Who Clears the Market When Passive Investors Trade?*

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Abstract

Each time a stock is bought or sold by a passive index fund, who takes the other side? We use a combination of datasets to account for as many shares possible in every stock that changes hands amongst mutual funds, institutions, insiders, short sellers, and firms, with the remainder attributed to retail and small institutional investors. Over the past 20 years across all stocks, *firms* are the primary providers of shares to passive investors on average. In addition, firms are the most responsive to index funds' buying: For every percentage point (pp) increase of index fund ownership in a stock, the firm itself responds at a rate of 0.69pps of share issuance. On a dollar basis, active mutual funds and financial institutions clear the market on average, but firms are still the most responsive, responding with $0.77 of greater share issuance or fewer shares repurchased for every additional $1 of index demand. The overarching Firm responsiveness story is robust to sample selection, treatment of outliers, return controls and fixed effects, and is consistent across industries and has been getting stronger over time.

Keywords: Market Clearing, Mutual Funds, ETFs, Passive Ownership, Active Management, Institutional Investors

JEL Classification: G11, G23

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1 Introduction

A defining characteristic of passive investing is that its demand is inelastic, as passive funds buy and sell stocks in response to flows and based on mechanical rules, regardless of the price of the underlying securities. Therefore, as passive investing has grown over the past 20 years, so have the associated inelastic demand shocks. But because of market clearing, if passive index funds and ETFs buy a stock, there must be one or more agents that sell the exact same amount of the stock.

In this paper, we ask: When passive index funds and ETFs are buying or selling, who takes the other side to clear the market? And more broadly, who has accommodated the rise of passive ownership, which went from holding 3% of the U.S. stock market in 2002 to more than 16% in 2021 (Investment Company Institute, 2023), by systematically selling shares to passive investors over the past 20 years?

Our main finding is that *Firms* are the single most responsive group in accommodating demand by passive investors via Index Funds. (As a convention, we capitalize the names of the investor groups in our data – e.g., Firms and Index Funds – to distinguish them from more general uses of these terms.) On average, Firms satisfy all Index Fund demand via share issuance through a combination of seasoned equity offerings (SEOs) and other issuance (e.g., stock awards and compensation). In terms of magnitudes, when Index Funds purchase an additional 1% of all shares outstanding, Firms respond by issuing about 0.69% of all shares outstanding. At first glance, this may seem surprising given the increased prevalence of share buybacks by large firms in recent years. Consistent with this sentiment, we find that, on a value-weighted basis, Firms do indeed buyback shares *on average*. However, even in dollar terms, Firms are just as *responsive* to Index Fund demand, reducing buybacks/issuing more shares at a rate of \$0.77 per \$1 of additional Index Fund purchases.

We also find that Short Sellers respond to Index Fund demand by increasing their short positions, and this pattern holds on an equal- and value-weighted basis. Taken together, our analysis suggests that the supply side responds nearly 1-for-1 to Index Fund demand in percent-ownership and dollar terms. This further implies that other institutional investors do not reduce their demand to offset increased passive demand. In fact, we find that non-passive mutual funds and Insurance companies, in particular, buy more (or sell less) of a stock when Index Funds also buy more.

Before proceeding, we wish to clarify two points about our paper's approach. First, our assessment of market clearing focuses on the end holders of shares. Our empirical methodology focuses on relatively low frequency (quarterly) changes in holdings, both to reduce the chance of picking up on the activity of intermediaries

and due to data limitations. We do not attempt to account for how shares sold by, say, Short Sellers might eventually make their way into passive vehicles through, e.g., high-frequency trading firms like Citadel or market makers like Goldman Sachs' equity trading desk.

Second, our empirical methodology is focused almost entirely on quantities rather than prices. This may seem like a counterintuitive choice, as price adjustments are a crucial mechanism that facilitates market clearing. While quarterly data helps us to better identify final buyers and sellers, it precludes us from precisely determining the timing of when position changes occurred. For example, if there is a large positive return in the third month of a quarter, we cannot distinguish whether (1) the return was to facilitate market clearing, or (2) a response to information about cash flows and unrelated to finding a willing counterparty.

Our market clearing analysis starts by classifying holdings and trades by investor type. We use a combination of datasets, including the Thomson Reuters S12 mutual fund holdings dataset, the CRSP mutual fund dataset, and the Thomson Reuters 13F dataset on institutional investor holdings. We form six mutually-exclusive investor groups using this data: Index Funds, Active Funds, Other (uncategorized) Funds, Insurance, Pension Funds, and Financial Institutions.[1] Our Financial Institutions group combines several subgroups (e.g., banks, investment companies, independent investment advisors) and subtracts the holdings of mutual funds. We do this to avoid double counting, as mutual fund holdings are also reported in 13F filings.

We aggregate holdings for each of our groups at the stock and quarter level. We then compute the quarterly change in (split-adjusted) shares held in each stock within each group. This gives us the aggregate position change at the group-stock-quarter level, i.e., a measure of each group's demand. We also add a seventh group: Insiders. Although we do not have insider holdings, we can construct the change in shares held by Insiders by aggregating transactions reported in the Thompson Reuters insiders dataset.

We form two additional groups that can affect the *supply* of shares. The first is Firms, which can issue and buyback shares. We compute Firms' "position change," to keep the language consistent with the other demand-side investor groups, by taking the negative of quarterly changes in the (split-adjusted) shares outstanding from CRSP. That is, when Firms issue shares, they increase the supply of shares, and Firms are "sellers" of shares and a buyer is required to clear the market. The second additional group is Short Sellers, who can borrow to short-sell shares or buy shares to cover their short positions. We compute Short Sellers' position changes by taking the negative of quarterly changes in short interest from Compustat. Thus, Short Sellers' position changes are of the same sign as all other groups – a negative position change means short

[1] We define our groups by building on 13F classifications on Brian Bushee's website.

interest has increased.

Our analysis leverages a market-clearing identity: the change in the Firm's (split-adjusted) shares outstanding must be equal to the net demand by all other investors. Of course, this identity is unlikely to perfectly hold in the data because, while our nine groups capture most sources of holdings and share changes, we do not capture every single one. For example, our data do not include information on institutions that are too small to file a 13F and retail investors. Any of the change in shares outstanding not accounted for by the net demand of all the groups we can quantify must have come from a group we cannot directly measure. So, our final group – which we call Other – is the residual demand needed to clear the market given the position changes of the groups we can observe.[2]

To make position changes of each group comparable across stocks, we normalize each group's change in shares held by the split-adjusted shares outstanding from the end of the previous quarter. For example, if Active Funds in aggregate purchased 100,000 shares of a stock in a quarter, we define demand by Active Funds as 100,000 divided by shares outstanding at the end of the previous quarter. A benefit of this scaling is that it puts the share change in units of the fraction of the company's shares before the supply of shares might have been affected by issuance or buybacks. This also puts our main variable in changes as a fraction of total ownership of a company.

We develop a regression framework to quantify how each group's position changes statistically relate to Index Funds' position changes. We estimate a series of univariate regressions, one for each group (except for Index Funds). For each group, we regress the position change of that group on Index Funds' position change at the stock-quarter level. In this framework, the intercept term (i.e., alphas) represent the estimated average buying/selling by each group when Index Funds do not change their holdings. The slope (i.e., betas) represent the sensitivity of each group's buying/selling as Index Funds increase or decrease their positions. Importantly, market clearing implies that the (scaled) sum of the alphas plus the sum of the betas across all groups must equal -1. Intuitively, this statement captures the fact that when passive investors increase their ownership by one percentage point (pp), every other group collectively must sell one percentage point of total ownership (similarly for passive selling and all other groups' buying).

The interpretation of any one regression coefficient is relatively straightforward. If a group has a negative coefficient, that group typically sells more when Index Funds buy more, and buys more when Index Funds sell more. That is, it is a statement about how each group's demand *responds* to passive demand. A positive

[2]In Appendix A.2, we show that Other group does appear to roughly resemble retail behavior, as its demand is correlated with retail order flow using the method in Boehmer et al. (2021), as well as trades in the retail brokerage dataset used by Odean (1998).

coefficient means the group tends to respond in the same direction as Index Funds, i.e., more buying by passive implies more buying (or less selling) by that group. The magnitude of the coefficient reveals the magnitude of the group's responsiveness to Index Funds' demand. For example, a beta estimate of 0.1 for the Insurance group means that when Index Funds buy an additional 1pp of all of a company's shares, Insurance buys more/sells less by 0.1pp.

We would like to highlight that our methodology applies to a significantly broader set of demand shocks than past studies of changes in passive ownership that arise due to index additions and deletions, as well as switching between indices. Many of these studies use index changes because they lead to salient, relatively large passive demand shocks over short periods of time. Although we can apply our regression framework specifically to these cases, they only account for roughly 2%-3% of stocks each quarter. The advantage of our methodology is that we can study the full cross-section of stocks, and speak to broader patterns of how responsive each group has been to demand by passive investors over the past 20 years.

Our main results, which use data for all stocks held by Index Funds from 2009 to 2021, suggest that Firms are the most responsive group to passive demand. As stated above, our regression of net Firm demand on net Index Fund demand yields a point estimate of -0.69 . This implies that for every 1pp of total stock ownership demanded by Index Funds, Firms respond at rate of 0.69 percentage points more shares issued/fewer shares bought. Short Sellers' beta of -0.26 is also relatively large in magnitude. Together, these two groups account for 95% of the *marginal demand* by passive investors. That is, passive demand is almost completely accommodated by adjustments in the *supply* of shares, either directly in the primary market or artificially from short sellers, rather than through less demand by other institutional investors.

Our regression framework also reveals that there are several groups which systematically trade in the *same* direction as passive investors. This includes Active Funds, who have the strongest tendency to respond in the same direction as passive index funds and ETFs, at least in terms of magnitudes. This implies that, while Active Funds have seen outflows over our sample period and Index Funds have received inflows of about the same magnitude, Active Funds do not necessarily sell their individual holdings on a stock-quarter basis to passive investors.

Our Financial Institutions group, which captures hedge funds, the proprietary arm of banks and other financial institutions, does not systematically take the other side of passive demand for the typical stock (its equal-weighted beta is close to zero; its value-weighted beta is -0.36), they are an active participant in clearing the market depending on the size and direction of Index Fund demand. Financial Institutions are one of the most responsive groups to Index Fund demand when Index Funds sell shares. The increased

responsiveness of Financial Institutions when Index Funds sell shares offsets a reduced responsiveness by Firms in such cases.

We conduct several robustness exercises. We can confirm that our results on each group's responsiveness are largely unaffected by (1) altering the sample period to start in 2001 or 2015, (2) adjusting the treatment of outliers, (3) value-weighting the regression (importantly, with value weights, the betas describe the share of every marginal *dollar* demanded by each group), (4) using year-over-year changes, (5) including returns or stock and quarter fixed effects as controls, and (6) reducing the sample to only the observations where the market clears (or nearly clears) amongst the groups we can directly observe in our data (i.e., where the demand from the residual Other group is close to zero). We also further rule out more nuanced explanations: our findings are not driven by (1) stale holdings data, (2) the mechanical trading of passive funds in response to primary market activity, or (3) by securities lending by passive funds themselves.

As discussed above, our main finding that Firms are the primary supplier of shares to Index Funds and ETFs seems difficult to reconcile with well-known trends in U.S. equities markets.[3] And, despite these trends, we find that even on a value-weighted basis, Firms' responsiveness to passive demand is stronger than on an equal-weighted basis, at 0.77pps more shares issued/fewer shares repurchased per 1pp increase in Index Fund ownership. So, if in dollar terms both Firms and passive investors have been net purchasers of shares, how can it be that Firms tend to respond to passive demand in the opposite direction? The answer is that our measure of responsiveness is a statement about the *marginal* demand, not *average* demand. The value-weighted results speak to the fact that in quarters where passive is buying relatively more, Firms buy back relatively fewer shares and even issue shares on average if Index Fund buying is large enough.

This clarification about responsiveness highlights that betas alone cannot tell the whole market clearing story. In fact, the equal-weighted and value-weighted results paint different pictures in terms of how markets clear on average. On an equal-weighted basis, Firms are the single largest provider of shares to passive investors. In terms of magnitudes, the equally-weighted average Index Fund purchase and Firm issuance at the stock-quarter level is 0.34pps and 0.64pps of total shares outstanding, respectively. Note that Firm's implied supply can exceed the 0.34pps demanded by Index Funds because investor groups like Insurance and Pension Funds consistently trade in the same direction as passive, and their demand is also accommodated by Firms. So, for the average stock in a given quarter in our sample, Firms take the other side of Index Funds to clear the market.

On the other hand, value-weighted average buying by passive funds at the stock-quarter level is 19 basis

[3]See e.g., coverage in the Financial Times.

points of shares outstanding. The corresponding value-weighted average Firm activity is 0.15pps of buybacks. So, if both Index Funds and Firms are both buying, who clears the market for the average dollar of demand? On a value-weighted basis, the largest providers of shares to passive over the past 20 years have been been Active Funds and Financial Institutions (e.g., hedge funds and banks), whose shrank over this period and therefore mechanically had to reduce their allocation to equities.

To better understand our main findings, we perform several additional tests and sample splits to understand sources of heterogeneity in who clears the market. The tests answer four separate questions: Do beta estimates vary (1) with year-over-year changes, (2) over time, (3) across indices, and (4) by industry?

For our year-over-year regressions, we find that Firms are even more responsive to Index Fund demand, consistent with the idea that some groups may act as intermediaries over a quarter (and Firms provide shares in the long run) and some types of Firm issuance may be observed with a delay. We also estimate our regressions quarter by quarter to get a sense of how betas have evolved over time. We find that Firms have increased their responsiveness to passive demand, with the coefficients steadily moving from -0.5 in 2009 to nearly -1 in 2021. On the other hand, the role of Financial Institutions has gradually declined, with responsiveness declining from -0.4 to 0.1 (i.e., in recent years Financial Institutions now respond to passive demand in the *same direction*). On the other hand, Short Sellers have been surprisingly stable over time, with an estimated responsiveness of around -0.3. Finally, our residual Other category has become less important over time, moving from -0.5 to about -0.2, which may be due to improved data in recent years.

Our analysis of index effects and market clearing yield some surprising findings. For stocks that switch major index membership (e.g., S%P 400 to 500 or Russell 1000 to 2000), we find that Firms are less responsive but have greater average issuance. That is, Firms issue more shares, but the shares issued are more of a constant. The average issuance for index switching stocks is 1.082pps (vs. 0.657 for non-switching stocks), but Firms' beta is -0.201 (vs. -0.763). Active Funds, Financial Institutions, and Short Sellers are more responsive in providing shares based on Index Fund demand for switching stocks compared to non-switchers.

Lastly, we estimate our series of group betas by industry. One might be concerned that our main results are entirely driven by the technology sector, which has come to dominate many market-capitalization weighted passive indices and where issuance may be relatively more common in the form of employee compensation. Instead, we find that the beta for Firms in the technology sector is -0.62, similar to our full sample estimate of -0.66. Health care, energy, and other (which includes financials) industries have betas that are negative and larger in magnitude than tech stocks. There are some industries where Firms are less responsive to Index Fund demand like the durable goods, non-durable goods, and retail industries. While the magnitude

of the betas varies across industries, *every* industry has a negative beta and all but the retail industry shows issuance on average, suggesting that industry alone is not a driver of Firms as the most significant group in clearing the market on average and in terms of responsiveness to Index Fund demand.

Lastly, we explore the mechanism through which Firms issue shares. We find that Firms respond by providing shares through both SEOs and other sources (e.g., compensation), and each has about an equal contribution to the responsiveness of Firms to Index Fund demand. In addition, contemporaneous Index Fund demand is the single best predictor of SEOs (which are unconditionally rare) and Firms' overall issuance, even when controlling for past Index Fund demand, contemporaneous and past stock returns, and stock and quarter fixed effects.

Taken together, our findings point to the following story: passive index funds and ETFs acquired an additional 15% of all shares in the U.S. stock market over the last 20 years. And, for a stock randomly sampled from the cross-section, the provider of nearly all of those shares was the firm itself. With introspection, this squares with an additional pattern in the data – no other demand-side group has reduced its equity holdings across all stocks by anywhere close to 15% – and therefore the shares *must* have come from the supply side.

1.1 Related Literature

Our work has implications for several areas of research in asset pricing and corporate finance. First, an old literature has argued that demand shocks unrelated to fundamentals should have no effect on prices (Scholes, 1972). More recent evidence, however, suggests that even non-fundamental demand shocks are crucial for explaining asset price fluctuations (Koijen and Yogo (2019), Gabaix and Koijen (2021)). We uncover an important part of the story, identifying which groups are on the other side of every passive demand shock over the past 20 years. Our findings add to a growing literature showing that the elasticity of investors who provide liquidity to passive demand and investor heterogeneity matters for asset prices ((Van der Beck, 2021), Haddad et al. (2022), Balasubramaniam et al. (2023)). We show that neglecting the role of the firm (and the whole supply side) in market clearing – especially in the case of buying by passive index funds and ETFs – omits a potentially central player in these demand systems.

In addition, our finding that firms are the ones who clear the market in the face of passive demand has implications for corporate finance. Past literature has shown that firms tend to issue equity when they think their equity is overvalued (Baker and Wurgler, 2002), and between equity and debt markets (Ma, 2019). We add to this evidence, showing that firms respond not just to information about future fundamentals (e.g.,

revenue, earnings), but also information about future demand. This has broader implications for the real effects of passive ownership, including its influence on capital structure and payout policy.

More broadly, we believe our paper contributes to a large literature on the effects of inelastic demand by passive funds. Many papers have focused on changes in index membership (see e.g., Madhavan (2003), Petajisto (2011), Chang et al. (2015), Coles et al. (2022), Van der Beck (2021)), which while important, account for a relatively small share of total trading by passive investors. In this paper, we develop a methodology to study every stock-level quarter-over-quarter change in passive ownership. Importantly, we show that the process for market clearing around index changes is not representative of the average way the market accommodates demand from passive investors. This suggests that the results from studies focused on index changes may not generalize to buying and selling by passive funds in response to flows, which are the predominant source of dollar buying and selling by passive funds.

Finally, perhaps the most closely related paper to ours – from a methodological perspective – is McLean et al. (2020), who also conduct a market clearing exercise, examining the changes in holding by 9 groups of investors. Their paper, however, is focused on the implications for return predictability. Specifically, they aim to understand if any particular group's buying/selling is related to future expected returns and anomalies. Our focus is instead on the market clearing itself, in terms of which investors are likely to take the other side of trades with passive ownership – and how this may vary depending on the direction of passive trading, the reason for passive trading and across time. To this end, we develop a novel regression framework to quantify the average tendency by our 9 non-passive groups to take the same or opposite side as net passive demand.

2 Data & Empirical Methodology

In this section, we describe the data sources we use for our main market clearing exercise. We then describe how we form groups using the data based on the type of market participant that could buy or sell shares. Lastly, we describe our empirical methodology to study how the market clears.

2.1 Data

2.1.1 Holdings Data

To construct our measures of holdings changes for each group of investor, we use several equity-holdings datasets: the Thomson Reuters S12 dataset for mutual funds, the Thomson Reuters S34 dataset on 13F filings, and the CRSP monthly stock file.

Thomson S12 The Thomson S12 provides holdings data for all funds registered under the Investment Company Act of 1940 (commonly referred to as 40 Act Funds). These are mostly mutual funds, exchange-traded funds (ETFs), closed-end funds, and unit-investment trusts.

We separate all funds into three categories: index (passive), active, and other. We classify a fund as an index fund based on the index fund flag and the fund's name in the CRSP mutual fund database using the method in Appel et al. (2016).[4] We classify a fund as active if it is in the universe of funds that can be linked between the CRSP mutual fund dataset and the Thomson S12 dataset using the WRDS MF links database but it is not otherwise classified as passive. Any remaining funds which cannot be matched between Thompson and the CRSP mutual fund database are included in the Other Funds group. It is worth highlighting that an update to the S12 data, which took place in February 2022, dramatically increased the size of the other funds group from 2017-present, mainly coming from increased coverage of foreign funds which hold US equities.

As discussed in Sammon and Shim (2023), the prevalence of stale filings can create problems when working with changes in holdings. To address this issue, we linearly interpolate holdings of each stock at the fund level across stale quarters.

Thomson S34 We obtain data on institutional investors' holdings from 13F filings recorded in the Thomson S34 dataset. Institutions are required to file a 13F if they hold more than $100M in qualified securities. To classify institutional investors into groups, we use the 13F classification data from Brian Bushee's website. The classification assigns each institution to one of the following categories: banks, investment companies,

[4]Specifically, we classify a fund as passive if it meets either of the following criteria: (1) It has a non-missing value for the index fund flag in the CRSP mutual fund database. This includes funds with code "D" (pure index funds), code "B" (index-based funds) and code "E" (enhanced index funds) (2) It has a name that makes it look like an index fund. To identify these funds, we use the same list of strings as Appel et al. (2016), which includes permutations of index names like "S&P" and "500". While this is a less conservative definition of passive funds than used in other papers (e.g., Crane and Crotty (2018), which only includes funds with an index fund flag of "D"), including these additional funds has little effect on the level of passive ownership. For example, in 12/2022, the level of passive ownership under the Crane and Crotty (2018) definition is 16.7%, while under our definition it is 17.1%.

independent investment advisors, insurance companies, corporate pension funds, public pension funds, university and foundation endowments, and miscellaneous. We combine insurance companies and university and foundation endowments because they are both very long horizon investors (and the endowments group is relatively small). We also combine corporate and public pension plans because they have common objectives.

Nearly all funds from the S12 data are under the umbrella of some financial institution that also files a 13F. This leads to significant overlap. We address this overlap by identifying all of the categories that may contain mutual fund holdings as part of the 13F holdings: banks, investment companies, independent investment advisors, and miscellaneous. We then combine the holdings of these four 13F categories together and subtract all S12 holdings. The remaining holdings form a single category which represents all financial institutions excluding funds. This is done for each stock in each quarter.

We see this as a conservative way to avoid double counting the holdings of mutual funds and other funds. We think of the holdings of financial institutions ex. funds as representing the holdings of hedge funds, large family offices, the proprietary arms of banks, and other large institutional investors.[5]

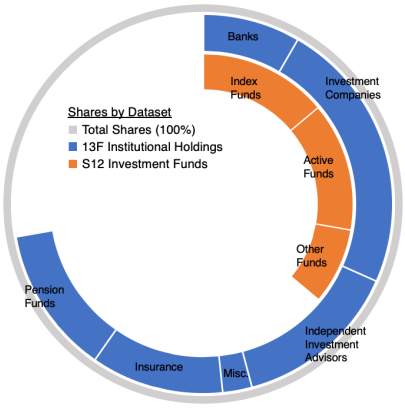
Figure 1 provides a visual illustration of the data, and the adjustment we use to ensure the categories are mutually exclusive. In the top panel of Figure 1, the circle represents 100% which is the total number of shares outstanding in a hypothetical stock. The orange region represents the ownership of all 40-Act Funds (roughly 35% in this example) and the blue region represents all 13F institutions (roughly 75%). These numbers are roughly in line with a typical stock-quarter in our sample.

The figure also illustrates the overlap of the mutual fund and 13F datasets – nearly all of the 40-Act Fund holdings are recorded in some combination of 13F filings for banks, investment companies, independent investment advisors, and miscellaneous institutions. We combine these 13F categories and subtract all holdings to create a separate category. The bottom panel of Figure 1 shows this new financial institutions ex-funds category, which is mutually exclusive. This leaves us with 6 mutually-exclusive investor groups that together sum up to total 13F institutional holdings but now with a separate accounting for index funds, active funds and other mutual funds.

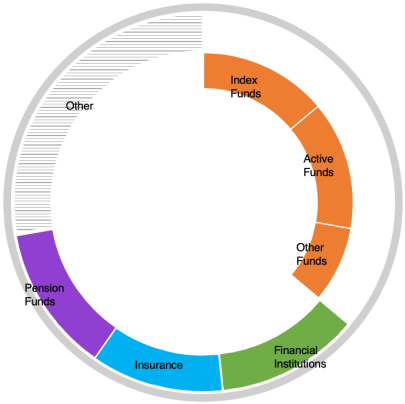
[5]It is possible that some of the Other Funds are foreign funds which are not part of institutions which file 13Fs. As we outline above, we subtract *all* the holdings in S12 filings from the 13F filings for groups known to manage mutual funds. We do this because, due to matching issues between S12 and 13F data, we cannot unambiguously determine if an S12 filing institution is part of a 13F filing institution or not. For example, VanEck's individual funds' S12s cannot be matched based on Thompson's identifiers to VanEck's overall 13F. In this case, if we assume that a lack of a match means that the S12 funds are not part of a 13F institution, we would be double counting VanEck's position changes. So, to be conservative, we assume all S12 filings are also part of a 13F filing. This will prevent double counting VanEck's position changes, and thus prevent creating an erroneous offsetting change in our Other group. On the other hand, in the case of a mutual fund which is part of an institution which does not file a 13F, we will erroneously create an offsetting Other trade.

The bottom panel of Figure 1 also highlights a placeholder for a residual category that represents all ownership that is outside of 13F filings. We attribute this group largely to retail investors, small and foreign institutional investors, as well as other miscellaneous sources of holdings. This is meant to provide a sense of who might account for owning the remainder of the shares of each company. We will describe this residual category in more detail in Section 2.2, where we discuss the methodology.

Figure 1: Dataset Decomposition and Investor Categories: Example



Panel A: Datasets and Categories



Panel B: Mutually-Exclusive Categories

Notes. Panel A presents the fraction of the average stock's shares outstanding owned by the investor categories we can observe in the S12 and 13F data. Panel B presents the same breakdown, except the categories have been refined to be mutually exclusive.

2.1.2 Other Data Sources

CRSP We use the CRSP monthly stock database for data on shares outstanding. While shares outstanding is not traditionally seen as an investor category, to do a complete accounting for how shares change hands,

we also include the firm itself (i.e., it can issue or buy back shares). We identify share issuance/buybacks based on changes in split-adjusted shares outstanding.

Computstat/Markit Another potentially important supply of shares is via short interest. Specifically, every share shorted effectively creates an additional share that needs to be held by another investor. In addition, when short sellers close their positions, the effective supply of shares decreases. In order to get a complete accounting of how shares can change hands, we also examine changes in short interest. Short interest data is obtained from Compustat following the method in Hanson and Sunderam (2014). The short interest ratio computed using Compustat data is highly correlated with the level of short interest reported by S&P Global's Markit database. We also use Markit to obtain data on the shares available for shorting, utilization rates and shorting costs.

Insiders For insiders, we do not have the level of holdings but only changes in holdings via their publicly reported buying and selling activity. We get data on insider transactions from the Thomson Reuters Insiders dataset, which we aggregate at the firm and quarter level.

2.1.3 Index Constituents Data

The next collection of datasets we leverage include information on index membership. We obtain S&P 500 and S&P 1500 membership data directly from S&P, while we get data on S&P MidCap 400 and S&P SmallCap 600 membership from Siblis Research. The S&P data starts in 2002 and ends in 2021. We also use data from Siblis research to determine Nasdaq 100 membership, which is available from 2015 to 2021. Russell index membership data is obtained directly from FTSE Russell, and runs from 2009 to 2021. Finally, CRSP index membership is provided directly by CRSP, and runs from 2015 to 2021.

We identify migrations within families of indices by identifying stocks which were simultaneously added to one index in the family and dropped from another (e.g., a stock which is dropped from the Russell 1000 and added to the Russell 2000 at the same time is classified as a Russell migration). We discuss our index membership data in more detail in Appendix A.3.

2.2 Constructing Investor Groups

We describe how we use the data described in Section 2 to measures position changes for each investor group in each stock and quarter.

Note that, throughout the paper, we capitalize the name of each of the groups we define below. We do this because many group names are also common finance-related words, and capitalization for group names distinguishes our specific groups to more common usage of the words (e.g., Insurance vs. insurance).

The first set of investor groups come directly from holdings data, where we can observe quarter-over-quarter changes in holdings per stock for each group. This gives us position changes for six categories in the holdings data: Index Funds, Active Funds, Other Funds, Insurance, Pension Funds, and Financial Institutions (excluding Funds). (Note: we will often use the term "passive investors" when describing the aggregate Index Fund group)

The next two groups account for share changes that come through changing the supply of shares in the market. The most direct way for the supply of shares to change is for the firm itself to either issue shares or buy shares back. For example, if index funds buy 1,000,000 shares of a stock and no other groups trade, it is possible that the firm issues 1,000,000 additional shares, which allows the market to clear. We label this group "Firm", and use changes in shares outstanding as the measure of share changes.

The supply of shares can also change through short sellers. From the example above, if an index fund buys 1,000,000 shares and no other groups adjust their positions (including no primary market activity from the firm), a hedge fund or other institution may sell shares short by borrowing from existing holders. For the purposes of market clearing, the accounting of shares is similar for short selling and firm issuance – passive owns 1,000,000 more shares and a hedge fund has a smaller position by 1,000,000 shares. We label this group "Short Sellers," and use changes in short interest as a measure of this group's buying and selling. To be clear, short sellers' position changes are signed just like all other groups – short seller buying (i.e., positive position changes) corresponds to decreases in short interest, and short seller selling (i.e., negative position changes) corresponds to increases in short interest.

Finally, we have insiders. As mentioned above, we do not have data on insider holdings. However, because insiders are required to disclose share transactions, we can document insider position changes.

As a summary, we construct position changes in each stock and each quarter for the following groups:

- Mutual Funds

1. **Index Funds**: Passively-managed index funds
2. **Active Funds**: Actively-managed funds
3. **Other Funds**: Funds which cannot be linked between Thompson S12 and the CRSP Mutual Fund data

- 13F Institutions

4. **Financial Institutions**: All financial institutions excluding mutual fund holdings
5. **Insurance**: Insurance and endowments
6. **Pension Funds**: Corporate and public pension funds

- Share Suppliers

7. **Firms**: Share buybacks and issuance
8. **Short Sellers**: Changes in the effective supply of shares from either increases in short interest or short covering

- Miscellaneous

9. **Insiders**: Company insiders required to disclose share transactions
10. **Other**: Retail, foreign institutions, small institutions and other groups we cannot measure directly. A residual category to enforce market clearing

The first 9 groups represent a careful accounting of all of the ways in which shares can change hands. However, we know that our holdings data is incomplete and does not account for every share of every stock. Adding firms, short sellers, and insiders can get closer to accounting for what is missing. Still, a non-trivial fraction of holdings, and thus of share changes, will be missed because of the omission of retail investors, foreign investors, institutions that are too small to file 13Fs and other groups we cannot measure directly. Because we know the market must clear, we attribute the remainder of share changes to a group we call Other to ensure that the market clears. That is, if the first 9 groups above collectively are net purchasers, then it must be that our Other group is a net seller for exactly the same number of shares. In this sense, we can think of the Other group as a residual group that enforces market clearing. This residual Other group is the 10th and final group.

The Other group can still be economically relevant in that it can accurately capture economic activity of non-U.S. institutions. One type of investor that must reside in this category is retail. While we do not claim that our Other category is a direct quantification of total retail trading activity, we do find that our Other category's position changes are correlated with proxies of net buying by retail investors. We document these patterns in Appendix A.2.

Since the Other group ensures market clearing, it also may be affected by data errors. If there is an erroneous position change in, say, Pension Funds, that will force the residual Other group to take the opposite position

to clear the market. We will keep this in mind when assessing the empirical results, and conduct analyses that try to assess the degree to which this group captures economic activity or data errors.

Figure 2 provides an illustrative example of what the data might look like. The figure shows each of the 10 groups and their respective share change. The quantity of the share change is represented by the block width and the direction of their share change is represented by which side of 0% they fall on. This example shows that Index Funds, Pension Funds and Insurance make up a majority of the buying, while Firms, Active Funds, and Financial Institutions make up a majority of the selling. The example also shows that shares changes for the first 9 groups do not clear the market, i.e., they do not sum to zero. Thus, the residual group appears on the selling side to make sure total buying equals total selling.

Figure 2: Share Changes by Group: Example

Notes. Example breakdown of net buying and selling by our 10 mutually exclusive investor categories. Bars above zero denote net buying, while bars below zero denote net selling. Because markets must clear, total net buying is by construction equal to total net selling.

2.3 Empirical Methodology

Because passive funds have plausibly inelastic demand (Haddad et al., 2022), we treat their position changes as a starting point to understand who clears the market. That is, our framework is built on the idea that passive funds demand liquidity by initiating the buying and selling. We develop a simple methodology to understand who takes the other side of passive trades.

It is important to note that when we refer to the investor group on the other side of a transaction, our methodology is designed to identify the long-term buyers and sellers of the stock (i.e., those that trade to adjust their portfolio allocations). While it is common for intermediaries, such as high-frequency and algorithmic trading firms and other financial institutions, to be the most common counterparty on a day-by-day or trade-by-trade basis, their goal is not to hold any portfolio in particular but to bridge the gap between final buyers and sellers. To the extent that these intermediaries take on strategic long-term bets, and thus hold shares at the end of a given quarter, they too will be counted in our final tally.

Denote the share change in stock i by investor group j in quarter t as a percentage of shares outstanding as

$$q_{i,j,t} = 100 \cdot \frac{shares_{i,j,t} - shares_{i,,j,t-1}}{shrout_{i,t-1}}, \tag{1}$$

where $shares_{i,j,t}$ are the (split-adjusted) shares held by group j, where the groups are each of the 10 groups listed in Section 2.2, and $shrout_{i,j,t}$ is the (split-adjusted) shares outstanding.[6] We multiple by 100 to convert the units of $q_{i,j,t}$ into percentage points of company ownership. For example, a number like 1.4 corresponds to a group purchasing 1.4% of all shares outstanding at the beginning of the quarter (end of the previous quarter). For most groups, we calculate the numerator in Equation 1 directly from changes in shares held. For others, the position change in the numerator comes directly from data (e.g., for Insiders and Short Sellers).

We then estimate a series of regressions of the form

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t} \tag{2}$$

for each group j except for Index Funds. β_j represents the degree to which group j trades with passive. If β_j is negative, group j changes positions in the opposite direction as passive on average (i.e., group j trades with passive to clear, at least part of, the market). The magnitude of β_j reveals what fraction of the passive change that group j is responsible for. Also note that α_j represents the average position change by group j across all stocks and quarters.

Because the market must clear, some other group or groups must be on the other side of passive changes. This can be mathematically represented as

$$\frac{\sum_j \alpha_j}{\overline{q}_{\text{IDX}}} + \sum_j \beta_j = -1, \tag{3}$$

where $\overline{q}_{\text{IDX}}$ is the mean Index Fund change across stocks and quarters as a percentage of all shares outstanding at the beginning of quarter t (equivalently, the end of quarter $t-1$). In words, Equation 3 simply says that all other groups in aggregate must collectively take the other side of passive position changes due to market clearing. In addition, the way the market clears is a combination of total average market clearing (sum of the alphas) plus the total sensitivities of each group to Index Fund changes (sum of the betas). See Appendix A.1 for a derivation of this market clearing expression.

[6] A natural question about Equation 1 is why not include short interest in the denominator of $q_{i,j,t}$ instead of just $shrout_{i,t-1}$, as short interest effectively increases the supply of shares. Our logic for omitting short interest is that when computing how many shares to hold, index funds do not consider short interest to count towards the firm's index-eligible shares outstanding.

The estimated alphas and betas from Equation 2 tell us two things about market clearing. First, they tell us how the market clears *on average*. For example, Insiders have an average position change of -0.073, which implies that, for the average stock-quarter, Insiders sell -0.073% of total ownership in their company.[7]

The second thing we can learn from estimating Equation 2 is each group's *sensitivity* to Index Fund changes. The beta tells us how much each group demand varies as a function of Index Fund demand. A group with positive beta means that, as Index Funds increase demand for a given stock-quarter, this group also increases its demand in that stock-quarter. This is also why the sum of the betas enters into the market clearing condition of Equation 3 – if one group demands more shares when Index Funds demand more shares, some other group must demand fewer shares.

In these regressions, we use variation in passive ownership changes across stocks and quarters. Some may be concerned that much of the variation within a quarter or within a stock may be relatively low given return chasing by passive investors or preference for certain types of stocks. We find that most of the variation is not explained by quarter and stock fixed effects. Regressing Index Fund ownership changes on just quarter and stock indicators explains about 15% of the variation. Figure 3 shows both the distribution of Index Fund ownership changes at the stock-quarter level and the distribution after removing both quarter and stock averages. While our main specification does not include fixed effects, our main takeaways are largely unchanged when estimating with or without stock and quarter fixed effects (see Section 3.4 for more details).

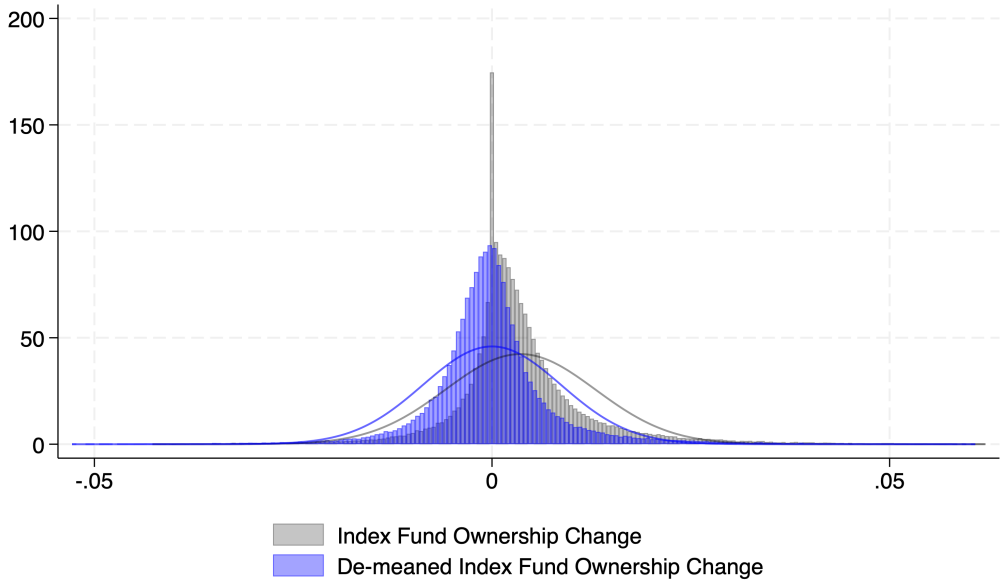
All of this is to say that most of the variation comes from heterogeneity in Index Fund ownership changes across stocks within a quarter. This rules out stories where Index Funds might buy or sell baskets of securities, and passive changes are driven mostly by portfolio-style trading. Any one index fund is likely to trade in this fashion (see Sammon and Shim (2023)), but, at the stock level, the combination of thousands of index funds leads to substantial heterogeneity that cannot be explained by scaling up and down in any one specific index.

2.4 Additional Filters

To be included in our sample, stocks must pass several additional filters. First, we only include ordinary common stocks (CRSP share codes 10-11) traded on major exchanges (CRSP exchange codes 1-3). Second, we exclude stocks which either are an acquiring permno or have an acquiring permno in either quarter

[7]The alphas by themselves tell us the fitted-value (i.e., predicted) for a stock-quarter with zero Index demand, *given* the estimated sensitivity of each group's demand to Index Funds. For example, Active Funds have an alpha of around -0.07, which means in a quarter with zero passive demand, they are predicted to sell around 0.07% of each stock, consistent with Active Funds experiencing redemptions over the last two decades.

Figure 3: Index Fund Ownership Change Distribution



Notes. This figure presents the distribution of Index Fund ownership changes. The unit of observation is the ownership change across all Index Funds at the stock-quarter level. For example, 0.02 corresponds to a 2% increase in Index Fund ownership of a stock in a quarter.

t or quarter $t-1$. This is because in such quarters, there can be large changes in split-adjusted shares outstanding, which can create extreme outliers in $q_{i,j,t}$.

Further, we require that each stock is included in one of the major index families (S&P 1500, Russell 3000 or CRSP Total Market), because our primary objective is to study market clearing when index funds trade. As described in Appendix A.3, our index data for the S&P 1500 universe starts in 2002, our Russell index data starts in 2009, and our CRSP index data (used by many Vanguard index funds) starts in 2015.[8] We use 2009 to 2021 as our baseline sample as this covers most stocks in most indices and still captures the significant growth in passive ownership. As a robustness exercise, we re-estimate our baseline empirical tests in Section 3 using data from 2002-2021 and 2015-2021. The findings are qualitatively similar to our baseline results. We provide these additional results in Appendix B.1.

Lastly, we trim outliers in each group below the 0.5 percentile and above the 99.5 percentile in our data. That is, we simply delete stock-quarter observations if any of our individual groups has a percentage share change that is in the extreme tails of that group's percentage position change distribution (this filtering excludes the residual Other group).

[8] Although Vanguard's transition to CRSP indices was initiated in 2022, it was not finished until 2014.

Table 1: Summary Statistics

	Change					Abs(Change)				
Investor Group	Mean	P25	P50	P75	SD	Mean	P25	P50	P75	SD
Index Funds	0.34%	-0.04%	0.22%	0.62%	0.97%	0.63%	0.15%	0.36%	0.78%	0.80%
Active Funds	0.02%	-0.69%	0.00%	0.68%	1.87%	1.19%	0.21%	0.69%	1.62%	1.44%
Other Funds	0.10%	-0.14%	0.01%	0.28%	0.70%	0.42%	0.05%	0.21%	0.54%	0.57%
Pension Funds	0.00%	-0.07%	0.00%	0.07%	0.24%	0.14%	0.02%	0.07%	0.19%	0.20%
Insurance	0.00%	-0.12%	0.00%	0.12%	0.54%	0.29%	0.03%	0.12%	0.35%	0.45%
Financial Institutions	0.09%	-1.52%	-0.07%	1.37%	3.63%	2.33%	0.58%	1.45%	3.02%	2.78%
Insiders	-0.07%	-0.01%	0.00%	0.05%	1.21%	0.31%	0.00%	0.03%	0.15%	1.18%
Other	0.24%	-1.30%	-0.07%	1.26%	4.04%	2.33%	0.54%	1.28%	2.75%	3.31%
Short Sellers	-0.06%	-0.58%	0.01%	0.60%	1.67%	1.06%	0.22%	0.59%	1.36%	1.30%
Firms	-0.66%	-0.43%	-0.08%	0.01%	3.48%	1.22%	0.06%	0.28%	0.91%	3.33%

Notes. This table reports the mean, 25th/50th/75th percentiles, and the standard deviation of signed and absolute position changes of all stocks for each of our ten investor groups in our baseline sample from 2009-2021. Position changes are computed as a fraction of shares outstanding at the end of the previous quarter. For details on the data, see Sections 2.1.1 and 2.1.2. For details on the investor groups, see Section 2.2.

It is, of course, possible that some groups drastically change their positions and that these observations are deleted erroneously. However, we suspect that many of these outliers come from data errors in the underlying holdings data.[9] In addition, some of the magnitudes we observe for some groups are improbably large, even after correcting issues of stale data as described in Section 2.1.1.

If the outliers come from data errors, replacing them with the 0.5 or 99.5 percentile values may not do much to correct the errors. In addition, an error for one group will have knock-on effects on our Other category. Specifically, in order to clear the market, it will force the residual Other group to also make an unrealistically large offsetting position change. This will affect the overall estimation of betas, and lead to less informative inference.

Nevertheless, as a robustness test, we repeat all of our baseline results in Section 3 using the raw data and using data where we winsorize outliers per non-residual group at the 0.5 and 99.5 percentiles. These additional results are qualitatively similar to the main results. See Appendix B.1 for these additional results.

Table 1 contains summary statistics on $q_{i,j,t}$ for all 10 groups of investors. A salient feature of the table is that the volatility of issuance/buybacks is significantly higher than that of passive demand shocks.

[9]See Appendix B in Sammon and Shim (2023) for a detailed analysis of the mutual fund holdings data.

3 Who Clears the Market?

In this section, we describe our baseline linear estimates from the empirical specification described above. Our main finding is that Firms are the most responsive group to demand by Index Funds. We then allow for a possibly non-linear relationship between demand by Index Funds and each of our investor groups, showing that Firms and Short-Sellers' responsiveness is driven by quarters with net buying by passive funds. We also examine a value-weighted version of our regression specification. The results are very similar to the equal-weighted specification in how sensitive the supply-side is to changes in Index Fund demand, but differ on who clears the market on average.

3.1 Baseline Linear Estimates

We estimate Equation 2 for each of the non-passive investor groups to account for how the market clears when Index Funds, in aggregate, add to or decrease their positions. Table 2 reports both the alpha and the beta for each group, as well as t-statistics, the number of observations, and the R^2.

In addition we report the average position change for each group, which we denote as $\overline{q}_j$. In the context of our regression framework, this can be interpreted as $\overline{q}_j = \alpha_j + \beta_j \cdot \overline{q}_{\text{IDX}}$ i.e., the average demand by each group, $\overline{q}_j$, is the fitted value for q_j at the average level of passive demand $\overline{q}_{\text{IDX}}$. The average equal-weighted position change for Index Funds is 0.34pp (i.e., a position increase of 0.34% of a stock's total shares outstanding). Therefore, the sum of $\overline{q}_j$ for all j must be -0.34% of shares outstanding, because the shares that passive buy must come from a combination of the other groups.[10]

First, we highlight the average position change for each group $\overline{q}_j$. There are three groups that provide shares to Index Funds: Firms (-0.673pp), Insiders (-0.074pp), and Short Sellers (-0.053). Note, these three groups collectively sell about 0.8pp, much more than the 0.34pp demanded by Index Funds. The reason for this is all other groups, at least on an equal-weighted basis, are adding to their positions in the same direction as Index Funds.[11] This first result shows that the typical share demanded by Index Funds comes from the supply side. In addition, Firms and Short Sellers, on average, provide *all* of the shares typically demanded by not only Index Funds but all other institutional investor groups.

[10] The sum of $\overline{q}_j$s may vary across tables because of subsample analysis or weighting differences. E.g., Table 4 reports value-weighted regressions and uses the corresponding value-weighted average change in passive ownership to compute $\overline{q}_j$ which differs from the equally-weighted average.

[11] It has been well documented that Active Funds in aggregate have seen redemptions over our sample period. This can be observed in our value-weighted analysis in Section 3.3, which captures this pattern in $\overline{q}_j$. In fact, given the equal-weighted $\overline{q}_j$ for Active Funds is positive and the value-weighted $\overline{q}_j$ is negative, this implies that Active Funds have tilted their portfolios towards small- and mid-cap stocks, while selling relatively large stocks to satisfy redemptions.

Second, we highlight the sensitivities of each group to Index Fund demand. These estimates give a sense of the equilibrium responsiveness of each group – when Index Funds demand relatively more shares, who provides those *additional* shares? Here, the answer is again the supply side – when Index Funds demand an additional 1pp of all of a company's shares, Firms and Short Sellers collectively provide about 0.96pp. Take together, these two results suggest that Firms and Short Sellers on average provide all of the shares demanded by Index Funds.

There are many other interesting observations. Active Funds, Pension Funds, and Insurance all have negative α_j and positive β_j. That is, the estimates suggest these groups are predicted to sell on average when Index Funds do not change their positions. These groups' positive beta also suggests that they tend to also buy more in the stocks that Index Funds buy more in. In the average stock-quarter, these groups all also increase their positions ($\overline{q}_j > 0$).

Financial Institutions have a positive alpha but a negative beta, suggesting that they take the other side of Index Fund demand as Index Funds demand more. The residual Other group has a positive intercept but a much larger-in-magnitude negative beta, suggesting that the residual group is more sensitive to larger Index Fund demand shocks than Financial Institutions. We will show that the responsiveness of both groups can be better understood by examining nonlinearities in how their position changes vary as a function of Index Fund changes.

We also note some patterns on statistical significance (we double-cluster standard errors at the stock and year-quarter level). The most statistically significant estimates are Firms' alpha and beta, with a t-statistic of -10.1 and -15.8, respectively. So not only are Firms' estimated coefficients the most negative, they are also the most reliably different from zero.

3.2 Non-Linear Analysis

In this subsection, we explore non-linear responses to passive demand. We will find that many groups' position changes have a non-linear response to Index Funds' demand.

Binscatter Plots We produce binscatter plots for each group's position change, measured in percent of shares outstanding purchased or sold, as a function of Index Fund position changes. We form 100 bins of equal size for each group, which means each bin has more than 1,300 observations. These plots illustrate the expected position change of each group conditional on Index Fund changes.

Table 2: Beta Estimates

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.203	6.932	-0.066	-2.455	137,431	0.011	0.004
Other Funds	0.091	3.172	0.070	2.940	137,431	0.015	0.101
Pension Funds	0.019	6.078	-0.004	-0.813	137,431	0.004	0.003
Insurance	0.070	8.816	-0.023	-1.578	137,431	0.015	0.001
Financial Institutions	-0.054	-0.803	0.115	1.421	137,431	0.000	0.096
Insiders	-0.101	-11.170	-0.039	-4.252	137,431	0.006	-0.074
Other	-0.272	-4.765	0.347	4.557	137,431	0.004	0.254
Short Sellers	-0.263	-9.198	0.037	0.848	137,431	0.023	-0.053
Firms	-0.694	-15.837	-0.435	-10.099	137,431	0.037	-0.673
Total	-1.001		0.002				-0.341

Notes. The table provides estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t},$$

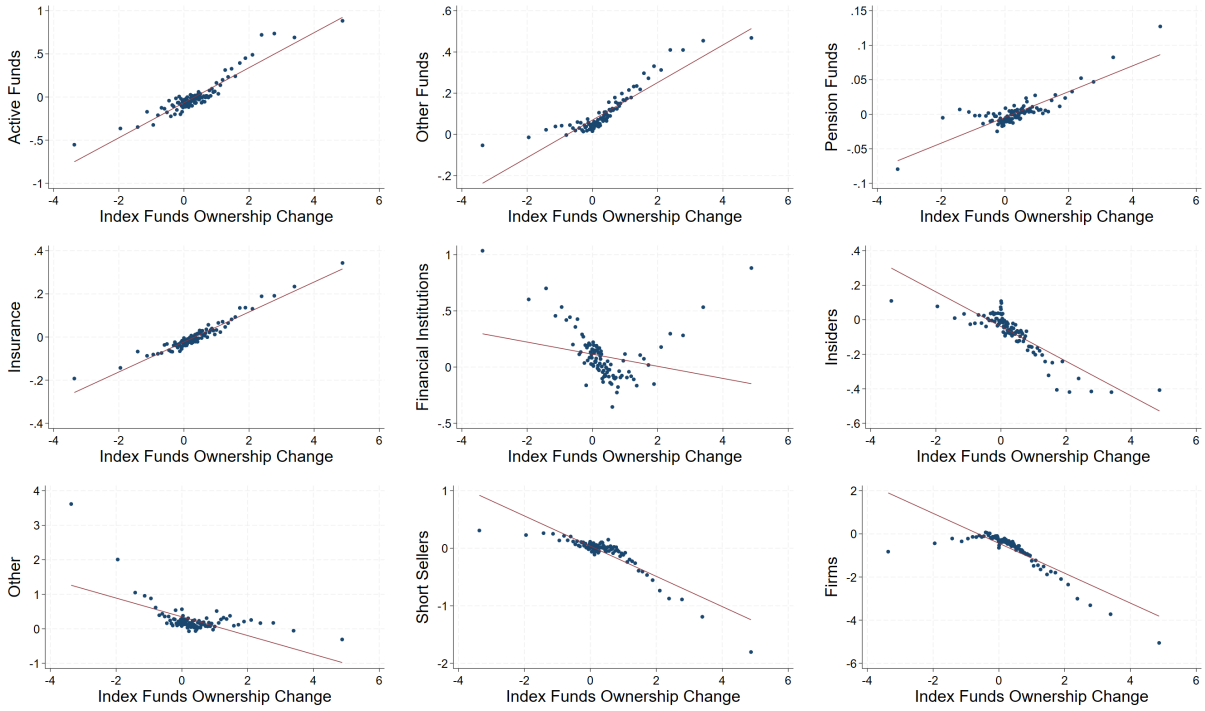
for each investor group j. $q_{i,j,t}$ is the quarterly holdings change in stock i for group j in year-quarter t in percent ownership of the company. $q_{i,\text{IDX},t}$ is the ownership change for Index Funds. T-statistics are computed from standard errors double clustered at the stock and time (year-quarter) level. The last column reports the average quantity change for each group across all stocks and quarters ($\overline{q}_j$). See Section 2.2 for more details on the investor groups, Section 2.3 for the empirical methodology, and Section 3.1 for more details on the table.

The figures reinforce some patterns documented in Table 2. Active Funds, Other Funds Pension Funds, and Insurance conditional mean is roughly linear in Index fund demand. The figures also confirm the significant negative relation between passive changes and the changes of Firms, Insiders, and Short Sellers. All three exhibit a similar pattern that was not clear from the beta estimates of Table 2: the negative relation is much stronger for positive passive changes than for negative. In fact, for Firms, it appears that there is no relation (or, if anything, a positive relation) between Firm and Index Funds position changes when passive changes are negative. We statistically examine this pattern below.

Figure 4 also uncovers some patterns which are not obvious from Table 2 alone. Financial Institutions' position changes seem to have a clear negative relation with passive changes for all but the largest positive changes. For the largest passive changes, it appears that Financial Institutions mimic Index Funds. This helps understand why Financial Institutions, which includes hedge fund position changes, may indeed be on the other side of Index Funds for all but relatively large positive position changes.

Lastly, these figures also provide a reasonable sanity check on the data: can we reliably clear the market for Index Funds' position changes with our data-driven groups? Or, do we have to regularly rely on the residual Other group to clear the market? Figure 4 suggest that our results are not heavily dependent on our Other group clearing the market. For all but the extreme negative passive changes, the Other group has nearly a flat relation with passive share changes. That is, we can, on average, roughly capture market clearing

Figure 4: Ownership Changes: Binscatter by Group



Notes. Each panel presents a bin scatter of net demand by each investor group – $q_{i,j,t}$ – against net demand by passive index funds and ETFs – $q_{i,\text{IDX},t}$. The unit of observation is security-year-quarter.

amongst the groups in our data with the exception of the extreme negative share changes from Index Funds.

For these extreme observations, the groups in our data do not seem to take the other side of Index Funds and nearly all of our observed passive changes must be cleared by the residual group. Given the general trend toward passive buying over the past 20 years, in the cases of extreme passive selling there may be a concurrent event which explains why the groups in our sample do not clear the market. For example, suppose that due to a corporate event (e.g., re-domiciling the firm for tax reasons) the stock became ineligible for many types of passive index funds and ETFs. In such cases, many institutions may also have mandates which prevent them from buying such stocks (Beber et al., 2021). This may be exactly the type of case where foreign institutional investors may take the other side, which would show up in our residual Other group.

Positive vs. Negative Passive Position Changes The binscatters above show that Firms' and Short Sellers' responsiveness to Index Fund demand is driven entirely by quarters where passive investors are net buyers of shares. To quantify this difference, we re-estimate our baseline regressions, splitting the sample

Table 3: Beta Estimates: Positive vs. Negative Passive Position Change

	Negative Passive Ownership Change						Positive Passive Ownership Change					
Investor Group	β_j	$t(\beta_j)$	α_j	Obs.	R^2	$\overline{q}_j$	β_j	$t(\beta_j)$	α_j	Obs.	R^2	$\overline{q}_j$
Active Funds	0.143	4.451	-0.077	38,428	0.003	-0.151	0.235	6.387	-0.096	98,255	0.010	0.065
Other Funds	0.026	2.418	0.044	38,428	0.001	0.031	0.116	3.125	0.049	98,255	0.018	0.128
Pension Funds	0.013	1.880	-0.004	38,428	0.001	-0.011	0.023	6.701	-0.009	98,255	0.005	0.007
Insurance	0.050	5.114	-0.030	38,428	0.004	-0.056	0.078	7.604	-0.031	98,255	0.014	0.022
Financial Institutions	-0.295	-3.209	0.103	38,428	0.004	0.256	0.101	1.161	-0.039	98,255	0.001	0.030
Insiders	-0.027	-2.843	0.002	38,428	0.000	0.016	-0.122	-8.846	-0.025	98,255	0.006	-0.109
Other	-0.976	-8.281	-0.005	38,428	0.034	0.501	-0.046	-0.681	0.181	98,255	0.000	0.149
Short Sellers	-0.100	-2.161	0.052	38,428	0.002	0.104	-0.360	-10.972	0.132	98,255	0.032	-0.115
Firms	0.165	6.142	-0.084	38,428	0.002	-0.169	-1.026	-16.609	-0.161	98,255	0.052	-0.864
Total	-1.001		0.001			0.520	-1.001		0.001			-0.685

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The sample is split based on whether passive index funds and ETFs were net buyers in a given stock in a given quarter (positive passive position change) or whether they were net sellers in a given stock in a given quarter (negative passive position change). The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

based on whether Index Funds' change in a stock-quarter was positive or negative. Table 3 presents the estimates for each subsample. Unsurprisingly, the number of observations in the positive change sample is much larger than the negative change sample, given the consistent growth of passive funds over this time period. There is still a sizeable sample, about a quarter of all observations, that saw Index Funds sell shares on net.

The beta estimates reveal several stark differences. First, the right panel shows that when Index Funds buy shares, Firms on average issue shares on a one-for-one basis, with an estimated β_j of almost exactly -1. The left panel shows that when Index Funds sell shares, Firms do the opposite as when Index Funds buy shares by selling alongside Index Funds, i.e., by issuing shares, although the magnitude is significantly smaller. Second, Short Sellers exhibit a similar pattern to Firms, in that they sell when Index Funds are buying but do not respond much to selling. Third, Financial Institutions trade much more with Index Funds for passive sales, consistent with the scatter plots presented in Section 3.2.

Lastly, the residual Other group does not, on average, need to do much to clear the market for passive buying. The estimates for the Other group is -0.091 and is statistically indistinguishable from zero, suggesting that for Index Fund buying, the groups in our data nearly clear the market amongst themselves. On the other hand, Index Fund selling is nearly completely bought by our residual Other group. One explanation for this is that net selling by index funds may be the result of stocks leaving the investable universe (e.g., redomiciling a company), which may imply that other, non-U.S. institutional investors (foreign or retail investors) become more natural buyers.

3.3 Value-Weighted Analysis

Value-Weighted Linear Estimates The baseline regressions give each stock-quarter an equal weight. We re-estimate the set of regressions but on a value-weighted basis, by giving each observation a weight within each quarter proportional to its market cap at the end of quarter $t-1$ (i.e., the beginning of quarter t). The baseline regressions give a sense of who typically clears the market for the average stock. The value-weighted regressions give a sense of who typically clears the market for the average dollar. These regressions also highlight the difference in equal- and value-weighted average Firm activity, which we will expand on and reconcile in Section 4.

Table 4 provides the alpha and beta estimates per group, as well as the average change per group, $\overline{q}_j$. The value-weighted regressions tell a similar story to the equal-weighted regressions above in terms of the sensitivities of each group: Firms and Short Sellers together have a sensitivity of less than -1. In fact, Firms are a bit more sensitive on a value-weighted basis (-0.774 vs. the equal-weighted estimate of -0.694). The most significant difference is the role of Financial Institutions, which has a statistically significant estimate of -0.360, compared to the equal-weighted estimate of -0.054. That is, Financial Institutions are more responsive on a dollar-weighted basis in clearing the market for Index Fund demand. To offset the increased responsiveness of Financial Institutions, Other and Short Sellers have a small decrease in their beta magnitudes. All of the groups with positive equal-weighted betas also have positive betas in dollar terms.

The value-weighted estimates of $\overline{q}_j$ show substantial differences from their equal-weighted counterparts. The groups that take the majority of the other side of Index Funds for the average dollar is not Firms, but rather Financial Institutions and Active Funds. This is consistent with outflows from hedge funds (captured within Financial Institutions) and Active Funds in aggregate. In addition, Firms have a $\overline{q}_j$ that is positive, consistent with large buyback programs instituted by large public companies.

Each of these three groups have slightly more nuanced stories when combined with their beta estimates. The average dollar change of a Firm is used to buyback shares, but Firms buy back significantly fewer and/or issue more shares when Index Funds increase their demand. The average dollar change for Financial Institutions offsets Index Fund demand, and they continue to supply additional shares as Index Funds demand more, though at about half the rate of Firms. The average dollar change for Active Funds also offsets Index Fund demand, but they respond to greater passive demand by selling less/buying more of the same stocks.

The equal- and value-weighted estimates collectively point to a single over-arching story. Firms are *by far* the most responsive to changes in Index Fund demand at both the stock and dollar level – when Index Funds

Table 4: Beta Estimates: Value-Weighted Regressions

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.254	3.826	-0.197	-9.276	137,431	0.010	-0.149
Other Funds	0.203	2.363	0.074	2.222	137,431	0.031	0.112
Pension Funds	0.028	5.083	-0.026	-3.518	137,431	0.005	-0.021
Insurance	0.100	4.304	-0.052	-2.758	137,431	0.014	-0.033
Financial Institutions	-0.360	-2.756	-0.150	-1.746	137,431	0.008	-0.218
Insiders	-0.104	-7.027	-0.044	-2.933	137,431	0.005	-0.064
Other	-0.155	-1.745	0.016	0.206	137,431	0.001	-0.013
Short Sellers	-0.191	-9.389	0.043	1.840	137,431	0.010	0.007
Firms	-0.774	-16.500	0.336	6.291	137,431	0.052	0.190
Total	-0.999		-0.000				-0.188

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j with each observation given a weight proportional to stock i's market capitalization in quarter $t-1$. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

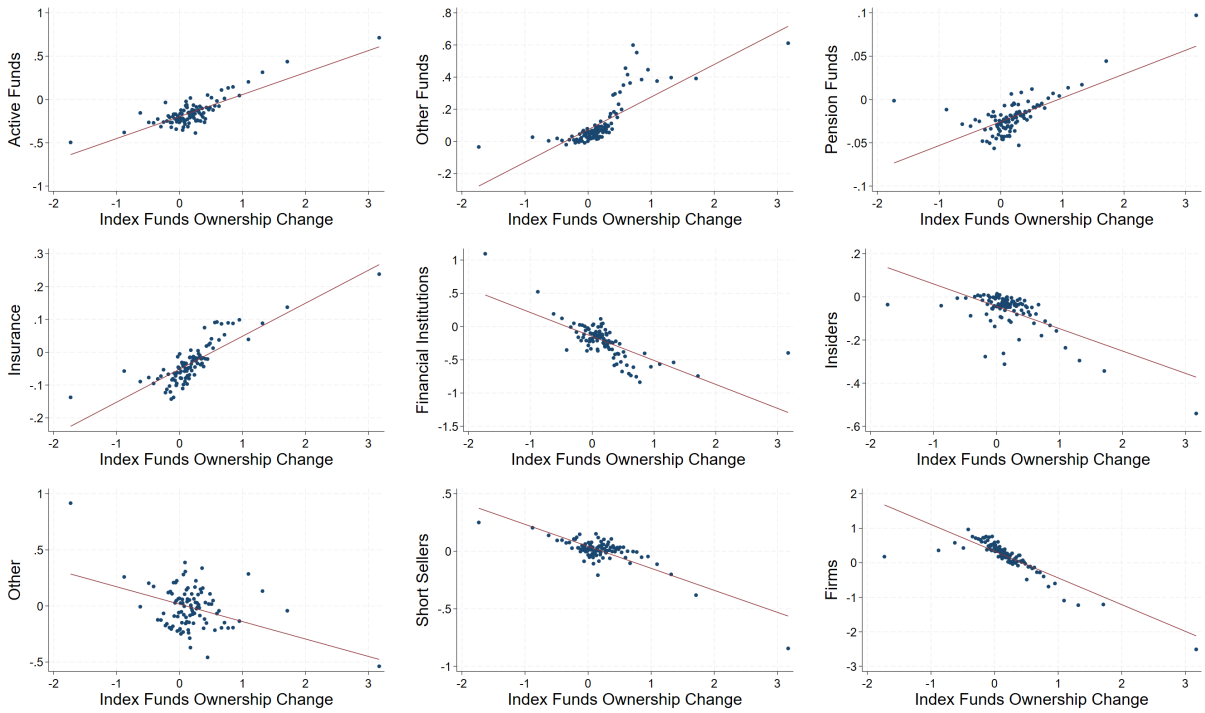
buy more, Firms provide more shares. In addition, Short Sellers and Insiders also provide more shares as Index Funds demand more shares. All 13F groups besides Financial Institutions (Active and Other Funds, Insurance, Pension Funds) all increase their demand for shares when Index Funds demand more shares. These statements all speak to the *relative* response of groups.

Value-Weighted Binscatter Plots Following the structure of the previous subsection, we provide binscatter plots that correspond to the value-weighted regressions in Table 4. Figure 5 presents the data in a value-weighted binscatter plot. We divide the data into 100 bins, and all observations in each bin are weighted by the previous quarter's market capitalization. The plots are very similar to the equally-weighted plots in Section 3.2. The biggest change is with Financial Institutions, which look to play a more definitive role in clearing the market for passive for all but relatively large Index Fund ownership increases. The other significant change is with the Other group, which looks much smaller and noisier, consistent with both retail investors focusing on small-cap stocks and a greater change of data errors in small-cap stocks.

3.4 Robustness Tests

We conduct several robustness tests for the main equal-weighted linear regression results. We briefly describe each below, and report tables and details in the appendix.

Figure 5: Ownership Changes: Value-Weighted Binscatter by Group



Notes. Each panel presents a value-weighted binscatter of net demand by each investor group – $q_{i,j,t}$ – against net demand by passive index funds and ETFs – $q_{i,\text{IDX},t}$. The unit of observation is security-year-quarter.

Sample Robustness In Appendix B.1, we provide additional estimates for different sample periods (2002-2021 and 2015-2021) and different treatment of outliers (raw data and winsorization). Most of the patterns in our baseline sample are also found in these additional samples. Notably, Firms' beta estimates range from -0.628 to -0.890 over these additional samples, and Short Sellers' beta estimates range from -0.230 to -0.300. Moreover, Active Funds consistently have position changes on the same side as Index Funds, with estimates ranging from 0.180 to 0.506.

The most notable differences in these alternative samples are for the Other group when adding back extreme observations. The beta estimates range from -0.713 (winsorized) to -1.302 (raw), a large difference from our baseline estimate of -0.327. This suggests our residual Other group does more work in clearing the market when including more extreme observations (i.e., when the market does not clear among the investor groups we can directly observe in the data). This provides some suggestive evidence that these extreme observations may be data errors, supporting our decision to drop them from our main sample.

Fixed Effects The baseline regressions do not include any fixed effects to ensure that the betas sum to -1 and we have clean estimates of market clearing. However, there may be events in a particular quarter or firm-level patterns that can explain demand or supply and affect market clearing. Here, we control for these effects by including both stock and quarter fixed effects in the series of regressions and re-estimate the betas.

Table 17 in Appendix B.2 provides the beta and alpha estimates for each group. Most of the beta estimates are largely unchanged – the supply side accounts for more than 75% of the shares needed to clear the market from passive position changes, with Firms providing more than half. This suggests that the overarching message from the baseline results also holds within a stock over time. This is in spite of the fact that the fixed effects soak up a significant amount of the variation in position changes. The R^2 of nearly every group's regression jumps significantly. In particular, the R^2 for Firms jumps from 0.034 in the baseline specification to 0.226 here. Although unreported in Table 17, we can report that most of the jump in R^2 comes from stock fixed effects, not quarter fixed effects.

Return Controls As discussed in the introduction, our paper is focused primarily on explaining quantities i.e., for each share bought or sold by passive investors, we ask who takes the other side on average. We acknowledge, however, that returns play an important role in how likely any one participant is to clear the market for passive demand. In Appendix B.3, we adapt our methodology to account for the effect of contemporaneous returns on each groups' demand.

Specifically, we run a version of our baseline regression, which also includes returns in quarter t, as well as the interaction between passive demand and returns. The results in Table 18 confirm that including returns and the associated interaction term in our baseline regression does not alter our main conclusions from Table 2 – in that Firms' demand is still the most responsive to passive demand.

To clarify the effect of including returns and the return interaction term in our baseline regression, in Table 19, we show the expected demand by each group at various points along the return distribution. The top panel – which conditions on passive investors buying 1 percentage point of shares outstanding – shows that Firms' issuance is increasing in the magnitude of contemporaneous returns. In the case of extreme positive returns, this could be due to firms taking advantage of perceived overvaluation. In the case of very negative returns, this could be driven by distressed firms with few other options being forced to issue equity. In the case of net selling by passive investors, we find a similar pattern, albeit with a smaller magnitude.

Data Errors As described in Section 2 and documented in detail in Sammon and Shim (2023), the S12 data is littered with many types of errors, some of which involve staleness in reported holdings. We also find evidence of data errors in the Thomson 13F data. In the Appendix, we discuss two sets of tests designed to address such data errors.

The first type of issue is due to general data errors where a group appears to increase or decrease its ownership of a stock but does not in reality. Such an error will cause a problem for our methodology if it forces the Other category to absorb too much demand. In Appendix C.2, we re-run a version of our baseline regressions, limiting the sample to only stock-quarters where the Other group has an ownership change of less than 0.005 in magnitude i.e., stock-quarter observations where we are confident these types of data errors are not present. Table 21 shows that the results on this subsample are consistent with the baseline results – Firms and Short Sellers collectively account for a significant fraction of the marginal shares demanded by passive.

The second and more specific issue that could contaminate our results is stale data. Suppose, for example, that Index Funds buy a stock in period t and Active Funds sell to them, but Active Funds' sales are erroneously not recorded in the data and stale holdings from the previous quarter are recorded instead. Then, the passive buying in quarter t will appear to be cleared by the Other group selling in period t. Further, if in quarter $t+1$ Active Funds report updated data, under our methodology this will appear as erroneous selling by Active in $t+1$, which will again be cleared by the Other group buying.

To quantify how problematic stale data is, in Appendix C.1 we test the degree to which passive changes in quarter t are related to other groups' position changes in the same stock but in quarter $t+1$. Given the example above, in the presence of stale data, we would expect to observe a negative relation between the residual group's position change in t and Index Fund demand at t, but a positive relation between the residual group's position change at $t+1$ and Index fund demand at t. Table 20 shows this is indeed the case, but suggests that the degree to which stale data affects our findings is low, given the magnitude is significantly smaller in $t+1$ than in t (0.124 vs -0.271).

3.4.1 Ruling Out Mechanical Stories

There are two potential mechanical effects that could contribute, or worse, drive the results found in Section 3. The first is the mechanical rules that Index Funds follow when Firms buy back or issue shares. The second is the availability and cost of shorting, which can be directly affected by passive ownership.

Primary Market Activity and Passive Investing One possible mechanical effect comes from the relationship between primary market activity and trading by index funds. Suppose, for example, that a firm buys back shares. From the index provider's perspective, this decreases the number of shares used to compute the stock's float-adjusted shares outstanding, and therefore would force passive funds to sell a fraction of their holdings (see Appendix A.4 and Sammon and Shim (2023) for details). Similarly, if a firm issues shares, index funds will have to buy a fraction of the issuance. That being said, passive funds mechanically trade an amount that is equal to the size of the primary market activity scaled by their percent ownership.[12] Given that Index Funds collective ownership of most stocks is between 10% and 20%, if this mechanical effect alone were driving our results, we would expect Firms' beta estimate to be -0.1 to -0.2. That is, a mechanical index methodology story cannot explain the magnitudes that we find.

In addition, because the mechanical effect should be completely symmetric with respect to increases or decreases in shares outstanding, we should see similar negative coefficients when firms are issuing or buying back shares. To test this, we split the baseline sample by Firm buybacks and issuance and estimate our series of regressions on each sample separately. Table 5 shows that Firms are much more likely to take the other side of passive index changes when they are issuing shares compared to when buying back (Firms' beta

[12] As a numerical example, consider a firm with 1000 shares outstanding, and 200 are held by passive funds and the passive funds are value-weighted. Suppose further that this firm does a buyback equal to 10% of shares outstanding, so the new effective shares outstanding is 900. Value-weighted passive index funds must hold a constant percentage of each constituent's float (Sammon and Shim, 2023), so to maintain an ownership level of 20%, the passive funds must sell 20 shares so they own $180/900 = 20\%$ of the company after the buyback. That is, passive funds mechanically trade an amount that is equal to the size of the buyback scaled by their percent ownership ($-100 \times 0.2 = -20$).

Table 5: Beta Estimates: Buybacks vs. Issuance

	Issuance						Buybacks					
Investor Group	β_j	$t(\beta_j)$	α_j	Obs.	R^2	$\overline{q}_j$	β_j	$t(\beta_j)$	α_j	Obs.	R^2	$\overline{q}_j$
Active Funds	0.219	7.437	0.027	89,263	0.013	0.118	0.092	2.254	-0.285	34,930	0.002	-0.267
Other Funds	0.094	3.423	0.089	89,263	0.017	0.128	0.074	1.799	0.035	34,930	0.007	0.050
Pension Funds	0.019	5.777	0.003	89,263	0.005	0.011	0.011	2.831	-0.023	34,930	0.001	-0.021
Insurance	0.071	9.318	-0.015	89,263	0.017	0.014	0.062	5.378	-0.046	34,930	0.008	-0.034
Financial Institutions	0.009	0.130	0.355	89,263	0.000	0.359	-0.489	-6.955	-0.399	34,930	0.018	-0.497
Insiders	-0.110	-10.718	-0.032	89,263	0.007	-0.078	-0.073	-5.860	-0.058	34,930	0.003	-0.073
Other	-0.263	-4.371	0.677	89,263	0.004	0.568	-0.353	-6.093	-0.356	34,930	0.010	-0.427
Short Sellers	-0.282	-9.598	0.040	89,263	0.027	-0.077	-0.180	-6.501	0.028	34,930	0.009	-0.008
Firms	-0.756	-15.049	-1.146	89,263	0.037	-1.459	-0.144	-8.180	1.103	34,930	0.009	1.074
Total	-0.999		-0.002			-0.416	-1.000		-0.001			-0.201

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The sample is split by whether the firm has done issuance (i.e., increased split-adjusted shares outstanding) or buybacks (i.e., decreased split-adjusted shares outstanding). The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

estimates are -0.756 vs -0.144). This is inconsistent with a mechanical link between Index Funds and Firms driving the estimates. In fact, when firms conduct buybacks, Financial Institutions step in to play a much larger role in taking the other side of passive trades.

Securities Lending and Passive Investing One might be concerned that there is a mechanical relationship between increases in passive ownership and increases in short interest. Specifically, as discussed in Blocher and Whaley (2015), passive funds can lend out a fraction of the shares they hold as a way to generate additional income. And, this increased availability of shares has been offered as an explanation for why stocks with more passive ownership may have more short interest on average (see e.g., Palia and Sokolinski (2021), von Beschwitz et al. (2022)). We note that, while the availability and cost to short shares can be mechanically driven by increases in passive ownership, the decision to sell when passive buys is only in part determined by the cost of shorting.

Specifically, suppose passive funds buy a stock, which increases the number of lendable shares and likely decreases the cost of shorting that stock. If there is existing demand to short a stock, changing the cost of shorting will almost mechanically increase the amount of short selling. Given that the typical stock in our sample is not hard to borrow (i.e., is not a special stock with lending fees above 1% (Aggarwal et al., 2015)), however, the marginal impact of this mechanical effect is likely small.

To quantify these effects, we explore the relation between short selling and passive ownership in Appendix C.3. We find that, unsurprisingly, the short interest ratio and shares available for lending – a calculation

of lending supply which we take directly from Markit – are positively related to passive ownership in the cross-section. In terms of magnitudes, we find a 1pp increase in passive ownership is correlated with a 0.09pp greater short interest ratio. This is already inconsistent with a purely mechanical relation between Index Funds and Short Sellers driving the results in Table 2, as the estimates here are substantially smaller.

In addition, utilization rates – i.e., the ratio of the number of shares shorted to the number of lendable shares – are negatively related to passive ownership. This is further evidence against a purely mechanical relationship between Index Funds and Short Sellers, because if every share that became available due to lending by passive index funds and ETFs was actually shorted, there would be no effect on utilization.

4 How Do Firms Supply Shares?

As we show in Sections 3.1 and 3.3, Firms' responsiveness to Index Fund demand is similar on both an equal-weighted and value-weighted basis. At first pass, this seems hard to square with two well-known broader trends. The first is the rise of passive ownership, which went from nearly nothing in the early 1990s to owning nearly 17% of the US stock market in 2021 (Investment Company Institute, 2023). The second trend is the substantial rise in the dollar value of buybacks over the past 20 years (see e.g., see the Financial Times, Guru Focus and New York Life). The apparent conflict is that if – on a value-weighted average basis – Firms have been buying back shares and Index Funds have been buying shares, how can Firms' demand be the most responsive to Index Funds on average? Further, it seems difficult to reconcile these trends with our main results that – on an equal-weighted basis – Firms have been the largest supplier of shares to Index Funds.

In this Section, we resolve this conflict by highlighting two important stylized facts. First, in every year in our sample, a significantly larger *number* of firms issue shares than buy back shares. Second, the average size of issuance is larger than the average size of buybacks. Together, these facts imply that the equal-weighted average firm in our sample has actually issued shares, and thus could have been the largest provider of shares to Index Funds who demanded shares on average.

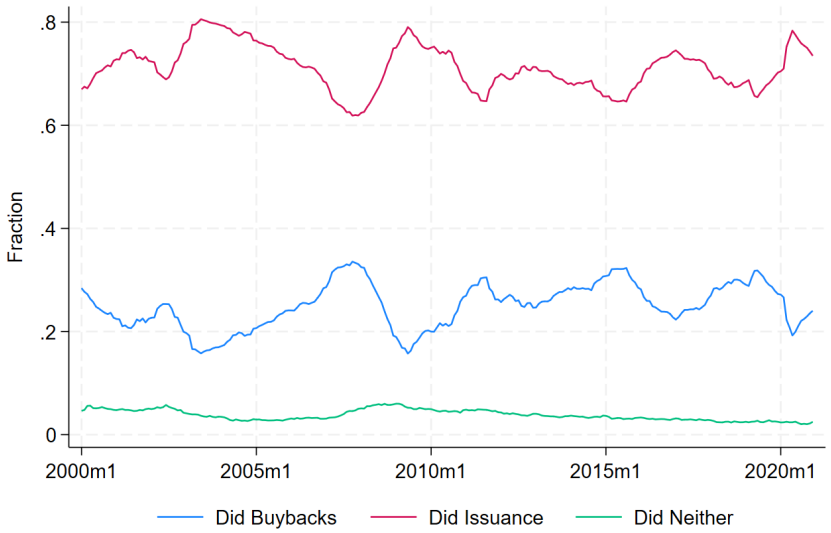
We then build on these facts to better understand how the market clears when firms buy back shares, and how these cases affect our baseline analyses, especially the value-weighted analysis which accounts for firm size. Lastly, we discuss possible mechanisms.

4.1 Stylized Facts on Buyback vs. Issuance

To perform this analysis, the first natural question is which *fraction* of firms conducts buybacks or issuance each year. In a given month, we classify a firm as doing buybacks over the next year if its split-adjusted shares outstanding has declined 12 months in the future. Similarly, we classify a firm as doing issuance over the next year if its split-adjusted shares outstanding are higher 12 months in the future. Finally, we say a firm has done neither if split adjusted shares outstanding are constant 12 months in the future. We use a 12-month horizon – instead of, say, a quarterly horizon – to reduce noise inherent in using possibly stale split-adjusted shares outstanding data in CRSP and to account for seasonalities.

Figure 6 plots the fraction of firms in each of these three categories since 2000. The first salient feature of this figure is that the fraction of firms doing neither buybacks nor issuance has been steadily declining. At the same time, there has been a slight upward trend in the fraction of firms doing buybacks or issuance. Another striking takeaway from this figure is that the fraction of firms doing buybacks is relatively small – hovering between 20 and 30 percent over the last few years. So, while the firms doing buybacks may have been doing more and more in dollar terms, they are still a relatively small fraction of the universe of firms we consider in this paper.

Figure 6: Fraction of Firms Doing Buybacks and Issuance

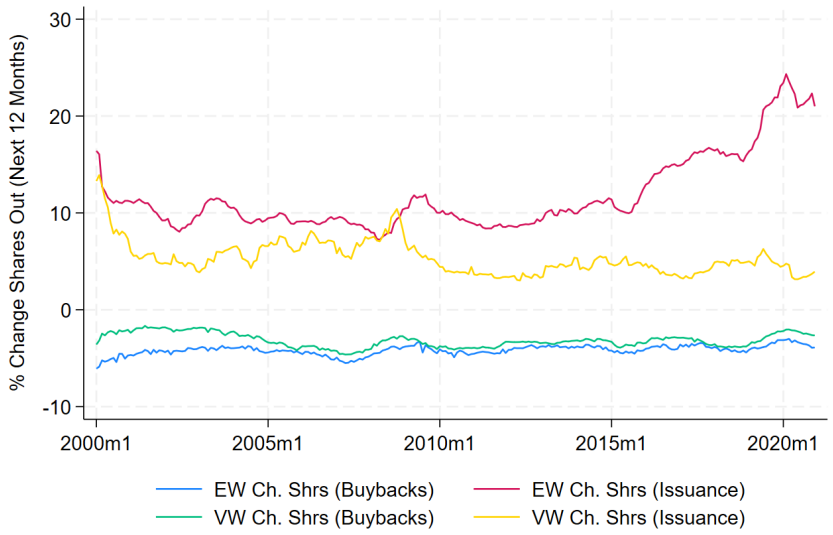


Notes. Fraction of firms which, over the next year, will do buybacks, issuance or neither. A firm is classified as having issued equity if it has a year-over-year increase in split-adjusted shares. A firm is classified as having done a buyback if it has a year-over-year decrease in split-adjusted shares. A firm is classified as having done neither if there has been no change in split-adjusted shares.

Figure 6 says nothing about the relative magnitudes of these phenomena. Specifically, it could be that each

year, many firms are issuing relatively small amounts of equity, while a few firms are buying back a significant amount of equity, so the overall net effect (on a value-weighted basis) is towards fewer shares outstanding. To examine this, we plot the equal-weighted and value weighted percentage change in shares outstanding for firms which do issuance or buybacks in Figure 7. Perhaps surprisingly, not only is the fraction of firms doing issuance larger than the fraction of firms doing buybacks, the average magnitude of issuance is larger than the average magnitude of buybacks – especially on an equal-weighted average basis.

Figure 7: Magnitudes of Buybacks and Issuance (Relative to Shares Outstanding)



Notes. Firms are split into groups based on whether they issued shares (i.e., had an increase in split-adjusted shares outstanding) or bought back shares (i.e., had a decrease in split-adjusted shares outstanding) over the next year. For each group, we plot the equal-weighted and value-weighted average percentage change in shares outstanding over the next 12 months.

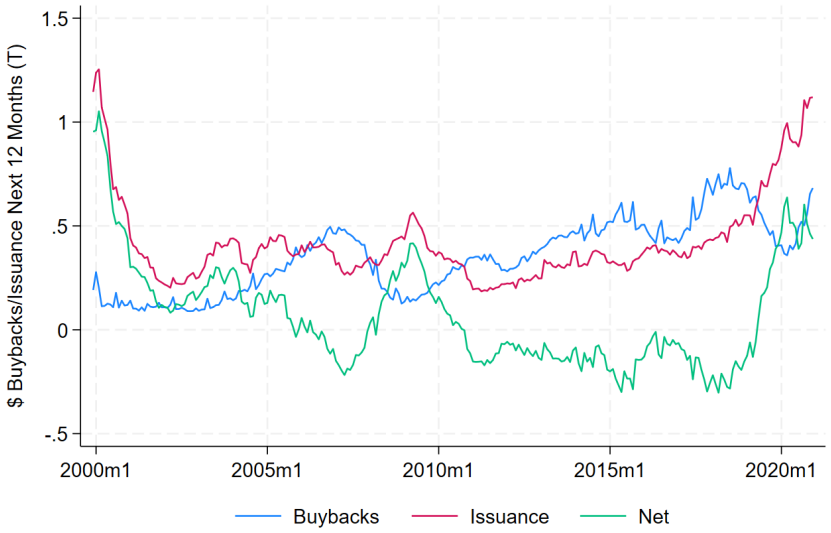
Putting together the results in Figures 6 and 7, the final natural question we study is whether there is issuance or buybacks *in aggregate*. To make buybacks and issuance comparable across firms, we first re-define these quantities to be in dollar terms. To do this, we need an assumption about the price firms paid for buybacks/received for issuance, so we assume that firms transact at the dollar volume weighted average split-adjusted price over the next 12 months. Then, we multiply the change in split-adjusted shares outstanding over the next 12 months by this average price to get an estimate of buybacks/issuance in dollars. Finally, we add this up across firms for each month to get a measure of net dollar issuance or buybacks.[13]

Figure 8 plots the total dollar amount for all firms that issued shares, bought back shares, and a signed net (aggregate buybacks minus aggregate issuance). Leading into the Global Financial Crisis, buybacks grew

[13]One might be concerned that there is some bias in using the average price over the next 12 months to estimate dollar buybacks/issuance. Specifically, one might think we are overstating net buybacks if firms that do buybacks have stock price increases, and firms that do issuance have stock price decreases. Our methodology, however, yields almost identical estimates for the amount of buybacks by S&P 500 firms in this chart, which is based on data directly from S&P Dow Jones.

significantly, becoming larger than issuance. This temporarily reversed during and after the Global Financial Crisis, and then switched back to a buyback-heavy regime from around 2011 to 2019. Finally, many firms issued equity during the COVID-19 crisis.

Figure 8: Total Dollar Value of Buybacks and Issuance



Notes. Firms are split into groups based on whether they issued shares (i.e., had an increase in split-adjusted shares outstanding) or bought back shares (i.e., had a decrease in split-adjusted shares outstanding) over the next year. We assume that firms do buybacks and issuance at the volume-weighted average split-adjusted price over the next year. The lines represent the estimated total dollar value of buybacks and issuance over the next 12 months for each group.

At first glance, Figure 8 might deepen the puzzle outlined at the start of this section. Passive ownership grew significantly, i.e., passive funds had to buy a significant fraction of each firm's shares outstanding, and at the same time, there were net aggregate dollar buybacks by firms. These trends still seem hard to reconcile with our main results that firms have provided liquidity to passive ownership. Recall, however, that the bulk of our analysis is effectively equal-weighted. This is one explanation for how, in dollar terms, buybacks may have dominated issuance, but for the (equal-weighted) average firm, issuance has been more prevalent than buybacks. This is supported by Figure 6, showing that more firms do issuance than buybacks, and Figure 7, showing that the average size for issuance is larger for buybacks.

4.2 Index Funds and Share Buybacks

To better understand how exactly Firms take the other side of passive changes for the average stock (i.e., on an equal-weighted basis) but not the average dollar (i.e., on a value-weighted basis), we split our sample based on two variables. We assign stock-quarters into samples based on whether the stock's passive change was positive or negative, and whether the firm itself, on net, bought back shares or issued shares. This allows

us to separately analyze the cases that appear somewhat puzzling, i.e., when Firms and Index Funds both buy or sell shares.

At a high level, the results in this subsection will clarify that: (1) while buybacks are important on average, firms' buyback *intensity* – which drives our estimates of β_j is not sensitive to passive demand, and (2) in quarters where firms decide to issue, how much they issue is very sensitive to passive demand. Together, we believe these patterns resolve the seeming conflict between the equal-weighted and value-weighted results.

Table 6 provides the estimates using a value-weighted regression, which weights observations in each regression based on each stock's market capitalization at the end of the previous quarter. This weighting better captures the apparent conflict between the market clearing findings throughout the paper and the propensity for large firms to do buybacks. The table also reports the intercept and its t-statistic, as well as the average group demand ($\overline{q}_j$) within each subsample. Since we condition on Firm buying or selling, the intercept involving Firm changes will be determined by the sample selection (e.g., a sample with Firm buying will systematically have a positive $\overline{q}_j$).

We first discuss the sample where Index Funds increase ownership and Firms buy back shares. That is, for these observations, Firms *cannot* clear the market for passive demand. Firms' $\overline{q}_j$ is large and positive (this is, in part, a function of the sample selection) but the estimated beta is close to zero and statistically insignificant. This shows that when Firms buy back shares, it is effectively a constant – the do not respond to changes in Index Fund demand. Then, who clears the market for these stocks to satisfy variation in Index Fund demand? Financial Institutions take the other side of nearly all passive demand, both on an average basis ($\overline{q}_j$ is negative and large in magnitude) and in its responsiveness (its beta is -0.934).

The other interesting samples are the two when Index Funds sell. When Index Funds sell and Firms buy, Firms do indeed buy more as passive sells more – the beta on Firms is -0.331. Financial Institutions are even more responsive – their beta is -0.617 – indicating that they buy more of the stocks that Index Funds sell, though they start from a point of also selling shares (their $\overline{q}_j$ is negative). Active Funds are also pronounced in this group – they on average sell shares ($\overline{q}_j < 0$) and respond by selling more shares as Index Funds sell more (β_j).

When Index Funds and Firms both sell shares, Firms tend to sell more when Index Funds sell more. So who clears the market? Financial Institutions continue to play a significant role – they buy shares on average ($\overline{q}_j = 0.3$) and respond to more Index Fund selling by buying additional shares ($\beta_j = -0.557$). The residual Other group plays a similarly large role. This is consistent with either retail investors buying, who are known

Table 6: Beta Estimates by Passive and Firm Direction, Value-Weighted

	Passive Selling, Firm Buying					Passing Buying, Firm Buying				
Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	$\overline{q}_j$	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	$\overline{q}_j$
Active Funds	0.161	1.554	-0.323	-9.086	-0.358	0.333	1.771	-0.326	-6.859	-0.234
Other Funds	0.045	0.982	-0.011	-0.390	-0.021	0.213	1.956	0.041	1.418	0.100
Pension Funds	-0.014	-1.143	-0.058	-7.552	-0.055	0.026	3.110	-0.040	-5.625	-0.033
Insurance	0.009	0.326	-0.090	-4.446	-0.092	0.087	2.402	-0.066	-3.464	-0.042
Financial Institutions	-0.617	-3.416	-0.435	-4.342	-0.302	-0.934	-3.212	-0.249	-2.595	-0.507
Insiders	-0.027	-1.043	-0.045	-1.654	-0.039	-0.122	-3.751	-0.025	-1.138	-0.059
Other	-0.111	-0.721	-0.359	-3.144	-0.335	-0.525	-2.421	-0.152	-1.634	-0.297
Short Sellers	-0.116	-1.766	0.042	1.673	0.067	-0.182	-5.093	0.019	0.703	-0.031
Firms	-0.331	-2.231	1.279	17.387	1.350	0.104	0.866	0.798	14.809	0.827
Total	-1.001		0.000		0.216	-1.000		-0.000		-0.276

	Passive Selling, Firm Selling					Passive Buying, Firm Selling				
Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	$\overline{q}_j$	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	$\overline{q}_j$
Active Funds	0.099	1.137	-0.047	-1.264	-0.082	0.288	4.254	-0.108	-4.349	0.014
Other Funds	-0.025	-0.514	0.104	2.695	0.113	0.205	2.793	0.090	3.603	0.177
Pension Funds	-0.021	-2.237	-0.019	-2.201	-0.012	0.039	6.372	-0.009	-1.017	0.008
Insurance	0.017	1.177	-0.052	-2.422	-0.058	0.104	5.150	-0.038	-1.898	0.006
Financial Institutions	-0.557	-4.115	0.105	1.085	0.300	-0.121	-0.873	0.024	0.252	-0.027
Insiders	0.010	0.937	-0.022	-2.036	-0.025	-0.174	-6.419	-0.017	-1.018	-0.091
Other	-0.550	-4.142	0.319	3.100	0.512	0.003	0.029	0.253	2.883	0.254
Short Sellers	-0.132	-2.856	0.076	2.059	0.122	-0.260	-10.147	0.096	3.183	-0.014
Firms	0.157	3.661	-0.465	-14.771	-0.520	-1.084	-13.004	-0.291	-4.781	-0.751
Total	-1.002		-0.001		0.350	-1.000		-0.000		-0.424

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The regression is estimated separately, in each column only including firms which are a member of each of the listed industries. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level. The number of observations per sample is as follows: Passive Selling, Firm Buying: 11,170 (10% of observations); Passing Buying, Firm Buying: 21,701 (19%); Passive Buying, Firm Selling: 58,035 (52%); Passive Selling, Firm Selling: 21,353 (19%).

to be contrarian. This is consistent with Section 3.2, which shows that when Index Funds sell in general, Financial Institutions and Other are the groups that absorb essentially all of the shares.

5 Extensions

We estimate several additional empirical specifications with the goal to better understand patterns in how the market clears. We examine how market clearing has evolved over time, changes with index-related events, and varies by industry.

5.1 Year-over-Year Estimates

Since we are interested in which groups ultimately clear the market in the long run, we estimate our baseline equal-weighted regressions but with year-over-year changes. This helps address the possibility that some groups may act as intermediaries over periods as long as two months, and our quarterly analysis misses the "final" buyer or seller. For example, a hedge fund may sell shares to an index mutual fund a few weeks before the end of a quarter, then the hedge fund may buy the shares back from an active mutual fund manager two months later. Our quarterly data may miss that this, in the long run, a transaction between an index mutual fund and an active mutual fund, but intermediated by the hedge fund.

We estimate a series of regressions with overlapping time periods. The regression we estimate for each group in our sample is

$$q_{i,j,t\to t+4} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t\to t+4} + \varepsilon_{i,j,t}, \tag{4}$$

where the ownership change for each group j or the Index Fund group is computed over four quarters. Because we have overlapping observations, we adjust standard errors for clustering at the stock-level, year-quarter-level, as well as for autocorrelation up to 6 quarters i.e., we follow the standard practice of including lags equal to 1.5× the number of overlapping observations.

Table 7 presents the estimates. If anything, we find that Firms play an even bigger role in clearing the market for passive demand. For the average passive demand, Firms provide *all* of the shares on a year-over-year basis, including not only the shares demanded by Index Funds but also all of the shares the other groups demand alongside Index Funds. This is captured by the series of $\overline{q}_j$, which show that Other Funds, Financial Institutions, and Other all demand shares on average along side Index funds. Essentially all of those shares are provided by Firms.

In addition, Firms are by far the most responsive group, with a beta of -1.441. This beta magnitude dwarfs all others. The closest other groups in magnitude are Financial Institutions and Active Funds, but both of these groups have the opposite sign. That is, these groups demand *more* shares when Index Funds demand more shares. This means that Firms not only respond to provide shares for passive investors as they demand more shares, but for the position changes of other groups that mirror the demand of Index Funds.

We also present binscatter plots with year-over-year changes that correspond to the year-over-year regressions in Appendix D.2. For the most part, the additional binscatter plots are similar to those presented in Figure 4. In summary, the year-over-year binscatters paint a familiar picture – Firms are extremely reponsive for

Table 7: Beta Estimates: Year-over-Year Regressions

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.350	7.827	-0.523	-3.883	117,987	0.036	-0.060
Other Funds	0.158	5.684	0.210	2.144	117,987	0.056	0.419
Pension Funds	0.040	6.636	-0.045	-2.048	117,987	0.025	0.008
Insurance	0.097	11.973	-0.132	-2.681	117,987	0.041	-0.004
Financial Institutions	0.569	4.497	-0.212	-0.722	117,987	0.029	0.541
Insiders	-0.167	-7.069	-0.069	-1.099	117,987	0.010	-0.290
Other	-0.328	-1.636	1.696	5.212	117,987	0.006	1.262
Short Sellers	-0.278	-14.577	0.173	1.633	117,987	0.038	-0.195
Firms	-1.441	-11.993	-1.097	-3.909	117,987	0.103	-3.005
Total	-1.000		0.001				-1.323

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j with each observation given a weight proportional to stock i's market capitalization in quarter $t-1$. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

Index Fund buying, but not for selling. In the quarterly analysis, Financial Institutions were very responsive for Index Fund selling. The year-over-year binscatters show that this responsiveness nearly completely goes away, suggesting that Financial Institutions buy more when Index Funds sell more on a quarterly basis but, in the long run, may even sell alongside Index Funds when they sell. As Index Fund demand decreases, Other, Short Sellers, and Insiders are the groups that provide the most shares and have the strongest market-clearing response.

5.2 Index Effects

There is a long literature that studies index additions and deletions as a shock to passive ownership that originates from Shleifer (1986) and Harris and Gurel (1986). In that spirit, we test whether there are differences in who trades with passive when stocks have switched indices (i.e., "switchers") or have not had any change in any major index it belongs to (i.e., "stayers").

Collectively, the tests point to a story where intermediaries can facilitate trading between Index Funds and other institutions if there is a clear signal or event where passive will demand shares. This is similar to the role intermediation might play in facilitating the trades required from index changes, as documented in Chinco and Sammon (2023). Without this signal for intermediaries, the supply side plays the largest role in clearing the market.

5.2.1 Index Switchers vs. Stayers

We examine stocks that did or did not switch membership in major indices. Each quarter, we define a stock as an index switcher ("switcher") if it moved into or moved between any of the major indices (e.g, S%P 500, 400, 600 and the Russell 1000 and 2000; see Section 2.1.3 for the full list). Otherwise the stock is categorized as a "stayer." We split the sample based on this designation.[14] Table 8 presents the estimates for each subsample.

The index stayers tell a largely similar story to the overarching theme of the paper – Firms account for most of the other side of passive (both on average and in terms of their responsiveness), with Short Sellers and Insiders also consistently contributing to clearing the market for Index Funds.

Market clearing is quite different for index switchers. Most notably, Firms play a much larger average role: $\overline{q}_j$ for Firms is -1.082pp, nearly all of the 1.102pp average Index Fund demand for index switchers. However, Firms are much less responsive, with a beta estimate of -0.201 (as opposed to -0.763 for stayers).[15] In order for the market to clear, which groups take a larger role on the other side of increased passive demand? The biggest differences come from Financial Institutions, Active Funds, and Other Funds. In fact, Active Funds and Other Funds appear to be breaking a persistent pattern we have seen throughout the paper: instead of trading in the same direction as Index Funds, they actually accommodate increased Index Fund ownership changes.

This points to a story where a salient event, like a stock switching indices, may help facilitate the transfer of shares amongst funds and institutional investors. Financial intermediaries may be able to use the attention these stocks garner to get demand-side institutions to adjust portfolio allocations to clear the market (Greenwood and Sammon, 2022). Firms also provide an important role in market clearing by providing a significant fraction of the shares on average, but are much less responsive to deviations from the average Index Fund demand than in the index stayers sample (and, for that matter, in most other subsamples).

In Appendix D.3, we repeat the analysis above but for year-over-year changes. The year-over-year estimates show that the lack of Firm responsiveness for switchers is largely temporary – over the course of a year, Firms are the most sensitive in providing shares to Index Funds, with a beta estimate of -0.701. In addition,

[14] Relative to the size of all stocks held by all indices in our data, switching is rare. We still think this is an important exercise given the salience of index switching and the attention it receives from investors and academics.

[15] One reason for this difference could be large differences within switchers based on whether a stock is coming from outside of a major index to inside a major index (and vice versa) relative to a stock that is switching indices within the same index family. For the former, many of the shares must come from outside of Index Funds. For the latter, many of the shares come from within the Index Fund group see, e.g., Greenwood and Sammon (2022)

Table 8: Beta Estimates: Index Switchers vs. Stayers

	Index Switchers						Index Stayers					
Investor Group	β_j	$t(\beta_j)$	α_j	Obs.	R^2	$\overline{q}_j$	β_j	$t(\beta_j)$	α_j	Obs.	R^2	$\overline{q}_j$
Active Funds	-0.024	-0.841	-0.054	1,424	0.001	-0.080	0.235	7.164	-0.073	134,394	0.013	0.002
Other Funds	-0.033	-2.083	0.255	1,424	0.008	0.219	0.104	3.060	0.065	134,394	0.018	0.098
Pension Funds	0.013	2.010	0.047	1,424	0.008	0.061	0.017	4.795	-0.005	134,394	0.003	0.000
Insurance	0.089	8.529	0.017	1,424	0.094	0.115	0.064	6.775	-0.024	134,394	0.011	-0.004
Financial Institutions	-0.147	-1.897	0.728	1,424	0.008	0.566	-0.068	-0.926	0.103	134,394	0.000	0.081
Insiders	0.001	0.123	-0.108	1,424	0.000	-0.107	-0.114	-10.580	-0.035	134,394	0.007	-0.071
Other	-0.328	-4.413	0.437	1,424	0.030	0.075	-0.249	-3.759	0.341	134,394	0.003	0.262
Short Sellers	-0.370	-7.681	-0.461	1,424	0.146	-0.869	-0.225	-8.835	0.042	134,394	0.015	-0.030
Firms	-0.201	-2.609	-0.860	1,424	0.015	-1.082	-0.763	-16.627	-0.414	134,394	0.039	-0.657
Total	-1.000		0.001			-1.102	-0.999		-0.000			-0.319

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The sample is split into index switchers – defined as those that are added to, dropped from or switch between the Russell 1000, Russel 2000, S&P 500, S&P 400, S&P 600, Nasdaq 100 or the CRSP Total Market. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

the negative beta estimates for Active Funds and Financial Institutions observed in the quarterly regressions flip to positive in the year-over-year regressions, reinforcing the role that these groups may play in short-term intermediation, especially when a salient event like switching an index draws attention to possible uninformed trading.

5.2.2 Index Migrations and Direct Additions/Deletions

We further study index switchers in light of how different market clearing looks relative to the baseline results. In addition, better understanding these stocks helps provide greater context to index switching events, which are the focus of a long literature. We separate index switchers into several categories. First, we examine direct additions, which are stocks that moved from outside of an index fund family to within it. For example, a stock that was added to the S&P 500 that was not previously held by the S&P 500, 400, or 600 would be a direct addition. Similarly, we also separately examine direct deletions.

Second, we examine stocks that migrated from one index to another related index (e.g., Russell 1000 to 2000). These events typically have a much smaller change in overall Index Fund ownership because many of the shares that need to be sold or bought are exchanged between Index Funds. That is, in these cases, the market clears for a nontrivial fraction (and in many cases, the majority) of shares within the Index Fund group. We separately study migrations that led to net buying or net selling by Index Funds. The alpha, beta and $\overline{q}_j$ estimates for our series of regressions for each subsample are presented in Table 9. The table also shows the number of observations for each sample to get a sense of how rare these events are, and also

presents the average ownership change for Index Funds and for all institutions (in percentage points) to get a sense of magnitudes for each type of event.

Panel A of Table 9 focuses on direct additions and deletions – showing that who clears the market in each of these cases is quite different. As in our baseline results, for additions, Firms and Short Sellers tend to be the most responsive in supplying shares (this time with Short Sellers supplying relatively *more* shares for each additional unit of Index demand than Firms), with Financial Institutions also playing an important role. For deletions, Short Sellers are about as active in clearing the market (by reducing their short positions) and Firms are not responsive at all. Instead, Other is the most responsive. This is consistent with these stocks leaving the investable universe and finding buyers in retail investors, as well as small institutional investors who may have fewer mandates preventing them from buying such stocks.

The betas alone, however, undersell the role of Firms and Short Sellers in accommodating passive demand around index additions. The alphas for these groups are large, and as a result, the associated $\overline{q}_j$s are large as well. Further, the alpha for Financial Institutions is large and positive, evidence that despite a negative beta, this group is predicted to be a net buyer around the typical index addition event, in a way that is not correlated to the size of the demand shock by Index Funds. Similarly, for deletions, we see the alpha for Other is large, further evidence that foreign institutions, small institutions and retail investors are needed to clear the market when a firm leaves the investable universe and is unlikely to be held by most U.S. institutions.

Panel B of Table 9 focuses on migrations. In the cases of migrations where Index funds are net buyers of shares (e.g., firms switching from the Russell 1000 to the Russell 2000), Financial Institutions are the most responsive, with a beta of -0.51. Short Sellers and Active are the next most responsive groups, with betas of -0.30 and -0.20, respectively. While Firms have a positive beta, they have a large negative alpha, and therefore a moderately negative $\overline{q}_j$, suggesting that they do play an important role in clearing passive demand around migration events with net passive buying, however more through what they tend to do on average, rather than how they respond to the amount of passive demand.

When Index Funds are net sellers of shares around migrations (e.g., the case of firms migrating from the Russell 2000 to the Russell 1000), Financial Institutions and Firms are the most responsive. That being said, around such events, the alpha for Firms is large and negative, leading to a negative $\overline{q}_j$ for this group. In fact, the $\overline{q}_j$s suggest that our Other group, as well as Financial Institutions and non-passive mutual funds tend to be the most important groups for clearing the market on average in this subsample.

Table 9: Beta Estimates: Index Additions, Deletions, and Migrations

	Panel A: Direct Adds/Drops					
	Betas		Alphas		$\overline{q}_j$	
Investor Group	Additions	Deletions	Additions	Deletions	Additions	Deletions
Active Funds	0.039	0.290	0.108	-0.307	0.200	-0.552
Other Funds	0.075	-0.059	0.036	0.037	0.213	0.087
Pension Funds	0.035	0.040	0.080	-0.044	0.162	-0.078
Insurance	0.074	0.087	0.144	-0.187	0.319	-0.261
Financial Institutions	-0.201	-0.098	1.552	-0.792	1.079	-0.709
Insiders	-0.044	-0.106	-0.056	-0.225	-0.159	-0.135
Other	-0.385	-0.980	0.307	2.046	-0.601	2.876
Short Sellers	-0.374	-0.215	-0.706	-0.480	-1.587	-0.298
Firms	-0.220	0.040	-1.465	-0.051	-1.984	-0.084
Total	-1.000	-1.000	0.000	0.000	-2.359	0.847
# Obs.					1,739	103
Avg. Index Fund Ownership Chg. (pps)					2.359	-0.847
Avg. Institutions Ownership Chg. (pps)					4.331	-2.359

	Panel B: Migrations					
	Betas		Alphas		$\overline{q}_j$	
Investor Group	Net Buying	Net Selling	Net Buying	Net Selling	Net Buying	Net Selling
Active Funds	-0.204	0.085	0.167	0.286	-0.261	0.143
Other Funds	-0.042	-0.075	0.098	0.312	0.010	0.438
Pension Funds	-0.005	-0.027	-0.100	0.048	-0.110	0.093
Insurance	0.081	0.028	-0.012	-0.065	0.158	-0.112
Financial Institutions	-0.507	-0.354	1.222	0.190	0.160	0.784
Insiders	0.015	-0.015	-0.155	-0.193	-0.123	-0.168
Other	-0.202	-0.307	0.005	0.555	-0.417	1.071
Short Sellers	-0.297	-0.033	-0.363	0.097	-0.986	0.153
Firms	0.162	-0.301	-0.863	-1.231	-0.524	-0.726
Total	-1.000	-1.000	0.000	0.000	-2.094	1.678
# Obs.					503	515
Avg. Index Fund Ownership Chg. (pps)					2.094	-1.678
Avg. Institutions Ownership Chg. (pps)					0.846	0.846

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. In Panel A, the sample is split into direct additions and deletions. Direct additions are defined as securities that are added to the S&P 500, S&P 400, S&P 600 from outside the S&P 1500 universe, securities added to the Russell 1000 or 2000 from outside the Russell 3000 universe and securities which are added to the Nasdaq 100 or CRSP Total Market Indices. Direct deletions are defined similarly, as firms that leave these indices to outside of their respective index universes. In Panel B, the sample includes only migrations, and is split based on whether there is net buying or net selling by passive funds. And example of a migration typically associated with net buying is a migration from the Russell 1000 to the Russell 2000, while an example of a migration typically associated with net selling is a migration from the Russell 2000 to the Russell 1000. The unit of observation is security-year-quarter.

5.3 Beta Estimates over Time

Given the time trend in passive ownership, significant events that likely adjusted portfolio allocations like COVID-19, and improvements in data quality, we further study how our series of beta estimates vary over time. To check for time trends in who is on the other side of passive trades, we estimate the baseline regressions for each group, but do so separately for each quarter in our data. That is, we estimate a series of cross-sectional regressions, which recover a beta estimate per non-passive group per quarter.

Figure 9 visually presents the beta estimates for each group using an 8-quarter moving average to smooth out estimation errors and get a better sense of the general patterns.

There are two other significant trends, each going in the opposite direction. Firms have beta estimates that are growing in absolute value, going from around -0.5 at the beginning of the sample and steadily declining over the full sample to end with estimates of nearly -1. Over the same period, Financial Institutions are steadily increasing, from an estimate of around -0.4 at the beginning of the sample to around 0.1 at the end.

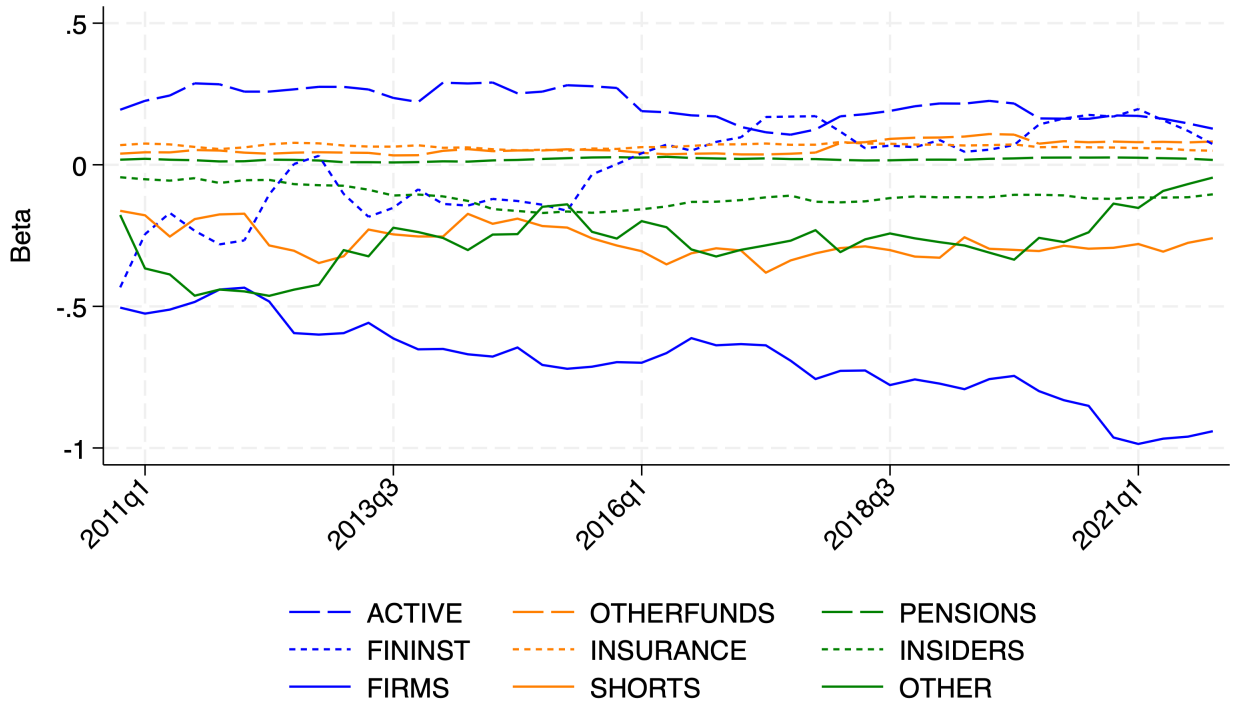
These patterns suggest that the void left in responsiveness by Financial Institutions, who by the end of the sample are, on average, buying and selling more when Index Funds buy or sell more, are offset by Firms who are becoming increasingly more responsive.

Our residual Other group's beta also appears to be trending somewhat toward zero over time, with an estimate around -0.4 in the first few years of our sample to around -0.1 at the very end of out sample. This is consistent with the Other group offsetting some data errors, but data quality improving over time. This could also relate to retail investors increasingly trading in a way that is orthogonal to Index Fund demand.

Many of the smoothed estimates are relatively stable over time. For example, Active Funds, Short Sellers, Insiders, and Insurance all have beta estimates that look roughly unchanged over the entire sample period.

These facts collectively support two non-mutually exclusive themes. First, as passive has continued to grow over time, Firms have continued to take a larger and larger role in making shares available as Index Funds demand more shares, while other institutions and mutual funds have had little to no responsiveness. Second, as the quality of our data has improved, one of our main conclusions, that share suppliers (Firms and Short Sellers) are more responsive in providing shares when Index Funds demand more, appears to gain more support.

Figure 9: Betas Estimates by Group over Time



Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. This regression is run separately each quarter, and the lines represent an 8-quarter moving average of the betas estimated each quarter.

5.4 By Industry Results

One reason why firms issue shares is for employee compensation. Employees may receive shares, then sell them in the market, which could end up in the hands of Index Funds. Note, however, that this does not include current executives, which are captured by our Insiders group. This type of compensation appears to be more prevalent with technology firms and young firms.

In this section, we examine whether the tendency for some industries to issue more stock (perhaps via compensation) are more responsive to Index Fund demand. This may also capture general tendencies in primary market activity by industry, including how responsive primary market activity in an industry (buybacks and issuance) might be to secondary market activity (Ma, 2019).

Table 10 presents the beta estimates in Panel (A) and the average position change in Panel (B) for each of the Fama-French 10 industries.[16] The table shows that beta estimates vary the most for Firms and Financial

[16]See Ken French's data library for details on industry classifications.

Institutions, and they tend to substitute for one another, just as in non-linear analysis in Section 3.2 and the over-time analysis in Section 5.3. Firms do indeed tend to be more responsive to Index Fund changes in industries known for more stock compensation (high-technology and healthcare), but also are active in other more surprising industries (energy and "other", which contains the financial sector). Regardless, Firms appear to at least be somewhat responsive to Index Funds for *every* industry. On the other hand, Financial Institutions have estimates close to zero or positive for several industries. The other seven groups have largely similar estimates, regardless of industry.

Panel (B) also reports the average position change by group. This shows that Firms and Insiders have the most consistently negative estimates across industries. On the other hand, Financial Institutions have just as many negative industry averages as positive. Taken together, Panels (A) and (B) suggest that Firms most steadily provide shares to Index Funds and are the most responsive in issuing more shares with greater Index Fund demand, regardless of industry. There is also heterogeneity across industries – energy, high tech, healthcare have both the most issuance on average and are the most responsive in issuing as Index Funds demand more.

6 Firm Issuance Mechanism

We further explore how exactly firms issue shares, and how those shares, on average, end up in the hands of passive investors.

We decompose Firm changes into changes from primary market activity (seasoned equity offerings, or SEOs, and buybacks) and changes from other sources of share issuance. We first assume all decreases in shares outstanding come from buybacks. We combine this with data on SEOs. These are, for the most part, mutually exclusive since if shares outstanding decreases, it must be that the firm, on net, bought back shares (this assumes a company would not have a seasoned equity offering, then buy back more shares than it offered).[17] All positive changes in shares outstanding we treat as issuance, and we then remove the SEO contribution to total issuance to get a measure of non-primary market issuance. This issuance captures employee stock awards, exercise of stock options, convertible debt, warrants, and other ways in which authorized shares or treasury shares can be awarded and make their way to the market.[18]

[17] We do find some observations do have this property but it appears to be related to somewhat stale shares outstanding data from CRSP. We keep these observations for consistency with the rest of the analysis. Dropping these observations does not change the main conclusions.

[18] This will underestimate the number of shares issued through compensation. From our analysis of 10K filings, some firms issue shares as compensation awards but also buy shares back in the market. Our methodology would count just the net effect – if buybacks are larger, we would attribute the whole change to buybacks and nothing to compensation.

Table 10: Beta Estimates by Industry

Panel A: Betas										
Investor Group	Nondurables	Durables	Manuf.	Energy	High Tech	Telecom	Shops	Health	Utilities	Other
Active Funds	0.131	0.132	0.096	0.243	0.161	0.111	0.157	0.203	0.074	0.251
Other Funds	0.069	0.085	0.073	0.074	0.097	0.052	0.078	0.079	0.112	0.103
Pension Funds	0.014	0.013	0.004	0.017	0.017	0.018	0.016	0.022	0.005	0.022
Insurance	0.053	0.102	0.068	0.072	0.065	0.049	0.075	0.072	0.069	0.070
Fin. Insts. Ex. Funds	-0.342	-0.474	-0.347	0.073	-0.167	-0.411	-0.391	0.105	-0.358	0.098
Insiders	-0.063	-0.114	-0.072	-0.058	-0.086	-0.082	-0.119	-0.051	-0.056	-0.128
Other	-0.395	-0.323	-0.247	-0.436	-0.233	-0.153	-0.333	-0.370	-0.222	-0.244
Short Sellers	-0.202	-0.183	-0.179	-0.287	-0.231	-0.173	-0.215	-0.324	-0.178	-0.292
Firms	-0.264	-0.238	-0.396	-0.699	-0.623	-0.411	-0.269	-0.737	-0.446	-0.880
Total	-0.999	-1.000	-1.000	-1.001	-1.000	-1.000	-1.001	-1.001	-1.000	-1.000

Panel B: $\overline{q}_j$										
Investor Group	Nondurables	Durables	Manuf.	Energy	High Tech	Telecom	Shops	Health	Utilities	Other
Active Funds	-0.031	-0.121	-0.087	-0.019	-0.018	-0.085	-0.162	0.069	0.020	0.076
Other Funds	0.072	0.077	0.090	0.060	0.120	0.043	0.070	0.112	0.103	0.113
Pension Funds	-0.008	-0.008	-0.011	0.010	0.001	0.000	-0.012	0.008	0.001	0.008
Insurance	-0.024	-0.009	-0.010	-0.012	-0.003	-0.024	-0.021	0.010	0.001	0.014
Fin. Insts. Ex. Funds	-0.066	-0.175	-0.119	0.163	0.147	0.086	-0.236	0.331	0.053	0.191
Insiders	-0.051	-0.017	-0.012	-0.078	-0.060	-0.051	-0.105	-0.014	-0.031	-0.113
Other	0.139	0.110	0.029	0.678	0.188	0.259	0.157	0.594	-0.001	0.287
Short Sellers	-0.036	0.064	0.020	-0.197	-0.034	-0.085	0.014	-0.127	-0.009	-0.075
Firms	-0.244	-0.170	-0.189	-1.039	-0.663	-0.422	0.042	-1.337	-0.508	-0.895
Total	-0.249	-0.249	-0.288	-0.433	-0.321	-0.279	-0.252	-0.353	-0.369	-0.395

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The regression is estimated separately, in each column only including firms which are a member of each of the listed industries. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

Table 11: Beta Estimates: Decomposing Firm Changes

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.203	26.530	-0.066	-12.588	137,431	0.011	0.004
Other Funds	0.091	33.930	0.070	35.578	137,431	0.015	0.101
Pension Funds	0.019	19.720	-0.004	-6.306	137,431	0.004	0.003
Insurance	0.070	37.946	-0.023	-17.628	137,431	0.015	0.001
Financial Institutions	-0.054	-3.090	0.115	11.577	137,431	0.000	0.096
Insiders	-0.101	-16.447	-0.039	-8.646	137,431	0.006	-0.074
Other	-0.225	-12.624	0.372	22.495	137,431	0.003	0.295
Short Sellers	-0.263	-38.307	0.037	9.114	137,431	0.023	-0.053
Firms (Primary Market)	-0.364	-25.871	0.196	22.043	137,431	0.023	0.071
Firms (Compensation, Other)	-0.376	-25.246	-0.656	-53.855	137,431	0.017	-0.785
Total	-1.000		0.002				-0.341

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The regression is estimated separately, in each column only including firms which are a member of each of the listed industries. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level. The number of observations per sample is as follows: Passive Selling, Firm Buying: 11,170 (10% of observations); Passing Buying, Firm Buying: 21,701 (19%); Passive Buying, Firm Selling: 58,035 (52%); Passive Selling, Firm Selling: 21,353 (19%).

This gives us two measures of Firm activity to replace our single measure that we have used throughout the paper. One measure captures primary market activity (buybacks and SEOs) and the other tracks compensation and other issuance. We construct variables just as before so that a positive value represents Firms buying shares and a negative value corresponds to selling shares (i.e., issuance). The variables are represented as a percentage of all shares outstanding, just as before.

Table 11 presents the beta estimates (the findings are very similar on a value-weighted basis except Firms' α_j is significantly more positive – see Section 4 for more details). It shows that both primary market activity and issuance for compensation and other sources are equally responsive to Index Fund demand. As Index Funds increase ownership, Firms on average increase both issuance in the primary market and issue more shares as compensation or other shares enter the public marketplace through other avenues.[19]

We also note that SEOs are extremely rare. We have 1,649 SEOs in our sample, which account for 1.4% of our stock-quarter observations. This means that another way to interpret the beta estimate of -0.364 is to say that the probability of a firm conducting an SEO is increasing when Index Funds demand more shares. We can also recast our overall results on Firm changes in this light – Firms are not only more likely to initiate an SEO with more passive buying, they are also more likely to increase the amount of stock rewards to employees and/or trigger the exercise of options or the conversion of convertible debt.

[19]Given the role that compensation plays in share issuance, one natural question is whether a significant fraction of our findings can be explained by industry. We present and discuss the beta estimates by industry in Section 5.4.

We conduct an additional analysis to confirm that Firms are not responding to other variables. We effectively run a horse race to understand which variables are most important in explaining the variation in two Firm-related variables: Firm changes as a percentage of the overall company (i.e., $q_{i,j,t}$ for j = Firms), and an indicator variable for whether a company engaged in an SEO, which we represent as $\mathbb{I}\{\text{Did SEO}\}_{i,t}$ and takes the value of 1 if stock i had an SEO in quarter t and 0 otherwise. We regress each of these two variables on a host of variables including our main variable, Index Fund ownership changes (i.e., $q_{i,\text{IDX},t}$). We also include lagged measures of Index Fund ownership changes. In addition, there is a literature that suggests high prices may cause Firms to issue shares. In this spirit, we include each stock's contemporaneous and past return as independent variables. Finally, we include stock and quarter fixed effects to capture both market-wide fluctuations and stock-specific tendencies. In equations, we estimate

$$q_{i,\text{Firms},t} = \alpha_j + \alpha_t + \sum_{k=0}^{4} \beta_{\text{IDX},k} \cdot q_{i,\text{IDX},t-1} + \sum_{k=0}^{4} \beta_{\text{r},k} \cdot r_{i,t-1} + \varepsilon_{i,t} \tag{5}$$

$$\mathbb{I}\{\text{Did SEO}\}_{i,t} = \alpha_j + \alpha_t + \sum_{k=0}^{4} \beta_{\text{IDX},k} \cdot q_{i,\text{IDX},t-1} + \sum_{k=0}^{4} \beta_{\text{r},k} \cdot r_{i,t-1} + \varepsilon_{i,t}. \tag{6}$$

We report the regression estimates in Table 12. Since the regressions including many lags require continuous data over longer horizons, we must drop many observations when including lagged passive demand or returns due to missing data. To make the comparisons apples-to-apples, we report a beta estimate for the baseline regression using the full sample and with no controls, then repeat the baseline regression with the more restrictive sample. These estimates are provided in columns (1)-(2) and (5)-(6). We then use the restricted sample to estimate Equations 5 and 6. We report the estimates with controls but without fixed effects in columns (3) and (7), and with both controls and fixed effects in columns (4) and (8).

The table shows that the single-most statistically and economically significant variable in explaining whether Firms conduct SEOs is Index Fund buying in the contemporaneous quarter. Even with the inclusion of the controls, the estimates on $q_{i,\text{IDX},t}$ do not change much (column (2) vs columns (3) and (4)). The estimates suggest that when Index Funds increase their ownership of a stock by two percentage points, the probability of an SEO increases by 3.4pps. Returns are also statitsically significant (quarters t, $t-1$, and $t-2$), but the economic magnitudes are tiny. The estiamted coefficients are each about 0.0001, which means that a 10% return above roughly the market return (because of quarter fixed effects) is associated with a 0.1pp increase in the probability of an SEO.

These estimates undersell just how strong a predictor Index Fund activity is for SEOs. Figure 10 provides a binscatter plot of $\mathbb{I}\{\text{Did SEO}\}_{i,t}$ on $q_{i,\text{IDX},t}$ using the restricted sample that requires all lags of the variables

Table 12: What Explains Firm Activity?

	$\mathbb{I}\{\text{Did SEO}\}_{i,t}$				$q_{i,\text{Firms},t}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$q_{i,\text{IDX},t}$	0.020	0.019	0.018	0.017	-0.694	-0.616	-0.554	-0.479
	(10.605)	(11.034)	(11.403)	(11.249)	(-15.837)	(-14.007)	(-14.394)	(-13.948)
$q_{i,\text{IDX},t-1}$			0.000	-0.002			-0.054	0.037
			(-0.193)	(-2.823)			(-2.258)	-1.581
$q_{i,\text{IDX},t-2}$			0.003	0.001			-0.087	-0.001
			(3.630)	(1.529)			(-3.209)	(-0.043)
$q_{i,\text{IDX},t-3}$			0.003	0.001			-0.107	-0.001
			(3.666)	-1.139			(-4.078)	(-0.069)
$q_{i,\text{IDX},t-4}$			0.003	0.001			-0.148	-0.010
			(4.037)	(0.901)			(-6.225)	(-0.678)
$r_{i,t}$			0.000	0.000			-0.007	-0.007
			(2.375)	(3.521)			(-3.633)	(-6.739)
$r_{i,t-1}$			0.000	0.000			-0.008	-0.007
			(3.327)	(5.722)			(-4.204)	(-10.677)
$r_{i,t-2}$			0.000	0.000			-0.003	-0.004
			(1.494)	(2.247)			(-1.781)	(-5.051)
$r_{i,t-3}$			0.000	0.000			-0.002	-0.002
			(0.814)	(0.778)			(-1.561)	(-2.253)
$r_{i,t-4}$			0.000	0.000			0.000	-0.001
			(0.229)	(0.254)			-0.176	(-0.973)
Observations	137,431	91,262	91,262	91,262	137,431	91,262	91,262	91,262
R^2	0.026	0.024	0.029	0.152	0.037	0.034	0.045	0.248
Fixed Effects	None	None	None	Stock-Qtr	None	None	None	Stock-Qtr

Notes. Estimates from our baseline regression specification:

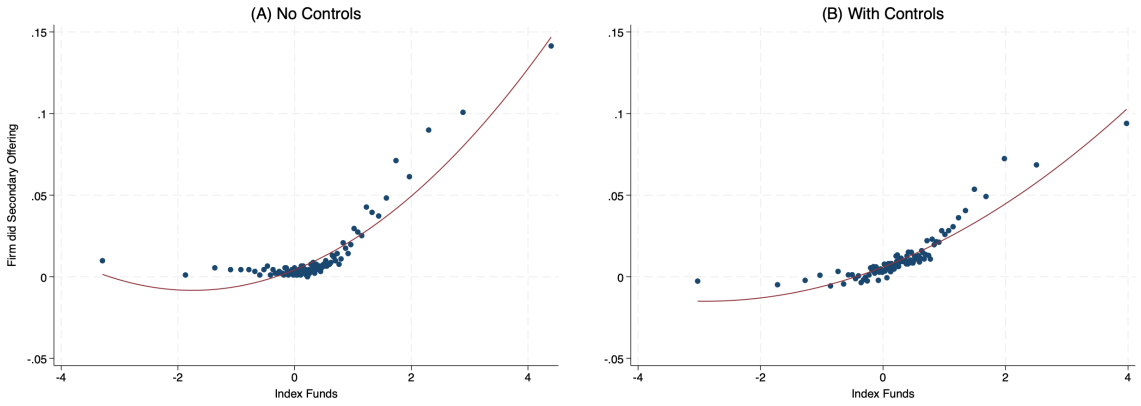
$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The regression is estimated separately, in each column only including firms which are a member of each of the listed industries. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level. The number of observations per sample is as follows: Passive Selling, Firm Buying: 11,170 (10% of observations); Passing Buying, Firm Buying: 21,701 (19%); Passive Buying, Firm Selling: 58,035 (52%); Passive Selling, Firm Selling: 21,353 (19%).

mentioned above to be available. Panel (A) provides a plot without any controls (specification (2) in Table 12), and Panel (B) shows the same plot but after accounting for all the control variables, including stock and quarter fixed effects (specification (4)). Both plots show that the relationship between the two variables is nonlinear. An increase in Index Fund ownership by 2pp corresponds to more than a 6% probability of an SEO without controls and 5% to 6% with controls. If Index Funds buy 4% of a company in a given quarter, the probability of an SEO jumps to about 15% and 10% (with and without controls). This is extremely high given the unconditional probability of an SEO of less than 1.5%.

Table 12 also shows changes in Index Fund ownership are the single most significant variable in explaining overall Firm activity, $q_{i,\text{Firms},t}$, both economically and statistically. The estimates decline in magnitude only slightly with the addition of control variables. The most statistically significant control variables are returns over the contemporaneous quarter and the past two quarters, though the economic magnitudes are small. The beta estimate of -0.007 on contemporaneous returns says that a 10% return above the market corresponds to increased issuance of 0.07% of the Firm's shares outstanding.

Figure 10: Probability of a Seasoned Equity Offering



Notes. Fraction of firms which, over the next year, will do buybacks, issuance or neither. A firm is classified as having issued equity if it has a year-over-year increase in split-adjusted shares. A firm is classified as having done a buyback if it has a year-over-year decrease in split-adjusted shares. A firm is classified as having done neither if there has been no change in split-adjusted shares.

7 Conclusion

We aim to answer a basic question: Who sells when passive investors buy, and who buys when passive investors sell? That is, when passive investors trade, who ultimately clears the market? To this end, we start by combining several datasets on investors' holdings with data on short interest, insider transactions, and shares outstanding. We aggregate all holdings and/or changes by group to study which groups take the

other side of passive demand, both positive and negative, at the stock and quarter level to clear the market.

We then develop a regression framework to assess (1) which groups are on average taking the opposite side of passive investors, and (2) which groups are the most responsive to passive investors. Treating passive investors as the focal group is built on the logic that passive demand is inelastic, and therefore one can view passive index funds and ETFs as initiating trades when adjusting their holdings. That being said, our methodology could be applied to any group of investors, e.g., it could be used to study which groups are on average trading against active mutual funds.

Our main finding is that Firms have been the single most significant provider of the shares purchased by Index Funds. We estimate that when passive investors demand 1pp more of Firms' shares outstanding, Firms respond at rate of 0.69 percentage points more shares issued/fewer shares repurchased. Short sellers are another important group for market clearing, with a response coefficient of -0.26. These two groups alone account for 95% of the marginal shares needed to clear the market in the face of additional passive demand. Firms play a smaller role in clearing the market when Index Funds sell a stock, which is where Financial Institutions play a bigger role in clearing the market for passive. Long-term investors (e.g., Active Funds, Insurance, and Pension Funds) typically mimic the direction of passive demand – they buy more/sell less when passive investors buy more.

We also explore market clearing in dollar terms and highlight several differences from the equal-weighted analysis. The most significant difference is that the typical Firm change in dollar terms is to buy back shares, not to issue. However, Firms are even more responsive to Index Fund demand in dollar terms than in ownership share (of a company) terms. This implies that Firms are particularly sensitive in reducing the degree of buybacks when Index Funds buy more. And, if Index Funds buy enough, Firms will even end up issuing shares. The value-weighted results also help reconcile the pattern of large buybacks amongst the largest firms in the U.S. stock market with our baseline equal-weighted analysis of market clearing: for the typical stock, Firms are the primary supplier of shares to passive investors. In dollar terms, Firms are the most *responsive* in accommodating passive investors, but Financial Institutions and Active Funds play a larger role in taking the other side of passive investors for the average dollar.

We perform a battery of robustness checks and show that our baseline results are not driven by stale data, mechanical relationships between firm activity and trading by passive funds or securities lending by passive funds. More broadly, while there is significant heterogeneity across index additions/deletions/non-changers and industries (e.g., technology vs. utilities), our results that the supply side (Firms and Short Sellers) is the primary provider of shares on the opposite side of passive demand is not specific to any one corner of

the market. If anything, our findings on Firms' sensitivity to Index Fund demand is more significant over longer horizons, and has been getting stronger over time.

We believe our results speak to several fields in finance. First, and perhaps most clearly, our findings link to the work studying rising passive ownership in financial markets. Several other papers have studied the effects of passive demand on asset prices, and how it depends on who is on the other side of the trade. That being said, existing analysis neglects a crucially important player: the firm itself. Our findings also have important implications for corporate finance in that it suggests that passive ownership may impact firms, including capital structure and payout policy, as well as real effects like investment. We consider these topics promising areas for future research.

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Who Clears the Market when Passive Investors Trade?

Marco Sammon and John J. Shim

INTERNET APPENDIX

A Data and Methodology Appendix

A.1 Market Clearing Derivation

From market clearing, we have

$$\sum_j q_{i,j,t} = 0, \tag{7}$$

and rewriting, we have

$$\sum_j q_{i,j,t} = -q_{i,\text{IDX},t} \tag{8}$$

where j now indexes all non-passive groups. Substituting, we have

$$\sum_j \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t} = -q_{i,\text{IDX},t} \tag{9}$$

which also for each stock in each quarter. This means we can sum over stocks and quarters, or

$$\sum_i \sum_t \sum_j \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t} = \sum_i \sum_t -q_{i,\text{IDX},t}. \tag{10}$$

We can simplify this to

$$\sum_i \sum_t \sum_j \alpha_j + \sum_j \beta_j \left(\sum_i \sum_t q_{i,\text{IDX},t} \right) = \sum_i \sum_t -q_{i,\text{IDX},t}. \tag{11}$$

since the sum of the error term over time and stocks is zero per group j. This further simplifies to

$$\frac{\sum_i \sum_t \sum_j \alpha_j}{\sum_i \sum_t q_{i,\text{IDX},t}} + \sum_j \beta_j = -1, \tag{12}$$

or

$$\frac{\sum_j \alpha_j}{\overline{q}_{i,\text{IDX},t}} + \sum_j \beta_j = -1, \tag{13}$$

where $\overline{q}_{\text{IDX}}$ is the average Index Fund ownership change over all stocks and quarters. If $\alpha_j = 0$ for all j, this yields $\sum_j \beta_j = -1$. Given that there are aggregate patterns for some groups of investors, it is likely that some of the α_j's will be non-zero. For example, Active Funds collectively have had outflows over the past two decades. This implies that their alpha would be negative (they, on average, sell shares). If the alphas are non-zero, then Equation 13 shows that the market clears through a combination of the sum of the betas and the sum of the alphas, scaled by the size of the passive ownership change.

A.2 Relationship Between the Residual Other Category and Retail Investors

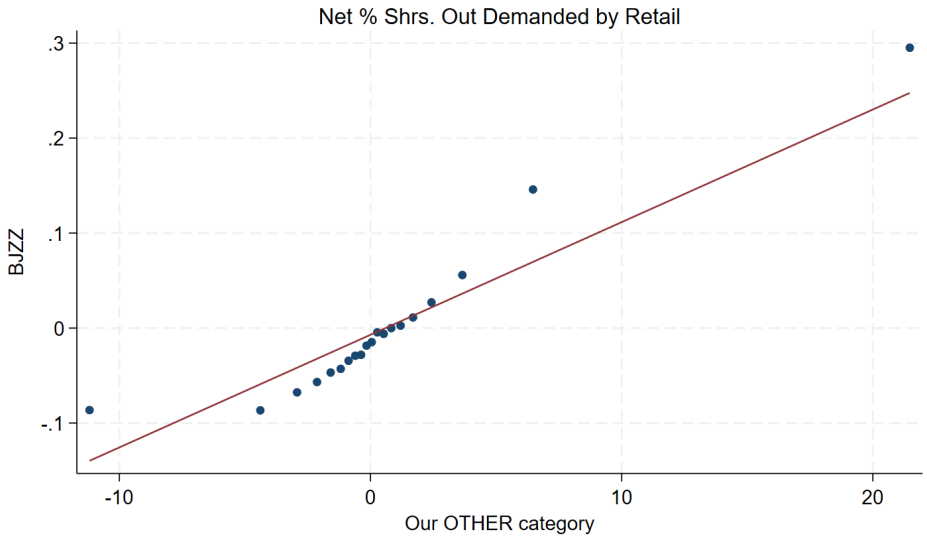
As discussed in the previous section, we have an Other category, whose demand is set to clear the market conditional on the demand of all the investor groups we can observe. This will capture several groups which we know are not included in our data including retail investors, small institutional investors who do not file 13Fs, and foreign institutional investors who also do not file 13Fs. In this section, we aim to understand whether or not this Other group's behavior is related to proxies of retail trading activity.

First, we compare our measure of Other buying and selling to the measure of retail buying and selling in Boehmer et al. (2021). Specifically, leveraging a regulatory requirement for wholesalers, we identify marketable retail buy and sell orders using sub-penny price improvements in the TAQ data. Then, for each stock, each day, we are able to construct a measure of net buying by retail investors. We aggregate this up to the stock-quarter level to match the frequency of our measure of Other demand. Of course, this procedure may produce type 1 and type 2 errors at the individual trade level (see e.g., Barber et al. (2022), Battalio et al. (2023)), but, as discussed in Laarits and Sammon (2023), aggregated versions of this measure are useful for ranking stocks based on retail trading intensity. We use this procedure to identify retail trades between 2010-2021, as before 2010, the algorithm is relatively less effective at identifying retail trades.

Figure 11 presents a bin scatter of our measure of Other demand against one constructed using the algorithm in Boehmer et al. (2021) (hereafter BJZZ). The figure shows that the two measures are strongly positively correlated – suggestive evidence that our measure is indeed capturing retail trading activity. That being said, the scale of the measure constructed using the method in BJZZ is roughly two orders of magnitude smaller than our measure of retail trading activity. This could be because BJZZ only captures a fraction of all retail orders (e.g., it will miss any retail orders that are not sent to wholesalers), and because our measure

– by construction – will pick up net trading by non-retail groups like foreign and small institutions.

Figure 11: Validation 1: Comparison to BJZZ

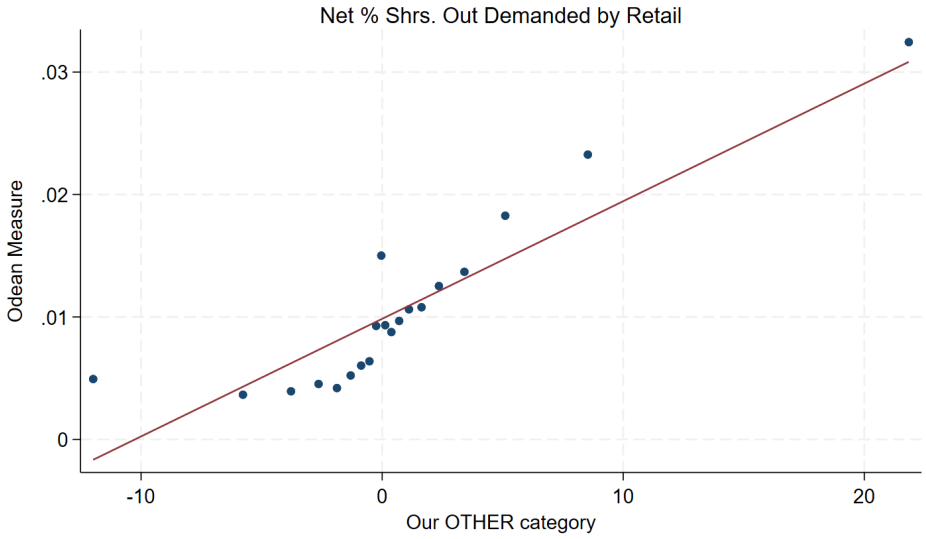


Notes. The x-axis variable is our measure of net Other demand, expressed as a percentage of shares outstanding. The y-axis variable is the net demand by retail investors, expressed as a percentage of shares outstanding, where retail buy and sell orders are identified using the algorithm in Boehmer et al. (2021) (BJZZ). The unit of observation is stock-quarter.

Our second validation exercise leverages the retail investor data in Barber and Odean (2000). Specifically, we start with the trade-level data they obtained from a retail brokerage, and aggregate it up to a stock-day measure of net buying by retail investors. This data runs from 1991-1996, and only represents trades at an individual brokerage. Therefore, even though the level will likely not match what we find, if this brokerage is representative of the population of retail investors as a whole, we would expected differences in net retail demand to match differences in our measure of retail activity. We aggregate this measure of net retail demand to the stock-quarter level to match the frequency of our measure of Other demand.

Figure 12 presents a bin scatter of our measure of Other demand against the measure of retail activity constructed using trades in Barber and Odean (2000). As with Figure 11, Figure 12 shows that the two measures are strongly positively correlated – further evidence that our measure is indeed capturing retail trading activity. That being said, the scale of the measure constructed using the Barber and Odean (2000) data several orders of magnitude smaller than our measure of retail trading activity. This could be because, as discussed above, their data only includes a single retail brokerage.

Figure 12: Validation 2: Comparison to Odean Data



Notes. The x-axis variable is our measure of net Other demand, expressed as a percentage of shares outstanding. The y-axis variable is the net demand by retail investors, expressed as a percentage of shares outstanding, where retail buy and sell orders are identified using the transaction-level data in Barber and Odean (2000). The unit of observation is stock-quarter.

A.3 Index Membership Data

The next collection of datasets we leverage include information on index membership, index weights and float adjustments. We obtain S&P 500 and S&P 1500 membership data directly from S&P. Starting in 2002, this includes float adjustments for all stocks in the 1500 universe. We get data on the S&P MidCap 400 and S&P SmallCap 600 membership from Siblis Research, and match this to the S&P 1500 data to obtain float adjustments, as the same float adjustment is applied to all sub-indices within the S&P index family. We get Russell index membership data from FTSE Russell. Starting in 2008, this includes daily index membership, as well as daily float adjustments and index weights. We get Nasdaq 100 index membership from Siblis research, which starts in 2014.

We get CRSP index membership directly from CRSP. This includes daily index membership, weights and float adjustments starting in 2014 for all CRSP sub-indices. In our analysis, we pool together all non-CRSP total market funds, as the AUM tracking these is small relative to the AUM in the three funds tracking the CRSP total index (VTSAX, VTI and VITNX[20]).

We identify migrations within families of indices by identifying stocks which were simultaneously added to

[20]Note that VITNX does not exactly track the CRSP total market index. According to Vanguard's website, "The fund replicates more than 95% of the market capitalization of the index and invests in a representative sample of the balance using a portfolio-optimization technique to avoid the expense and impracticality of full replication." This is in contrast to VTSAX and VTI, which are designed to fully replicate the CRSP total market index.

one index in the family and dropped from another (e.g., a stock which is dropped from the Russell 1000 and added to the Russell 2000 at the same time is classified as a Russell migration).

In addition to classifying funds based on whether they are active or passive, we also aim to identify the index each passive fund is tracking. To identify funds tracking CRSP indices, we obtain a list of fund tickers from Vanguard's website. To identify funds tracking Russell, S&P and Nasdaq indices, we use the funds' names in the CRSP mutual fund database. For example, to identify S&P 500-tracking funds, we look for combinations of "S&P", "S & P", "SandP", "S and P", "SP" (all non-case sensitive) and "500". For the S&P 500, we validate our name-based classification by comparing it a classification based on the Lipper Objective Code "SP" (i.e., the Lipper Objective Code for S&P 500 funds). We find these two methods yield similar results, allaying concerns about misclassification using our names-based methodology. We also hand check the largest funds tracking each index to ensure they are classified correctly.

We then compute the ratio of the AUM of all funds tracking each index to the total index float (i.e., the sum of the float adjusted market capitalization of all index members). Then, at the stock level, we compute the expected number of shares held by each family of index funds as shares outstanding $\times$ AUM Tracking/Index Capitalization $\times$ IWF (where IWF is the investable weight factor, expressed as a fraction). The logic is that an index tracker – by construction – holds a constant percentage of each constituent's float (Sammon and Shim, 2023).[21] As a specific example, suppose that S&P 500 tracking funds own 10% of the index's float. And then, consider an individual stock with a float adjustment of 0.8. Then, the index funds are expected to own 10% of the stock's float i.e., $10\% \times 0.8 = 8\%$ of the firm's shares outstanding.

One concern with this method for computing expected ownership by each family of index funds is that it likely understates the true size of index trackers, as there are many investors tracking these benchmarks – e.g., direct replication by institutional investors and shadow indexing by active investors – which will not be captured by index fund holdings alone (Chinco and Sammon, 2023). Given that our market clearing exercise is based on investor type, not investor mandate, we believe this is not an issue in our setting.

Another concern with this method is that it will identify funds tracking subsets of the indices we're actually interested in e.g., S&P 500 value funds like IVE. As we show in Appendix A.5, there is significant variation in the passive ownership share across stocks in these sub indices. That being said, we perform several validation exercises to ensure that our measure of expected buying around index change events is not biased by ignoring these sub-index classifications. The logic is that if about half the stocks added to a particular

[21] We illustrate this directly in Appendix A.4. Specifically, we show that index funds hold a constant percentage of each constituent's float, rather than each constituent's shares outstanding.

index are growth stocks, and half the stocks added to the index are value stocks, the fraction of the index's float held by index funds will still capture the average buying across these sub indices and thus the average expected buying by such funds.

A.4 Float Adjustments

In this Appendix, we aim to highlight (1) the importance of accounting for float adjustments and (2) differences in float adjustments applied to the same stock at the same point in time across index families.

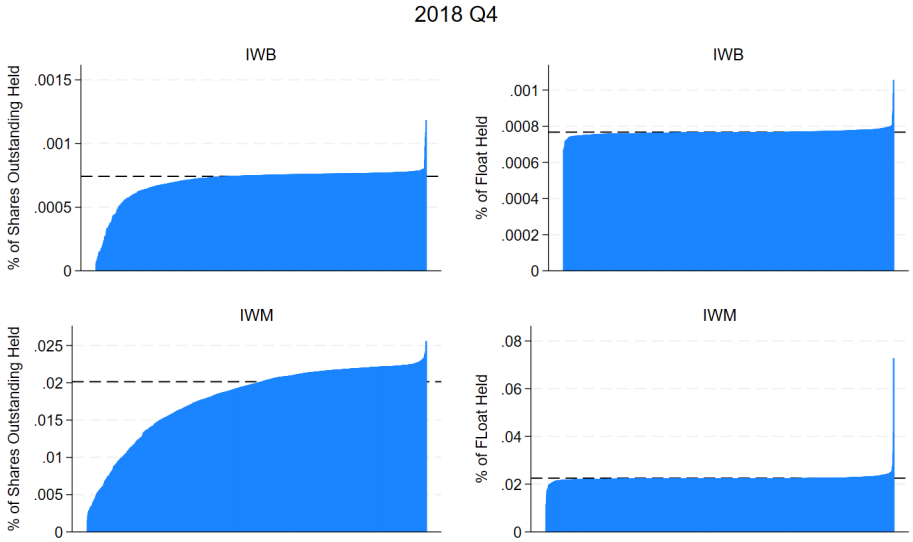
As highlighted in Sammon and Shim (2023), an index fund should hold a constant percentage of the underlying constituents' float (rather than a constant percentage of the underlying constituents' shares outstanding). Of course, there will be some exceptions to this e.g., for dual class shares like Berkshire Hathaway, the index provider may choose to just include one share class in the index, and hold enough of that single share class to account for the float-adjusted market capitalization of the entire firm.

To highlight the importance of float adjustments, in Figure 13, we compare the fraction of a stock's shares outstanding with the fraction of a stock's float owned by Russell 1000 and 2000 funds. In the top left panel, we plot the percent of each stock in the Russell 1000's shares outstanding held by IWB, a Russell 1000 ETF. Compare this to the top right panel, which plots the fraction of each stock's float held by IWB. IWB holds an almost constant percentage of each stock's float, even though it doesn't hold a constant percentage of each stock's shares outstanding – exactly as predicted by how an ideal value-weighted passive index fund would function. Some of the extreme outliers on the far right are from firms with multiple share classes like Berkshire Hathaway and Under Armour.

In the bottom left panel, we plot the fraction of each stock in the Russell 2000's shares outstanding held by IWM, a Russell 2000 fund. In the bottom right panel, we plot the fraction of each stock's float held by IWM. As above, IWM appears to hold a constant fraction of each stock's float, but not shares outstanding. In fact, the difference is even starker than in the top two panels, as large float adjustments are more common among these relatively smaller stocks.

Another interesting feature of float adjustments is that they are not standardized across index families. For example, S&P and Russell might have different float adjustments for the same stock at the same point in time, owing to differences in their methodologies for computing the float-adjustment factors. Figure 14 is a scatter plot, comparing the float adjustment factor for the S&P indices (x-axis) against the float adjustment factor

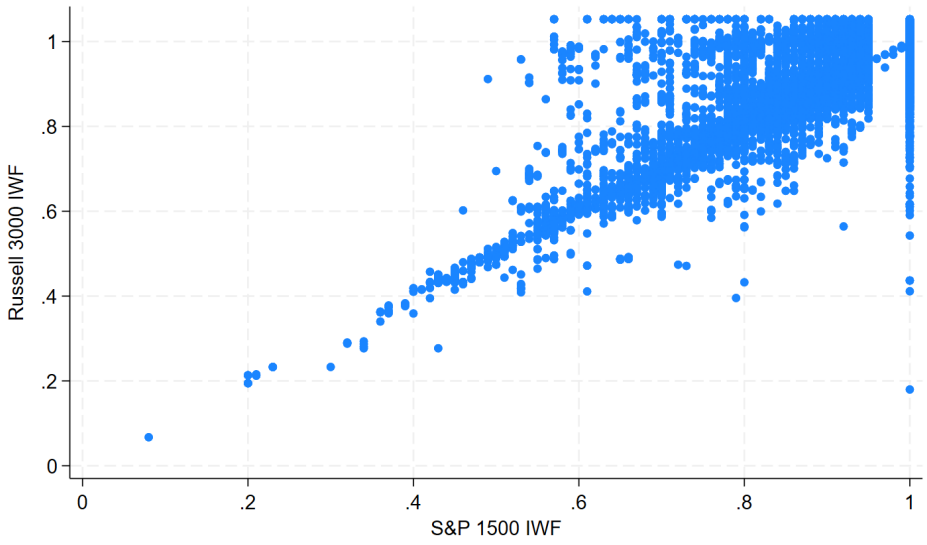
Figure 13: Fraction of Stocks' Shares Outstanding and Float Held by IWM and IWB



Notes. In the top left panel, we plot the percent of each stock in the Russell 1000's shares outstanding held by IWB, a Russell 1000 ETF. In the top right panel, we plot the fraction of each stock's float held by IWB – where float is computed by multiplying the stock's shares outstanding by Russell's IWF. In the bottom left panel, we plot the fraction of each stock in the Russell 2000's shares outstanding held by IWM, a Russell 2000 fund. In the bottom right panel, we plot the fraction of each stock's float held by IWM.

for the Russell indices (y-axis) for stocks that are in both the S&P 1500 universe and Russell 3000 universe. While they are clearly positively correlated, there are many stocks which S&P applies no adjustment to, but Russell has a float significantly smaller than the firm's market capitalization (and vice versa).

Figure 14: Comparing Float Adjustments in the S&P 1500 and Russell 3000 Universe



Notes. Scatter plot of the float adjustment factor for the Russell indices (y-axis) against the float adjustment factor for the S&P indices (x-axis) for stocks that are in both the S&P 1500 universe and Russell 3000 universe. Unit of observation is stock-quarter.

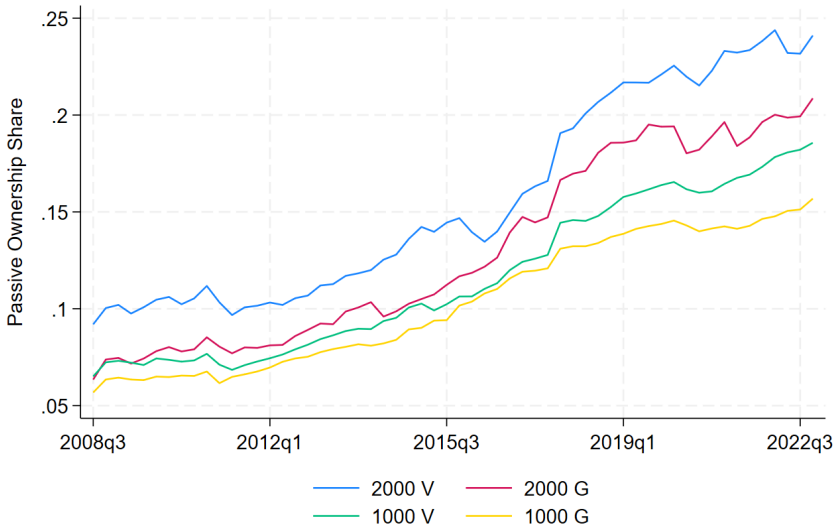
A.5 Sub-Indices

One concern with our methodology for computing expected buying by passive funds is that when computing the AUM of funds tracking each index, we do not distinguish between e.g., an S&P 500 fund, an S&P 500 value fund and an S&P 500 growth fund. Therefore, one might be concerned that our measure of expected buying may be systematically wrong for e.g., value stocks and growth stocks within the S&P 500.

To quantify the possible magnitude of such bias, we compare the level of passive ownership for various Russell sub-indices, for which we also have daily index membership. We label a stock as a growth stock if it has positive shares in a Russell growth index, but zero shares in a Russell value index. Similarly, we label a stock as a value stock if it has positive shares in a Russell value index, but zero shares in a Russell growth index. There are some stocks that have positive shares in both growth and value indices – but to simplify our analysis, we exclude them.

Figure 15 contains the results. For both the Russell 1000 and the Russell 2000, value indices seem more popular with passive investors than growth indices. In terms of magnitudes, the value indices have a roughly 4% higher level of passive ownership than the growth indices. That being said, this is the overall difference – and may be coming from sources other than just Russell 1000/2000 value and growth funds (e.g., other value and growth funds that happen to partially overlap with the Russell indices).

Figure 15: Level of Passive Ownership by Russell Sub-Index



Notes. Average level of passive ownership for stocks in the Russell 1000 Value (1000 V), Russell 1000 Growth (1000 G), Russell 2000 Value (2000 V) and Russell 2000 Growth (2000 G). Exclude firms which are partially included in both the Value and Growth indices.

Table 13: Beta Estimates: 2009-2021, Raw Data

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.524	4.768	-0.184	-2.836	147,588	0.085	0.008
Other Funds	0.136	6.619	0.060	1.838	147,588	0.039	0.110
Pension Funds	0.049	3.259	-0.016	-1.369	147,588	0.012	0.002
Insurance	0.104	7.228	-0.037	-1.863	147,588	0.035	0.001
Financial Institutions	0.675	2.194	0.007	0.044	147,588	0.028	0.255
Insiders	-0.117	-6.242	-0.108	-4.889	147,588	0.002	-0.151
Other	-1.359	-2.525	1.033	3.474	147,588	0.062	0.534
Short Sellers	-0.230	-6.300	-0.004	-0.073	147,588	0.024	-0.088
Firms	-0.783	-7.354	-0.751	-9.401	147,588	0.036	-1.038
Total	-1.001		-0.000				-0.367

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The unit of observation is security-year-quarter. Unlike in Table 2, the data is not trimmed for each group at the 0.5 and 99.5 percentiles. Instead, we include the raw (untrimmed, unwinsorized) data. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

B Baseline Robustness

In this section, we present several versions of our baseline regression to confirm that our results are not specific to the sample of years and are robust to including firm fixed effects, time fixed effects and return controls.

B.1 Baseline Robustness: Sample Selection Robustness

We present four additional tables in this section. Table 13: Raw data, 2009-2021 Table 14: Winsorized data, 2009-2021 Table 15: Trimmed data, 2002-2021 Table 16: Trimmed data, 2015-2021

B.2 Baseline Robustness: With Fixed Effects

B.3 Baseline Robustness: Return Controls

While in this paper we focus primarily on quantities, we, of course, acknowledge that returns may play a role in how likely any one participant is to clear the market. To study the effect of contemporaneous returns on position changes of each group, we estimate the baseline regression but include the stock's quarterly market-adjusted return (as a decimal) as an additional independent variable as well as return interacted

Table 14: Beta Estimates: 2009-2021, Winsorized Data

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.390	6.374	-0.129	-3.091	147,588	0.043	0.015
Other Funds	0.133	5.176	0.059	2.040	147,588	0.036	0.108
Pension Funds	0.042	4.589	-0.011	-1.248	147,588	0.022	0.004
Insurance	0.103	7.754	-0.036	-1.941	147,588	0.034	0.002
Financial Institutions	0.395	2.687	0.108	1.037	147,588	0.010	0.253
Insiders	-0.135	-10.548	-0.084	-5.928	147,588	0.007	-0.134
Other	-0.613	-1.936	0.774	4.020	147,588	0.014	0.548
Short Sellers	-0.288	-9.774	0.021	0.445	147,588	0.031	-0.085
Firms	-0.900	-11.615	-0.641	-10.057	147,588	0.048	-0.972
Total	-0.873		0.061				-0.260

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The unit of observation is security-year-quarter. Unlike in Table 2, the data is not trimmed for each group at the 0.5 and 99.5 percentiles. Instead, we Winsorize at the 0.5 and 99.5 percentiles. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

Table 15: Beta Estimates: 2002-2021, Trimmed Data

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.193	7.015	-0.052	-2.209	172,807	0.007	0.011
Other Funds	0.086	3.148	0.060	3.361	172,807	0.012	0.088
Pension Funds	0.022	7.423	-0.007	-1.243	172,807	0.004	0.000
Insurance	0.065	7.894	-0.029	-2.281	172,807	0.008	-0.008
Financial Institutions	-0.152	-2.265	0.123	1.445	172,807	0.001	0.073
Insiders	-0.084	-10.920	-0.033	-4.684	172,807	0.005	-0.060
Other	-0.250	-4.674	0.228	2.918	172,807	0.003	0.146
Short Sellers	-0.238	-6.433	0.037	0.802	172,807	0.015	-0.041
Firms	-0.642	-16.196	-0.327	-8.757	172,807	0.032	-0.537
Total	-1.000		0.000				-0.327

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The unit of observation is security-year-quarter. Run on an expanded sample from 2002-2021. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

Table 16: Beta Estimates: 2015-2021, Trimmed Data

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.179	5.198	-0.088	-2.419	80,729	0.013	-0.014
Other Funds	0.105	2.890	0.094	2.328	80,729	0.022	0.137
Pension Funds	0.021	5.682	-0.007	-1.224	80,729	0.009	0.002
Insurance	0.072	7.672	-0.011	-0.564	80,729	0.027	0.019
Financial Institutions	0.053	0.704	-0.013	-0.152	80,729	0.000	0.009
Insiders	-0.093	-10.669	0.000	-0.041	80,729	0.007	-0.038
Other	-0.264	-3.657	0.490	6.942	80,729	0.005	0.381
Short Sellers	-0.301	-9.488	0.074	1.681	80,729	0.038	-0.050
Firms	-0.771	-12.621	-0.537	-9.103	80,729	0.044	-0.855
Total	-0.999		0.002				-0.410

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The unit of observation is security-year-quarter. Run on the subsample from 2015-2021. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

Table 17: Baseline Estimates with Fixed Effects

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.146	9.011	-0.047	-8.944	137,431	0.080	0.003
Other Funds	0.053	7.200	0.083	34.597	137,431	0.167	0.101
Pension Funds	0.018	7.351	-0.004	-5.402	137,431	0.062	0.002
Insurance	0.063	13.196	-0.021	-13.575	137,431	0.085	0.001
Financial Institutions	-0.095	-1.894	0.129	7.525	137,431	0.089	0.096
Insiders	-0.074	-11.847	-0.048	-21.645	137,431	0.139	-0.073
Other	-0.315	-6.751	0.362	23.122	137,431	0.134	0.254
Short Sellers	-0.265	-9.678	0.038	4.084	137,431	0.095	-0.053
Firms	-0.531	-14.967	-0.491	-38.383	137,431	0.224	-0.673
Total	-1.000		0.001				-0.342

Notes. Estimates from a modified version of our baseline regression specification with stock and quarter fixed effects:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \gamma_i + \psi_t + \varepsilon_{i,j,t}$$

for each investor group j. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

with Index Fund changes, or

$$q_{i,j,t+1} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \beta_{ret} \cdot r_{i,t} + \beta_{\times} \cdot q_{i,\text{IDX},t} \times r_{i,t} + \varepsilon_{i,j,t+1}, \tag{14}$$

where $r_{i,t}$ is the return of stock i in quarter t. We estimate each series of regressions separately for positive and negative returns (which splits the sample relatively evenly, since we use market-adjusted returns).

Table 18 presents the estimates, with Panel A showing the results for the subsample with positive market-adjusted returns. A first takeaway is that our main results that firms are on the other side of passive demand remains unchanged in this subsample even when including return controls, with the coefficient on passive demand marginally increasing from -0.66 (baseline) to -0.67 (un-interacted passive demand in Equation 14).

To walk through a specific interpretation of this result, consider the estimates for the Firms category. Suppose that there is a positive demand shock by passive investors which is equal to 10% of the firm's lagged shares outstanding. The estimate for β_j implies that the firm would supply additional shares equal to 6.7% of lagged shares outstanding. Suppose further that the contemporaneous return was 0.1=10%. The estimate for β_{ret} implies firms will unconditionally issue 0.0019=19 basis points of shares outstanding. Finally, the estimate for $\beta_{\times}$ implies that firms will issue $0.328 \times 0.1 \times 0.1 = 0.0033 = 33$ basis points of shares outstanding. So, in this scenario, the net effect is for the firm to supply 6.7% + 0.19% + 0.33% = 7.26% of shares outstanding. So, directionally, the results imply that in quarters with more positive returns and larger passive buying, firms will supply a larger number of shares, relative to quarters with smaller positive returns (i.e., positive returns closer to zero). Of course, we need to be careful about interpreting any of these relationships as causal as, e.g., the positive relationship between issuance and returns could be driven by firms having superior information about future firm performance and issuing shares if they appear to be overvalued.

Panel B shows the results for the subsample with negative market adjusted returns. As with Panel A, the coefficient on the un-interacted passive demand term is nearly unchanged from the baseline results in Table 2. Again, to illustrate our preferred interpretation of these results, we will walk through an example for the Firms category. Suppose again that there is a positive demand shock by passive investors which is equal to 10% of the firm's lagged shares outstanding. The estimate for β_j implies that the firm would supply additional shares equal to 6.0% of lagged shares outstanding. Suppose further that the contemporaneous return was -0.1 = -10%. The estimate for β_{ret} implies firms will unconditionally buy back 0.0045 = 45 basis points of shares outstanding. Finally, the estimate for $\beta_{\times}$ implies that firms will issue $0.234 \times 0.1 \times 0.1 = 0.0023 = 23$ basis points of shares outstanding. So, in this negative returns scenario, the net effect

is for the firm to supply 5.8% - 0.45% + 0.23% = 5.8% of shares outstanding. So, the case of negative contemporaneous returns is overall quite similar to the case with positive returns, at least for this numerical example.

Broadly, the results in Table 18 confirm that including returns and the associated interaction term in our baseline regression does not alter our main conclusions from Table 2. This is not to say that price adjustment is not an important part of the market clearing mechanism. Rather, it is evidence that the tendency of firms to take the opposite position of passive demand is not heavily dependent on contemporaneous price changes.

To better understand how market clearing changes with returns, we calculate the expected ownership change for each group by evaluating Equation 14 with estimated betas and different percentiles of stock returns. Table 19 presents the estimates for an increase or decrease in Index Fund ownership by one percentage point (pp). The table shows that when Firms sell more as returns are greater. Greater Firm selling with high returns is offset primarily by more buying by Financial Institutions (this is how the market clears). We estimate that in moving from the 25th to the 75th percentile of returns, Firms sell about 0.38pp and 0.18pp more when Index Funds are buying and selling, respectively, while Financial Institutions buy 0.33pp and 0.23pp more.

The pattern flips when returns are negative. Firms tend to issue more with more extreme negative returns, regardless of Index Fund buying or selling (though the overall level of issuance is greater when Index Funds are buying). This is offset primarily by the Other category, consistent with the idea that retail investors may act as contrarians and buy when stocks are falling, regardless of how Index Fund ownership has changed.

C Ruling Out the Influence of Data Errors and Mechanical Effects of Passive Ownership

In this section, we aim to rule out the effect of data errors on our results, as well as allay concerns that our results are driven by mechanical effects of passive ownership on each groups' demand.

C.1 General Data Errors

One concern arises from the nature of the data. As described in Section 2 and documented in detail in Sammon and Shim (2023), the S12 data is littered with many types of errors, some of which involve staleness

Table 18: Beta Estimates with Return Controls

	Panel A: Index Fund Ownership Increase by 1pp					
	Negative Return Percentile			Positive Return Percentile		
	25th	50th	75th	25th	50th	75th
Active Funds	-0.391	-0.197	-0.083	0.026	0.053	0.098
Other Funds	-0.089	-0.045	-0.018	0.001	0.001	0.001
Pension Funds	-0.004	-0.002	-0.001	0.000	0.000	0.000
Insurance	-0.044	-0.022	-0.009	0.007	0.013	0.025
Financial Institutions	-0.070	-0.036	-0.015	0.099	0.216	0.407
Insiders	0.046	0.023	0.009	-0.001	-0.001	-0.001
Other	1.616	0.819	0.351	-0.013	-0.027	-0.049
Short Sellers	-0.137	-0.071	-0.033	-0.015	-0.028	-0.051
Firms	-0.915	-0.468	-0.206	-0.114	-0.238	-0.440
Total	0.012	0.001	-0.005	-0.010	-0.010	-0.010

	Panel B: Index Fund Ownership Decrease by 1pp					
	Negative Return Percentile			Positive Return Percentile		
	25th	50th	75th	25th	50th	75th
Active Funds	-0.369	-0.188	-0.081	0.004	0.009	0.018
Other Funds	-0.090	-0.046	-0.020	-0.003	-0.007	-0.012
Pension Funds	-0.004	-0.002	-0.001	-0.000	-0.001	-0.002
Insurance	-0.010	-0.005	-0.003	0.004	0.008	0.016
Financial Institutions	-0.591	-0.297	-0.124	0.076	0.162	0.302
Insiders	0.057	0.029	0.013	0.002	0.005	0.010
Other	1.791	0.911	0.395	-0.016	-0.043	-0.089
Short Sellers	-0.038	-0.019	-0.007	0.002	0.003	0.004
Firms	-0.758	-0.385	-0.167	-0.059	-0.127	-0.237
Total	-0.012	-0.001	0.005	0.010	0.010	0.010

	Panel C: Returns by Percentile					
	Negative Return Percentile			Positive Return Percentile		
	25th	50th	75th	25th	50th	75th
Return	-21.700	-11.014	-4.749	5.794	12.670	23.880

Notes. Estimates from a modified version of our baseline regression specification, which also controls for the return on stock i at time t in decimal ($r_{i,t}$), as well as the interaction between returns and position changes:

$$q_{i,j,t+1} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \beta_{ret} \cdot r_{i,t} + \beta_{\times} \cdot q_{i,\text{IDX},t} \times r_{i,t} + \varepsilon_{i,j,t+1}$$

for each investor group j. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

Table 19: Estimated Ownership Change by Return Percentile

	Panel A: Index Fund Ownership Increase by 1pp					
	Positive Return Percentile			Negative Return Percentile		
	25th	50th	75th	25th	50th	75th
Active Funds	0.275	0.300	0.340	-0.097	0.097	0.211
Other Funds	0.106	0.107	0.108	0.077	0.122	0.148
Pension Funds	0.028	0.028	0.027	0.014	0.017	0.018
Insurance	0.086	0.094	0.106	0.049	0.070	0.083
Financial Institutions	0.192	0.319	0.526	-0.063	-0.029	-0.008
Insiders	-0.126	-0.126	-0.126	-0.102	-0.126	-0.140
Other	-0.156	-0.146	-0.129	1.321	0.524	0.056
Short Sellers	-0.313	-0.335	-0.371	-0.466	-0.400	-0.361
Firms	-1.094	-1.241	-1.482	-1.712	-1.265	-1.003
Total	-1.001	-1.001	-1.001	-0.979	-0.990	-0.996

	Panel B: Index Fund Ownership Decrease by 1pp					
	Positive Return Percentile			Negative Return Percentile		
	25th	50th	75th	25th	50th	75th
Active Funds	-0.089	-0.091	-0.093	-0.434	-0.253	-0.147
Other Funds	-0.010	-0.014	-0.019	-0.085	-0.041	-0.015
Pension Funds	-0.002	-0.003	-0.004	-0.021	-0.019	-0.018
Insurance	-0.039	-0.034	-0.027	-0.047	-0.042	-0.039
Financial Institutions	0.463	0.549	0.689	0.044	0.338	0.510
Insiders	0.005	0.008	0.013	0.069	0.041	0.025
Other	0.745	0.717	0.672	2.240	1.350	0.828
Short Sellers	0.132	0.133	0.134	0.079	0.098	0.110
Firms	-0.210	-0.278	-0.389	-0.846	-0.472	-0.254
Total	0.994	0.987	0.976	1.000	1.000	1.000

	Panel C: Returns by Percentile					
	Positive Return Percentile			Negative Return Percentile		
	25th	50th	75th	25th	50th	75th
Return	5.80%	12.67%	23.88%	-21.70%	-11.01%	-4.75%

Notes. The numbers in Panels A and B report an investor group's expected percentage point (pp) change in ownership of a stock given a (1) one pp increase or decrease in Index Fund ownership, and (2) the stock return. To generate these expected changes, we first estimate

$$q_{i,j,t+1} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \beta_{ret} \cdot r_{i,t} + \beta_{\times} \cdot q_{i,\text{IDX},t} \times r_{i,t} + \varepsilon_{i,j,t+1}$$

for each investor group j, where $q_{i,\text{IDX},t}$ is the change in ownership in stock i in quarter t by Index Funds and $r_{i,t}$ is stock i's return in quarter t. We then calculate the expected ownership change for each group by using the estimated betas and evaluate the regression using 1% or -1% as $q_{i,\text{IDX},t}$ and returns drawn from either the 25th, 50th, or 75th percentile of positive and negative returns in our entire sample. Panel C reports the returns for various percentiles from the distribution of all positive and negative stock returns in our sample. See Table 18 for the estimated betas, and Section 3.4 and Appendix B.3 for more details.

in reported holdings. We also find evidence of data errors in the Thomson 13F data. We address two types of data errors: (1) general data errors where a group appears to increase or decrease its ownership of a stock but does not in reality, and (2) stale data.

General data errors result in an inability to clear the market amongst the groups in our sample, and force the residual Other group to take a position that mechanically clears the market. This will have the effect of attenuating the beta estimates of each of the non-residual groups, and push the beta estimate of the Other group toward -1. In this sense, the data errors have the same effect as the well-known attenuation bias due to measurement error. This suggests that our estimates for the non-residual groups in Table 2 are an underestimate.

To further allay concerns about these more general data errors, we provide an additional robustness test in Appendix C.2 where we limit the sample to only stock-quarters where the Other group has an ownership change of less than 0.005 in magnitude. That is, we require all of the investor groups in our data to clear (or nearly clear) the market amongst themselves without the need of a residual group to ensure market clearing. While this omits a significant fraction of the data, the general message is consistent with the baseline results – Firms and Short Sellers collectively account for a significant fraction of the shares demanded by passive. The magnitude is a bit lower than the baseline estimates: Firms have a beta of -0.44 (vs. -0.69 in the baseline) and Short Sellers have a beta of -0.19 (vs. -0.26). Financial Institutions play a much larger role in clearing the market in this sample, with a beta estimate of -0.46 (vs. -0.05). The changes in point estimates are likely driven by observations with large positive or negative changes in Index Fund ownership, which we discuss and explore more in Section 3.2.

Stale data may impact the results in an a way that is different than more general data errors. Imagine a scenario where, in reality, Index Funds buy a stock in period t and Active Funds sell to them, but Active Funds' sales are erroneously not recorded in the data and stale holdings from the previous quarter are recorded instead. In order to clear the market, the residual Other group will then be responsible for clearing the market in period t. In addition, the active sale, which is now recorded with a delay in $t+1$, will be cleared by the Other group's buying. That is, the Other group will look as if it acts as an intermediary between groups over quarters.

To quantify how problematic stale data is, we test the degree to which passive changes in quarter t are related to other groups' position changes in the same stock but in quarter $t+1$. That is, we estimate

$$q_{i,j,t+1} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t+1} \tag{15}$$

Table 20: Beta Estimates with Future Group Changes

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.071	6.183	-0.059	-1.820	128,060	0.001	-0.033
Other Funds	0.033	5.865	0.082	2.513	128,060	0.002	0.094
Pension Funds	0.006	3.766	-0.002	-0.397	128,060	0.001	0.000
Insurance	0.018	5.050	-0.012	-0.758	128,060	0.001	-0.005
Financial Institutions	0.076	2.839	0.056	0.695	128,060	0.000	0.084
Insiders	-0.054	-9.855	-0.044	-4.618	128,060	0.002	-0.064
Other	0.057	2.127	0.194	2.851	128,060	0.000	0.215
Short Sellers	-0.088	-3.817	0.014	0.334	128,060	0.003	-0.018
Firms	-0.259	-12.930	-0.483	-10.779	128,060	0.006	-0.578
Total	-0.140		-0.254				-0.306

Notes. Estimates a modified version of our baseline regression specification where we compare investors' net demand in quarter $t+1$ against passive demand in quarter t:

$$q_{i,j,t+1} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

for each group in our sample. The notable difference is the left-hand side variable, $q_{i,j,t+1}$, is in quarter $t+1$, not t.

If the sign of the beta estimate for the Other group flips sign from t (the baseline regressions) to $t+1$, that would be consistent with, though not definitive proof of, the data being stale. We report these beta estimates in Table 20.

The table shows a beta estimate for the residual group of 0.124. That is, Index Fund changes at t are negatively related to the residual group's position change in t but positively related in $t+1$. This is consistent with the data being somewhat stale. However, the degree to which stale data affects the findings seems low, given the magnitude is significantly smaller in $t+1$ than in t (0.124 vs -0.271). In addition, the groups most likely to have stale data appear are those that have the opposite of Other in $t+1$, which, again, is Firms.

This robustness test also yields more insight into the role of Firms and Short Sellers. Table 20 shows that these groups adjust positions in $t+1$ in the opposite direction of Index Fund changes in t. That is, if Index Funds buy a stock in quarter t, Firms and Short Sellers tend to sell in both quarters t and $t+1$. The estimates for Firms and Short Sellers, respectively, are -0.316 and -0.104. While the betas for future changes are about a third of the magnitude of betas for contemporaneous changes, they are the most economically significant coefficients for quarter $t+1$.

Table 21: Beta Estimates: Sample with Low Other Group Activity

Investor Group	β_j	$t(\beta_j)$	α_j	$t(\alpha_j)$	Obs.	R^2	$\overline{q}_j$
Active Funds	0.034	1.136	-0.078	-3.637	31,317	0.000	-0.070
Other Funds	0.059	3.054	0.059	3.332	31,317	0.005	0.074
Pension Funds	0.010	3.083	-0.006	-1.357	31,317	0.001	-0.004
Insurance	0.045	8.172	-0.024	-1.888	31,317	0.005	-0.013
Financial Institutions	-0.455	-9.539	-0.032	-0.693	31,317	0.024	-0.146
Insiders	-0.055	-7.392	0.016	2.630	31,317	0.005	0.002
Other	-0.009	-3.089	-0.012	-4.268	31,317	0.000	-0.014
Short Sellers	-0.193	-7.345	0.092	2.561	31,317	0.014	0.044
Firms	-0.436	-13.109	-0.017	-0.841	31,317	0.041	-0.126
Total	-1.000		-0.002				-0.252

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The unit of observation is security-year-quarter. Run on the subsample of observations where the absolute value of $q_{i,j,t}$ is less than 0.10%. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.

C.2 Tests With Minimal Residual Demand

All of our measures of net demand come directly from the data except our residual Other category, which is necessary to ensure market clearing holds in our data. The Other category by construction makes a position change that all other investors that are not included in our data must have done in order for the market to clear. There are a few ways to look at this. One, this is some combination of foreign investors, small institutions, and retail traders (in Appendix A.2, we provide evidence that our Other category is related to measures of retail trading activity). An alternative interpretation is this the Other category represents an aggregation of data errors for the investors we do have in our data. This can be from mistiming (e.g., reporting delays, stale data) or just pure data errors, and are all collected in this residual group. Last, it could be that there is some kind of dark matter that clears the market, but we do not know who they are.

As a check, we examine only the observations where the market clears or nearly clears amongst the investor groups we can directly measure in our data. That is, we filter out all observations where our residual group are required to trade more than 0.50% of shares outstanding to make the market clear. Table 21 presents the estimates.

C.3 Mechanical Relationships: Shorting and Passive Ownership

As shown in the main body of the paper – increases in passive ownership seem to be accommodated by short selling i.e., the shares passive investors demand are created through increased short interest. One concern with these results is that there is a mechanical relationship between increases in passive ownership and short selling. Specifically, as previously documented (see e.g., Palia and Sokolinski (2021), von Beschwitz et al. (2022)) passive funds are able to lend out a fraction of the shares they hold to generate additional income and this may lead to higher short interest in high passive ownership stocks.[22]

To test this, we leverage data from Markit (also used in e.g., Muravyev et al. (2022)) on short interest, estimated quantities of shares available for lending, utilization rates and expected borrowing costs. We start with a straightforward cross-sectional regression of these quantities on passive ownership, non-passive institutional ownership, firm size, percentage growth in firm market capitalization over the past 12 months, firm fixed effects and time fixed effects.

The results are in Table 22. The first column includes the results for the short interest ratio (SIR), defined as the ratio of the number of shares shorted to the number of shares outstanding (Hanson and Sunderam, 2014). The point estimate is positive and significant, suggesting that a 1% increase in passive ownership is correlated with a 9 basis point increase in SIR. Overall non-passive institutional ownership is also correlated with higher levels of short interest, consistent with evidence in Daniel et al. (2021).

Column 2 shows the results for the estimated supply of lendable shares, defined as Markit's estimate of shares available for lending divided by shares outstanding. Again, the point estimate is positive and significant, suggesting that a 1% increase in passive ownership is correlated with a 77 basis point increase in the amount of lendable shares. The results in columns 1 and 2 are already evidence against a purley mechanical effect of passive ownership on short interest. For example, if passive funds lent out exactly 30% of the shares they owned, we would expect a point estimate of around 30. Of course, passive funds can lend out 30% of the value of their portfolio. And, it may be that this is not distributed equally among all their holdings.

Column 3 shows the results for the utilization rate, defined as the quantity shorted divided by Markit's estimate of the number of lendable shares. The point estimate is negative and significant, suggesting that a 1% increase in passive ownership is correlated with an 18 basis point decrease in utilization. While

[22] As discussed in Appendix B of Blocher and Whaley (2015), Sec 18 of the 1940 Act would allow passive funds to lend out up to 30% of the value of their portfolio. Later interpretations of this rule suggest it would be possible to lend out up to 50% of the portfolio value, due to the fact that the collateral received against the securities lent effectively increase the assets of the portfolio, and therefore increase the amount of lending that could be done.

Table 22: Shorting and Passive Ownership in the Cross-Section

	% Shrout		% Lendable	
	SIR	Lendable	Util.	Cost
	(1)	(2)	(3)	(4)
SIR				0.41***
				(0.03)
Pass	0.09***	0.77***	-0.18***	-0.22***
	(0.01)	(0.03)	(0.04)	(0.02)
Othr. Inst.	0.06***	0.06***	0.06***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)
ln(1+Mkt. Cap.)	-0.00***	0.02***	-0.01***	-0.02***
	(0.00)	(0.00)	(0.00)	(0.00)
% Ch. Mkt. Cap.	-0.01***	-0.02***	0	0.03***
	(0.00)	(0.00)	(0.01)	(0.01)
Observations	220,562	220,562	220,562	220,562
R-squared	0.584	0.889	0.529	0.51
Permno FE	YES	YES	YES	YES
YQ FE	YES	YES	YES	YES

Notes. Cross sectional regression of the short interest ratio (SIR), the supply of lendable shares (Lendable), the utilization rate (Util) and shorting cost (Cost) on passive ownership and control variables. The short interest ratio is defined as the ratio of the number of shares shorted to the number of shares outstanding (Hanson and Sunderam, 2014). The supply of lendable shares is defined as Markit's estimate of shares available for lending divided by shares outstanding. The utilization rate is defined as the quantity shorted divided by Markit's estimate of the number of lendable shares. Expected shorting costs are defined as the Indicative Fee variable provided by Markit. The unit of observation is stock-quarter.

this initially seems counter intuitive, it makes sense given the results in columns 1 and 2: short interest increases, but the amount of lendable shares increases more, so utilization goes down. Finally, column 4 shows that higher levels of SIR are correlated with higher shorting costs, and generally, stocks with more passive ownership have lower shorting costs.

Collectively, the results in Table 22 suggest that our results on short interest increasing to accommodate passive ownership are not a mechanical function of passive funds themselves lending out their shares. First, the magnitudes in column 1 are not large enough to explain our findings. Second, the negative relationship with utilisation in column 3 suggests that even if the lendable quantity of shares increases in high passive stocks, this is likely not a binding constraint for investors who would like to short.

D Additional Empirical Results

In this section, we present additional empirical results, including the relationship between each groups' demand and contemporaneous/past returns, as well as more year-over-year estimates.

D.1 Group Changes and Returns

While our paper does not explore or study the way in which returns may help facilitate or even determine who clears the market, we acknowledge that returns play an important role. Our primary concern is that who clears the market depends on returns. In this subsection, we present reduced-form evidence on the relationship between each groups' demand and contemporaneous/past returns at the stock-level and index-level. The goal of this exercise is to take a first step toward understanding how these different measures of returns are differently important to each group, and thus affect their tendency to clear the market under different situations. This is different than the analysis in Appendix B.3, where we include return controls in regressions quantifying how each group responds to Index demand.

We have several reasons to believe that current and past returns are likely important for each group's demand. For example, one could imagine that after high returns, firms are more likely issue equity for several reasons including, e.g., (1) they believe their stock is overvalued and rationally issue shares to effectively short the stock (Baker and Wurgler (2002), Dong et al. (2012)); (2) some part of employee compensation is in options, which are more likely to be in the money and therefore exercised after high returns, or firms may be more likely to issue options as compensation after a series of high realized returns (Bergman and Jenter, 2007), and (3) an increase in price may be evidence of an increase in investment opportunities (as in, e.g., the Q theory of investment Abel and Eberly (2011)), and firms issue equity to invest in these new opportunities (Bolton et al., 2011).

Similarly, one could imagine that after high returns, there is more buying by passive funds because e.g., (1) high returns lead to being added to more passive benchmarks and thus more passive ownership or (2) high returns at the stock level are correlated with high returns in the indices that stock belongs to, which ultimately lead to passive inflows. More broadly, benchmarked investors who did not previously hold a stock in their benchmark will incur even more tracking error after such a stock experiences high returns (i.e., has a larger weight in the benchmark), and thus will be more inclined to add it to their portfolio.

Before presenting our reduced-form evidence on the relationship between each groups' demand and returns, we would like to caution that the goal of this exercise is not to identify the *causal* relationship between returns and investor behavior. In fact, we believe that in discussing these results, it will make clear that designing such a test is not straightforward in our setting for several reasons. Because we can only observe quarter-over-quarter changes in holdings, we cannot exactly observe the relative timing of returns and passive funds' ownership changes, and thus cannot identify whether issuance tends to precede or lag passive buying.

Further, even if we observed that issuance appeared to lag passive buying, the causality could still run from passive demand to issuance. One possible mechanism for this is if short sellers anticipated issuance by firms in response to passive demand, shorted the stock to accommodate this demand, and bought back from firms at a later date. More broadly, we want to emphasize that it cannot be that after high returns all groups buy. Markets must clear, so if, e.g., high returns lead to increased demand by passive funds, unless another group wants to permanently reduce its allocation to US equities, firms must issue.

As a first step to quantify the role of returns as a coordinating device for investor behavior, we run a regression of demand by each of our groups $q_{i,j,t}$ on contemporaneous and lagged returns

$$q_{i,j,t} = \beta_1 r_{i,t} + \beta_2 r_{b,t} + \beta_3 r_{i,(t-4,t-1)} + \beta_4 r_{b,(t-4,t-1)} + \alpha_i + \alpha_t + \varepsilon_{i,j,t} \tag{16}$$

separately for each investor group j. $r_{i,t}$ is the return on security i in quarter t, while $r_{b,t}$ is the return on the major index(es) stock i belongs to in quarter t. If the stock only belongs to the S&P 500, 400, or 600 (but not one of the Russell 3000 indices), $r_{b,t}$ is defined as the return on that index. If the stock only belongs to the Russell 1000 or 2000 (but not one of the S&P 1500 indices), $r_{b,t}$ will be defined as the return on that Russell index. If the stock is in both an S&P 1500 index, and a Russell 3000 index, $r_{b,t}$ will be an equally-weighted average of the return on the indexes it belongs to. $r_{i,(t-4,t-1)}$ is the cumulative return on stock i over the past four quarters (i.e., excluding the contemporaneous quarter t), while $r_{b,(t-4,t-1)}$ is the cumulative return on the index(es) stock i belongs to over the past four quarters. The regression in Equation 1 also includes security fixed effects (α_i) and time fixed effects (α_t).

For this test, we start with our baseline sample of security-firm-quarter observations, and then exclude stocks which switch indices in a given quarter. We do this to remove mechanical effects of changes in market capitalization on index assignment and therefore passive demand. This is to avoid, for example, a scenario where a firm has negative returns, leading it to switch from the Russell 1000 to the Russell 2000, and therefore net buying by passive funds over our sample Coles et al. (2022) .

Table 23 presents the results. Column 1 shows that, perhaps unsurprisingly, passive changes are much more sensitive to benchmark-level returns than stock-level returns. This highlights an important complication in linking returns and investor behavior: some investors may adjust their positions based on stock-level returns, while other investors will adjust their holdings based on index-level returns. And, in this specification, we are only conditioning on high level benchmark returns, not the returns of any sub-indices (e.g., value versus growth) or non-market capitalization based indices (e.g., sector indices). Further, stock returns and index

Table 23: Relationship between Firm-Level Returns, Benchmark Returns and Demand by Investor Groups

	Passive (1)	Active (2)	Other Fund (3)	Pension (4)	Insurance (5)	Fin Inst (6)	Insiders (7)	Other (8)	Short (9)	Firm (10)
Pos Quarter (t) Ret	0.162**	1.352***	0.105	-0.00809	0.167***	0.671	-0.0991	-1.382***	0.700***	-1.668***
	(0.069)	(0.189)	(0.063)	(0.024)	(0.057)	(0.495)	(0.074)	(0.366)	(0.097)	(0.551)
Neg Quarter (t) Ret	-0.102	2.265***	0.645***	-0.0651**	0.380***	-0.429	-0.0643	-4.213***	1.125***	0.459
	(0.089)	(0.266)	(0.159)	(0.028)	(0.077)	(0.437)	(0.147)	(0.525)	(0.227)	(0.326)
Pos Quarter (t) Bench	0.28	-0.5	0.00473	-0.131	-0.0984	-1.091	-0.213	0.463	0.783	0.503
	(0.525)	(0.380)	(0.534)	(0.098)	(0.116)	(0.982)	(0.169)	(0.763)	(0.554)	(0.493)
Neg Quarter (t) Bench	3.317***	-1.123	0.444	0.224	0.248	-1.211	-0.227	0.595	-0.285	-1.983**
	(0.885)	(1.225)	(0.826)	(0.174)	(0.412)	(1.304)	(0.412)	(1.338)	(1.483)	(0.808)
Pos Past Year Ret	0.0400**	-0.138***	0.00371	0.0262***	0.0579***	0.106	-0.0501**	0.344***	0.0548*	-0.445***
	(0.017)	(0.050)	(0.023)	(0.009)	(0.015)	(0.076)	(0.021)	(0.125)	(0.028)	(0.078)
Neg Past Year Ret	-0.288***	-0.281	0.0422	-0.0354	-0.0253	-0.32	-0.128***	-0.291	0.478***	0.848**
	(0.076)	(0.172)	(0.073)	(0.023)	(0.048)	(0.302)	(0.027)	(0.361)	(0.111)	(0.352)
Pos Past Year Bench	1.948***	0.381	-0.664	0.122	0.43	0.339	-0.0373	-1.44	-0.0299	-1.05
	(0.727)	(0.775)	(0.589)	(0.155)	(0.326)	(1.821)	(0.346)	(1.661)	(1.286)	(0.631)
Neg Past Year Bench	-0.611	0.617	0.152	-0.199**	-0.0554	0.214	-0.0772	-0.0323	-0.562	0.554
	(0.475)	(0.419)	(0.244)	(0.086)	(0.102)	(0.721)	(0.181)	(0.665)	(0.583)	(0.456)
Observations	124,447	124,447	124,447	124,447	124,447	124,447	124,447	124,447	124,447	124,447
R-squared	0.203	0.103	0.385	0.111	0.15	0.153	0.131	0.136	0.069	0.197
Fixed Effect	Stock/YQ	Stock/YQ	Stock/YQ	Stock/YQ	Stock/YQ	Stock/YQ	Stock/YQ	Stock/YQ	Stock/YQ	Stock/YQ

Notes. Estimates from a regression of investor demand on contemporaneous and returns:

$$q_{i,j,t} = \beta_1 r_{i,t} + \beta_2 r_{b,t} + \beta_3 r_{i,(t-4,t-1)} + \beta_4 r_{b,(t-4,t-1)} + \alpha_i + \alpha_t + \varepsilon_{i,j,t}$$

for each investor group j. $r_{i,t}$ is the return on security i in quarter t, while $r_{b,t}$ is the return on the index(es) stock i belongs to in quarter t. Similarly, $r_{i,(t-4,t-1)}$ is the cumulative return on stock i over the past four quarters (i.e., excluding the contemporaneous quarter t), while $r_{b,(t-4,t-1)}$ is the cumulative return on the index(es) stock i belongs to over the past four quarters. The unit of observation is security-year-quarter. ϕ_i represent security fixed effects, while ψ_t represent time fixed effects. Standard errors (in parenthesis) double clustered at the stock and time (year-quarter) level.

returns may be correlated for a variety of reasons, leading to concerns of multicollinearity if one were to include the returns of all indices stock i belonged to on the right hand side of Equation 16. Column 2, on the other hand, shows that active mutual fund managers respond strongly to firm-level returns, rather than benchmark-level returns. Already this is suggestive evidence against returns as a coordinating device for our main results that active and passive mutual funds tend to trade in the same direction in Table 2.

Further, we find issuance is not sensitive to benchmark returns, but rather firm level returns. Again, this is suggestive evidence against returns as a coordinating device for firms consistently trading in the opposite direction as passive investors (who seem to focus on past benchmark returns) in Table 2. Finally, we find after high returns, short sellers tend to cover their shorts – consistent with short-squeeze logic – but which is directionally inconsistent with short sellers being on the opposite side of passive demand on average.

To reiterate, the results in Table 23 are not a dispositive test that rules out the role of returns as a coordinating device for our investor groups. In fact, as mentioned above, active investors strongly chase individual stock returns. So, it could be that active funds buy the same stocks that passive funds buy because, e.g., mechanical passive demand pushes up prices, which leads to higher realized returns and thus active demand. Our main takeaway is that, while returns are certainly correlated with how investors trade, this sensitivity is different across group – and fully accounting for (1) causality and (2) the types of returns each group may care about

is far from a straightforward exercise. Further, while we cannot rule out that returns do not simultaneously drive both passive buying and firm issuance, even if they did, we believe our results are just as interesting in their own right. Specifically, even if returns are the true driver of the relationship between passive demand and firm issuance, our results suggest that when passive buys, nobody on the demand side reduces their demand to accommodate passive buying, i.e., no other group is willing to reduce their allocation to equities.

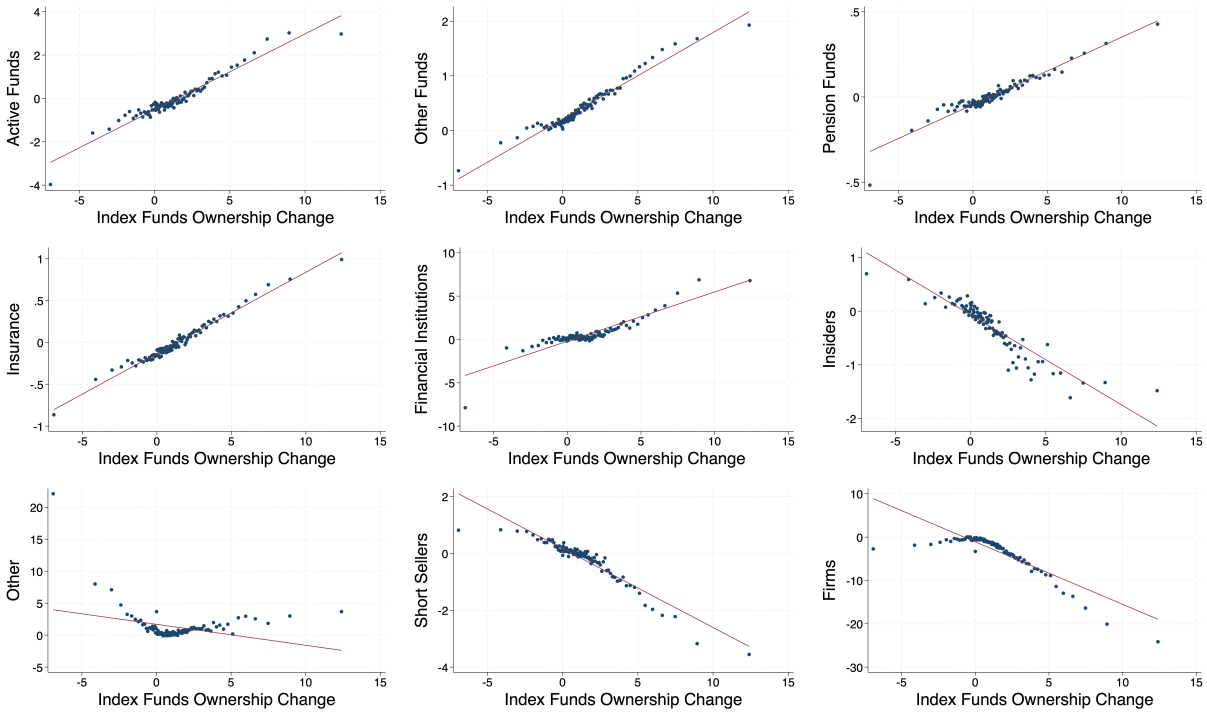
D.2 Year-over-Year Binscatter Plots

Figure 16 displays similar binscatter plots with equal-weighted observations but year-over-year ownership changes instead of quarterly changes. The most significant change is the role of Financial Institutions in market clearing – they tend to change positions in the same direction as Index Funds. The only clearly negative beta estimates come from Firms, Short Sellers, and Insiders. Firms and Short Sellers tend to be more responsive in taking the other side of Index Fund buying with little to no activity on the other side of Index Fund selling. This is, again, where the Other group clears nearly all of the reduced demand by Index Funds. Insiders are also responsive when Index Funds sell but the responsiveness is small relative to the Other group.

D.3 Index Stayers vs. Switchers: Year-over-Year Estimates

We present additional results that support the analysis on index-switching stocks vs. non-index-switching stocks ("stayers"). We provide the estimates for the same sample split but with year-over-year changes. As mentioned in Section 5.2.1, we find that over a longer horizon, shares demanded by Index Funds for index-switching stocks are also largely cleared by Firms, along with a contribution from Short Sellers and Other. All other groups have little-to-no activity. That is, over the long run, Active Funds, Other Funds, and Financial Institutions, all groups that contributed something in clearing the market for passive demand, only do so on a short-term basis. In the long run, it is Firms again that provide shares.

Figure 16: Ownership Changes: Year-over-Year Binscatter by Group



Notes. Each panel presents a bin scatter of net demand by each investor group – $q_{i,j,t}$ – against net demand by passive index funds and ETFs – $q_{i,\text{IDX},t}$. The unit of observation is security-year-quarter.

Table 24: Index Switchers vs. Stayers: Year-over-Year

	Index Switchers						Index Stayers					
Investor Group	β_j	$t(\beta_j)$	α_j	Obs.	R^2	$\overline{q}_j$	β_j	$t(\beta_j)$	α_j	Obs.	R^2	$\overline{q}_j$
Active Funds	0.063	0.955	-0.357	1,252	0.002	-0.293	0.368	8.195	-0.538	115,380	0.038	-0.420
Other Funds	-0.023	-1.398	0.697	1,252	0.002	0.674	0.167	5.667	0.200	115,380	0.060	0.254
Pension Funds	0.016	2.135	0.075	1,252	0.008	0.091	0.040	6.542	-0.048	115,380	0.024	-0.035
Insurance	0.091	5.948	-0.048	1,252	0.073	0.044	0.097	11.901	-0.134	115,380	0.039	-0.103
Financial Institutions	0.100	1.214	0.285	1,252	0.002	0.386	0.594	4.469	-0.233	115,380	0.030	-0.042
Insiders	-0.098	-2.300	-0.492	1,252	0.007	-0.591	-0.171	-7.026	-0.063	115,380	0.010	-0.118
Other	-0.206	-1.405	1.776	1,252	0.006	1.568	-0.345	-1.684	1.695	115,380	0.006	1.584
Short Sellers	-0.242	-5.184	-0.211	1,252	0.045	-0.456	-0.275	-13.392	0.181	115,380	0.036	0.092
Firms	-0.701	-4.750	-1.724	1,252	0.062	-2.433	-1.473	-12.324	-1.060	115,380	0.104	-1.534
Total	-1.000		0.001			-1.011	-0.998		0.000			-0.321

Notes. Estimates from our baseline regression specification:

$$q_{i,j,t} = \alpha_j + \beta_j \cdot q_{i,\text{IDX},t} + \varepsilon_{i,j,t}$$

for each investor group j. The sample is split into index switchers – defined as those that are added to, dropped from or switch between the Russell 1000, Russel 2000, S&P 500, S&P 400, S&P 600, Nasdaq 100 or the CRSP Total Market. The unit of observation is security-year-quarter. t-statistics are computed based on standard errors which are double clustered at the stock and time (year-quarter) level.