Passive Ownership, Index-Linked Investing, Prearranged Trades, Index Funds, Direct Indexers, Reconstitution Day

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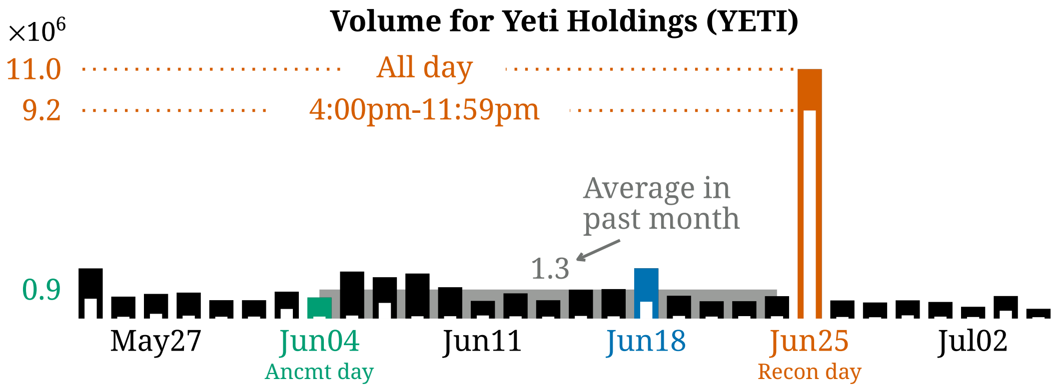

Figure 1. Volume for Yeti Holdings (YETI) around Russell reconstitution day 2021 in millions of shares. Solid bars represent total volume each day. White bars represent volume from 4:00pm to 11:59pm. On June 4th (green), FTSE Russell announced that Yeti would join the Russell 1000 following market close on June 25th (red). June 18th (blue) was a triple witching day on the 3rd Friday in June. Grey region is average daily volume from June 4th to 24th.

Introduction

Passive investors trade less than active investors. But they still have to trade when a stock gets added to or dropped from their benchmark index. And most of their rebalancing takes place on reconstitution days. We use this burst of rebalancing volume to estimate the true scale of passive investing. Each time a stock gets added to or dropped from a benchmark index, we ask: “How much money would have to be tracking that index in order to explain all the reconstitution-day volume we observe in the data?”

Consider Yeti Holdings (YETI), which was added to the Russell 1000 on June 25th 2021. Yeti initially represented 0.02% of the Russell 1000 and had a closing price of $92.07 per share on June 25th. FTSE Russell announced the change on June 4th, but everyone could see it coming months in advance. Nevertheless, in spite of having ample notice, Yeti’s volume was flat in the days leading up to reconstitution at 1.3 million shares per day. Then, it suddenly spiked to 11.0 million shares on reconstitution day itself.

Suppose Yeti’s entire spike in volume on June 25th came from Russell 1000 rebalancing. If that were the case, then passive investors would have spent

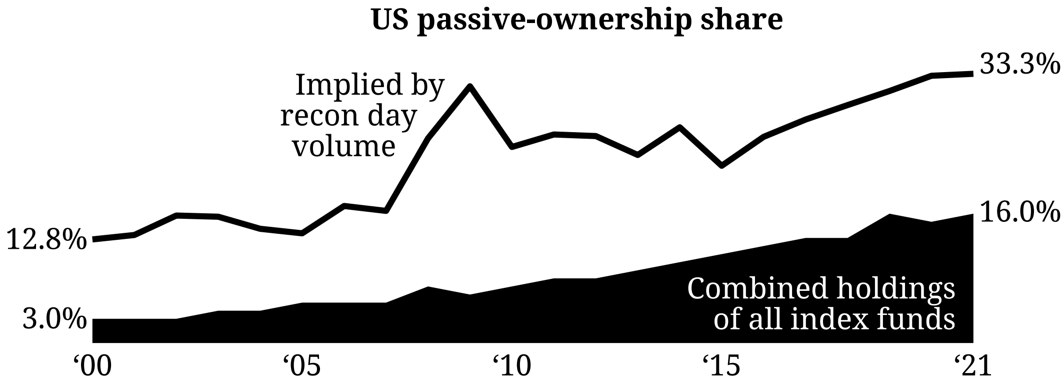

Figure 2. Black line depicts the percent of the US stock market owned by passive investors tracking the S&P 500, S&P MidCap 400, Russell 1000, Russell 2000, and Nasdaq 100. Calculation is based on total volume experienced by index additions and deletions on reconstitution day. Black ribbon shows that percent of the US stock market owned by domestic index equity mutual funds and ETFs according to the Investment Company Institute (ICI). Sample: 2000 to 2021.

0.02% of their wealth purchasing $11.0m \times \$92.07 \approx \$1.0b$ in Yeti shares:

$$\underbrace{\mathit{AUMindexed} \times \overset{0.02\%}{\mathit{IndexWeight}}}_{\text{value of required position}} = \underbrace{\overset{11.0m}{\mathit{ReconDayVolume}} \times \overset{\$92.07}{\mathit{Price}}}_{\text{value of shares purchased}} \tag{1}$$

Hence, Russell 1000 investors must have had $\frac{11.0m \times \$92.07}{0.02\%} = \$5.3t$ in assets under management (AUM) given Yeti's spike in reconstitution-day volume.

We perform this same calculation for five popular benchmark indexes: the Russell 1000, the Russell 2000, the S&P 500, the S&P MidCap 400, and the Nasdaq 100. Each individual addition to and deletion from an index produces a separate estimate for the total amount of money tracking the index. Each year from 2000 to 2021, we take the average of all estimates for each of our five indexes. We then sum the five annual averages and divide by total US stock-market capitalization.

Our estimates for the US passive-ownership share in Figure 2 are twice as large as previously thought. Investment Company Institute (2022, ICI) reports that index funds collectively held 16% of the US stock market in 2021. We put the true passive-ownership share at 33.3% in 2021. Our number is twice as large because "a lot of investors invest passively but do so outside the public universe of index funds and ETFs…Many big institutional investors hand bespoke index-mimicking mandates to the likes of BlackRock, State Street, or Vanguard, which don't appear in the formal index fund data."[1] These direct indexers show up in our 33.3%. They are missing from ICI's 16%.

The way that passive investors rebalance is noteworthy. We are only able to infer the US passive-ownership share from reconstitution-day volumes because passive investors rebalance all at once on reconstitution day. In fact, they often prearrange rebalancing trades weeks in advance. These prescheduled trades get executed at the closing price on reconstitution day, whatever that price happens to be. This is why 83.6% = 9.2*m* / 11.0*m* of Yeti's volume on June 25th 2021 occurred during or after the closing auction in Figure 1.

Passive investors are not uninformed. They dedicate substantial resources to managing reconstitution events, and there is an entire ecosystem that helps make this possible. Rebalancing facilitators start lining up liquidity providers months prior to reconstitution day (Madhavan, Ribando, and Udevbulu, 2022). And, until recently, these liquidity providers earned large profits for committing to rebalancing trades so far in advance.[2] At its peak, Goldman's equity index rebalancing desk reportedly "[generated] more revenue per employee than almost any other" at the company.[3]

Tesla's addition to the S&P 500 on December 18th 2020 shows what happens when this ecosystem collapses. In this particular case, passive investors found it hard to prearrange enough rebalancing trades given Tesla's enormous size. The initial announcement on November 17th caught many people by surprise. There was also a lot of uncertainty about "which current constituent Tesla [would] replace [or] how Tesla [would] be added. (S&P Dow Jones Indices, 2020b)" As a result, passive investors spread out their rebalancing trades during the days and weeks leading up to December 18th. Only 52.4% of the company's

[1] Robin Wigglesworth "How passive are markets, actually?" *The Financial Times.* Sep 4, 2022.

[2] Alex Morrell "'It can't get much worse than this': A trail of portfolio managers have resigned as the once lush index-rebalance strategy dries up." *Business Insider.* May 11, 2023.

[3] Sridhar Natarajan and Max Abelson "They Quit Goldman's Star Trading Team, Then the Bank Raised Alarms." *Bloomberg News.* Aug 1, 2022.

reconstitution-day volume occurred after hours. By comparing our estimate based on Tesla to those based on other nearby additions and deletions, we show that episodes like this one did not materially affect our results.

33.3% is a big number, but there are reasons to think that it might still be too low. For one thing, this point estimate for the US passive-ownership share only reflects the holdings of passive investors who are tracking five benchmark indexes. It does not reflect any passive holdings tracking the MSCI World or the CRSP Total Market indexes. These additional assets could substantially increase our headline numbers. For example, Vanguard's total equity holdings were \$4.4*t* as of December 2021, and most of these positions were benchmarked to CRSP indexes. This would push our 33.3% in 2021 up to 39.8%.

At the same time, if active investors are trading a lot on reconstitution days, then our 33.3% headline number might be too high. We address this concern by recomputing our estimates for the US passive-ownership share using increasingly narrow definitions of passive rebalancing volume. To get anywhere near 16%, we have to use a restrictive definition that excludes both active trading as well as large amounts of passive rebalancing.

It is important to be clear about who we are calling "passive". Our estimation strategy treats every \$1 that gets rebalanced in a sudden burst on reconstitution day as a \$1 that is passively invested. As a result, our 33.3% headline number likely contains assets held by active managers who are closet indexing. Index additions and deletions do not have elevated trading volume in the days around reconstitution. This implies that, when active managers closet index, they trade the passive portion of their portfolio exactly like any other passive investor would. There is very little evidence of loose index tracking.

Consider an active manager who has 20% of her \$1*b* in total AUM closet indexed to the Russell 1000 in June 2021. Unlike a Russell 1000 ETF, this active manager does not need to build a 0.02% position in Yeti all at once on reconstitution day. She could enter this position the week before. Yet Figure 1 shows no upward tilt in Yeti's volume prior to reconstitution. So this active manager must be rebalancing her \$200*m* position in the Russell 1000 all at once on reconstitution day, just like an ETF would. This is true even though she does not face the same explicit constraints as an ETF does. Our procedure counts this \$200*m* as passively invested money tracking the Russell 1000.

Right now, it is common for theorists to model passive investors as uninformed traders in Grossman and Stiglitz (1980). This paradigm assumes that the passive-ownership share is common knowledge and that these investors choose their demand after observing the price. Neither of these assumptions holds true in the data. The passive-ownership share cannot be common knowledge if previous estimates were off by a factor of two. And many passive investors choose to preschedule rebalancing trades before seeing the closing price. Instead of modeling passive investors as uninformed, theorists should focus on their defining feature: inelastic demand (e.g., see Haddad, Huebner, and Loualiche, 2022).

Our empirical results also contain important lessons for policymakers. Everyone in Las Vegas during the early 2000s realized that the number of out-of-town home buyers had skyrocketed (Chinco and Mayer, 2016). By contrast, no one noticed that the US passive-ownership share was twice as large as previously thought. This oversight says something about the magnitude and nature of its effect. The rise of passive investing could be harming markets. But, if it is, it is doing so in more subtle ways that are not captured by existing models.

Finally, our findings highlight the fact that investors have a choice about how to passively invest. Buying into an index fund is not the same thing as direct indexing. "People often forget that open-ended investment funds only hold a slice of markets, and conflate passive's mutual fund industry market share with its overall market ownership."[1] A world with less Blackrock, Vanguard, and State Street might not be a world with less passive investing. It might just be a world with more direct indexing.

Paper Outline

We describe our data in section 1. Then, in section 2, we report our main estimates for the US passive-ownership share. We paint a picture of what volume and prices look like for index additions and deletions in section 3. And we describe the mechanics of how passive investors rebalance in section 4.

Related Work

This paper builds on several strands of literature connected to index-linked investing (Wurgler, 2011). First, it used to be the case that, when a firm got added to a popular benchmark, its stock price rose (Harris and Gurel, 1986; Shleifer, 1986; Beneish and Whaley, 1996; Wurgler and Zhuravskaya, 2002; Madhavan, 2003; Petajisto, 2011). Index inclusions also affect correlations and liquidity (Barberis, Shleifer, and Wurgler, 2005; Greenwood, 2008; Baker, Bradley, and Wurgler, 2011; Chang, Hong, and Liskovich, 2015; Burnham, Gakidis, and Wurgler, 2018; Brogaard, Ringgenberg, and Sovich, 2019).

In particular, Greenwood and Sammon (2022) shows that the effect of index inclusion on prices has shrunk over time. This is true even though the passive-ownership share has grown dramatically over the past 20 years. Figure 2 shows that it went from 12.8% in 2000 to 33.3% in 2021. Together, these two findings strongly suggest that index-inclusion effects have more to do with how passive investors trade than with the overall size of the passive industry. Prescheduled rebalancing trades are an important topic for future academic research.

ETFs have experienced explosive growth in recent years (Madhavan, 2016; Lettau and Madhavan, 2018). There is evidence that the rise of ETFs has increased the closing volume and volatility for the stocks they hold (Ben-David, Franzoni, and Moussawi, 2018; Da and Shive, 2018; Chinco and Fos, 2021; Bogousslavsky and Muravyev, 2021). However, ETFs are just one particular kind of passive-investment vehicle. ETFs are not the only kind of passive investor rebalancing all at once on reconstitution day.

We recognize that ETFs are some of the most actively traded assets, and much of this trading activity comes from institutional investors (Robertson, 2019; Huang, O'Hara, and Zhong, 2021). Industry surveys regularly find that institutional investors are replacing index-futures positions with analogous positions in ETFs (Greenwich Associates, 2016). However, we are studying how passive investors, such as ETFs, rebalance their holdings. This is conceptually distinct from how often investors trade one particular kind of passive investment vehicle—namely, ETFs.

It is true that active investors will sometimes park a fraction of their holdings in passive-investment vehicles (Cremers and Petajisto, 2009; Cremers, Ferreira, Matos, and Starks, 2016; Pavlova and Sikorskaya, 2022). Unlike an ETF, active managers have no obligation to rebalance right at market close on reconstitution day. Nevertheless, we find that they rebalance just like an ETF would. This is evidence supporting Gabaix and Koijen (2022)'s Inelastic Markets Hypothesis.

Textbook order-execution models such as Kyle (1985), Bertsimas and Lo (1998), and Almgren and Chriss (2001) predict that investors will smooth out their demand to limit price impact. This is true for an active investor with a long-lived signal about firm fundamentals. It is also true for a passive investor with a long-lived signal about her own tracking difference. We show that this prediction does not apply to passive rebalancing.

We document that the spike in reconstitution-day volume for index additions and deletions is associated with prearranged trades, making it especially liquid for passive investors to trade on that day. By contrast, in a sunshine-trading model à la Admati and Pfleiderer (1991), active investors would also find it more liquid to trade on reconstitution days. While we focus on US equity indexes, Bessembinder, Carrion, Tuttle, and Venkataraman (2016) shows that things are different for commodity indexes.

Many theory papers use Grossman and Stiglitz (1980) to model the rise of passive investing (e.g., see Baruch and Zhang, 2021; Bond and García, 2022; Buss and Sundaresan, 2021; Buffa, Vayanos, and Woolley, 2022; Lee, 2021; Schmalz and Zame, 2023). We argue that this is the wrong framework because it assumes that the passive share is common knowledge and that investors choose their demand after observing prices. Coles, Heath, and Ringgenberg (2022) fixes half the problem by assuming inelastic demand in a Grossman and Stiglitz model.

Finally, our analysis connects to the literature looking at how passive investors affect firm decisions (Appel, Gormley, and Keim, 2016; Bebchuk, Cohen, and Hirst, 2017; Edmans and Holderness, 2017; Azar, Schmalz, and Tecu, 2018; Backus, Conlon, and Sinkinson, 2021; Heath, Macciocchi, Michaely, and Ringgenberg, 2022; Lewellen and Lewellen, 2022). We highlight how index funds are not the only way to passively invest.

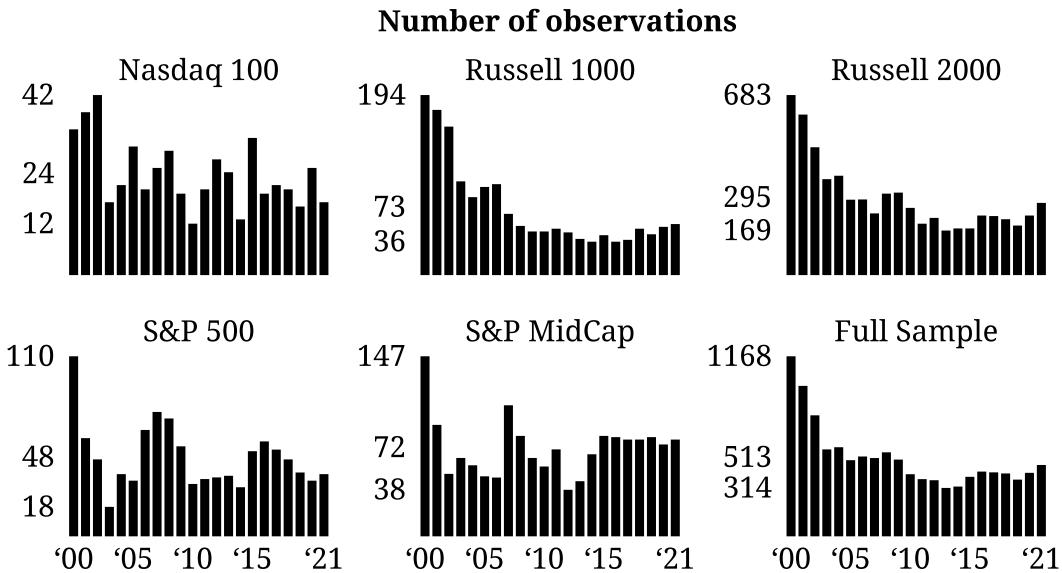

Figure 3. Number of stocks added to or dropped from each benchmark index by year. y-axis labels represent max, mean, and min. Sample: 2000 to 2021.

1 Data Description

This section describes the data we use in our analysis. Subsection 1.1 details the five benchmark indexes in our study. Subsection 1.2 discusses variable construction. And subsection 1.3 provides summary statistics.

1.1 Benchmark Indexes

We estimate the combined AUM of passive investors tracking five popular benchmark indexes: the S&P 500, the S&P MidCap 400, the Russell 1000, the Russell 2000, and the Nasdaq 100.

S&P 500 and MidCap 400. The S&P 500 is a float-adjusted value-weighted index that, loosely speaking, tracks the 500 largest public US companies. The index is maintained by S&P Dow Jones (S&P Dow Jones Indices, 2022). The S&P MidCap 400 is an analogous index tracking the next largest 400 US companies. A committee decides who gets added to and dropped from each benchmark index, and this committee makes its decision based on more than just firm size. For example, a firm must have positive earnings the quarter before being added.

S&P Dow Jones regularly reconstitutes the S&P 500 and MidCap 400 on a quarterly basis. These scheduled events take place on the third Friday of March, June, September, and December which represent triple-witching days when stock options, index options, and index futures all expire at the same time. However, the index provider also makes ad hoc changes at other times during the quarter due to corporate events like bankruptcies or mergers. We find similar point estimates for the total AUM indexed to the S&P 500 and MidCap 400 when using regularly scheduled and ad hoc changes.

For the S&P 500, we have quarterly index membership and changes directly from S&P Dow Jones. For the S&P MidCap 400, we have quarterly index membership and changes from Siblis Research. We use these data to interpolate daily index membership and weights in each benchmark. For the S&P 500, we include a float-adjustment factor directly from the index provider. Our weights for the S&P MidCap 400 are based on market capitalization in CRSP and do not include a float-adjustment factor.

We treat migrations between the S&P 500 and MidCap 400 as signals about AUM indexed to the S&P 500. By contrast, when estimating the AUM indexed to the S&P MidCap 400, we only include direct additions to and deletions from the index. Figure 3 shows that we have data on 38 changes to the S&P 500 in 2021 (both adds and drops); whereas, there were 79 stocks directly added to or dropped from the S&P MidCap 400 in our data set.

Russell 1000 and 2000. The Russell 1000 and 2000 are float-adjusted value-weighted indexes, which are provided by FTSE Russell. The Russell 1000 tracks the 1000 largest stocks in the Russell 3000E universe, and the Russell 2000 tracks the next 2000 largest stocks (FTSE Russell, 2022). Unlike the S&P 500 and MidCap 400, membership in the Russell 1000 and 2000 is largely rule based.

The entire Russell family of US indexes reconstitutes on the last Friday in June each year. FTSE Russell ranks stocks by market capitalization in late May. The index provider then formally announces changes to the Russell 1000 and 2000 roughly two weeks in advance of reconstitution day. That being said, it is usually possible to predict which stocks will be added and dropped long before this formal announcement.

Russell reconstitution day occurs on the fourth Friday in June each year. For years 2000 to 2008, we get end-of-month index membership from FTSE Russell. We use this end-of-month data to interpolate daily index membership and weights. These weights are based on market capitalization in CRSP and do not include a float-adjustment factor. Starting in 2009, we have daily data on index membership and weights directly from FTSE Russell.

Figure 3 shows that in 2021 FTSE Russell added 55 and 274 stocks to the Russell 1000 and 2000 respectively. While the index provider rarely makes ad hoc changes prior to reconstitution day, some passive investors must divest in response to certain corporate events, such as a bankruptcy. They cannot wait until reconstitution day to do their rebalancing. For this reason, we do not use stocks that exit the Russell 3000E universe in our estimation procedure.

Nasdaq 100. The Nasdaq 100 is a modified value-weighted index provided by the Nasdaq. The benchmark tracks securities issued by the 100 largest non-financial stocks that are exclusively listed on the Nasdaq exchange. Although it has been around since the mid-1980s, the Nasdaq 100's popularity has grown along with the rise of Invesco's QQQ ETF. Like with the S&P 500 and MidCap 400, there is a selection committee that decides membership in the Nasdaq 100. Since 2014 the committee has included companies with multiple share classes in the benchmark.

Nasdaq regularly reconstitutes the Nasdaq 100 on the third Friday in December. Figure 3 shows that in 2021 there were 17 changes to the Nasdaq 100. This annual rebalancing event lines up with the final witching day of the calendar year. However, like with the S&P 500 and MidCap 400, there are also ad hoc changes to the Nasdaq 100 at other times during the year. For example, Honeywell International (HON) replaced Alexion Pharmaceuticals (ALXN) on July 20th 2021. We find similar point estimates for the AUM indexed to the Nasdaq 100 when using both regularly scheduled and ad hoc changes.

We get quarterly data on Nasdaq 100 index membership and changes from Siblis Research. Use these data to interpolate daily index membership and weights. Our weights for the Nasdaq 100 are based on market capitalization in CRSP and do not include a float-adjustment factor.

Other Benchmarks. In an ideal world, we would be able to include data on other popular benchmark indexes in our study, too. For example, our 33.3% estimate for the US passive-ownership share in 2021 does not reflect the passive AUM tracking the MSCI World or the CRSP Total Market. At the moment, though, this is prohibitively expensive. This limitation suggests our estimate for the US passive-ownership share might be too low. If we were to include Vanguard's \$4.4*t* in equity holding in December 2021, our 33.3% would climb to 39.8%.

To estimate the AUM indexed to a particular benchmark, we need accurate data on each constituent's weight in the benchmark. For the Russell 1000 and Russell 2000, we purchased daily benchmark weights directly from FTSE Russell for \$7,500. We are able to interpolate the daily weights for the S&P 500, S&P MidCap 400, and Nasdaq 100 from known quarterly values. For the S&P 500, these quarterly values come directly from S&P Dow Jones.

We have approached other index providers about purchasing similar data. When we talked to MSCI, they quoted us a price of \$240*k* for the daily data from 2000 to 2021. When we asked CRSP for the same thing, they flatly refused to provide data on daily benchmark weights to academics at any price. This pattern of events is consistent with the observation that index providers earn huge licensing on this information (An, Benetton, and Song, 2022). Passive investors are not uninformed traders. It is expensive to acquire information about benchmarks in a timely fashion.

1.2 Variable Construction

Each time a stock gets added to or dropped from a benchmark, we compute the dollar value of the spike in volume it experiences on reconstitution day. Then, under the assumption that this spike represents passive rebalancing, we back out the total AUM of passive investors given the stock's benchmark weight.

Let $IndexWeight_{b,n}(t_{Recon})$ denote the nth stock's weight in benchmark b on reconstitution day t_{Recon}. For additions, $IndexWeight_{b,n}(t_{Recon})$ represents the stock's initial weight in benchmark b when markets open on the following trading day $(t_{Recon} + 1)$. For deletions, $IndexWeight_{b,n}(t_{Recon})$ represents the nth stock's final weight in benchmark b at market close on t_{Recon}.

Stock characteristics

S&P 500	Full Sample		Adds		Drops	
	Avg	Sd	Avg	Sd	Avg	Sd
MCap [$1*b*]	12.0	24.8	14.5	31.8	9.0	11.8
IndexWeight [*bps*]	8.7	12.6	9.4	13.6	8.0	11.4
ADV [1*m*]	4.9	11.4	3.3	5.8	6.4	14.7
PastRet [%]	10.6	41.8	22.1	42.0	−1.0	38.2
S&P MidCap 400	Full Sample		Direct Adds		Direct Drops	
MCap [$1*b*]	2.8	2.6	3.2	1.9	2.4	3.2
IndexWeight [*bps*]	22.7	23.0	25.4	15.4	19.6	29.5
ADV [1*m*]	1.6	4.3	1.1	1.7	2.1	6.0
PastRet [%]	12.5	44.8	21.4	44.2	1.5	43.2
Russell 1000	Full Sample		Direct Adds		Migrations	
MCap [$1*b*]	4.4	6.9	8.9	12.7	3.0	2.1
IndexWeight [*bps*]	2.4	4.4	4.5	8.7	1.8	0.7
ADV [1*m*]	1.8	5.0	2.8	5.7	1.4	4.7
PastRet [%]	27.0	60.5	18.2	60.8	29.6	60.2

Table 1a. Characteristics of changes to S&P 500, S&P MidCap 400, and Russell 1000. *MCap*: Market cap on reconstitution day in billions of dollars. *IndexWeight*: Weight in benchmark in basis points. *ADV*: Average volume during the 22 trading days prior to reconstitution in millions of shares per day. *PastRet*: Return during the 6 months prior to reconstitution in percent. Sample: 2000 to 2021.

We use several variables to capture the spike in volume experienced by index additions and deletions on reconstitution day. $DailyVolume_n(t)$ denotes the nth stock's volume on day t as reported in CRSP. This daily data covers our entire sample period from 2000 through 2021. When comparing reconstitution-day volume across stocks, we normalize by average daily volume during the previous 22 trading days, $ADV_n = \frac{1}{22} \cdot \sum_{\ell=1}^{22} DailyVolume_n(t_{Recon} - \ell)$.

Since much of the spike in reconstitution-day volume is tied to the closing price, we also use TAQ's millisecond-level daily-update consolidated trade database. This data starts on September 10th 2003, which is after Russell recon-

Stock characteristics, continued

Russell 2000	Full Sample		Direct Adds		Migrations	
	Avg	Sd	Avg	Sd	Avg	Sd
MCap [$1*b*]	0.6	0.6	0.4	0.5	1.2	0.7
IndexWeight [*bps*]	3.5	3.5	2.4	2.4	8.5	3.8
ADV [1*m*]	0.7	2.4	0.5	2.1	1.8	3.5
PastRet [%]	39.2	131.6	49.4	141.0	−8.9	48.6
Nasdaq 100	**Full Sample**		**Adds**		**Drops**	
MCap [$1*b*]	12.0	18.8	15.9	22.6	8.0	12.7
IndexWeight [*bps*]	30.9	42.7	40.4	48.7	21.3	33.1
ADV [1*m*]	6.3	23.0	5.5	16.8	7.1	27.8
PastRet [%]	11.5	50.0	30.4	53.4	−7.7	37.6

Table 1b. Characteristics of changes to Russell 2000 and Nasdaq 100. *MCap*: Market cap on reconstitution day in billions of dollars. *IndexWeight*: Weight in benchmark in basis points. *ADV*: Average volume during the 22 trading days prior to reconstitution in millions of shares per day. *PastRet*: Return during the 6 months prior to reconstitution in percent. 2000 to 2021.

stitution day that calendar year. So we only use it from 2004 through 2021. We remove observations flagged with "M" and "Q" sale conditions, which represent duplicate observations produced by Nasdaq's trade-reporting protocol (Tuttle, 2013). We also remove corrected trades. The remaining TAQ volume each day matches daily volume reported in CRSP.

Let $\mathit{VolumeAtClose}_n(t)$ denote the nth stock's volume at the closing auction on day t. As we discuss in subsection 4.1, passive investors often use prescheduled trades to rebalance. These trades get executed at the price determined by the closing auction at 4:00pm on reconstitution day. So they typically hit the tape some time after hours. For this reason, our preferred intraday measure of passive rebalancing volume is $\mathit{Volume1600to2359}_n(t)$, which represents the nth stock's volume from 4:00pm through 11:59pm on reconstitution day.

$\mathit{VolumeAtClosingPrice}_n(t)$ denotes the nth stock's volume executed at the closing price on day t as indicated by trade condition "6" in TAQ. Earlier in our sample, prescheduled trades sometimes included price improvement, meaning that *VolumeAtClosingPrice* is likely too conservative. For example, FTSE Russell added Maxim Integrated Products (MXIM) to the Russell 1000 on June 26th 2009. A Russell 1000 investor might have prearranged on May 8th to buy 10k Maxim shares at $0.01 below the closing price on June 26th 2009. These 10k shares would not be captured by $\mathit{VolumeAtClosingPrice}_{\mathrm{MXIM}}(\text{June 26th 2009})$.

We explore a variety of proxies for passive rebalancing volume in subsection 2.3. None of these other measures is perfect. However, by looking at a wide range of proxies, we are able to get a better sense of the true scale of passive ownership as well as how much uncertainty there is about this level.

1.3 Summary Statistics

Tables 1a and 1b describe the characteristics of stocks that got added to or dropped from each of our five benchmark indexes. As expected, index additions are different from index deletions. For example, index additions tend to be larger and have higher returns over the past 6 months.

We are exploiting the difference between an index switcher's reconstitution-day volume and its own prior volume. We are not comparing index switchers to stocks that just missed getting added or dropped. We are not using the Russell 1000 cutoff for identification (Chang, Hong, and Liskovich, 2015; Appel, Gormley, and Keim, 2020). We know S&P Dow Jones strategically chooses which companies to add (Beneish and Whaley, 1996; Bennett, Stulz, and Wang, 2022).

Tables 2a and 2b then describe the reconstitution-day volume experienced by these index additions and deletions. We normalize each stock's volume measures by the stock's average daily volume during the previous 22 trading days, ADV_n. For example, the top panel of Table 2a indicates that, on average, changes to the S&P 500 see 12.3 days' worth of volume on reconstitution day.

We also report summary statistics for closing volume on reconstitution day, volume from 4:00pm to 11:59pm, and volume at the closing price. For example, the top panel of Table 2b shows that, on average, stocks that get added to the Russell 2000 experience 14.2 trading days' worth of volume just during the period from 4:00pm to 11:59pm on reconstitution day.

Reconstitution-day volume

S&P 500	Full Sample		All Adds		All Drops	
×*ADV*	Avg	Sd	Avg	Sd	Avg	Sd
DailyVolume	12.3	9.8	16.4	10.6	8.5	7.2
Volume1600to2359	8.7	8.3	12.6	9.1	5.2	5.7
VolumeAtClosingPrice	6.5	9.3	9.0	8.1	4.3	9.8
VolumeAtClose	2.7	4.6	4.1	5.7	1.5	2.8
S&P MidCap 400	Full Sample		Direct Adds		Direct Drops	
DailyVolume	10.7	8.9	12.1	9.3	9.1	8.2
Volume1600to2359	7.8	7.1	9.3	7.0	6.1	6.8
VolumeAtClosingPrice	5.6	5.7	6.4	5.7	4.8	5.6
VolumeAtClose	2.9	4.4	3.6	4.8	2.2	3.9
Russell 1000	Full Sample		Direct Adds		Migrations	
DailyVolume	5.4	4.2	4.6	4.2	5.6	4.1
Volume1600to2359	4.6	3.7	2.5	1.9	5.1	3.9
VolumeAtClosingPrice	3.3	2.9	1.8	1.3	3.7	3.0
VolumeAtClose	1.4	2.2	0.8	1.2	1.5	2.3

Table 2a. Reconstitution-day volume for S&P 500, S&P MidCap 400, and Russell 1000. *DailyVolume*: Total volume on reconstitution day. *Volume1600to2359*: Volume from 4:00pm to 11:59pm on reconstitution day. *VolumeAtClosingPrice*: Volume at the closing price on reconstitution day. *VolumeAtClose*: Closing volume on reconstitution day. All volume measures are normalized by *ADV*. Sample for *Volume1600to2359*, *VolumeAtClosingPrice*, and *VolumeAtClose* starts in 2004.

2 Passive Ownership

This section reports our headline numbers for the US passive-ownership share. In subsection 2.1, we describe our approach to estimating the US passive-ownership share. In subsection 2.2, we give our primary estimates based on daily volume and volume from 4:00pm to 11:59pm. In subsection 2.3, we report a range of estimates based on alternative proxies for passive rebalancing volume. Finally, in subsection 2.4, we investigate our measurement errors.

Reconstitution-day volume, continued

Russell 2000	Full Sample		Direct Adds		Migrations	
×*ADV*	Avg	Sd	Avg	Sd	Avg	Sd
DailyVolume	14.2	17.1	15.9	18.3	6.3	4.9
Volume1600to2359	14.2	16.9	15.9	17.9	5.5	4.3
VolumeAtClosingPrice	9.8	20.5	10.9	22.0	4.1	4.8
VolumeAtClose	6.4	8.7	7.4	9.1	1.2	2.1
Nasdaq 100	Full Sample		All Adds		All Drops	
DailyVolume	4.8	4.4	4.7	3.1	4.9	5.4
Volume1600to2359	2.2	2.4	2.0	1.6	2.5	3.0
VolumeAtClosingPrice	1.3	1.5	1.2	1.0	1.4	1.8
VolumeAtClose	1.4	1.6	1.3	1.1	1.5	2.0

Table 2b. Reconstitution-day volume for Russell 2000 and Nasdaq 100. *DailyVolume*: Total volume on reconstitution day. *Volume1600to2359*: Volume from 4:00pm to 11:59pm on reconstitution day. *VolumeAtClosingPrice*: Volume at the closing price on reconstitution day. *VolumeAtClose*: Closing volume on reconstitution day. All measures normalized by *ADV*. Sample for *DailyVolume*: 2000 to 2021. Sample for *Volume1600to2359*, *VolumeAtClosingPrice*, and *VolumeAtClose* starts in 2004.

2.1 Estimation Strategy

Suppose stock ADD replaced stock DROP in benchmark b at market close on day t_{Recon}. Let $AUMindexed_b(t_{Recon})$ denote the total AUM held by passive investors tracking this index on reconstitution day. Further suppose that ADD initially represented $IndexWeight_{b,\text{ADD}}$ of the index. If passive investors perfectly matched this portfolio weight, then they had to build new positions worth

$$IndexWeight_{b,\text{ADD}} \times AUMindexed_b(t_{Recon}) \tag{2}$$

Now imagine that passive investors are the only people trading ADD on reconstitution day and that these passive investors do all their trading at market close. In this scenario, $DailyVolume_{\text{ADD}}(t_{Recon})$ as reported in CRSP would

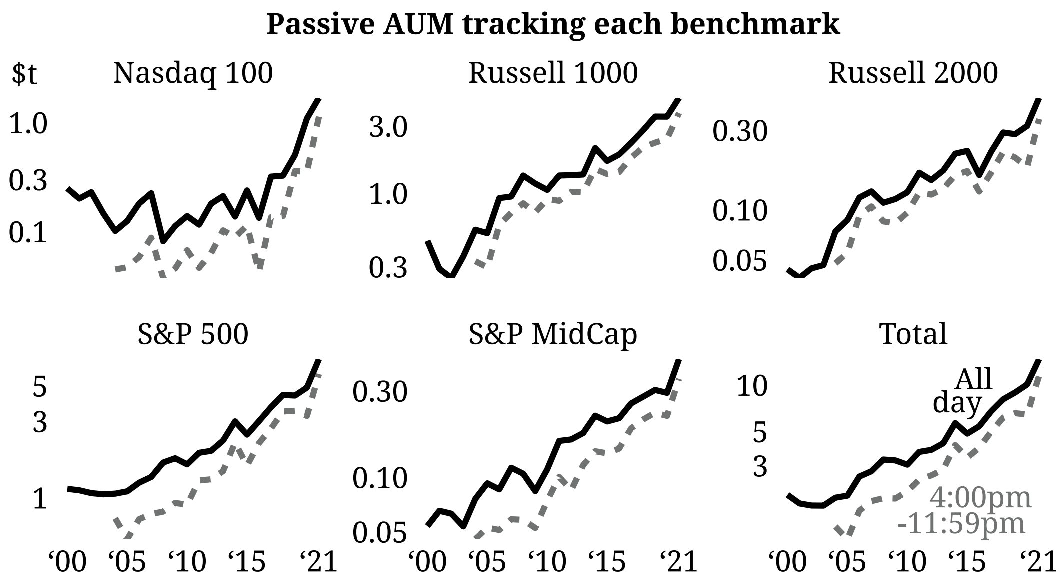

Figure 4. Solid line is passive AUM tracking each benchmark implied by using *DailyVolume* as proxy for passive rebalancing volume; 2000 to 2021. Dotted line is passive AUM implied by *Volume1600to2359*; 2004 to 2021.

capture all passive rebalancing volume. And these trades would be worth

$$DailyVolume_{\text{ADD}}(t_{Recon}) \times Price_{\text{ADD}}(t_{Recon}) \tag{3}$$

where $Price_{\text{ADD}}(t)$ denotes ADD's closing price per share on day t.

We impute the total AUM tracking benchmark b by equating (2) and (3) and solving for $AUMindexed_b(t_{Recon})$

$$\widetilde{AUMindexed}_{b,\text{ADD}}(t_{Recon}) \leftarrow \frac{DailyVolume_{\text{ADD}}(t_{Recon}) \times Price_{\text{ADD}}(t_{Recon})}{IndexWeight_{b,\text{ADD}}} \tag{4}$$

The $\widetilde{\text{tilde}}$ indicates that $\widetilde{AUMindexed}_{b,\text{ADD}}(t_{Recon})$ is an implied value, and the ADD subscript indicates that this implied value is based on a single addition.

Figure 4 shows the average implied $\widetilde{AUMindexed}_{b,n}$ across all stocks added to or dropped from a given benchmark b in year y:

$$\widetilde{AUMindexed}_b(y) = \text{Avg}\left(\widetilde{AUMindexed}_{b,n} \,\middle|\, \begin{array}{c}\text{stock } n \text{ was added to} \\ \text{dropped from bench-} \\ \text{mark } b \text{ in year } y\end{array} \right) \tag{5}$$

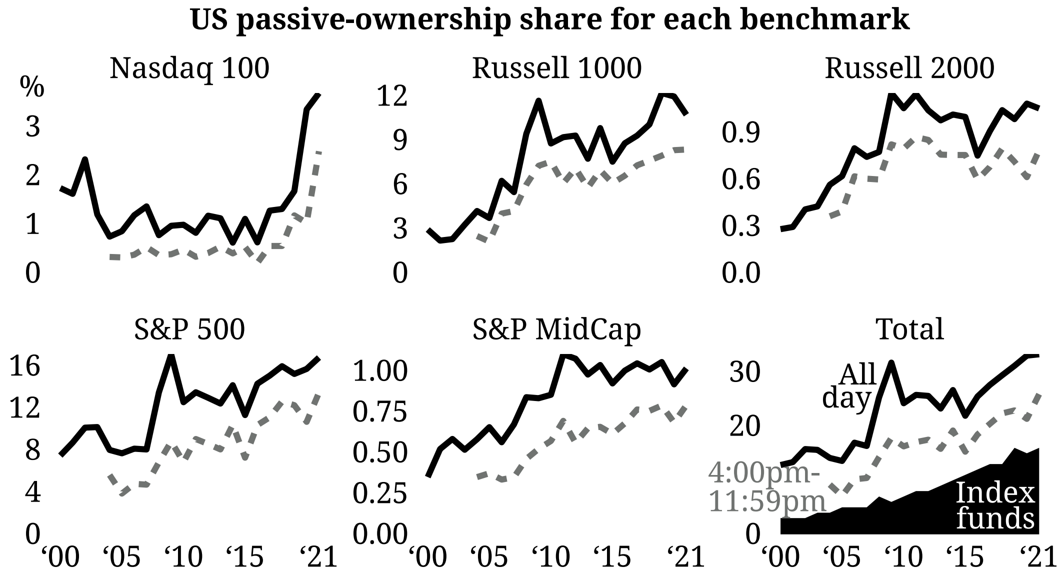

Figure 5. Solid line is percent of the US stock market owned by passive investors when using *DailyVolume* as proxy for passive rebalancing; 2000 to 2021. Black ribbon denotes percent owned by index funds according to the Investment Company Institute. Dotted line is percent owned by passive investors when using *Volume1600to2359* as proxy for passive rebalancing; 2004 to 2021.

The solid lines represent estimates for passive AUM where we proxy for passive rebalancing volume with *DailyVolume* as described in Equation (4). The dotted lines perform the same calculation with *Volume1600to2359*.

2.2 Headline Numbers

To compute the passive-ownership share associated with benchmark b in year y, we divide $\widetilde{AUMindexed}_b(y)$ by US stock-market capitalization

$$\widetilde{\%Indexed}_b(y) = 100 \times \frac{\widetilde{AUMindexed}_b(y)}{TotalMarketCap(y)} \tag{6}$$

Figure 5 reports these estimates for each benchmark. The solid lines represent calculations using *DailyVolume*. The dotted lines use *Volume1600to2359*.

The bottom-right panel reports the sum across all five benchmarks we study

$$\begin{aligned}\widetilde{\%Indexed}(y) = \widetilde{\%Indexed}_{\text{S\&P 500}}(y) + \widetilde{\%Indexed}_{\text{S\&P MidCap}}(y) \\ + \widetilde{\%Indexed}_{\text{Russell 1000}}(y) + \widetilde{\%Indexed}_{\text{Russell 2000}}(y) \\ + \widetilde{\%Indexed}_{\text{Nasdaq 100}}(y)\end{aligned} \tag{7}$$

The solid line corresponds to the headline numbers reported in Figure 2 from the introduction. When using *DailyVolume* as the proxy for passive rebalancing on reconstitution days, we find that 33.3% of the US stock market was held by passive investors in 2021. When using *Volume1600to2359* instead of *DailyVolume*, we still put the US passive-ownership share at 25.9% in 2021.

The bottom-right panel in Figure 5 also reports the share of the US stock market owned by index funds. This percentage comes from annual reports made by the Investment Company Institute (ICI; e.g., see Figure 2.9 in Investment Company Institute, 2022). The ICI's numbers reflect the combined holdings of all domestic equity index mutual funds and ETFs. These numbers include the AUM of index funds that track benchmarks other than the five in our study, such as Vanguard funds tracking the CRSP Total Market index. If we add Vanguard's total equity holdings in December 2021, \$4.4*t*, to our existing numbers, then our 33.3% would grow to 39.8%.

Many investors chose to invest passively while licking their wounds following the 2008 financial crisis, and we see a large spike in the overall passive-ownership share in the bottom-right panel of Figure 5. However, notice that there is no corresponding spike in the ownership share of index funds. This is because these investors often chose to direct index rather than buy shares of an index funds. Direct indexing was particularly attractive in this sort of scenario because it allowed investors to engage in tax-loss harvesting.

Tables 3a and 3b report the specific numerical values underpinning the black and blue lines in Figure 5. Since *DailyVolume* comes from CRSP, we can use this proxy to impute $\widetilde{\%Indexed}_b(y)$ for each of our five benchmarks all the way back to 2000 in Table 3a. By contrast, Table 3b only reports values dating back to 2004 because *Volume1600to2359* is based on TAQ data.

Estimates based on *DailyVolume*

	S&P 500	S&P MidCap	Russell 1000	Russell 2000	Nasdaq 100	Total
2000	7.49	0.35	2.96	0.28	1.74	12.82
	(0.68)	(0.03)	(0.18)	(0.01)	(0.17)	(1.07)
2001	8.72	0.52	2.20	0.30	1.63	13.36
	(0.69)	(0.06)	(0.14)	(0.01)	(0.21)	(1.12)
2002	10.14	0.58	2.30	0.41	2.33	15.77
	(0.54)	(0.10)	(0.11)	(0.01)	(1.16)	(1.92)
2003	10.19	0.52	3.28	0.43	1.20	15.62
	(1.55)	(0.04)	(0.18)	(0.01)	(0.21)	(1.98)
2004	8.02	0.58	4.21	0.57	0.75	14.13
	(0.58)	(0.06)	(0.27)	(0.05)	(0.07)	(1.03)
2005	7.70	0.66	3.74	0.62	0.86	13.57
	(0.85)	(0.04)	(0.20)	(0.02)	(0.10)	(1.20)
2006	8.14	0.56	6.26	0.80	1.19	16.95
	(0.86)	(0.05)	(0.33)	(0.02)	(0.23)	(1.48)
2007	8.07	0.67	5.49	0.75	1.37	16.35
	(0.62)	(0.04)	(0.41)	(0.03)	(0.23)	(1.33)
2008	13.48	0.84	9.44	0.78	0.78	25.32
	(1.43)	(0.07)	(0.49)	(0.02)	(0.03)	(2.04)
2009	17.11	0.83	11.69	1.15	0.97	31.76
	(1.29)	(0.04)	(0.66)	(0.02)	(0.08)	(2.09)
2010	12.56	0.86	8.79	1.06	0.99	24.25
	(1.28)	(0.06)	(0.39)	(0.01)	(0.36)	(2.10)
2011	13.51	1.10	9.22	1.15	0.83	25.80
	(1.07)	(0.06)	(0.34)	(0.02)	(0.08)	(1.57)
2012	12.98	1.08	9.33	1.04	1.18	25.60
	(1.11)	(0.14)	(0.34)	(0.02)	(0.12)	(1.73)
2013	12.43	0.98	7.75	0.98	1.12	23.26
	(1.32)	(0.09)	(0.42)	(0.02)	(0.12)	(1.97)
2014	14.18	1.04	9.83	1.02	0.62	26.69
	(1.39)	(0.06)	(0.56)	(0.03)	(0.11)	(2.15)
2015	11.34	0.92	7.55	1.00	1.11	21.93
	(0.87)	(0.05)	(0.40)	(0.02)	(0.16)	(1.50)
2016	14.32	1.00	8.80	0.75	0.63	25.51
	(0.99)	(0.06)	(0.20)	(0.01)	(0.15)	(1.41)
2017	15.08	1.05	9.32	0.91	1.28	27.65
	(1.07)	(0.06)	(0.49)	(0.01)	(0.40)	(2.04)
2018	15.98	1.01	10.08	1.04	1.31	29.43
	(1.03)	(0.05)	(0.29)	(0.03)	(0.16)	(1.56)
2019	15.24	1.06	12.21	0.99	1.68	31.18
	(1.22)	(0.04)	(1.53)	(0.05)	(0.54)	(3.37)
2020	15.72	0.92	11.98	1.09	3.36	33.06
	(1.75)	(0.04)	(0.75)	(0.16)	(0.99)	(3.68)
2021	16.80	1.02	10.74	1.06	3.69	33.30
	(1.14)	(0.04)	(0.51)	(0.03)	(1.11)	(2.83)

Table 3a. Percent of the US stock market owned by passive investors when using *DailyVolume* to proxy for passive rebalancing volume. Numbers in parentheses are standard errors clustered by announcement. 2000 to 2021.

Estimates based on *Volume1600to2359*

	S&P 500	S&P MidCap	Russell 1000	Russell 2000	Nasdaq 100	Total
2004	5.64	0.35	2.51	0.36	0.33	9.20
	(0.42)	(0.02)	(0.15)	(0.01)	(0.06)	(0.66)
2005	3.87	0.37	2.14	0.40	0.32	7.10
	(0.48)	(0.03)	(0.13)	(0.01)	(0.01)	(0.67)
2006	4.80	0.34	4.04	0.62	0.38	10.17
	(0.45)	(0.03)	(0.24)	(0.02)	(0.04)	(0.78)
2007	4.72	0.35	4.21	0.61	0.53	10.42
	(0.40)	(0.02)	(0.66)	(0.03)	(0.11)	(1.22)
2008	6.85	0.46	5.99	0.60	0.37	14.28
	(0.53)	(0.03)	(0.32)	(0.02)	(0.04)	(0.94)
2009	8.82	0.52	7.28	0.83	0.39	17.83
	(0.81)	(0.03)	(0.60)	(0.01)	(0.09)	(1.55)
2010	6.86	0.57	7.56	0.80	0.48	16.27
	(1.23)	(0.05)	(0.40)	(0.01)	(0.24)	(1.94)
2011	9.06	0.70	6.09	0.87	0.33	17.05
	(1.00)	(0.07)	(0.28)	(0.02)	(0.06)	(1.43)
2012	8.59	0.56	7.10	0.85	0.41	17.51
	(1.22)	(0.06)	(0.30)	(0.01)	(0.07)	(1.67)
2013	8.07	0.65	5.79	0.76	0.54	15.81
	(1.11)	(0.08)	(0.41)	(0.02)	(0.05)	(1.67)
2014	10.42	0.66	6.98	0.76	0.40	19.21
	(1.23)	(0.05)	(0.39)	(0.02)	(0.08)	(1.76)
2015	7.28	0.62	6.09	0.76	0.53	15.28
	(0.76)	(0.04)	(0.40)	(0.02)	(0.12)	(1.34)
2016	10.39	0.68	6.61	0.60	0.21	18.48
	(0.89)	(0.05)	(0.21)	(0.01)	(0.11)	(1.28)
2017	11.13	0.77	7.31	0.68	0.56	20.44
	(1.04)	(0.05)	(0.28)	(0.01)	(0.39)	(1.77)
2018	12.62	0.76	7.63	0.80	0.56	22.36
	(0.87)	(0.04)	(0.24)	(0.02)	(0.08)	(1.25)
2019	12.27	0.79	7.97	0.71	1.18	22.93
	(0.99)	(0.04)	(0.29)	(0.01)	(0.45)	(1.77)
2020	10.69	0.69	8.34	0.62	1.03	21.36
	(1.31)	(0.04)	(0.28)	(0.01)	(0.10)	(1.75)
2021	13.47	0.79	8.38	0.79	2.50	25.93
	(0.81)	(0.04)	(0.40)	(0.01)	(1.07)	(2.33)

Table 3b. Percent of the US stock market owned by passive investors when using *Volume1600to2359* as proxy for passive rebalancing volume. Numbers in parentheses are standard errors clustered by announcement. 2004 to 2021.

We report standard errors on our estimates for each $\widetilde{\%Indexed}_b(y)$. We cluster these standard errors by announcement to account for the fact that stocks can be added to and dropped from the S&P 500, S&P MidCap 400, and Nasdaq 100 at different times throughout the year. All additions to the Russell 1000 and Russell 2000 occur simultaneously on the last Friday in June each year. For these two benchmarks, clustering has no effect on our standard errors.

2.3 Range of Estimates

Our headline numbers indicate that, given on all the volume experienced by index additions and deletions on reconstitution days, passive investors likely held 33.3% of the US stock market in 2021. Even if we look only at the volume from 4:00pm onward on reconstitution days, we still get a passive-ownership share of 25.9%. This is well above the percentage owned by index funds as reported by the ICI, 16%. Moreover, the ICI's numbers include index funds that track benchmarks not included in our sample, like the CRSP Total Market index.

DailyVolume and *Volume1600to2359* are not perfect proxies for passive rebalancing volume on reconstitution days. On one hand, both measures ignore passive rebalancing done prior to reconstitution day. Some passive investors rebalance months ahead of time. And, to the extent that this happens, it will cause us to underestimate the true passive-ownership share.

On the other hand, *DailyVolume* and *Volume1600to2359* could be capturing reconstitution-day volume coming from active investors. This would lead us to overestimate the true passive-ownership share. We see no evidence that active investors are delaying trades so that they can take advantage of the high liquidity experienced by index additions and deletions at market close on reconstitution day in subsection 3.1. Admati and Pfleiderer (1991)'s sunshine-trading story would not apply in a world where passive investors prescheduled all their rebalancing trades months in advance via intermediaries.

In Table 4 we report a range of estimates for the US passive-ownership share based on different proxies for passive rebalancing on reconstitution days. That way, readers can judge for themselves how much extra volume our headline numbers might be capturing.

Column (1) in Table 4 corresponds to the total reported in Table 3a based on *DailyVolume*. Column (2) reports the results of the same calculation but using *DailyVolume* − *ADV*. This column looks at an index addition/deletion's volume on reconstitution day in excess of its volume on a typical trading day. It is unlikely that non-Russell investors trade the same way on Russell reconstitution day as they would on any other day during the previous month. "Let's face it, for the New York Stock Exchange, Russell reconstitution…is the greatest show on earth."[4] However, if other investors kept on trading index additions and deletions in the exact same way on reconstitution days, then column (2) suggests that our headline numbers might be overestimating the true passive-ownership share by somewhere between 2%pts and 5%pts.

Column (3) in Table 4 corresponds to the total column in Table 3b, which is based on *Volume1600to2359*. On a typical day, most trading activity occurs during normal market hours. This was true for Yeti Holdings (YETI) in Figure 1 from the introduction, and in subection 3.1 we show this pattern holds more generally. However, reconstitution days are different. On reconstitution days, the bulk of trading occurs after hours. Thus, our passive-ownership share based on *Volume1600to2359* is only slightly below our estimate using *DailyVolume*.

One important reason for this pattern is that passive investors often preschedule rebalancing trades to get executed at the closing price on reconstitution day. So we report the $\widetilde{\%Indexed}(y)$ implied by *VolumeAtClosingPrice* in column (4) in Table 4. These estimates look very similar to the ones in column (3) based on *Volume1600to2359*, which is consistent with the idea that much of the volume from 4:00pm-11:59pm comes from prescheduled trades. There is a larger gap between columns (3) and (4) earlier in our sample. However, as previously noted, it used to be common for prearranged trades to include some price improvement. *VolumeAtClosingPrice* will miss these trades.

Finally, column (5) in Table 4 gives our most conservative estimate for the US passive-ownership share based only on *VolumeAtClose*. These numbers help address concerns about possible double counting of active trades that get

[4]Gordon Charlop, managing director at Rosenblatt Securities, in Chuck Mikolajczak "Investors brace for annual Russell index rebalancing with pandemic imprint." *Reuters.* Jun 18 2021.

covered after hours. However, if a large institutional investor places an upstairs block order for an index addition to be executed at the closing price, this order will not hit the tape until after market close. So there is good reason to think that the estimates for $\widetilde{\%Indexed}(y)$ in column (5) is too low.

Even still, there is no statistically measurable difference between our point estimate for $\widetilde{\%Indexed}(2021)$ based on *VolumeAtClose*, 14.22% ± (1.98%), and ICI's estimate based on index-fund holdings, 16%. This further underscores the importance of passive investors who operate "outside the public universe of index funds and ETFs."[1] We know that closing volume omits common rebalancing trades. And our data only includes a subset of all benchmark indexes. Nevertheless, the numbers in column (5) are on par with the widely accepted previous estimates for the US passive-ownership share.

2.4 Measurement Error

In an ideal world, when ADD replaces DROP in benchmark b on day t_{Recon}, both of these changes would yield the same value for $AUMindexed_b(t_{Recon})$

$$\widetilde{AUMindexed}_{b,\text{ADD}}(t_{Recon}) = \widetilde{AUMindexed}_{b,\text{DROP}}(t_{Recon}) \tag{8}$$

In fact, every stock which get added to or dropped from benchmark b on day t_{Recon} should yield the same point estimate for $AUMindexed_b(t_{Recon})$.

We use this internal-consistency requirement to gauge the magnitude of our measurement errors. Let $\%Error_{b,n}(t_{Recon})$ denote the difference between the passive share implied by a single addition or deletion and the average passive share implied by all additions and deletions in the same year

$$\%Error_{b,n}(t_{Recon}) = \widetilde{\%Indexed}_{b,n}(t_{Recon}) - \widetilde{\%Indexed}_b(y) \tag{9}$$

For example, Yeti's volume on June 25th 2021 implied that 11.1% of the US stock-market was owned by Russell 1000 investors. The reconstitution-day volume for the average Russell 1000 addition in 2021 implied a passive-ownership share of 10.7%. Thus, the measurement error associated with Yeti's addition to the Russell 1000 on June 25th 2021 was 11.4% − 10.7% = 0.4%pts.

Range of estimates

	All day (1)	Minus *ADV* (2)	4:00pm-11:59pm (3)	Closing price (4)	Closing auction (5)
2004	14.13	11.71	9.39	5.38	1.06
	(1.03)	(1.02)	(0.63)	(0.48)	(0.20)
2005	13.57	11.44	7.10	4.34	0.94
	(1.20)	(1.06)	(0.67)	(0.45)	(0.20)
2006	16.95	14.14	10.33	6.59	1.77
	(1.48)	(1.38)	(0.76)	(0.45)	(0.34)
2007	16.35	13.41	10.49	7.38	2.49
	(1.33)	(1.20)	(1.22)	(1.02)	(0.61)
2008	25.32	20.40	14.49	10.79	2.83
	(2.04)	(1.70)	(0.91)	(2.75)	(0.53)
2009	31.76	27.49	17.83	9.82	4.88
	(2.09)	(1.89)	(1.55)	(0.88)	(0.87)
2010	24.25	20.50	16.54	9.54	4.53
	(2.10)	(1.65)	(1.83)	(1.02)	(0.90)
2011	25.80	21.79	17.64	10.72	3.78
	(1.57)	(1.42)	(1.49)	(0.68)	(0.74)
2012	25.60	22.41	18.14	9.79	4.11
	(1.73)	(1.71)	(1.74)	(0.86)	(0.68)
2013	23.26	19.56	16.11	10.26	3.51
	(1.97)	(1.82)	(1.66)	(0.89)	(0.76)
2014	26.69	23.03	19.66	11.98	4.22
	(2.15)	(1.97)	(1.62)	(0.87)	(1.11)
2015	21.93	19.79	15.32	11.80	5.46
	(1.50)	(1.28)	(1.33)	(1.04)	(0.97)
2016	25.51	22.42	18.70	15.14	5.99
	(1.41)	(1.34)	(1.22)	(0.97)	(1.11)
2017	27.65	24.23	20.44	17.05	9.53
	(2.04)	(1.79)	(1.77)	(1.42)	(1.65)
2018	29.43	25.98	22.36	19.08	11.30
	(1.56)	(1.38)	(1.25)	(0.98)	(1.25)
2019	31.18	24.79	23.44	17.93	10.54
	(3.37)	(2.98)	(1.99)	(1.13)	(1.91)
2020	33.06	26.92	21.36	19.33	11.51
	(3.68)	(3.01)	(1.75)	(1.29)	(1.53)
2021	33.30	28.46	25.93	21.99	14.22
	(2.83)	(2.85)	(2.33)	(2.20)	(1.98)

Table 4. Total passive-ownership share as implied by six different proxies for passive rebalancing on reconstitution days. Column (1): *DailyVolume*. Column (2): *DailyVolume − ADV*. Column (3): *Volume1600to2359*. Column (4): *VolumeAtClosingPrice*. Column (5): *VolumeAtClose*. Numbers in parentheses are standard errors clustered by announcement. Sample in columns (1) and (2): 2000 to 2021. Sample in columns (3), (4), and (5): 2004 to 2021.

Average absolute measurement error

	S&P 500	S&P MidCap	Russell 1000	Russell 2000	Nasdaq 100	Full Sample
$\|\%Error\|$	5.49	0.33	1.87	0.23	0.76	0.99

Table 5. Average absolute difference between the passive-ownership share implied by each index change and the average passive-ownership share implied by all changes to that index in the same year. Sample: 2000 to 2021.

Table 5 reports the average magnitude of the measurement error for each benchmark index. The typical addition to the Russell 1000 yields an estimate for $\widetilde{\%Indexed}_{b,n}(t_{Recon})$ that is ±0.33%pts of the average for the year. The precision of estimate based on Yeti's addition to the Russell 1000 was representative of the precision of all Russell 1000 additions.

The numbers reported in Table 5 are larger than the standard errors reported in Table 3a by a factor of $\sqrt{\text{\# adds/drops each year}}$. For example, Figure 3 tells us that that our data contains 48 changes to the S&P 500 each year. The average standard error on our annual estimates for the percent of the US stock market owned by S&P 500 trackers in Table 3a is 1.06%pts. Table 5 says that the typical S&P 500 addition/deletion yields an estimate that is ±5.49%pts away from the annual average, which would imply a standard error of $5.49\%/\sqrt{48} = 0.80\%$.

Next we explore how our measurement errors are related to characteristics of the stocks being added or dropped. We do this by running regressions

$$\%Error_{b,n}(t_{Recon}) = \hat{\alpha} + \hat{\beta} \cdot X_{b,n}(t_{Recon}) + \hat{\varepsilon}_{b,n}(t_{Recon}) \tag{10}$$

where $X_{b,n}(t_{Recon})$ represents one of the following variables: a stock's market cap the day prior to reconstitution, its reconstitution-day return, its dollar volume on reconstitution day, its weight in the benchmark, an indicator for whether the stock is an addition, an indicator for whether the stock was migrated.

Table 6 reports the results of these regressions. The negative coefficient on *MCap* in column (1) says that we tend to slightly underestimate the passive-ownership share when analyzing the reconstitution-day volume of larger stocks. A \$1*b* increase in an index addition/deletion's market cap is associated with

Predicting over- and underestimates

Dep variable:	*%Error*					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.07**	0.02	−0.06	0.06**	−0.55***	−0.16***
	(2.11)	(0.88)	(1.27)	(2.34)	(4.07)	(3.92)
MCap	−0.02**					
	(2.17)					
Ret		0.00				
		(0.19)				
$Volume			0.19			
			(1.44)			
IndexWeight				−0.01***		
				(4.28)		
IsAddition					0.63***	
					(4.59)	
IsMigration						0.64***
						(5.10)
# Obs	11,263	11,180	11,263	11,263	11,263	11,263
Adj. R^2	0.67%	0.00%	1.67%	0.21%	0.68%	1.12%

Table 6. Each column reports the results of a separate univariate regression. The dependent variable is always the difference between the passive-ownership share implied by each index change and the average passive-ownership share implied by all changes to that index in the same year, *%Error*. The right-hand-side variable is different in each column. *MCap* is the market cap of the stock being added or dropped on the day before reconstitution in billions of dollars. *Ret* is the realized return of the stock being added or dropped on reconstitution day in percent. *$Volume* is the dollar volume of the stock being added or dropped on reconstitution day in billions of dollars. *IndexWeight* is the weight of the stock being added or dropped in basis points. *IsAddition* is an indicator variable that is one if a stock is being added to the index and zero otherwise. *IsMigration* is an indicator variable that is one if a stock is being moved between benchmark indexes and zero otherwise. Numbers in parentheses are t-stats clustered by announcement. Sample: 2000 to 2021.

a 2bps underestimate. The zero coefficient on *Ret* in column (2) implies that, when an index addition or deletion has a large reconstitution-day return, this does not cause us to over- or underestimate the passive-ownership share.

Column (3) in Table 6 suggests that, when a stock has more dollar volume on reconstitution day, we tend to overestimate the passive-ownership share. Whereas, column (4) implies that, when a stock represents a larger share of the benchmark index, we tend to underestimate the true passive-ownership share. It is noteworthy that, while we have spent most of our time so far worrying about how reconstitution-day volume might be overstating passive rebalancing volume, there is only a significant coefficient in column (4) on the benchmark weights. We will return to this point shortly.

Finally, columns (5) and (6) in Table 6 show that our estimates for the passive-ownership share are roughly 64bps higher for both additions and migrations. Again, these effects are statistically significant and economically small. 64bps is 20× smaller than the US passive-ownership share in 2000, 12.8%. The effects also likely have more to do with our sample construction than with the underlying economics. For example, we only look at additions to the Russell 1000 and Russell 2000; all migrations between the S&P 500 and the S&P MidCap 400 get counted as signals about the amount of money held by S&P 500 trackers.

At the end of the day, most of our measurement error seems to be coming from uncertainty about the precise weights used by the benchmark indexes. We get $\mathit{IndexWeight}_{b,n}(t_{Recon})$ directly from FTSE Russell starting in 2009. We have to interpolate these values from quarterly or monthly observations for the rest of our sample—i.e., for the S&P 500, the S&P MidCap 400, the Nasdaq 100, and the Russell 1000/2000 prior to 2009. Our measurement error all but disappears when we have precise index weights directly from the index provider.

The gray lines in Figure 6 show the passive-ownership share tracking each benchmark index. These lines correspond to the solid lines reported in Figure 5. The white dots in each panel correspond to individual estimates for $\widetilde{\mathit{\%Indexed}}_{b,n}(t_{Recon})$ that are either 4× larger or smaller than the average for the year. There are almost no outliers for the Russell 1000 and Russell 2000 starting in 2009 when we have index weights directly from FTSE Russell.

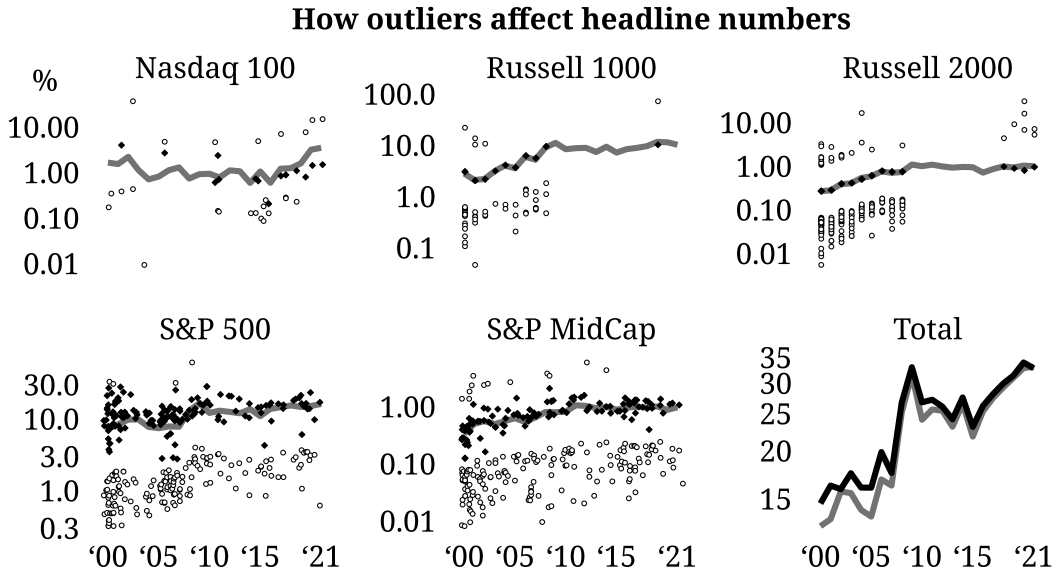

Figure 6. Grey line represents average passive-ownership share tracking each benchmark when using *DailyVolume* as proxy for passive rebalancing volume. White dots are estimates for passive-ownership share implied by specific outliers. Black dots represent the average passive-ownership share implied by all remaining changes to the same benchmark on the same date. Black line is the total passive-ownership share across all five benchmark indexes when excluding these outliers. Sample: 2000 to 2021.

Whenever we have to interpolate benchmark weights, we use an extremely conservative approach. Most of the outlier white dots are below the annual estimates for each index's ownership share. If we were to omit these outliers from our sample, our headline numbers for the US passive-ownership share would go up as shown by the black line in the bottom-right panel.

3 Reconstitution Events

The previous section used the spike in rebalancing volume on reconstitution days to impute the passive-ownership share. In this section, we provide more information about the spike itself. Subsection 3.1 describes how trading volume jumps up on reconstitution day after being nearly flat in the days immediately prior. Subsection 3.2 looks at price pressure on reconstitution days, and subsection 3.3 highlights how not to measure liquidity on these days.

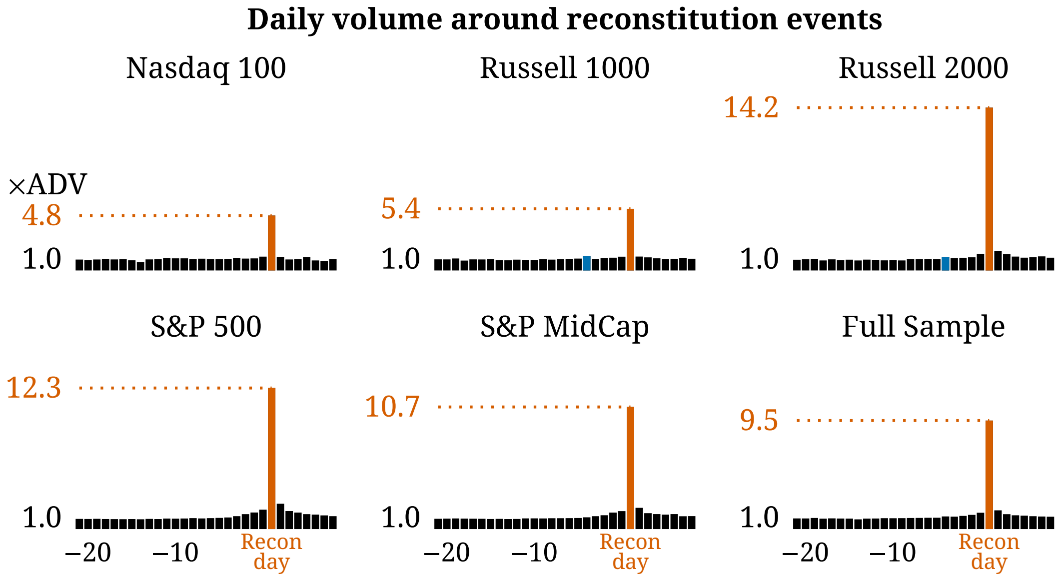

Figure 7. Average daily volume for index additions and deletions on days $t \in \{t_{Recon} - 22, \ldots, t_{Recon} + 7\}$. We normalize each stock's volume on day t by *ADV* during the 22 trading days before reconstitution. All panels have same scale. Red bars and numbers are associated with reconstitution day. Blue bars denote the Friday before Russell reconstitution, which falls on a triple witching day each year. Sample: 2000 to 2021.

3.1 Trading Volume

Figure 7 shows the average $DailyVolume_n(t)$ for index additions and deletions on each day covering a 30-day window around reconstitution. To make volume numbers comparable, we normalize the values for each stock by ADV_n.

The typical index addition/deletion sees 9.5× its normal volume on reconstitution day. There is no benchmark index for which reconstitution days look ordinary. And some benchmarks have truly outstanding levels of reconstitution-day volume. For example, additions to the Russell 2000 see 14.2 days' worth of volume on reconstitution day. These stocks only have 1.4× normal volume on the day before reconstitution.

It is not optimal for passive investors to wait until sundown on Christmas eve to do all their Christmas shopping in textbook order-execution models such as Kyle (1985), Bertsimas and Lo (1998), and Almgren and Chriss (2001). And if

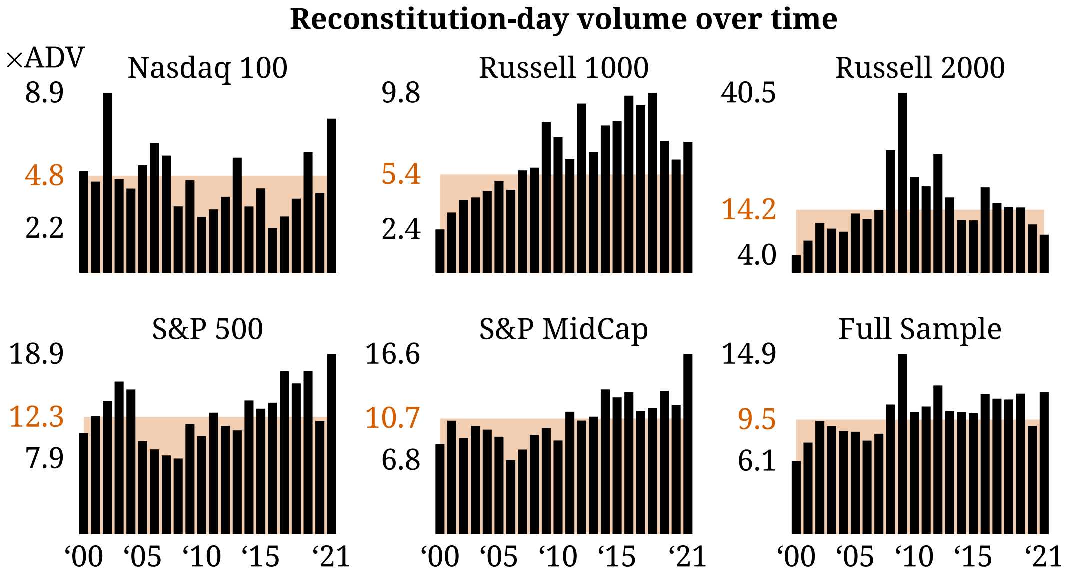

Figure 8. Black bars denote the average volume on reconstitution day experienced by index additions and deletions in a given year. We normalize each stock's reconstitution-day volume by its *ADV* during the 22 trading days prior to reconstitution. The highest and lowest y-axis labels in black represent the maximum and minimum annual values. The middle y-axis label in red represents the time-series average over entire sample period. Sample: 2000 to 2021.

markets really were this liquid on reconstitution days, then sunshine-trading models like Admati and Pfleiderer (1991) would predict that other traders should also want to get in on the action.

Neither class of model seems to describe what happens in our data. The size of this spike directly contradicts the liquidity-vs-immediacy trade off at the heart of many popular microstructure models. We also do not see any evidence of active investors delaying trades to take advantage of reconstitution-day liquidity like in a sunshine-trading model.

Figure 8 depicts how the magnitude of the reconstitution-day spike in volume has evolved over time for each benchmark index in our study. There is not an obvious common pattern across all five benchmarks. Additions to and deletions from both the S&P 500 and the S&P MidCap 400 have seen more and more reconstitution-day volume over time. Whereas, we find a qualitatively different pattern for changes to the Russell 1000 and Russell 2000.

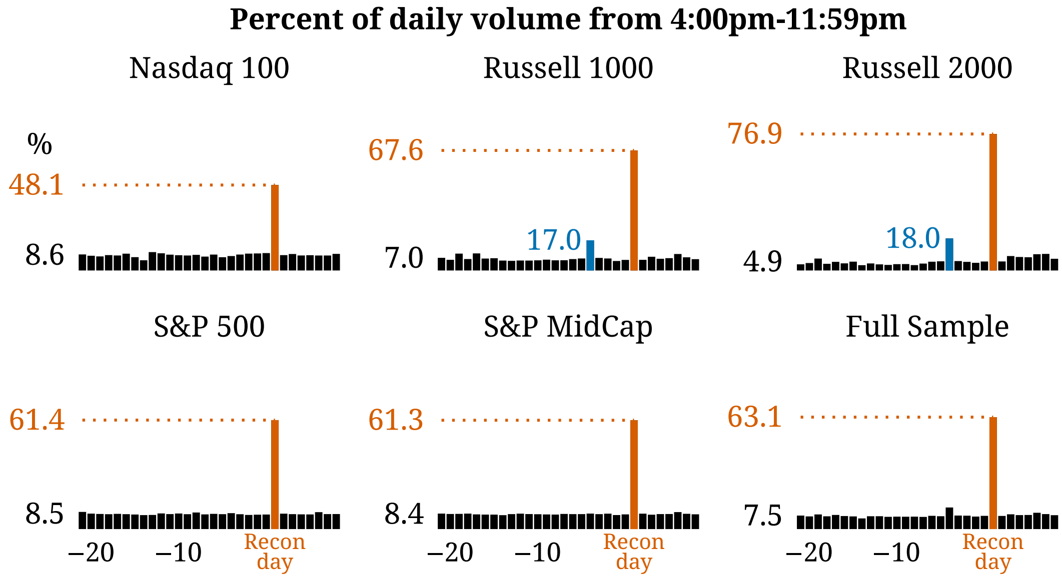

Figure 9. Percent of daily volume executed from 4:00pm-11:59pm for index additions and deletions in days $t \in \{t_{Recon} - 22, \ldots, t_{Recon} + 7\}$. All panels have same scale. Black y-axis labels represent the percent executed from 4:00pm-11:59pm on a typical day prior to reconstitution. Red bars and numbers are connected to reconstitution day. Blue corresponds to the Friday before Russell reconstitution, which falls on a triple witching day. Sample: 2004 to 2021.

Figure 9 shows the fraction of $DailyVolume_n(t)$ for index additions and deletions that gets executed from 4:00pm-11:59pm on each day in the 30-day window around reconstitution. If $\frac{Volume1600to2359_n(t)}{DailyVolume_n(t)} = 1$, then there was not a single share of the nth stock traded during normal trading hours on day t.

In the 22 days prior to reconstitution, 7.5% of daily volume got traded from 4:00pm to 11:59pm for a typical index addition/deletion. On reconstitution day, 63.0% of all volume for adds and drops got executed either during the closing auction or after hours. For the typical Russell 2000 addition, this number is as high as 76.8%. The triple witching day on the Friday before Russell reconstitution day only yields $\frac{Volume1600to2359_n(t-5)}{DailyVolume_n(t-5)} = 18.1\%$ for Russell 2000 additions.

3.2 Price Pressure

Given that passive investors are doing some much trading at market close on reconstitution day, you might expect to see large price effects on reconstitution

Reconstitution-day abnormal returns

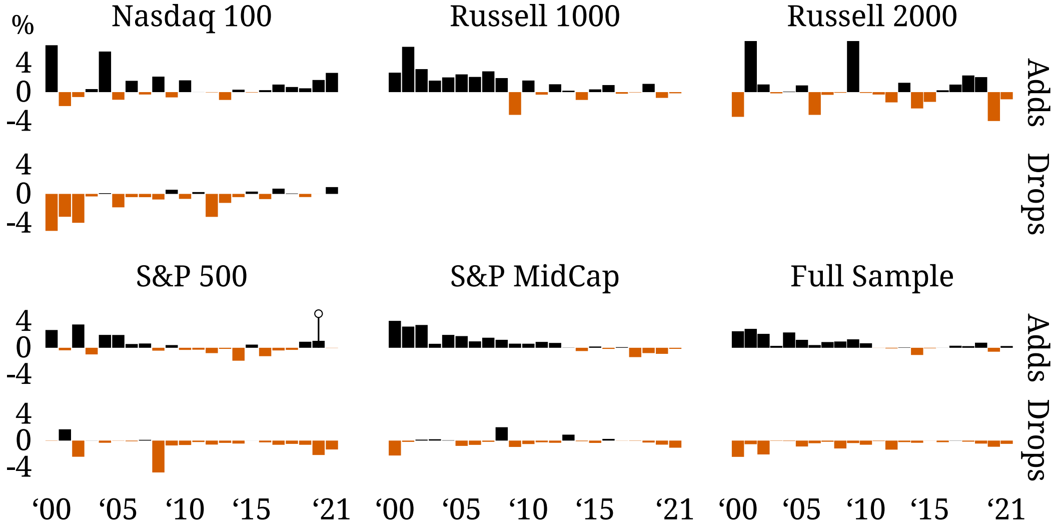

Figure 10. Each bar denotes the average return in excess of the market on reconstitution day for a value-weighted portfolio of either index additions or index deletions. y-axis has units of % per day, and all panels have same scale. The bar for additions to the S&P 500 in 2020 does not include Tesla. The white circle shows the average reconstitution-day return in excess of the market for S&P 500 additions in 2020 when including Tesla. Sample: 2000 to 2021.

day. There used to be one (Harris and Gurel, 1986; Shleifer, 1986; Beneish and Whaley, 1996; Wurgler and Zhuravskaya, 2002; Madhavan, 2003; Petajisto, 2011). However, as Greenwood and Sammon (2022) document, there is no longer much predictable price pressure on reconstitution days.

To illustrate this fact, we form two kinds of value-weighted portfolios on t_{Recon}. We create one for index additions

$$RetAdds_b(t_{Recon}) = \frac{\sum_{n \in Adds_b} MCap_n(t_{Recon} - 1) \cdot Ret_n(t_{Recon})}{\sum_{n \in Adds_b} MCap_n(t_{Recon} - 1)} \tag{11}$$

and another for index deletions, $RetDrops_b(t_{Recon})$. Figure 10 reports the average value of $RetAdds_b(t_{Recon})$ and $RetDrops_b(t_{Recon})$ in excess of the market for all reconstitution events for a given benchmark each year.

The bottom-right panel show that the returns to buying index additions and the returns to selling index deletions have steadily converged to nearly zero. This has happened in spite of the fact that the overall passive-ownership share has grown from 12.8% to 33.3% during this same period. Price changes on reconstitution day seem to have more to do with how passive investors rebalance than with how many passive investors rebalance.

To be clear: index inclusion does affect prices. The effect just does not come by way of passive rebalancing demand on reconstitution days. For example, Greenwood and Sammon (2022) document that, even in the modern era there are announcement-day returns associated with direct additions and deletions.

3.3 Liquidity Measures

Passive investors are able to push huge volumes through markets on reconstitution days. And in recent years they have been able to do so without moving prices by all that much. Clearly, passive investors find the market for index additions and deletions to be very liquid on reconstitution days. However, things look very different when we look at standard liquidity measures in the WRDS Intraday Indicators database.

At first glance, Figure 11a seems to suggest that index additions and deletions are less liquid on reconstitution days. The height of each bar represents the percent change in an index addition/deletion's price in response to a \$100m buy order on each day $t \in \{t_{Recon} - 22, \ldots, t_{Recon} + 7\}$. Taller bars are associated with less liquidity. This liquidity measure is based on Kyle (1985)'s λ. It captures the trade off between liquidity and immediacy.

But to create the data behind Figure 11a, WRDS needs to be able to sign trades. Was a particular trade initiated as a buy order or a sell order? The standard way to do this is via the Lee and Ready (1991) algorithm. And the Lee and Ready algorithm is unable to classify trades that get executed at the midpoint or at a price determined by the closing auction.

Figure 11b indicates that these sort of trades make up the bulk of volume for index additions and deletions on reconstitution days. Only 36.6% of trades can be signed on reconstitution day for the typical index addition/deletion in our sample; whereas, on a normal trading day, 92.2% of trades can be signed. Even on triple witching days, roughly 80% of trades can be signed.

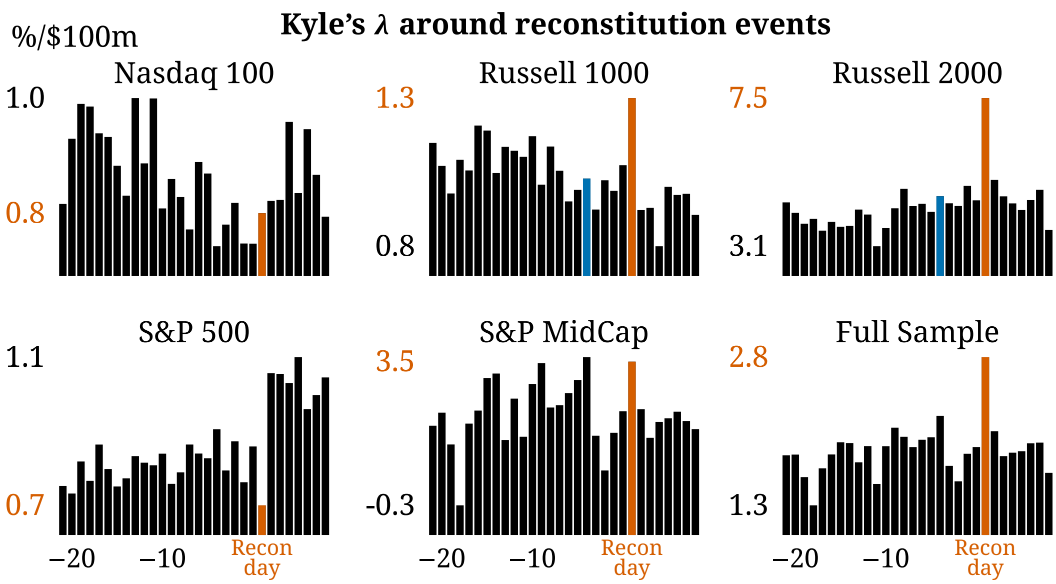

Figure 11a. Kyle's λ for index additions and deletions in days $t \in \{t_{Recon} - 22, \ldots, t_{Recon} + 7\}$. y-axis has units of percent change in price per \$100m buy order. Red denotes reconstitution day. Blue flags the Friday before Russell reconstitution, which falls on a triple witching day. Sample: 2004 to 2021.

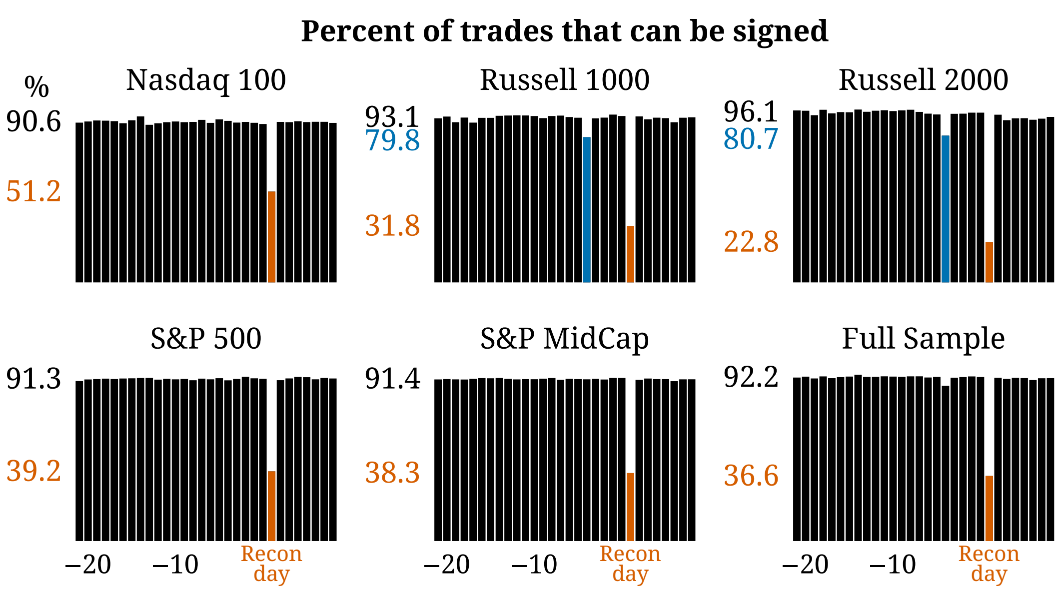

Figure 11b. Percent of signed trades on days $t \in \{t_{Recon} - 22, \ldots, t_{Recon} + 7\}$. All panels have same scale. Black y-axis label is average during 22 trading days before reconstitution. Red label gives value on reconstitution day. Blue label gives value on Friday before Russell reconstitution. Sample: 2004 to 2021.

This observation suggests that academic researchers need to be careful when assessing reconstitution-day liquidity. It also suggests that active investors do not trade normally on reconstitution days during regular market hours. The people who bought Yeti Holdings at 2:00pm on June 25th 2021 rather than waiting until the close had an unusually good reason for doing so. As such, these trades produced a larger price impact.

4 Rebalancing Mechanics

We have just seen that there is a spike in trading volume for index additions and deletions on reconstitution days. We now discuss the trading behaviors used by passive investors that produce this spike. First, in subsection 4.1 we describe how an entire ecosystem has emerged to allow passive investors to prearrange rebalancing trades to be executed on reconstitution day. Then, in subsection 4.2, we look at a particular example of what happens when this trading apparatus breaks down.

4.1 Active Preparations

"Most index funds trade on the exact same date that the index changes. That's because holding non-index stocks adds too much risk (seen as tracking error) to portfolio performance. (Mackintosh, 2020)" Our empirical results in subsection 3.1 indicate that direct indexers trade in the same way. There is only a tiny increase in volume in the days immediately prior to reconstitution. Then, there is a huge spike in volume on reconstitution day.

To be able to trade this way, passive investors get help from an entire ecosystem of other investors. Market participants begin preparing for reconstitution events months ahead of time. For example, Russell reconstitution day occurs on the last Friday in June each year. And Madhavan, Ribando, and Udevbulu (2022) suggests that from March to May: "Rebalance facilitators…use publicly available market information to predict anticipated changes to the index to estimate the size of the upcoming index rebalance. And liquidity providers, such as hedge funds, use the index predictions to establish trade positions in anticipation of supplying liquidity on the rebalance effective date."

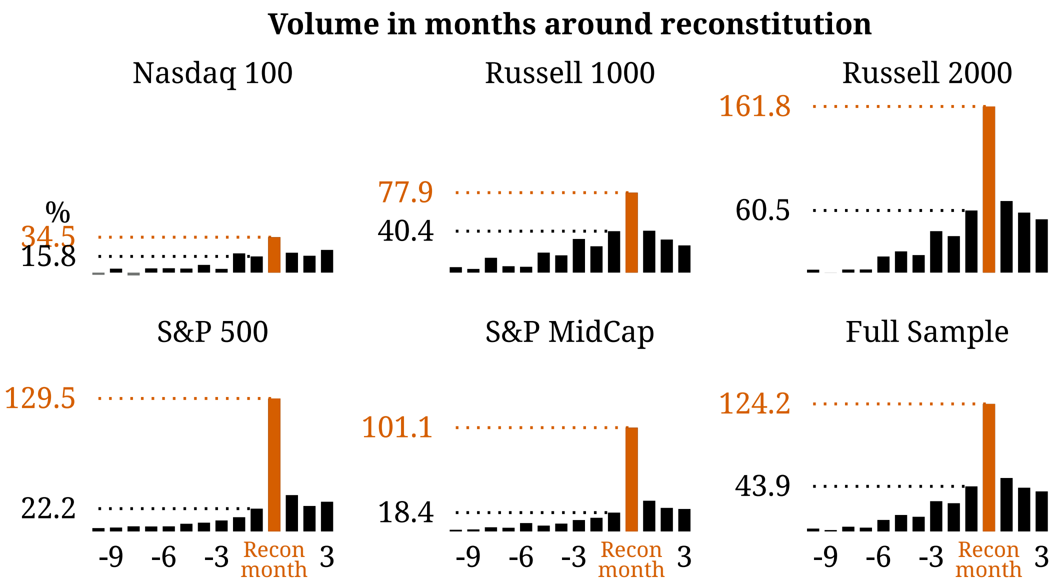

Figure 12. Average daily volume for index additions and deletions in months $m \in \{m_{Recon} - 10, \ldots, m_{Recon} + 3\}$. y-axis reports the percent difference between a stock's average daily volume in month m and its average daily volume 11 months prior to reconstitution, $100 \times \left(\frac{DailyVolume_n(m)}{DailyVolume_n(m_{Recon}-11)} - 1\right)$. All panels have same scale. Red y-axis label denotes the month of reconstitution. Black y-axis label denotes the month prior to reconstitution. Sample: 2001 to 2021.

Anecdotally, we have heard from market participants that rebalance facilitators and liquidity providers begin preparing for Russell reconstitution day in January. And our data confirms these stories. Figure 12 shows the average daily volume for index additions and deletions in the months (rather than days like in Figure 7) around reconstitution. The height of each bar represents the percent difference between the typical addition/deletion's daily volume in month m and its daily volume 11 months prior to reconstitution, $100 \times \left(\frac{DailyVolume_n(m)}{DailyVolume_n(m_{Recon}-11)} - 1\right)$. We see volumes begin to rise 6 months prior to reconstitution for stocks added to the Russell 1000 and 2000.

While some passive investors do gradually rebalance during the months prior to reconstitution, most of the extra volume in Figure 12 comes from rebalancing facilitators (e.g., JP Morgan, Goldman Sachs, etc) and liquidity providers (e.g., hedge funds). These traders are making preparations so that passive investors can rebalance all at once on reconstitution day.

Some passive rebalancing is organized the day of reconstitution via market-on-close orders. However, many passive investors prefer to prearrange their rebalancing trades. A direct indexer tracking the Russell 1000 might contact, say, JP Morgan in February to set up rebalancing trades which will be executed at the closing price on the last Friday in June. JP Morgan would then line up liquidity providers—i.e., a group of hedge funds who are willing to sell each Russell 1000 addition and a group who is willing to buy each deletion. The deal would get finalized months ahead of reconstitution. On reconstitution day, these trades would get executed as a large upstairs transaction.

Early in our sample period, it was common for prearranged rebalancing trades to include price improvement. For example, in 2007 it would not have been unusual for JP Morgan to sell each Russell 1000 addition to the direct indexer at the closing price on Russell reconstitution day minus $0.01. Our understanding is that this practice is much less common today.

These prearranged trades explain why there is so little price impact on reconstitution day. "The industry does a good job of forecasting and facilitating index demand. [...] Despite the huge volumes, the annual Russell reconstitution is usually a relatively orderly close. A few stocks typically see some market impact late in the day, but in general the index trades are matched up pretty well by liquidity providers. (Mackintosh, 2020)"

For theorists, there are two particularly noteworthy things about this trading arrangement. First, it is explicitly designed so that passive investors can trade a specific quantity regardless of the prevailing price. This is the exact opposite of Grossman and Stiglitz (1980) where all traders observe the equilibrium price before choosing their demand.

Second, passive investors devote substantial resources to managing reconstitution events. There are sell-side analysts specializing in index reconstitution events in the same way that there is sell-side research on firm fundamentals (Nomura, 2022). This is a service being offered.[5] And it has been around for decades.[6] Passive investors are not uninformed.

[5] e.g., see `www.bloomberg.com/what-goes-into-maintaining-an-equity-index/`.
[6] Editors. "Managing the Russell Recon: A Decade of Change." *Traders Magazine.* Jun 20, 2005.

4.2 Case Study: Tesla

Perhaps it would be better if passive investors were not so fixated on matching a particular index provider's exact portfolio weights. But, given that they are, it seems like the practice of prearranging rebalancing trades is a good thing. It allows passive investors to do all their rebalancing at market close on reconstitution day with minimal distortions.

One way to highlight this point is to look at what happens in a situation where passive investors could not preschedule their rebalancing trades. Market events conspired to construct exactly this sort of situation for Tesla Inc (TSLA)'s addition to the S&P 500 in December 2020.

Market participants usually have a good idea about who will be added to the S&P 500 before S&P Dow Jones makes its formal announcement. However, it came as something of a surprise when the index provider announced on November 17th that Tesla would get added to the S&P 500 on December 18th 2020. Even though the company was the 6th largest US firm, S&P Dow Jones had "passed [Tesla] over in several previous index reshuffles."[7] Many did not expect the company to get added in December 2020 either.

In addition to being surprised, market participants had relatively little time to prepare. While S&P Dow Jones made a formal announcement 22 trading days prior to Tesla's inclusion, this was all the time that investors got to prepare. By contrast, for a normal event, investors are able to predict the change months ahead of time. Even if investors cannot predict exactly which stocks will be added to or dropped from the S&P 500, they usually have a shortlist of candidates.

To further complicate matters, rebalancing facilitators found it hard to line up liquidity providers. S&P Dow Jones' initial press release did not say "which current constituent Tesla [would] replace [or] how Tesla [would] be added. (S&P Dow Jones Indices, 2020b)" And liquidity providers were still feeling the effects of recent losses incurred when S&P Dow Jones postponed its March 2020 reconstitution (S&P Dow Jones Indices, 2020a).[8]

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[7] Richard Waters "Tesla to join S&P 500 in December." *The Financial Times.* Nov 16, 2020.

[8] Nathan Vardi "Hedge Funds Suffered Losses As Index Rebalancing Trade Went Awry." *Forbes.* Mar 27, 2020.

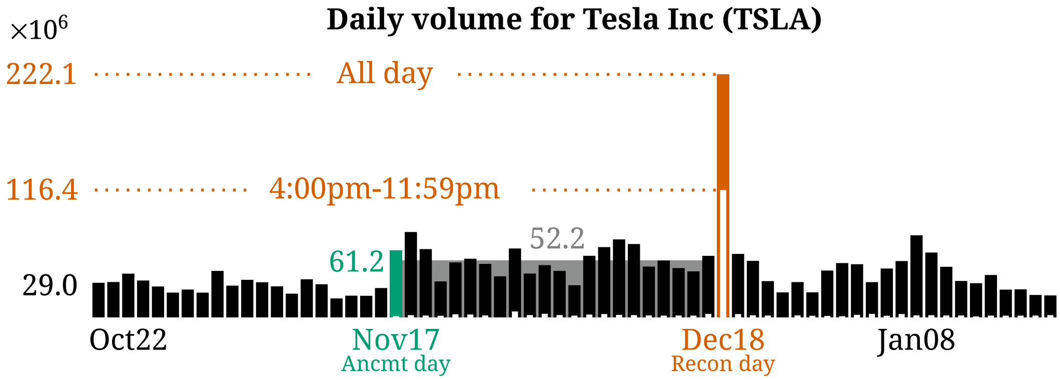

Figure 13. Volume for Tesla Inc (TSLA) around its addition to the S&P 500 in millions of shares. Solid bars represent total volume each day. White bars represent volume from 4:00pm to 11:59pm. On November 17th (green), S&P Dow Jones announced that Tesla would join the S&P 500 following market close on December 18th (red). Black y-axis label denotes Tesla's average daily volume in 6 months prior to this announcement. Grey region is Tesla's average daily volume from November 17th to December 17th.

In short, the usual trading apparatus behind passive rebalancing broke down when Tesla was added to the S&P 500. And we see the effects of this breakdown in Tesla's trading volume data. While Yeti's volume in Figure 1 was flat in the days prior to Russell reconstitution day 2021, Tesla's volume in Figure 13 jumps up on announcement day. Its average daily volume from November 17th through December 18th is 52.2 million shares per day. Its volume was 29.0 million shares per day during the 6 months prior to November 17th.

Consistent with the idea that investors were surprised by Tesla's inclusion, Figure 14 shows that its price jumped by 8.21%pts on November 17th. Its price then continued to rise right up until reconstitution day as passive investors tracking the S&P 500 frantically tried to find enough Tesla shares to make up 2.43% of their entire portfolio.

The company's share price was $136.03 at market close on November 16th. By market close on December 18th, it had risen by 71.46% to $231.67. The final 5.96% of Tesla's enormous announcement-to-reconstitution return came on reconstitution day itself. This price increase matches up with the volume pattern we see in Figure 13. While 222.1 millions Tesla shares got traded on December

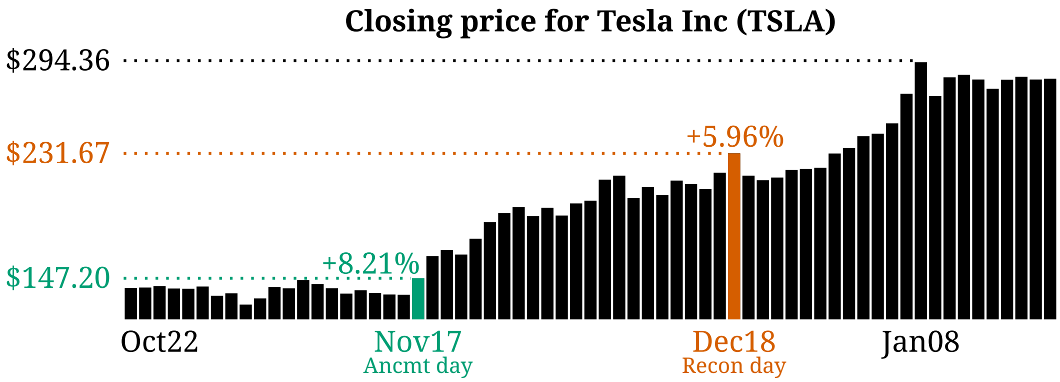

Figure 14. Tesla Inc (TSLA)'s closing price in the days around its addition to the S&P 500. On November 17th (green), S&P Dow Jones announced that Tesla would join the S&P 500 following market close on December 18th (red). Percentages reported in the figure are realized returns on announcement day and reconstitution day. Black y-axis label is Tesla's closing price on January 8th.

18th 2020, this only represents $222.1/52.2 = 4.2\times$ Tesla's average daily volume during the month prior to reconstitution.

Furthermore, $(222.1 - 116.4)/222.1 = 47.6\%$ of these shares got traded during normal market hours, which generated a huge price impact. When we include Tesla's 5.96% reconstitution-day return, the returns to S&P 500 additions in 2020 are 5.14%pts higher than the market return (Figure 10; white dot in lower left panel). All other S&P 500 additions in 2020 have abnormal reconstitution-day returns of just 1.20% (Figure 10; corresponding black bar). This is true even in a year with substantial disruptions due to COVID.

Conclusion

Each time a stock gets added to or dropped from a popular benchmark index, we ask: "How much money would have to be tracking that index to explain the huge spike in rebalancing volume we observe on reconstitution day?" We find that passive investors held 33.3% of the US stock market in 2021. This headline number is roughly double previous estimates because it reflects not only the holdings of index funds (16% of the market in 2021) but also the holdings of direct indexers and active managers who are closet indexing.

Financial economists should care about correctly estimating the US passive-ownership share for the same reasons that rain-forest ecologists care about correctly estimating the relative biomass of insects in the canopy. These aggregate numbers matter. We need to get them right. That is just good science. Think about how different the macro-finance literature would look if Mehra and Prescott (1985) had estimated an equity premium half as large.

The particular way that we estimate the US passive-ownership share also gives theorists guidance on how to model the rise of passive investing going forward. To start with, the true passive-ownership share cannot be common knowledge if previous estimates were 50% too low. We should not be modeling investors as choosing between active and passive strategies based on a broad understanding of how many other investors have made the same decision.

Some market participants are aware of the true scale of passive ownership. For example, in a 2017 white paper, researchers at BlackRock estimated that index funds held \$5.0*t* in combined AUM while direct indexers held \$6.8*t* (Novick et al., 2017). The Investment Company Institute is also clearly aware that index funds are not the only kind of passive investor. They are in no way misleading market participants. The title of Figure 2.9 in Investment Company Institute (2022) is "Index Fund Share of US Stock Market Is Small."

However, in spite of this disclaimer, "people often [forgot] that open-ended investment funds only [held] a slice of markets, and [conflated] passive's mutual fund industry market share with its overall market ownership."[1] Prior to this paper, there was no easy way for market participants to gauge how much additional money was being passively invested outside of index funds. And there was no broad appreciation of how strictly direct indexers and closet indexers were tracking their benchmark indexes.

Passive rebalancing has turned reconstitution days into some of the biggest trading days of the year. And the way that passive investors rebalance does not match up with the usual noisy rational-expectations paradigm, which assumes that investors observe the equilibrium price before choosing their demand. Passive investors often prearrange rebalancing trades to be executed at the closing price on reconstitution day, regardless of what that price is.

Financial economists should not be modeling passive investors as uninformed traders à la Grossman and Stiglitz (1980). Passive investors are often sophisticated traders who dedicate substantial resources to managing reconstitution events. These investors are informed traders who care about tracking error rather than firm fundamentals. Theorists should focus on passive investors' inelastic demand à la Haddad, Huebner, and Loualiche (2022).

We would also like to see future models distinguish between direct indexing and index funds. These investment vehicles seem to be used in different ways. Surveys regularly find that institutional investors are replacing index-futures positions with analogous positions in ETFs (Greenwich Associates, 2016). It is not a coincidence that many new benchmarks choose to reconstitute at market close on triple-witching days—i.e., exactly when index futures expire.

The distinction between index funds and direct indexers also contains an important lesson for policymakers. The right counterfactual for thinking about a world where Blackrock, Vanguard, and State Street are smaller is a world with a lot more direct indexing. It is not obvious that regulating the "Big Three" will reduce the total AUM being passively invested.

Finally, policymakers can learn a lot from the fact that no one noticed that the US passive-ownership share was twice as high as previously thought. This oversight says something about the magnitude and nature of the effect. The rise of passive investing could still be harming markets. But, if it is, it is doing so in more subtle ways that require further analysis.

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