Paying for Beta: Leverage Demand and Asset Management Fees

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Abstract

We examine how investor demand for leverage shapes asset management fees. We show that in the sample of U.S. equity mutual funds: (1) fees increase in fund market beta precisely for beta larger than one; (2) this relation becomes stronger and high-beta funds experience larger inflows when leverage constraints tighten; and (3) low net alphas are especially common among high-beta funds. These results are consistent with a model in which asset managers compete for leverage-constrained investors with heterogeneous risk aversion. The cost of leverage for investors in form of additional fees equals 46–64 basis points per year.

Keywords: Leverage; Financial Intermediation; Mutual Funds
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1 Introduction

Many investors delegate portfolio decisions to professional money managers and pay fees for the asset management service. The extent of delegation and the fee revenues have grown significantly over the last four decades.[1] French (2008) reports that individual investor holdings of U.S. common equity declined from 47.9% in 1980 to only 21.5% in 2007, while open-end mutual fund holdings increased from 4.6% to 32.4%.[2] Over the same period, investors sacrificed about 10% of their annual real return for asset management fees and transaction costs. The differences in fees between funds represent a long-standing puzzle for financial economists especially since many funds charge fees higher than their risk-adjusted returns (Fama and French (2010)).

In this paper, we examine the role of investors' demand for leverage as a new determinant of asset management fees. We find that investors pay asset managers considerable fees for the provision of leverage, which makes embedded leverage an important source of fee variation. At the same time, the cost of leverage in form of extra fees is at the lower end relative to alternatives, suggesting that asset managers provide leverage to their investors at a competitive price.

Our basic idea can be illustrated through the following example. Consider two rational investors with different risk profiles who need to choose an asset manager and can easily obtain leverage. The risk-seeking investor seeks an above-the-market return with a market beta of 1.5, while the risk-averse investor seeks a below-the-market return with a beta of 0.5. To obtain the desired return, the risk-seeking investor borrows 50% of her wealth and makes a leveraged investment in a market index fund. The risk-averse investor equally splits her holdings between the index fund and the risk-free asset. But if the risk-seeking investor cannot borrow, she has to find a manager who can deliver a leveraged portfolio with a beta of 1.5. This manager can charge an extra fee for providing leverage, irrespective of fees associated with the manager's risk-adjusted return or other factors.

To sharpen this intuition and to guide our empirical analysis, we present a simple framework in which investors delegate capital to asset managers. Asset managers differ in the amount of embedded leverage they provide as measured by their market betas (Frazzini and Pedersen (2020)), and investors vary in their risk aversion. To focus specifically on

[1] In 2018, only the U.S. equity mutual fund investors paid more than $50B in fees. This calculation is based on the Investment Company Institute 2019 report. The total mutual fund industry assets under management as of December 2018 amount to $17.7T, where equity funds represent 52% of assets. The value-weighted expense ratio for the equity funds equals 0.55%.

[2] Stambaugh (2014) extends the time series to 2012, providing consistent evidence on the long-term decline in direct equity ownership by individual investors.

the effect of leverage on fees, we assume that asset managers are homogeneous along other dimensions. As a result, if neither investors nor asset managers face leverage constraints, price competition drives fees towards zero across all managers.

Under leverage constraints, investors are willing to pay extra fees to high-beta asset managers because these managers provide returns that investors cannot obtain on their own. The willingness to pay for embedded leverage increases with the tightness of leverage constraints and declines with investor risk aversion. As a result, the equilibrium features sorting of investors across managers such that risk-seeking investors invest with high-beta managers. When beta is greater than one, fees progressively increase with beta because managers with higher betas possess local market power over their constrained, risk-seeking investors. At the same time, risk-averse investors do not require leverage since they look for below-the-market returns. These investors split their portfolios between the cheap market index fund and the risk-free asset. Consequently, fees of asset managers with betas smaller than one do not increase in beta. These results continue to hold if the funds' gross performance declines in beta (Frazzini and Pedersen (2014) and Boguth and Simutin (2018)) or if funds choose their betas endogenously.

Our framework delivers three new testable hypotheses. First, we expect to observe an asymmetric relation between market beta and fees across funds. In particular, fees increase in beta when beta is larger than one, but they are non-increasing in beta when beta is smaller than one. Second, the relation between beta and fees in the range of betas greater than one becomes stronger when leverage constraints tighten. Finally, we show that fund net alpha is expected to decline in beta, and is particularly negative for beta greater than one. The effect of high fees on high-beta funds comes on top of the risk-return relation inherited from the asset market, through which portfolios of high-beta stocks may already have low gross alphas (Black, Jensen, and Scholes (1972), Frazzini and Pedersen (2014)). As a result, our theory suggests that net-of-fees underperformance is exacerbated for high-beta funds.

We examine these hypotheses in the sample of the U.S. domestic equity mutual funds. Implementing a variety of tests and controlling for the known determinants of fees, we confirm our first hypothesis: when beta is larger than one, fund fees increase with fund beta. When fund beta is below one, the relation between beta and fees becomes economically and statistically insignificant. The effect of beta on fees for betas above one is economically meaningful. Our estimates from various regressions and portfolio sorts show an increase of 46–64 basis points per year when beta increases by one (i.e., per unit of leverage), while the median total fee in our sample amounts to 152 basis points. The effect also stands as economically comparable to the effects of other determinants of fees. An increase of one standard deviation in beta is associated with an increase of 10 basis points in fees according to our baseline regressions, while a similar change in log fund size or log fund age changes fees by 21 basis points and 9 basis points, respectively.

In terms of robustness, our findings are not confounded by differences in pricing policies across fund families, demand for style investing, differences in investors across fund distribution channels, decline in fund offerings with fund beta, differences in trading or equity valuation costs, or differences in fund usage of derivatives and short-selling. We also show that the long-term survival propensities of high-beta funds are not different from low-beta funds, implying that these funds do not die off quickly, and investors indeed pay the increased fees. Moreover, our results can not be explained by the alternative idea that investors generally pay higher fees for funds with higher total returns, since the relation between beta and fees is strongly asymmetric.

We next explore our second hypothesis and examine whether the relation between beta and fees becomes stronger if leverage constraints are tight. We present two series of tests. The first group of tests is focused on the cross-sectional differences between institutional and retail investors. Our hypothesis is that the relation between beta and fees is stronger for share classes offered to retail investors, since they tend to face tighter leverage constraints.[3] We find that, for the same increase in beta, the increase in fees paid by retail investors is almost twice as large as for institutional investors. This result is consistent with our second prediction suggesting that constrained investors are willing to pay more for embedded leverage.

In our second series of tests, we examine the effects of time variation in leverage constraints on the cross-sectional relation between beta and fees. Since there is almost no time variation in fees within a given fund once it is launched, we focus on fees in the cross-section of newly launched funds in different periods. In particular, we compare funds that are launched in periods of tight leverage constraints to funds launched in less constrained periods. We expect the relation between beta and fees to be stronger in the cross-section of funds launched in constrained periods. We use a number of measures associated with leverage constraints such as: (1) the betting-against-beta (BAB) factor from Frazzini and Pedersen (2014); (2) the intermediary capital ratio (ICR) from He, Kelly, and Manela (2017); and (3) the leverage constraint tightness (LCT) measure from Boguth and Simutin (2018). We find that funds introduced in constrained periods charge two to four times more per unit of beta relative to funds introduced in less constrained periods.

[3] Frazzini and Pedersen (2014) show that individual investors are more likely to hold high-beta stocks, consistent with the intuition that they are more leverage-constrained.

Additionally, we find that both new and existing high-beta funds exhibit increased inflows in constrained periods. Funds with betas at the top of our sample distribution experience 1.1 percentage points (0.34 standard deviations) higher net flows in constrained periods than funds with a beta of one. This result further supports the leverage demand channel, as an increase in demand precisely leads to a simultaneous increase in equilibrium prices (fees) and quantities (assets under management). We also examine complementary channels for market adjustment to increased demand such as an increase in beta for existing funds or an increased entry of new high-beta funds, but do not find any evidence for these channels based on our data.

We proceed to examine our third hypothesis and explore the implications of leverage-driven fees for fund net-of-fee performance. Using portfolio sorting, we first document that fund net alpha declines in fund market beta. In the sample of funds with betas greater than one, the difference in net alphas between the low-beta and the high-beta fund portfolios amounts to 60 basis points per year. We quantify the contribution of fees to this pattern by analyzing both gross and net alphas. Our analysis shows that high fees for high-beta funds and lower gross alphas contribute to the decline in net alpha on a comparable basis. These results suggest that demand for leverage plays an influential role in accounting for the low net-of-fees performance of many equity mutual funds.

Our analysis establishes that fund investors pay for the provision of leverage in form of increased fees. We complete the picture by investigating how high-beta funds obtain leverage. The asset manager's leverage strategy directly affects the total costs of leverage for high-beta fund investors, which are determined by the combination of extra fees and reduced gross alpha.

Asset managers can generally lever up their portfolios in two broad ways: (1) investing in high-beta stocks; and (2) engaging in alternative investment practices such as borrowing capital directly, trading derivatives, or using short-selling. Using data on fund investment practices collected from N-SAR filings, we show that only 29% of funds with betas greater than one engage in any of the alternative investment practices associated with leverage. High-beta funds are as likely to engage in these practices as the rest of the funds, and fund beta within the sample of high-beta funds does not depend on whether the fund borrows money, conducts short-selling, or uses derivatives. These findings indicate that the vast majority of high-beta funds obtain their embedded leverage by investing in high-beta stocks, unlike specialized leveraged ETFs that strongly rely on derivatives (Lu and Qin (2020)). At the same time, high-beta funds do not exhibit higher trading costs than other funds, confirming that the relation between beta and fees is mostly driven by investor demand.

We conclude by providing an estimate of the total cost of leverage for high-beta fund investors. The portfolio sorting analysis suggests a gross performance loss of 103 basis points per year when beta is increased by one. Together with the extra fee of 46–64 basis points per year, we obtain a total cost of 149–167 basis points per year for one unit of leverage. The "all-in cost" that investors pay for leverage when investing in high-beta funds is therefore economically significant, but not higher than for leveraged ETFs (Frazzini and Pedersen (2020), Lu and Qin (2020)), or for levering up by borrowing at standard rates and investing in market ETFs.

1.1 Contributions to the Literature

Our key contribution is to empirically examine the effects of investor leverage demand on price competition in asset management. An important strand of literature shows that in models with fully competitive markets and rational investors, asset management fees generally converge towards fund gross alpha (Berk and Green (2004), Pástor and Stambaugh (2012)). In contrast, the empirical literature finds that many active funds charge fees which are significantly higher than their risk-adjusted returns.[4] Significant variation in fees exists even among index funds which, by definition, are not expected to deliver above-benchmark performance to their investors (Elton, Gruber, and Busse (2004), Hortaçsu and Syverson (2004)). The literature concludes that the large and persistent dispersion in fees cannot be fully rationalized by "neoclassical" models, and that investors in high-fee funds likely experience significant losses due to their lack of financial sophistication or investment mistakes (Gil-Bazo and Ruiz-Verdú (2009), Cooper, Halling, and Yang (2020)).

Our work provides a new angle on this debate by uncovering a novel source of fee variation. We show that the provision of leverage represents an additional service, and its value is not directly captured by fund gross alpha. Thus, the leverage demand channel can explain how fees can be larger than fund risk-adjusted performance, without requiring investors to be naive or irrational. Consequently, our evidence presents a novel perspective on the underperformance of money managers, complementing other explanations such as the presence of non-sophisticated investors (Gil-Bazo and Ruiz-Verdú (2008), Gârleanu and Pedersen (2018)), time variation in performance (Glode (2011)), weak incentives to generate

[4]For early evidence on the underperformance of actively managed funds, see Jensen (1968), Ippolito (1989), and Gruber (1996). For the recent advancements, see, for example, Gil-Bazo and Ruiz-Verdú (2009), Fama and French (2010), Del Guercio and Reuter (2014), Berk and van Binsbergen (2015), and Cremers, Fulkerson, and Riley (2019).

performance (Del Guercio and Reuter (2014)), and paying for "peace of mind" (Gennaioli, Shleifer, and Vishny (2014), Gennaioli, Shleifer, and Vishny (2015)).[5]

This paper also fits the growing literature on the effects of leverage constraints in asset pricing. Our novel contribution is to link this literature to the literature on fee determination and fund net performance. Building on the idea of Black (1972), Frazzini and Pedersen (2014) and Frazzini and Pedersen (2020) show that embedded leverage is associated with lower risk-adjusted returns. Our results extend their work, suggesting that fund investors pay a premium for access to leverage not only in form of lower risk-adjusted returns but also via higher fees. Our setting encompasses the entire sample of U.S. equity mutual funds and shows that the insight that investors "are willing to pay for embedded leverage" (Frazzini and Pedersen (2020)) is not limited to the small sample of leveraged ETFs. We also find that the leverage-based premium in form of fees is unique and not confounded by other factors, and it significantly varies over time and in the cross-section of investors in a manner consistent with the underlying variation in leverage demand.[6]

As such, this paper is also related to the literature on performance-based competition in delegated money management. In addition to the early work by Berk and Green (2004), recent theoretical research includes Cuoco and Kaniel (2011), Kaniel and Kondor (2012), and Pástor and Stambaugh (2012). Christoffersen and Musto (2002), Khorana, Servaes, and Tufano (2008), Gil-Bazo and Ruiz-Verdú (2009), Cooper, Halling, and Yang (2020), and Sheng, Simutin, and Zhang (2020) examine the determinants of mutual fund fees empirically.

The rest of the paper is organized as follows. In Section 2, we present our theoretical framework and derive the key testable hypotheses. Section 3 describes our data and methodology. In Section 4, we empirically examine the testable hypotheses on leverage-demand-driven fees and their implications. Section 5 discusses how funds provide leverage

[5] Gennaioli, Shleifer, and Vishny (2014) and Gennaioli, Shleifer, and Vishny (2015) argue that managers can charge fees for providing access to financial markets even in the absence of superior performance. Our paper follows their general idea of delegation, but takes a different perspective. In their model, managers charge fees for providing access to any risky asset—even investing in the baseline market portfolio requires paying a fee. In the equilibrium, the fees are the same for all managers. In contrast, in our framework investors are free to invest in the market portfolio for a trivial fee but they are unable to easily lever it up. Consequently, equilibrium fees are expected to vary across managers due to the variation in embedded leverage and in the risk aversion of investor clienteles. As a result, our view distinctly predicts an asymmetric relation between beta and fees in the cross-section of managers, which we confirm empirically.

[6] The demand for leverage has also been found to be related to the time variation in the aggregate portfolio beta of mutual funds (Boguth and Simutin (2018)) and to discounts on closed-end funds (Dam, Davies, and Moon (2019)), while returns on leveraged funds can be used to evaluate asset managers' costs of leverage (Lu and Qin (2020)). Furthermore, leverage-constrained fund managers may prefer high-beta stocks due to benchmarking requirements (Christoffersen and Simutin (2017)), or in order to attract investor flows during market run-ups (Karceski (2002)).

and derives estimates of the total cost of leverage for fund investors. Concluding remarks are provided in Section 6.

2 Theoretical Framework

2.1 Setup

Our model has two time periods and two types of agents: asset managers and investors. At time 0, asset managers set fees, and investors choose asset managers. At time 1, managers liquidate their portfolios and distribute net-of-fees assets to their investors. In line with the literature on delegated asset management, we assume that investors do not manage portfolios of risky assets on their own.[7] This assumption is made to simplify our analysis, and it does not imply that investors are unsophisticated or exhibit any behavioral biases. For example, investors may rationally choose to delegate their investments because they face much higher costs of selecting, trading, or rebalancing large diversified portfolios relative to asset managers.

Asset Managers There is a set of $J+1$ asset managers who manage funds with different market betas $0 < \beta_0 < \beta_1 = \beta_M < \ldots < \beta_J$, where β_M stands for the asset manager who offers a market index fund. In our baseline model, fund betas remain fixed such that managers compete solely on fees. We later confirm the robustness of our results in an extended model where new funds can enter the market, choosing their optimal betas and fees endogenously.

Asset managers charge fees ϕ_j per dollar invested. A fund with β_j has an expected before-fee excess return of $\mu_j = \beta_j \mu_M + (1-\beta_j)\xi$ and volatility $\sigma_j = \beta_j \sigma_M$ resulting from its portfolio holdings. Here, $\mu_M = E[R_M - R_f]$ and $\sigma_M^2 = Var[R_M]$ are the excess return and variance of the market portfolio, and R_f is the risk-free asset return. Our specification for fund returns nests the capital asset pricing model (CAPM) which is obtained for $\xi = 0$. In addition, our model incorporates the "betting against beta" (BAB) case where leverage constraints affect returns in the asset market. In this case, $\xi > 0$ represents the tightness of

[7] See, for example, Cuoco and Kaniel (2011), Gennaioli, Shleifer, and Vishny (2014), and Gennaioli, Shleifer, and Vishny (2015). This assumption also fits well with the recent evidence on the prevalence of delegation and the significant decline in direct shareholdings by individual investors. Specifically, the individual investor holdings of U.S. common equity dropped from 47.9% in 1980 to around 20% in 2012 while the open-end mutual fund holdings increased from 4.6% to 32.4% over the same period (French (2008), Stambaugh (2014)).

funding constraints for asset managers (Frazzini and Pedersen (2014), Boguth and Simutin (2018)).

Investors There is a unit measure of investors. Investors have constant absolute risk aversion (CARA) preferences and are heterogeneous with respect to their risk aversion γ_i. Each investor is endowed with one unit of wealth. Investors decide to invest a fraction ω_i of their wealth with one asset manager of their choice, while the remaining wealth is invested into the risk-free asset. Investors face heterogeneous borrowing constraints, $\omega_i \leq l$. In particular, a fraction ψ of the investors is strictly borrowing-constrained with $l = \underline{l} = 1$, while a fraction $1 - \psi$ faces a relaxed constraint with $l = \bar{l} > 1$.

Agents' Objectives and Equilibrium Each investor decides how much to invest into risky assets and also chooses an asset manager. Formally, investor i solves the problem

$$\max_{j, \omega_i^j} \ \omega_i^j(\mu_j - \phi_j) + R_f - \frac{\gamma_i}{2} {\omega_i^j}^2 \sigma_j^2, \tag{1}$$

choosing an asset manager $j \in \{0, 1, \ldots, J\}$ with beta β_j and an investment weight $\omega_i^j \in [0, l]$ subject to the given borrowing constraint.

Each asset manager maximizes revenues that she generates from fees. Asset manager j solves the problem

$$\max_{\phi_j} \ \phi_j AUM_j(\phi_j), \tag{2}$$

where AUM_j are the assets under management that are allocated to j when the fee is set to ϕ_j. We assume perfect supply-side competition for market index funds with $\beta_M = 1$, following the intuition that all market index funds are very similar and entry barriers in this highly competitive segment are relatively low. As a result, the fee ϕ_M on the market index fund equals marginal production/management costs, which we set to zero for simplicity.[8] All asset managers with betas different from 1 offer differentiated products and are subject to monopolistic competition with the other funds, taking the investors' demand function as given when maximizing revenues. A model equilibrium is a combination of fees $\phi_0, \phi_1, \ldots, \phi_J$ for the asset managers such that, for optimal investor choices resulting from (1), fee revenues are maximized for all asset managers according to (2).

[8] Some market index funds charge fees which are exactly zero, and many major index funds charge fees which are very close to zero. For example, the Fidelity ZERO Total Market Index Fund seeks to replicate returns of the entire U.S. equity market, while charging a zero fee. The Vanguard Total Stock Market Index Fund charges a fee of 4 basis points, and is also available as an ETF for 3 basis points. Incorporating a small non-zero fee for the market index fund does not affect the economic implications of our model.

2.2 Model Solution

We solve the model and describe the relation between the embedded leverage of a fund (captured by its market beta) and fees in equilibrium. Our main result is that for beta greater than one, fees increase in beta. To derive the equilibrium, we characterize the investors' choice dependent on their risk aversion. We show that investors form clienteles such that those with lower risk aversion choose funds with higher beta. These results are discussed in detail in Appendix A.1, Propositions A1–A3. As a consequence of this "sorting", asset managers have local market power over their respective clienteles, and high-beta funds can charge their risk-seeking investors higher fees for the provision of leverage. The following proposition summarizes this main result and its implications for the simple case of four asset managers with betas $0 < \beta_0 < \beta_1 = \beta_M = 1 < \beta_2 < \beta_3$:[9]

Proposition 1. *[Paying for Beta] Suppose* $0 < \beta_0 < \beta_1 = \beta_M = 1 < \beta_2 < \beta_3$. *In this case:*

(i) $\phi_2 - \phi_M > 0$ *and* $\phi_3 - \phi_2 > 0$. *Managers with higher beta earn higher fees, if beta is greater than one.*

(ii) $\frac{\partial(\phi_2 - \phi_M)}{\partial \psi} > 0$, $\frac{\partial(\phi_3 - \phi_2)}{\partial \psi} > 0$, $\frac{\partial(\phi_2 - \phi_M)}{\partial \bar{l}} < 0$, $\frac{\partial(\phi_3 - \phi_2)}{\partial \bar{l}} < 0$. *The increase of fees in beta for beta greater than one becomes steeper when investors face tighter borrowing constraints, i.e., when the fraction* ψ *of strictly constrained investors increases, or when* $\bar{l}$*, the borrowing bound of less constrained investors, decreases.*

(iii) if manager net performance relative to the CAPM is defined as $\alpha_j = \mu_j - \beta_j \mu_M - \phi_j$*, then* $\alpha_2 < \alpha_M$ *and* $\alpha_3 < \alpha_2$. *Managers' net performance is strictly decreasing in beta for managers with betas greater than one.*

We illustrate this result in Figure 1, which depicts the relation between betas and fees for multiple scenarios. The model is calibrated as specified in Appendix Table A1. The blue line (solid, round markers) refers to the baseline case when the CAPM holds in the asset market. Investors with low enough risk aversion choose the asset manager with $\beta_3 = 1.7$. Since these investors have higher willingness to pay for embedded leverage, they pay the highest fee in equilibrium. The next group of investors chooses the asset manager with $\beta_2 = 1.3$ and pays a lower fee. More risk-averse investors invest in the market index fund with $\beta_M = 1$. The most risk-averse investors are indifferent between the asset manager with

[9] To solve for the model equilibrium explicitly, we assume that γ_i is equally distributed on $[\underline{\Gamma}, \overline{\Gamma}]$, where $\underline{\Gamma}$ specifies the risk aversion of the least risk-averse investors and $\overline{\Gamma}$ is the risk aversion of the most risk-averse investors. The model can be solved analytically for linear cases as characterized by Proposition A2, for which we explicitly prove Proposition 1 in Appendix A.4, based on the detailed derivations in Appendix A.2. For the nonlinear case, we can efficiently compute the equilibrium numerically.

$\beta_0 = 0.3$ or investing in the market index fund plus cash, such that fees for beta smaller than one are bounded by the market index fund.

The yellow line (solid, diamond markers) refers to the setting with tighter leverage constraints. In this case, the willingness to pay for embedded leverage increases for all the investors, and the asset managers with betas above one can charge even higher fees for the same beta. As a result, the scenario of tighter borrowing constraints features an increased slope of the beta-fee relation. The green line (dashed, triangle markers) refers to the setting with a larger number of funds, for which we solve the model numerically. The relation between beta and fees remains the same.

Finally, the orange line (dotted, square markers) presents a scenario with a considerable BAB effect in the asset market. In this case, fees of low-beta funds may decline in beta since fund gross alpha declines in beta. The potential decline for beta smaller than one is very modest for sensible calibrations. Intuitively, the decline becomes more pronounced when the BAB effect is stronger ($\xi \gg 0$), but in such a scenario the fund investors' demand for low-beta funds will likely also be lower, counteracting the effect. At the same time, the relation between beta and fees remains positive for funds with beta greater than one, while flattening slightly.

Our results have a direct implication for the fund net performance as measured by the CAPM net-of-fee alpha. In the presence of a BAB effect in the asset market, fund gross alphas decline in beta. But since fund fees are increasing in fund beta when beta is larger than one, net alpha declines in beta further, beyond what is implied by the BAB effect on gross alpha. Intuitively, investors pay for the provision of leverage, and the value of this service is not captured by the manager's alpha. As a result, high-beta funds appear as especially underperforming net-of-fees.

In Appendix A.3 we show that our results remain robust in a more general framework with endogenous choice of fund beta. In particular, we extend our framework to allow for the entry of new asset managers to the market, who optimally choose both beta and fees. In this setting, we find that a new entrant optimally chooses her beta far away from the betas of incumbent funds to avoid competition.[10] As a result, the local market power of funds over their investor clientele remains, and the relation between beta and fees predicted by our baseline model is confirmed.

[10]The economic intuition is very similar to the classical Hotelling model. If asset managers choose both fees ("prices") and betas ("location"), they differentiate themselves as much as possible to lower the competition intensity. A scenario where new entrants choose betas infinitesimally close to their competitors would only occur in the unrealistic case where asset managers compete solely on "location" (betas), while fees are fixed.

2.3 Testable Hypotheses

In our empirical work, we examine three specific hypotheses that are implied by Proposition 1. We first formulate our hypothesis regarding the baseline asymmetric relation between beta and fees across funds.

Hypothesis 1. *After controlling for the known determinants of fees, fees increase with beta for funds with beta larger than one, and fees are non-increasing in beta for funds with beta smaller than one.*

Hypothesis 1 follows directly from Proposition 1(i). Since our theory focuses on the effects of embedded leverage on fees, it is complementary to the effects of other known determinants of fees such as fund gross performance, its size, age, and fund family pricing policies (Gil-Bazo and Ruiz-Verdú (2009), Cooper, Halling, and Yang (2020)). Consequently, in our empirical work we include a proper set of control variables to test whether the effect of beta is unique and is not being subsumed by other variables known to explain fees.

Since our model suggests that leverage constraints drive the relation between beta and fees, it is natural to explore how the relation varies with the tightness of leverage constraints. This motivates the second hypothesis.

Hypothesis 2. *The relation between beta and fees for funds with beta larger than one is stronger*

(i) for funds held by retail investors than for funds held by institutional investors,

(ii) during periods of tight borrowing constraints relative to less constrained periods.

Hypothesis 2 follows from Proposition 1(ii). The relation between beta and fees becomes stronger when either the fraction of strictly constrained investors increases, or when less constrained investors face a lower borrowing limit. In line with Frazzini and Pedersen (2014), we assume that retail investors face more severe leverage constraints relative to institutional investors, and we utilize this difference in the cross-section of investor types in the first part of Hypothesis 2. In terms of the theory, we can think about this hypothesis in two ways. First, retail investors as a group can have a higher fraction of individuals who are severely constrained. Second, the borrowing limit of less constrained retail investors can be lower than the borrowing limit of less constrained institutional investors.

The second part of Hypothesis 2 is also implied by Proposition 1(ii). The tightness of leverage constraints varies not only in the cross-section of investors but also over time (Frazzini and Pedersen (2014), He, Kelly, and Manela (2017), Boguth and Simutin (2018)). If either the fraction of constrained investors or the borrowing limit varies over time, then the strength of the relation between beta and fees is expected to vary as well. While our data reveal that fees do almost not vary *within* funds (see Section 3.3), we can still explore this implication *across* funds that are launched in different time periods. In particular, funds introduced to the market in times of tight leverage constraints should have a stronger relation between beta and fees relative to funds introduced in less constrained times. In our empirical work, we focus on specific time-varying measures of leverage constraints to test this hypothesis.

Since funds with higher betas charge higher fees, our model has a direct implication for fund net performance. This implication is derived in our third hypothesis.

Hypothesis 3. *When betas are larger than one, fund net CAPM alpha declines in beta faster than gross CAPM alpha.*

Hypothesis 3 follows from Proposition 1(iii). As fees increase in fund beta for betas greater than one, our theory suggests that fund net alphas should decline with beta due to the effect of fees. Importantly, we do not argue that fees are the only driving factor of the relation between beta and net alpha. For example, a relatively flat security market line in the asset market (see Black, Jensen, and Scholes (1972), Frazzini and Pedersen (2014)) implies that stocks with high beta have low alpha. As a result, funds with higher beta can have a lower gross alpha which results in a lower net alpha. However, our model suggests that fees can further reduce net alphas of high-beta funds beyond what is already implied by their portfolio holdings. As a result, when beta increases, fees progressively increase the gap between net and gross performance. Consequently, if we sort funds into portfolios with respect to their betas, we expect net alphas to decline in beta faster than gross alphas.

3 Data and Methodology

3.1 Data and Variables

3.1.1 Main Dataset: U.S. Equity Mutual Funds

Our main dataset is a sample of the U.S. equity mutual funds. We obtain our data from the CRSP U.S. Mutual Fund Database for the period from January 1991 to December 2016. Our sample starts in 1991 because monthly reporting of fees, total net assets, and investment objectives becomes consistent and precise after 1990 (see also Gil-Bazo and Ruiz-Verdú (2009)). We start with the initial sample of all open-end mutual funds and keep only domestic equity funds using the information on fund investment objectives. We identify passive funds and exchange-traded funds (ETF) based on the CRSP definitions.

To obtain a proper estimate of fund ownership costs to investors, we combine the information on fund annual expense ratios and loads. We follow Sirri and Tufano (1998) and Gil-Bazo and Ruiz-Verdú (2009) assuming an average fund share holding period of seven years. As a result, we define the mutual fund total annual fee as the sum of the fund's annual expense ratio and one-seventh of the sum of the front load and the back load. In Section 4.1.5 we show that our results are not sensitive to alternative definitions of fees.

We use two datasets in our main tests: the fund share class dataset and the fund-level dataset. We obtain the fund share class dataset directly from the CRSP database. To construct the fund-level dataset, we calculate the averages of the CRSP variables across the share classes within a fund for each month, weighted by the share class total net assets in that month. We discuss the summary statistics of these datasets in detail in Section 3.3.

In some of our time-series tests, we also use a fund launch dataset. To obtain these data, we define the month of a share class's first appearance in the CRSP database as the month of its launch, and collect the fund share class data only for this month. The summary statistics for the fund launch dataset are reported in Appendix Table B1.

3.1.2 Supplementary Datasets: Fund Portfolio Characteristics and Investment Practices

For our comprehensive analysis of leverage-based asset management fees and to rule out alternative explanations, we compile two supplementary datasets. The first dataset includes proxies for fund management costs based on the funds' portfolio characteristics. These data allow us to analyze whether fees of high-beta funds are partly driven by higher stock trading or equity valuation costs (see Section 4.1.7). We collect data on funds' portfolio holdings from Thomson Reuters and calculate stock characteristics using information from the CRSP and Compustat databases. As a proxy for stock trading costs, we compute proportional effective spreads (PES) (Lesmond, Schill, and Zhou (2004), Hasbrouck (2009), and Novy-Marx and Velikov (2016)) for the funds' portfolios. As proxies for equity valuation costs, we compile portfolio characteristics from Sheng, Simutin, and Zhang (2020) such as asset tangibility, asset growth, operating profitability, analyst coverage, and idiosyncratic volatility. Details on this dataset are provided in Appendix B.1.

The second supplementary dataset is based on funds' N-SAR filings and provides detailed information on fund investment practices. These data allow us to examine how funds obtain leverage in Section 5. To compile this dataset, we collect information from N-SAR forms, which funds are required to file semiannually with the SEC. We collect these filings from the EDGAR database using an automated scraping algorithm and match them by the fund name to our main fund-level sample. Of particular interest for our analysis is the information provided in Item 70 of the N-SAR forms and its subitems. These items entail detailed information on whether a fund has engaged in various investment practices during the reporting period, such as borrowing money, short-selling, and futures and options trading. Details on the dataset on investment practices are provided in Appendix B.2.

3.2 Estimation of Market Beta and Fund Performance

We estimate the market model with a rolling window to evaluate a fund's market beta and its performance relative to the market portfolio in each month. Specifically, we estimate the following time-series regression for each fund:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{Mt} - R_{ft}) + e_{it}. \tag{3}$$

In this regression, R_{it} is the return on fund i for month t, R_{ft} is the 1-month U.S. Treasury bill rate, R_{Mt} is the market return obtained from Kenneth French's website, and α_i is the average return unexplained by the market model that we annualize and further refer to as an estimate of fund CAPM alpha. We use two variants of this model following Fama and French (2010). The first variant uses fund net returns to estimate fund net alpha, and the second variant uses fund gross returns to estimate fund gross alpha. We define the monthly fund gross return as a sum of the monthly fund net return and one-twelfth of the annual fund fee. We refer to the estimate of β_i as the fund market beta. We present our results based on the estimates of fund betas derived from fund gross returns, but they remain virtually unchanged if we use betas derived from fund net returns.

To estimate the models of fund performance, we follow Gil-Bazo and Ruiz-Verdú (2009) and require the fund to have at least 48 months of performance data available in the last 5 years, and we use 5-year rolling regressions to obtain estimates for each month. As a result, our estimates of fund performance and fund market beta become available after January 1995. For the fund launch sample, we estimate the models for the first 48 months of fund operation. We drop funds with extremely high fees in the sample (those above 99.9% of the sample distribution) and focus on betas in the middle 95% (i.e., 2.5%–97.5%) of the sample distribution.[11]

We present the distribution of the number of funds across market betas in Figure 2. The distribution is almost symmetric with many fund offerings concentrated around betas in the range of 0.9–1.1. As beta moves away from one, the number of fund offerings declines. Most of the U.S. equity mutual funds have market betas in the range of 0.2–1.7.

3.3 Summary Statistics

We present the summary statistics for our main variables in Table 1. The information at the fund share class level is shown in Panel A. The average annual fee over the sample period is 1.57%, and its standard deviation is 0.75%. The standard deviation of fees within a given fund over time equals only 0.03%, indicating that almost all the variation in fees is driven by the differences across funds rather than the time variation within funds. The distribution of fees is relatively symmetric across funds as the median fee equals 1.52%. The funds at the top 5% of the fee distribution charge a 2.76% fee while the funds at the bottom 5% of the distribution charge only 0.37%.

The average fund market beta equals 1, with a standard deviation of 0.21, and a within-fund standard deviation of 0.04. Similar to fund fees, there is significantly more variation in market beta across funds than within funds. The average gross CAPM alpha equals 1.33% (t-stat = 10.7, with standard errors clustered by month), while the average net alpha equals -0.26% (t-stat = -2.31), suggesting that the returns to investors turn negative on average due to the effect of fees. Passive funds represent 7% of the share-class-months in our sample and ETFs represent 2%.[12]

We report the summary statistics at the fund level in Panel B. The average fee equals 1.38%, and it is lower relative to the fee from the fund share class data since the high-fee share classes tend to have less assets under management. The distributions of beta and alpha are very similar to those from the share-class-level data. The average gross alpha equals 1.45% (t-stat = 10.7), while the average net alpha equals only 0.04%, statistically indistinguishable from zero (t-stat = 0.37). This is again in line with larger funds charging

[11] Our results are robust under different data cleaning criteria that drop more (e.g., those above 99%) or fewer (e.g., those above 99.99%) extremely high fees, or that focus on a narrower (e.g., the middle 90%) or wider (e.g., the middle 98%) range of betas.

[12] The definitions of a passive fund and an ETF do not necessarily overlap. A fund can be defined both as a passive fund and an ETF as in the example of any index-linked ETF. Index mutual funds meet the definition of passive funds but not of ETFs. In addition, some ETFs do not follow any index and are therefore considered to be actively managed.

lower fees. The distributions of fees, betas, and alphas are roughly the same in the sample of fund launches (see Appendix Table B1).

We next examine the role of between-fund and within-fund variation in fees. The preliminary comparison of the standard deviation across funds to the standard deviation within funds has already revealed that fees and beta vary substantially more across funds than within funds. A more formal analysis of the relative importance of cross-sectional and time-series variations can guide us to properly design our empirical tests.

We report the R-squared from the regressions of variables on fund share class fixed effects and fund fixed effects in the last columns of Panels A and B, respectively. The time-invariant characteristics drive 96% of the variation in fees in the share class sample and 90% of the variation in fees in the fund-level sample. Furthermore, the time-invariant characteristics are responsible for 70% of the variation in betas in the share class sample and 66% of the variation in betas in the fund-level sample. These statistics suggest that almost all the variation in fees and most of the variation in betas is driven by differences across funds rather than within funds. Consequently, we design our tests of the beta-fee relation based on the variation in fees and beta across managers, rather than on the variation within managers.

4 Hypothesis Testing

4.1 Asymmetric Relation between Market Beta and Fund Fees

We examine the three testable hypotheses derived from our model. We start by testing Hypothesis 1 and examine the baseline relation between fees and embedded leverage as measured by fund market beta. Our first econometric specification is a panel regression of the form:

$$Fee_{ift} = \gamma_f + \gamma_t + \lambda Beta_{ift} + \rho X_{ift} + e_{ift}. \tag{4}$$

In this regression, Fee_{ift} is the fee for fund i in fund family f in month t, $Beta_{ift}$ is the fund market beta, γ_f is a fund family fixed effect, γ_t is a month fixed effect and X_{ift} is a set of fund-level time-varying control variables such as a fund's CAPM alpha, the logarithm of fund age in months, the logarithm of fund total net assets, an indicator variable that equals one if a fund is passively managed, and an indicator variable that equals one if a fund is an ETF. Standard errors are double-clustered by fund family and month. We use fund-months as a unit of observation in the fund-level tests and fund-share-class-months as a unit of observation in the fund share class tests. We include fund family fixed effects in our specifications to control for unobserved family-specific determinants of fees such as family pricing policies. As suggested by our framework, we estimate equation (4) separately for funds with betas larger than one and smaller than one.

Our second approach combines both the high-beta and low-beta subsamples in a single specification. In particular, we estimate a panel regression of the form:

$$Fee_{ift} = \gamma_f + \gamma_t + \delta(Beta_{ift} \times (0,1)[Beta_{ift} > 1]) \\ + \theta(0,1)[Beta_{ift} > 1] + \lambda Beta_{ift} + \rho X_{ift} + e_{ift}. \quad (5)$$

In this specification, $(0,1)[Beta_{ift} > 1]$ is an indicator variable which equals one if the fund's market beta is greater than one. Therefore, δ becomes the coefficient of interest which is interpreted as the marginal effect of beta on fees for funds with beta larger than one.

4.1.1 Main Tests

We first examine the relation between beta and fees non-parametrically. We present the binscatter plot of residual fees against market betas separately for funds with betas larger than one and smaller than one in Figure 3. The residual fee is estimated in two steps. First, we regress the fee on all the control variables and fixed effects as specified in (4), and then we calculate the residual fee as the original fee minus the predicted value from the estimation in the first step. The results in Figure 3 are consistent with the model's central predictions: (1) fees increase with market beta when beta is larger than one; and (2) fees are non-increasing in beta when beta is smaller than one.

We present the formal regression results in Table 2. The estimates from the share-class-level regressions in the first two columns confirm the graphical evidence from Figure 3. The result in column (1) shows that fees increase in beta when beta is larger than one. The coefficient on beta is statistically significant at the 1% level. The relation between betas and fees for betas above one is economically meaningful: when fund beta increases from 1 to 1.7, the top of our trimmed sample distribution, fund fees increase by 34 (0.48×0.7) basis points, which is about a 22% increase relative to the median fee. This relation also stands as economically significant relative to the effects of other determinants of fund fees: An increase of one standard deviation in beta is associated with an increase of 10 (0.48×0.21) basis points in fees, while a one-standard-deviation change in log fund size or log fund age changes fees by 21 (0.09×2.34) basis points and 9 (0.21×0.44) basis points, respectively. The estimate of the coefficient on beta for funds with betas below one is economically negligible and statistically indistinguishable from zero (column (2)).

Column (3) reports the results from our second approach. The coefficient on the interaction term between beta and the indicator for beta being greater than one equals 0.46, which is in line with the difference between the coefficients on beta from columns (1) and (2). The results across all specifications also show that older and smaller funds as well as funds with higher CAPM alphas and active funds have higher fees.[13]

We next present the results for the fund-level data in columns (4)–(6). Overall, the estimates are very similar to those obtained through the share-class-level sample. The result in column (4) shows that for betas larger than one, the coefficient on beta is again large and significant. The coefficient exhibits a similar economic magnitude relative to the coefficients from the share-class-level regressions: when fund beta increases from 1 to 1.7, fund fees increase by 25 (0.35×0.7) basis points, which is about 19% of the median level. The estimate of the coefficient on beta for betas smaller than one is again very small and statistically indistinguishable from zero (column (5)). The results from the interaction-based approach in column (6) are also similar to the results from the share class sample.

In sum, the combined evidence consistently supports Hypothesis 1. If borrowing-constrained investors pay fees for leverage, fees are expected to increase in beta only for funds with betas larger than one. Additionally, the asymmetry of the beta-fee relation, which is predicted by our model, sets a high hurdle for some potential alternative explanations. For example, if investors do not risk-adjust returns due to lack of sophistication or other reasons, they may perceive higher total returns of high-beta funds as "fund performance". As a result, these investors may generally be willing to pay higher fees for funds with higher beta. However, this explanation would imply an increasing relation between beta and fees for all levels of beta and is thus difficult to reconcile with fees being flat in beta for beta smaller than one.

4.1.2 Robustness to Fund Offerings across Betas

We discuss a number of robustness checks for our main results. We first examine the robustness of our findings to the variation in the number of fund offerings with beta, as documented in Figure 2. Our concern is that fees may increase with beta due to the decline in the number of alternative choices, and not due to the effects of leverage demand. To address this concern,

[13]Passive funds may exhibit non-zero alphas relative to the common benchmarks such as the CRSP value-weighted market portfolio (Cremers, Petajisto, and Zitzewitz (2012)). In our robustness checks below, we show that our results continue to hold if we focus only on active funds.

we construct two measures to capture the intensity of fund offerings within different ranges of betas. The first measure counts the overall number of funds for each 0.1-wide beta bin in a specific month (e.g., funds with betas between 0.8-0.9 are assigned to one bin, and funds with betas between 1.1-1.2 are assigned to another bin, etc.). The second measure computes the Herfindahl-Hirschman Index (HHI) for each beta bin in a specific month, where a fund's market share is defined as the fund's assets under management (AUM) divided by the AUM of all the funds in the same beta bin. We use the value of the respective intensity measure for all funds in the corresponding beta bin.

We estimate equation (4) including the intensity measures in our specifications and report the results in Panel A of Table 3. For brevity, we only present the estimated coefficients on beta and on the interaction between beta and the indicator for beta being larger than one, which directly correspond to the specifications from Table 2. The detailed results are reported in Appendix Tables B3 and B4. Our main results remain unchanged, and the estimates of the coefficients on beta are quantitatively and qualitatively similar to the estimates from Table 2. The results are robust for both the fund share class sample (columns (1)–(3)) and the fund-level sample (columns (4)–(6)).

4.1.3 Robustness to Differences in Investors across Distribution Channels

We next explore whether the effects of beta on fees vary across distribution channels. Since the funds sold to investors via brokers have higher fees and higher beta relative to direct-sold funds (Del Guercio and Reuter (2014)), our results could be confounded by the differences in clienteles across these channels. To mitigate this concern, we examine the relation between beta and fees separately for direct-sold and for broker-sold funds. We follow Sun (2021) and consider a fund share class to be direct-sold if it charges no front or back load, and has an annual distribution fee ("12b-1 fee") of no more than 25 basis points; otherwise, a fund share class is considered as broker-sold.

We report the estimated coefficients on beta in Panel B of Table 3. The effect of beta on fees is quantitatively similar and statistically significant across the channels, suggesting that our results are robust to the differences in clienteles between direct-sold and broker-sold funds.

4.1.4 Robustness to Demand for Style Investing

We next examine the effects of fund styles on our main results. Since investors seek for exposure to different types of stocks, fund fees may vary across styles (Gil-Bazo and Ruiz-

Verdú (2009)). If funds in investment categories (styles) with high-beta stocks have higher fees, the relation between beta and fees may reflect the demand for style investing rather than the demand for leverage. To account for this, we add fund style fixed effects to our main specifications. We define fund styles using the Lipper classification of the U.S. equity funds, which constitutes the basis for the CRSP fund style classifications.

The estimated coefficients on beta in Panel C of Table 3 show that the effect of beta on fees holds within styles. While accounting for style investing leads to more moderate estimated effects, the coefficients remain statistically significant and large for the funds with betas greater than one relative to the funds with betas less than one. It is also possible that the demand for a certain style may actually be caused by an underlying demand for leverage. In light of this view, obtaining smaller effects after controlling for fund style is not surprising and consistent with our other results.

4.1.5 Robustness to Definition of Fees

We next study the robustness of our results to the definition of fund fees. In our main tests, we combine fund expense ratios as well as front and back loads to approximate the total costs of holding a fund. However, the information on loads is more poorly populated in the CRSP data, especially in the early years of the sample. To address this issue, we estimate equations (4) and (5) when fees include only expense ratios. The results, presented in Panel D of Table 3, are almost identical to the baseline estimates, suggesting that the asymmetric relation between beta and fees is not driven by loads or by incomplete data.

4.1.6 Robustness to Passive Funds

We argue that embedded leverage is an important fee determinant for equity mutual funds in general, including the large set of actively managed funds. Alternatively, our results could be driven exclusively by the set of passive funds in our sample, including funds which charge fees for pure provision of leverage (Frazzini and Pedersen (2020), Lu and Qin (2020)).[14] To address this concern, we examine the relation between beta and fees only within the sample of actively managed funds. The results in Panel E of Table 3 show that the coefficients remain virtually unchanged, suggesting that the relation is not driven specifically by passive funds.

[14]In their analysis of leveraged ETFs, Lu and Qin (2020) find 269 domestic equity funds with betas greater than one relative to their benchmark indices (see Table 1, Panel A in their paper).

4.1.7 Robustness to Trading and Valuation Costs

Finally, we check whether our results are driven by fund trading or equity valuation costs. If high-beta stocks are more expensive to trade or to evaluate, then high fees of high-beta funds can be driven by higher management costs and not by beta itself. To analyze whether our results are confounded by variation in management costs, we make use of our portfolio characteristics dataset introduced in Section 3.1.2 (see also Appendix B.1). In particular, we use the proportional effective spread (PES) as a proxy for a stock's trading costs (Lesmond, Schill, and Zhou (2004), Hasbrouck (2009), and Novy-Marx and Velikov (2016)). We also use multiple portfolio characteristics from Sheng, Simutin, and Zhang (2020) as proxies for costs of equity valuation, adding these variables to our baseline specification in the sample of funds with beta larger than one.

We report the results in Appendix Table B9. Briefly, the relation between beta and fees is highly robust to the inclusion of a variety of proxies for trading and valuation costs. In line with Sheng, Simutin, and Zhang (2020), funds that invest in hard-to-evaluate firms charge higher fees.[15] However, fund beta itself has a distinct effect on fees which is robust to the inclusion of all the cost proxies together. Therefore, we conclude that our results are unlikely to be driven by trading or valuation costs.

4.2 Heterogeneity in Borrowing Constraints

4.2.1 Comparison of Retail and Institutional Investors

We proceed to examine Hypothesis 2 and explore variation in the tightness of borrowing constraints across investor types. We expect the relation between beta and fees for betas larger than one to be stronger among retail investors relative to institutional investors, since retail investors are more likely to face borrowing constraints (Frazzini and Pedersen (2014)). We test this prediction by introducing an indicator variable that equals one if a share class is offered to retail investors.[16] We add this variable to our baseline specification from equation (4), interacting it with market beta to evaluate the relation between beta and fees for different investor clienteles.

We present the results in Table 4. In the share class sample, the coefficient on market beta equals 0.30, being interpreted as the baseline effect of beta on fees among institutional

[15] As highlighted by Sheng, Simutin, and Zhang (2020), these firms may be younger, have less tangible assets, lower analyst coverage, and faster asset growth.

[16] Almost all share classes are offered either only to retail investors or only to institutional investors, and we remove the very few exceptions from our sample that are indicated to be offered to both investor types.

share classes (column (1)). The coefficient on the interaction between market beta and the indicator for retail share classes equals 0.13, indicating that the effect of beta on fees is 43% (0.13/0.30) larger for retail share classes. The estimated coefficients remain virtually unchanged when we control for fund performance (column (2)).

We next examine the robustness of our results in the sample of funds at launch, when the share class was first offered to the investors. Overall, we obtain similar findings, reported in columns (3) and (4). The coefficient on the interaction between market beta and the indicator for retail share classes equals 0.21, while the coefficient on market beta itself equals 0.22. This result implies that when a share class is offered to retail investors, the fund family charges them almost 100% more (0.21/0.22) for the same increase in beta relative to institutional investors.[17] Across all specifications, the baseline coefficients on market beta are statistically significant at the 1% level, and the additional effect for retail share classes is significant at or around the 5% level.

In sum, the comparison of retail and institutional share classes supports Hypothesis 2. More borrowing-constrained retail investors pay more for beta relative to less borrowing-constrained institutional investors.

4.2.2 Time Variation in Tightness of Borrowing Constraints

We next explore the effects of time variation in borrowing constraints. Hypothesis 2 suggests that the relation between beta and fees for betas larger than one is more pronounced in times when it is more difficult to borrow capital. We use three measures of borrowing constraint tightness: the betting-against-beta (BAB) factor from Frazzini and Pedersen (2014), the intermediary capital ratio (ICR) from He, Kelly, and Manela (2017), as well as the leverage constraint tightness (LCT) measure from Boguth and Simutin (2018). We use monthly variation in each measure and define periods when a measure takes on extreme values as constrained periods, separately for each measure. Low values of the BAB and the ICR measures as well as high values of the LCT measure indicate tighter borrowing constraints. Consequently, we define periods with the BAB or ICR measure in the first quartile of its time distribution or periods with the LCT measure in the fourth quartile as constrained periods. Accordingly, a time period is defined as unconstrained if the measure's value belongs to the opposite extreme quartile of its time distribution: the fourth quartile for the BAB and ICR measures, and the first quartile for the LCT measure. We introduce a new indicator

[17] Note that the fund market beta is computed over the first 48 months after the fund's introduction to investors, as described in Section 3.2 (see also Gil-Bazo and Ruiz-Verdú (2009), Fama and French (2010)). As the time variation in beta within funds is limited (see Table 1), we can assume that this conventional procedure provides a good estimate for the fund beta at the time of fund launch.

variable that equals one if a period is defined as constrained. We add this variable to our main specifications and interact it with market beta to evaluate the effects of time variation in borrowing constraints on the relation between beta and fees.

The ideal test would examine the effects of time-series variation in borrowing constraints on time-series variation in fees within a given fund. However, Table 1 clearly shows that there is almost no time variation in fees within funds after they are introduced to the market. Taking this empirical fact as given, we cannot test our hypothesis based on within-fund variation. To circumvent this problem, we examine the effects using cross-sectional variation within the sample of funds at launch, combined with time-series variation in borrowing constraint tightness. In particular, we test whether funds introduced in constrained periods charge higher fees per unit of beta relative to funds introduced in unconstrained periods. These tests are also in line with our model framework that focuses on the cross-sectional differences between asset managers.

We present the results in Table 5, starting with the BAB factor as a measure of borrowing constraint tightness (columns (1) and (2)). The coefficient on the interaction between market beta and the indicator for constrained periods equals 0.42, statistically significant at the 5% level. At the same time, the coefficient on market beta, interpreted as the effect in unconstrained periods, equals 0.12, statistically indistinguishable from zero. These results suggest that funds introduced in constrained periods, as measured by the BAB factor, additionally charge roughly three times more (0.42/0.12) per unit of beta relative to funds introduced in unconstrained periods.

The results for the ICR measure are reported in columns (3) and (4), and are similar to the results based on the BAB factor. The coefficient on the interaction between market beta and the indicator for constrained periods equals 0.36, while the coefficient on market beta equals 0.24. After controlling for fund performance, the difference between the coefficients further increases (column (4)). According to the ICR-based results, funds introduced in constrained periods additionally charge two times more (0.44/0.22) per each unit of beta.

Finally, we repeat the analysis using the LCT measure and present the results in columns (5) and (6). The coefficient on the interaction between market beta and the indicator for constrained periods is approximately equal to the coefficient on market beta, suggesting an almost doubled effect in constrained periods. However, both coefficients are not significant in this case, potentially reflecting that LCT is a measure of fund managers' leverage constraints and less indicative of fund investors' constraints.

In sum, the evidence on the time variation in borrowing constraints additionally supports Hypothesis 2. In more constrained periods, investors pay more for the same beta relative to less constrained periods.

4.2.3 Evidence on Time Variation in Demand

Our main argument is that the relation between beta and fees is driven by increased demand for high-beta funds. To evaluate the importance of this demand channel, we examine the effects of time variation in borrowing constraints on fund flows. In particular, we test whether high-beta funds experience higher net flows immediately after borrowing constraints tighten. As fund flows vary significantly over time for a given fund as opposed to fees, which show almost no time variation, we can take full advantage of within-fund variation in flows for these tests. We set up a panel regression at the fund share class level of the form:

$$Netflow_{i,t+1} = \gamma_i + \gamma_t + \lambda\,(Beta_{it} \times Constrained_t) + \theta Beta_{it} + \rho X_{it} + e_{i,t+1}, \qquad (6)$$

where $Netflow_{i,t+1}$, defined as $\frac{TNA_{i,t+1} - TNA_{i,t}(1+R_{i,t+1})}{TNA_{i,t}}$, is the net fund flow for fund i in month $t+1$, γ_i and γ_t are fund and month fixed effects, and X_{it} is the set of fund-level time-varying control variables from the main specification. Standard errors are double-clustered by fund family and month. This specification is similar to the one from the previous section, where we evaluate the effects of borrowing constraints on fees across funds.

We report our findings in Table 6. The results consistently support the leverage demand channel, strengthening the evidence on fees from Table 5. Higher-beta funds exhibit higher net flows in constrained periods, as measured by the BAB factor and the ICR measure (columns (1)–(4)). When fund beta increases from 1 to 1.7 in constrained time periods, the fund experiences an additional increase in net flows of 0.6–1.1 percentage points according to the estimates in columns (2) and (4). This effect equals 19%–34% of the standard deviation of net flows, indicating that the economic magnitude is non-negligible. Consistent with the results on fees, when we measure the tightness of borrowing constraints using the LCT factor, the coefficient for constrained times is positive but not statistically significant (column (6)).

In sum, our findings in Tables 5 and 6 suggest that investors' demand for leverage drives both prices and quantities in the asset management market. Specifically, the leverage demand effect leads to cross-fund dispersion in prices (fund fees) of new funds and time-series fluctuation of quantities (fund AUM) among all the funds. In a series of additional tests, we examine a number of complementary channels for market adjustment to time-variation in borrowing constraints. These channels include an increase in fund market beta among existing funds as well as an increased entry of high-beta funds in constrained time periods. Overall, we find no evidence for these additional mechanisms of market adjustment (see Appendix Tables B10 and B11).[18]

4.2.4 Differences in Fund Survival

Our final concern with respect to the variation in fees across funds is that investors may not pay these fees in the long run. In particular, there is a possibility that high-beta funds are more likely to shut down quickly after the initial launch. In this case, the variation in fees induced by the demand for leverage would not translate to variation in long-term payments by the investors.

We examine this possibility by estimating the Cox proportional hazards model for the effect of fund beta on fund hazard rates, with lower hazard rates implying a longer survival time. The hazard function is based on equation (4) and is given by:

$$h(t) = h_0(t) \times exp\left[\gamma_f + \gamma_t + \lambda Beta_{ift} + \rho X_{ift}\right]. \tag{7}$$

Similar to our baseline specification, we estimate equation (7) separately for funds with beta smaller and larger than one.

Table 7 reports the results. Overall, we find no evidence that high-beta funds are more likely to shut down quickly. Columns (1)–(2) show that for funds with beta larger than one the coefficients on beta are statistically insignificant, suggesting that the fund hazard rate does not depend on fund beta. For funds with beta smaller than one, the fund hazard rate tends to decline in beta after controlling for fund performance (column (4)). In columns (5) and (6), we present the results from a modified hazard function which corresponds to our approach in equation (5). The coefficient on the interaction between beta and the indicator for beta being greater than one is insignificant, suggesting again that the effect of beta on fund survival is similar for high-beta and low-beta funds.

[18]Our results show, first, that the average change in funds' market betas does not covary with leverage constraints in an economically meaningful way. For example, we find that funds with beta greater than one reduce their by beta by 0.0007 on average in constrained times as measured by the BAB factor, which is neither economically nor statistically significant. Second, our results reveal that there are *less* entries and *more* exits of high-beta funds in constrained times compared to unconstrained times. Therefore, the investors' higher willingness to pay for leverage does not cause more high-beta funds to enter the market, potentially due to the more challenging conditions asset managers themselves are facing.

4.3 Implications for Fund Net Performance

We finally test Hypothesis 3 and examine the effects of leverage constraints on fund net performance. Our model suggests that the presence of leverage constraints is associated with reduced net alphas since investors pay fees not only for performance but also for embedded leverage. Consequently, we expect fund net alpha to decline in beta faster than gross alpha in the cross-section of funds for beta larger than one.

We conduct a portfolio analysis to test this prediction. We sort funds with betas larger than one into five equally-weighted portfolios according to the funds' beta and calculate mean gross and net alphas as well as mean gross and net returns for these portfolios.[19] The results for the share-class-level dataset are presented in Panel A of Table 8. Consistent with our regression results, fees are steadily increasing with beta across fund portfolios (column (2)). The difference in fees between the high-beta portfolio and the low-beta portfolio is equal to 0.23%.

We report the average gross CAPM alphas in column (3). Gross alpha is declining with beta in line with a relatively flat security market line in the asset market (see Black, Jensen, and Scholes (1972), Frazzini and Pedersen (2014)). The difference in gross alphas between high-beta funds and low-beta funds equals -0.37%, but it is not statistically significant at the 10% level. At the same time, net alpha declines with beta one-and-a-half to two times as fast as gross alpha (column (4)). The difference in net alphas between the high-beta portfolio and the low-beta portfolio equals -0.60%, statistically significant at the 5% level. The results are very similar for the fund-level analysis presented in Panel B.

These findings suggest that two mechanisms can jointly explain why net performance declines with beta: (1) the leverage demand effect of fund investors presented in this paper, which drives the increase in fees; and (2) the asset market mechanism which drives the decline in gross alpha (e.g., Frazzini and Pedersen (2014)). Both mechanisms are in line with Hypothesis 3, and they generate comparable effects on the observed decline in net alpha.

Finally, the results in columns (5) and (6) show that high-beta funds have higher average excess returns. High-beta funds are therefore indeed attractive to leverage-constrained risk-seeking investors, even though the risk-return relation inherited from the asset market is flatter than predicted by the CAPM. This is again in line with the BAB case in our calibrated

[19]Naturally, we focus on active mutual funds for the analysis of fund performance, excluding passive mutual funds and ETFs from this analysis.

model: a flatter security market line slightly weakens the relation between beta and fees for funds with betas greater than one, but this effect is not large enough to eliminate the relation.

5 Implied Costs and Provision of Leverage

Our results establish that mutual fund investors pay considerable fees for the provision of embedded leverage. In this section, we conclude the analysis by investigating how high-beta funds obtain leverage, and by providing estimates of the combined costs of leverage for fund investors. This analysis allows us to evaluate the efficiency of leverage provision through asset managers and to put the "all-in cost"—consisting of extra fees and reduced gross alphas—into perspective.

5.1 How Do Funds Obtain Leverage?

We first examine how high-beta funds obtain leverage. Asset managers can lever up their portfolios in two broad ways: (1) investing in high-beta stocks; and (2) engaging in alternative investment practices such as borrowing capital directly, trading derivatives, or using short-selling. We use data from the N-SAR sample introduced in Section 3.1.2 (see also Appendix B.2) to examine which practices are employed by mutual funds to obtain leverage.

We present the summary statistics for fund investment practices in Table 9. Only 30% of the sample funds employ any alternative investment practice, consistent with the estimates for usage of derivatives from Kaniel and Wang (2021). The most common practices are trading in stock index futures (17%), borrowing money (8%), and trading options on equities (7%). The fraction of funds engaged in each of the other practices is below 3%. Furthermore, the funds with beta greater than one do not engage in alternative investment practices more frequently than the rest of the funds. The fraction of high-beta funds engaged in any of these practices equals 29%, which is approximately the same as in the entire sample. A similar pattern holds for each investment practice separately: the difference in the fraction of funds engaged in a practice between the entire sample and the sample of high-beta funds is 2% for trading stock index futures and 1% or lower for all other practices. These results show that most high-beta funds are not especially reliant on borrowing, usage of derivatives, or short-selling, suggesting that they achieve high beta by holding high-beta stocks.

As an additional measure for the presence of alternative practices, we also examine the difference between the fund's beta and the weighted average beta of its stock holdings. A positive difference indicates that the fund uses instruments other than stocks to lever up its portfolio. The results in Table 9 show that only 25% of high-beta funds have betas larger than the betas of their stock portfolios. This finding is again in line with the prevalent reliance on high-beta stocks for obtaining high-beta portfolios.

Finally, we formally examine the relation of investment practices to fund beta within the sample of high-beta funds by regressing fund beta on our proxies for alternative investment practices. All the specifications include the same set of control variables and fixed effects as in our main specifications for fees. Standard errors are double-clustered by fund family and month. We report the results in Table 10. Overall, the effects are economically negligible. The funds which engage in borrowing, usage of derivatives, or short-selling, as reported in their N-SAR filings, have betas lower by 0.01, relative to the funds which do not engage in these practices (column (1)). A positive difference between the fund's beta and the beta of its stock portfolio is associated with a tiny increase of 0.03 in fund beta (column (2)). The usage of stock index futures, options on them, or short-selling is associated with marginally smaller betas (columns (5), (6), (8)). These results again indicate that a fund's engagement in alternative investment practices is largely unrelated to an increased fund beta.

In sum, our findings show that high-beta funds do not use derivatives and other alternative investment practices more frequently than other funds. Instead, general high-beta funds mostly invest in high-beta stocks, in sharp contrast to specialized leveraged ETFs, which make ample use of derivatives such as equity swaps (Lu and Qin (2020)).[20]

5.2 Do Fund Investors Overpay for Leverage?

We complete the picture by evaluating the total costs of leverage for high-beta fund investors. If these costs are comparable to the costs of alternative leverage strategies, then high-beta funds supply leverage at a competitive price, which makes them attractive for risk-seeking investors. These alternatives include investing in specialized leveraged ETFs or borrowing and investing in market index funds or ETFs. On the other hand, if the costs are excessive due to either very high fees or very low gross performance, investors would be better off by obtaining leverage through others means.

In terms of fees charged for leverage, our baseline regression estimate shows an increase of 46 basis points when beta increases by one (i.e., per one unit of leverage). The portfolio sorts in Panel A of Table 8 show an increase of 23 basis points in fees when beta increases by 0.36, from 1.03 (quintile (1)) to 1.39 (quintile (5)). This implies a fee of 64 basis points

[20]While our full sample of U.S. equity mutual funds contains 4,775 funds, the number of leveraged ETFs in the comprehensive sample compiled by Lu and Qin (2020) amounts to 269 funds.

for one unit of leverage (23/0.36). The combination of these estimates suggests an extra fee of 46–64 basis points per year.[21] In terms of performance loss, the difference in gross alpha between the bottom and the top beta quintiles amounts to 37 basis points, suggesting a loss of 103 basis points per year when beta is increased by one (37/0.36). Our results on investment practices in the previous section suggest that this loss mostly comes from investing in high-beta stocks. Combining the extra fees with the performance loss puts the total cost of leverage in the range of 149–167 basis points per year.

We compare this estimate to the alternative of investing in specialized leveraged ETFs. The performance loss for leveraged ETFs is smaller by half, being equal to only 53 basis points per year as established by Lu and Qin (2020).[22] Providing leverage through investing in high-beta stocks thus results in a larger performance drop relative to derivatives-based strategies as employed by leveraged ETFs. At the same time, leveraged ETFs charge much higher expense ratios per unit of leverage, ranging from 95 basis points (Frazzini and Pedersen (2020)) to 127 basis points (Lu and Qin (2020)). Compared to these benchmarks, the fee of 46–64 basis points per unit of leverage charged by high-beta funds is significantly smaller. The "all-in cost" of leverage for high-beta fund investors is therefore comparable to leveraged ETFs, which experience a lower performance drop but charge higher fees.

The total leverage cost of 149–167 basis points per year is also considerably lower than other conventional estimates of borrowing costs. For example, the average interbank interest rate (LIBOR) over our sample period equals 288 basis points per year, and the average AAA bond yield equals 567 basis points per year. These rates are, however, only available to large financial institutions or low-risk corporations. Retail investors have to pay much higher margin rates when obtaining leverage from their brokers. Even in the recent extremely low interest rate environment, the margin rates offered by major retail brokerages are in the range of 500–800 basis points per year.[23] Therefore, investing in high-beta funds for obtaining leverage appears to be attractive for many investors when compared to the alternative of levering up by borrowing money and investing in the market portfolio.

[21] In line with these baseline estimates, we mostly obtain regression-based cost estimates in the range of 30–65 basis points per year throughout the paper, depending on time period and investor type. In our additional robustness checks, we estimate the main specification every 5 years between 1995 and 2016, and find that the coefficients mostly remain in the same range (see Appendix Table B12).

[22] Lu and Qin (2020) calculate the performance loss as a difference in performance between leveraged ETFs and index ETFs.

[23] For example, the margin rate equals: 5% at Robinhood, 6.83% at Fidelity, 6.83% at Charles Schwab, 7% at Vanguard, and 7.75% at TD Ameritrade. These rates are collected in January 2021 from the websites of these companies, assuming a margin loan of $100,000. The rates are higher for smaller loans.

6 Conclusion

In this paper, we examine the role of investors' leverage demand in the determination of asset management fees. If investors face borrowing constraints and are limited in making leveraged investments on their own, they seek for managers to obtain the desired leveraged returns. As a consequence, asset managers can charge fees for the provision of leverage, and this channel produces an asymmetric relation between beta and fees which varies with the tightness of leverage constraints. The empirical evidence from the U.S. equity mutual funds provides strong support for our hypotheses: fees vary across funds, investors, and market conditions in a manner consistent with the leverage-based explanation.

Our results shed light on the well-known poor performance of asset managers who charge fees that are significantly higher than the managers' risk-adjusted returns. We propose that high-beta funds provide an additional service to their borrowing-constrained investors. The investors can lever up their portfolios through the asset manager and pay fees for the embedded leverage irrespective of the fund performance. Consequently, fund gross alpha may not fully capture the full range of services provided by asset managers. Many high-beta funds appear as "underperforming" net-of-fees while their investors can actually improve their welfare by gaining access to leverage. Our estimates of the total cost of leverage underline this notion, suggesting that high-beta fund investors obtain access to embedded leverage at a competitive price.

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Figure 1: The Theoretical Relationship between Beta and Fees

This figure presents the relation between fund betas and fees as predicted by our model. The blue line (solid, round markers) stands for a scenario with "few" funds (i.e., two $\beta > 1$-funds, the market ETF, and an arbitrary number of $\beta < 1$-funds) where the parameters are set according to the "less constrained" scenario in Appendix Table A1. The yellow line (solid, diamond markers) repeats the scenario with "few" funds but for the case when all the investors face strict borrowing constraints ($l = 1$). The green line (dashed, triangle markers) describes a setting with "many" funds according to Appendix Table A1 for which we numerically solve for the equilibrium. The orange line (dotted, square markers) results from the BAB case, while all other lines employ the CAPM case. Hollow circles indicate that in the CAPM case, the fee for any $\beta < 1$ fund is exactly zero. In all scenarios, fund fees result endogenously from the model equilibrium.

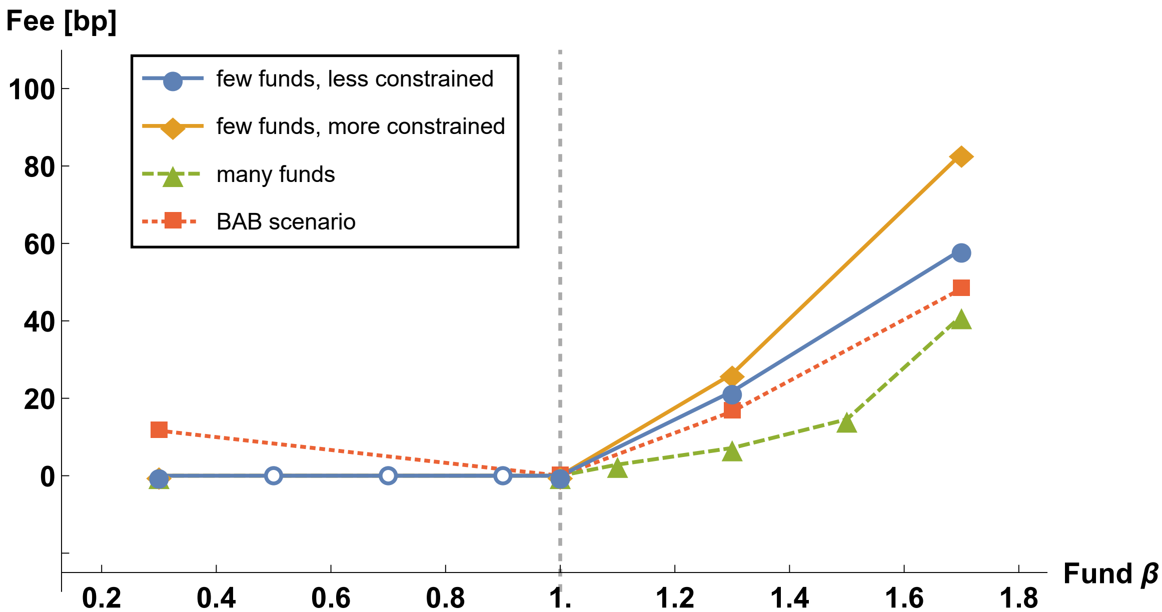


Figure 2: Distribution of Fund Beta

This figure presents the empirical distribution of funds across market betas. The bars show the fraction of funds for each level of beta. *Beta* is an estimate of the slope from the market model for fund returns.

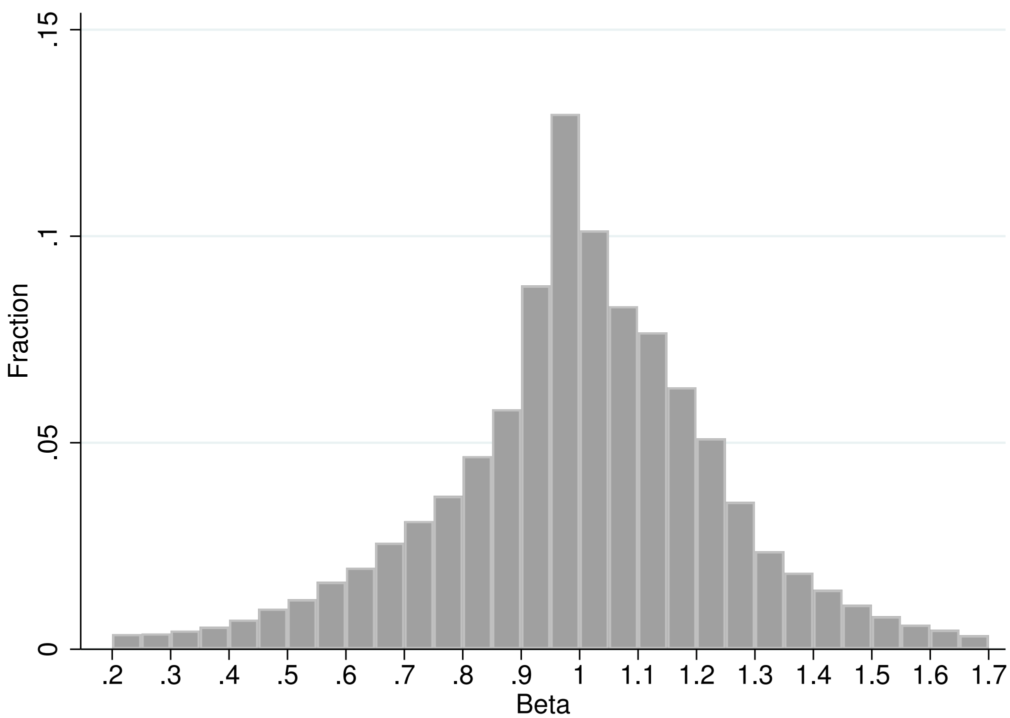


Figure 3: The Empirical Relationship between Beta and Fees

This figure presents the binscatter plot of residual fees against fund betas separately for funds with betas larger than one and smaller than one. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *Residual fee* is estimated in two steps: First, we regress the fee on all the control variables and fixed effects. Second, we calculate the residual fee as the original fee minus the predicted value based on the estimation in the first step. The shaded areas represent 95% confidence intervals.

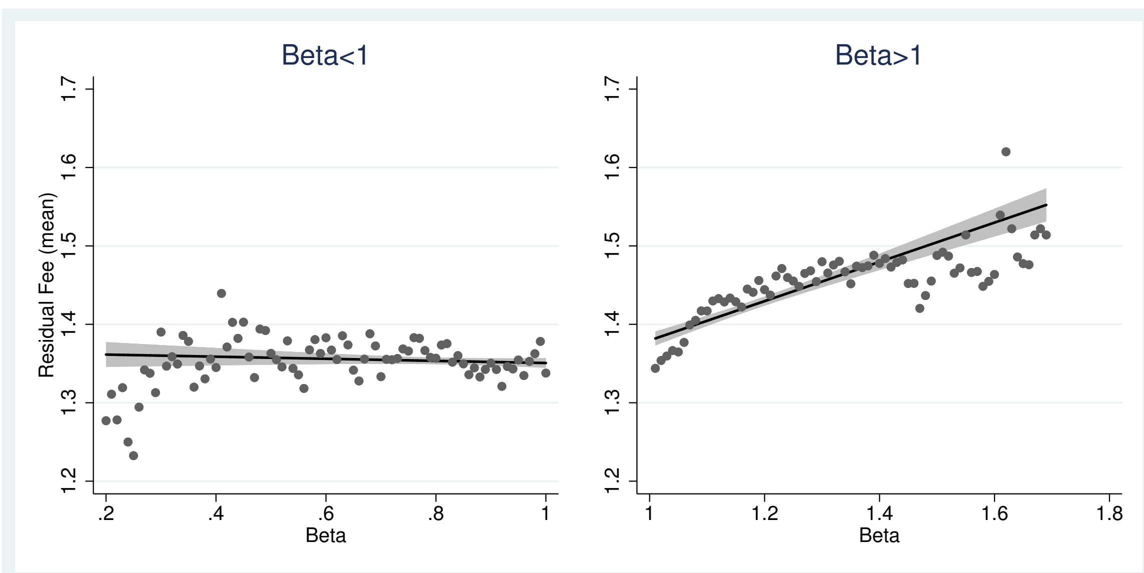


Table 1: Summary Statistics

This table presents summary statistics for the sample of fund-month observations over the period 1991–2016 at the fund share class level (Panel A) and at the fund level (Panel B). The fund characteristics are from the CSRP mutual fund database. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *Gross CAPM alpha* and *Net CAPM alpha* are annualized estimates of the intercept from the market models for fund gross returns and fund net returns, respectively. *Log(TNA)* is the natural logarithm of fund total net assets. *Log(Age)* is the natural logarithm of fund age in months. *(0,1) Passive fund* indicator equals one if a fund is passively managed. *(0,1) ETF* indicator equals one if a fund is an ETF. *(0,1) Retail fund* indicator equals one if a share class is offered to retail investors. *Net flow* is the monthly net fund flow. *Number of funds per beta bin* is the number of funds (in thousands) with the value of beta falling into each 0.1 bin (e.g., funds with betas between 0.8–0.9 are in a bin, funds with betas between 1.1–1.2 are in another bin, etc.) in a specific month. *HHI per beta bin* is the TNA-weighted Herfindahl-Hirschman Index (HHI) that is estimated for each 0.1 bin of beta in each month. The last columns of Panels A and B report the R^2 of the regressions of variables on fund share class fixed effects or fund fixed effects, respectively.

Panel A: Fund share classes	N	Mean	SD	Within SD	5%	25%	50%	75%	95%	R^2 - fund share class FE
Fee (%)	989,552	1.57	0.75	0.03	0.37	0.99	1.52	2.15	2.76	0.96
Beta	989,552	1.00	0.21	0.04	0.61	0.90	1.00	1.13	1.35	0.70
Gross CAPM alpha (%)	989,552	1.33	4.95	0.12	-4.88	-1.12	0.85	3.27	9.59	0.39
Net CAPM alpha (%)	989,552	-0.26	4.90	0.13	-6.63	-2.62	-0.63	1.63	7.81	0.39
Log(TNA)	989,552	4.15	2.34	0.36	0.09	2.65	4.27	5.80	7.76	0.88
Log(Age)	989,552	4.81	0.44		4.15	4.46	4.77	5.12	5.56	
(0,1) Passive fund	989,552	0.07	0.26		0.00	0.00	0.00	0.00	1.00	
(0,1) ETF	989,552	0.02	0.15		0.00	0.00	0.00	0.00	0.00	
(0,1) Retail fund	989,552	0.66	0.47		0.00	0.00	1.00	1.00	1.00	
Net flow (%)	975,601	-0.66	3.16		-6.71	-2.22	-0.76	0.68	6.78	
N of funds per beta bin	989,552	1.14	0.69		0.15	0.49	1.13	1.84	2.11	
HHI per beta bin	989,552	0.03	0.03		0.01	0.01	0.02	0.03	0.07	

Table 1: Summary Statistics (continued)

Panel B: Funds	N	Mean	SD	Within SD	5%	25%	50%	75%	95%	R^2 - fund FE
Fee (%)	439,539	1.38	0.69	0.07	0.27	0.93	1.30	1.84	2.54	0.90
Beta	439,539	1.00	0.24	0.05	0.56	0.87	1.00	1.14	1.39	0.66
Gross CAPM alpha (%)	439,539	1.45	5.52	1.88	-5.57	-1.14	0.95	3.60	10.72	0.34
Net CAPM alpha (%)	439,539	0.04	5.47	1.87	-7.16	-2.46	-0.34	2.12	9.17	0.34
Log(TNA)	439,539	5.64	1.86	0.37	2.54	4.37	5.68	6.95	8.65	0.85
Log(Age)	439,539	4.84	0.47		4.13	4.48	4.84	5.18	5.64	
(0,1) Passive fund	439,539	0.10	0.30		0.00	0.00	0.00	0.00	1.00	
(0,1) ETF	439,539	0.05	0.22		0.00	0.00	0.00	0.00	1.00	
Net flow (%)	434,090	-0.39	2.76		-5.66	-1.74	-0.55	0.71	6.28	
N of funds per beta bin	439,539	0.37	0.22		0.05	0.17	0.31	0.58	0.69	
HHI per beta bin	439,539	0.05	0.05		0.01	0.03	0.04	0.05	0.12	

Table 2: Relation between Fund Market Beta and Fund Fees

This table reports the results from regressing mutual fund fees on fund market beta and fund characteristics separately for funds with betas larger than one and smaller than one, and on the interaction between fund market beta and an indicator for beta being larger than one. Columns (1)–(3) report the results for the fund-share-class-level sample, and columns (4)–(6) report the results for the fund-level sample. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1)[Beta>1]* indicator equals one if the fund's beta is greater than one. *Gross CAPM alpha* is an annualized estimate of the intercept from the market model for fund gross returns. *Log(TNA)* is the natural logarithm of fund total net assets. *Log(Age)* is the natural logarithm of fund age in months. *(0,1) Passive fund* indicator equals one if a fund is passively managed. *(0,1) ETF* indicator equals one if a fund is an ETF. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level			Fund level		
	(1)	(2)	(3)	(4)	(5)	(6)
	Beta>1	*Beta<1*	*Full Sample*	*Beta>1*	*Beta<1*	*Full Sample*
Beta(0,1)[Beta>1]*			0.46***			0.37***
			(0.09)			(0.08)
Beta	0.48***	0.01	-0.04	0.35***	-0.02	-0.07
	(0.05)	(0.06)	(0.05)	(0.05)	(0.06)	(0.06)
(0,1)[Beta>1]			-0.38***			-0.29***
			(0.09)			(0.08)
Gross CAPM alpha	0.02***	0.01***	0.17***	0.01***	0.00***	0.08***
	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.02)
Log(Age)	0.21***	0.17***	0.19***	0.07***	0.10***	0.09***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)
Log(TNA)	-0.09***	-0.06***	-0.07***	-0.06***	-0.04***	-0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
(0,1) Passive fund	-0.52***	-0.60***	-0.57***	-0.52***	-0.60***	-0.57***
	(0.09)	(0.06)	(0.06)	(0.08)	(0.06)	(0.06)
(0,1) ETF	-0.24	0.09	-0.08	-0.34	0.04	-0.16
	(0.25)	(0.12)	(0.19)	(0.23)	(0.15)	(0.20)
Observations	511,810	476,797	988,613	219,912	218,872	438,795
R-squared	0.48	0.47	0.47	0.69	0.66	0.66
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table 3: Relation between Fund Market Beta and Fund Fees: Baseline Robustness Checks

This table reports the results of robustness checks for the main tests presented in Table 2. Panel A reports the results from regressing fund fees on fund market beta and measures of the intensity of alternative fund offerings. Panel B reports the results from regressing fund fees on fund market beta separately for *Broker-sold* and *Direct-sold* funds. Panel C reports the results from regressing fund fees on fund market beta and style fixed effects. Panel D reports the results from regressing only fund expense ratios on fund market beta. Panel E reports the results from regressing fund fees on fund market beta only in the sample of active funds. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Number of funds per beta bin* is the number of funds with the value of beta falling into each 0.1 bin (e.g., funds with betas between 0.8–0.9 are in a bin, funds with betas between 1.1–1.2 are in another bin, etc.) in a specific month. *HHI per beta bin* is the TNA-weighted Herfindahl-Hirschman Index (HHI) that is estimated for each 0.1 bin of beta in each month. A fund share class is considered *Direct-sold* if it charges no front or back load, and has an annual distribution fee ("12b-1" fee) of no more than 25 basis points; otherwise it is considered *Broker-sold*. *Style fixed effects* are defined based on the fund Lipper classification. All the specifications include fund family fixed effects, month fixed effects, and the full set of control variables. Appendix Tables B3–B8 present the detailed results for these tests. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level			Fund level		
	(1)	(2)	(3)	(4)	(5)	(6)
Sample	*Beta*>1	*Beta*<1	*Full Sample*	*Beta*>1	*Beta*<1	*Full Sample*
Coefficient on	*Beta*	*Beta*	*Beta*(0,1)[Beta>1]*	*Beta*	*Beta*	*Beta*(0,1)[Beta>1]*
Panel A: Controlling for fund offerings (Tables B3–B4)						
Add *N of funds per beta bin*	0.33***	-0.09	0.52***	0.28***	-0.00	0.35***
	(0.07)	(0.07)	(0.11)	(0.07)	(0.07)	(0.10)
Add *HHI per beta bin*	0.52***	0.04	0.49***	0.39***	0.03	0.38***
	(0.06)	(0.05)	(0.09)	(0.05)	(0.06)	(0.08)
Panel B: Distribution channels (subsamples) (Table B5)						
Within *Broker-sold*	0.45***	0.06	0.37***			
	(0.06)	(0.06)	(0.09)			
Within *Direct-sold*	0.39***	0.09	0.30***			
	(0.04)	(0.06)	(0.07)			
Panel C: Fund styles (Table B6)						
Add *Style fixed effects*	0.27***	0.02	0.23***	0.21***	0.04	0.14**
	(0.06)	(0.06)	(0.08)	(0.05)	(0.06)	(0.07)
Panel D: Expense ratios only (Table B7)						
	0.43***	0.04	0.37***	0.32***	0.01	0.31***
	(0.05)	(0.05)	(0.07)	(0.03)	(0.05)	(0.07)
Panel E: Active funds only (Table B8)						
	0.49***	0.04	0.44***	0.37***	0.01	0.34***
	(0.06)	(0.07)	(0.09)	(0.05)	(0.07)	(0.09)

Table 4: Relation between Fund Market Beta, Fund Fees, and Investor Type

This table reports the results from regressing fund fees on fund market beta and its interactions with an indicator for retail share classes. All the regressions are estimated for funds with betas larger than one. Columns (1) and (2) present the results for the fund-share-class-level sample, and columns (3) and (4) present the results for the fund launch sample. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *Gross CAPM alpha* is an annualized estimate of the intercept from the market model for fund gross returns. *(0,1) Retail* indicator equals one if a share class is offered to retail investors. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level		Fund launch	
	(1)	(2)	(3)	(4)
*(0,1) Retail * Beta*	0.13*	0.12*	0.21**	0.20**
	(0.07)	(0.07)	(0.09)	(0.09)
Beta	0.30***	0.34***	0.22***	0.24***
	(0.06)	(0.06)	(0.06)	(0.06)
(0,1) Retail	0.77***	0.73***	0.65***	0.65***
	(0.09)	(0.08)	(0.12)	(0.12)
Gross CAPM alpha		0.01***		0.01***
		(0.00)		(0.00)
Observations	511,810	511,810	5,186	5,186
R-squared	0.71	0.71	0.70	0.71
Control variables	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes

Table 5: Relation between Fund Market Beta, Fund Fees, and Tightness of Borrowing Constraints

This table reports the results from regressing fund fees on fund market beta and its interactions with measures of borrowing constraint tightness. The measures include the BAB measure from Frazzini and Pedersen (2014), the ICR measure from He, Kelly, and Manela (2017), and the LCT measure from Boguth and Simutin (2018). All the regressions are estimated for funds with betas larger than one at the time of fund launch. The sample consists of months when the measure of tightness is either in the first quartile or in the fourth quartile of its distribution across time. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *Gross CAPM alpha* is an annualized estimate of the intercept from the market model for fund gross returns. *(0,1) Constrained* indicator is defined for each measure separately and equals one if the BAB or ICR measures are in the first quartile of their distributions across time, and if the LCT measure is in the fourth quartile of its distribution across time. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*						
Measure of borrowing constraint tightness	BAB		ICR		LCT	
	(1)	(2)	(3)	(4)	(5)	(6)
*(0,1) Constrained * Beta*	0.42**	0.41**	0.36*	0.44**	0.14	0.13
	(0.19)	(0.20)	(0.19)	(0.21)	(0.20)	(0.20)
Beta	0.12	0.14	0.24***	0.22**	0.17	0.18
	(0.10)	(0.11)	(0.08)	(0.09)	(0.14)	(0.14)
Gross CAPM alpha		0.01***		0.01*		0.00
		(0.00)		(0.00)		(0.00)
Observations	2,616	2,616	2,150	2,150	2,462	2,462
R-squared	0.72	0.72	0.74	0.74	0.70	0.70
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Relation between Fund Market Beta, Net Fund Flows, and Tightness of Borrowing Constraints

This table reports the results from regressing net fund flows on fund market beta and its interactions with measures of borrowing constraint tightness. The measures include the BAB measure from Frazzini and Pedersen (2014), the ICR measure from He, Kelly, and Manela (2017), and the LCT measure from Boguth and Simutin (2018). All the regressions are estimated for funds with betas larger than one. The sample consists of months when the measure of tightness is either in the first quartile or in the fourth quartile of its distribution across time. *Net Flow* is the net fund flow in the given month in percentage points. *Beta* is an estimate of the slope from the market model for fund returns. *Gross CAPM alpha* is an annualized estimate of the intercept from the market model for fund gross returns. *(0,1) Constrained* indicator is defined for each measure separately and equals one if the BAB or ICR measures are in the first quartile of their distributions across time, and if the LCT measure is in the fourth quartile of its distribution across time. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Net Flow*						
Measure of borrowing constraint tightness	BAB		ICR		LCT	
	(1)	(2)	(3)	(4)	(5)	(6)
*(0,1) Constrained * Beta*	0.72***	0.84***	0.80*	1.55***	0.43*	0.34
	(0.24)	(0.25)	(0.45)	(0.39)	(0.25)	(0.28)
Beta	-1.45***	-0.40	-1.36***	-0.72**	-1.18***	0.24
	(0.30)	(0.34)	(0.36)	(0.35)	(0.28)	(0.33)
Gross CAPM alpha		0.14***		0.15***		0.15***
		(0.01)		(0.01)		(0.01)
Observations	248,680	248,680	245,295	245,295	199,966	199,966
R-squared	0.20	0.22	0.23	0.24	0.23	0.25
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table 7: Relation between Fund Market Beta and Fund Survival

This table reports the results from estimating the Cox proportional hazards model for the effect of fund market beta on fund hazard rates. A lower hazard rate implies a longer survival time. The results are separately reported for funds with betas larger than one and smaller than one, and for the specification that includes the interaction between fund market beta and an indicator for beta being larger than one. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1)[Beta>1]* indicator equals one if the fund's beta is greater than one. *Gross CAPM alpha* is an annualized estimate of the intercept from the market model for fund gross returns. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

	Cox proportional hazard estimates					
	(1)	(2)	(3)	(4)	(5)	(6)
	Beta>1		*Beta*<1		Full Sample	
*Beta**(0,1)[Beta>1]*					0.19	0.38
					(0.39)	(0.38)
Beta	-0.09	-0.16	-0.29	-0.52*	-0.22	-0.49*
	(0.26)	(0.28)	(0.28)	(0.29)	(0.26)	(0.27)
(0,1)[Beta>1]					-0.16	-0.33
					(0.39)	(0.38)
Gross CAPM alpha		-0.03		-0.03***		-0.03**
		(0.03)		(0.01)		(0.01)
Observations	153,127	153,127	164,785	164,785	317,912	317,912
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: Average Returns, CAPM Alphas, and Fees for Fund Portfolios Sorted by Market Beta

This table reports average returns, CAPM alphas, and mutual fund fees for five equally weighted mutual fund portfolios sorted by their market betas. All the funds have betas larger than one. Panel A presents the results from the fund share class sample and Panel B presents the results from the fund-level sample. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *Gross CAPM alpha* and *Net CAPM alpha* are annualized estimates of the intercept from the market models for fund gross returns and fund net returns, respectively. *Net Return* is the annualized fund monthly return net-of-fees. *Gross Return* is the sum of the fund's *Net Return* and the fund's *Fee*. The t-statistics for tests of differences between the averages are reported. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively.

Panel A: Share class level	(1)	(2)	(3)	(4)	(5)	(6)
Quintile	*Beta*	*Fee*	*Gross CAPM Alpha*	*Net CAPM Alpha*	*Gross Return*	*Net Return*
(1) Low *Beta*	1.03	1.65	0.74	-0.90	8.17	6.52
(2)	1.09	1.71	0.80	-0.91	8.30	6.59
(3)	1.16	1.77	0.73	-1.05	8.73	6.95
(4)	1.24	1.81	0.44	-1.37	9.32	7.51
(5) High *Beta*	1.39	1.88	0.37	-1.51	9.93	8.05
High *Beta* – Low *Beta*		0.23***	-0.37	-0.60**	1.77	1.54
t-statistic		18.10	-1.47	-2.43	0.30	0.26
Panel B: Fund level						
(1) Low *Beta*	1.03	1.48	0.81	-0.67	8.22	6.74
(2)	1.09	1.55	0.97	-0.59	8.54	6.99
(3)	1.16	1.60	0.84	-0.76	8.90	7.30
(4)	1.27	1.66	0.65	-1.01	9.55	7.90
(5) High *Beta*	1.42	1.70	0.40	-1.29	9.42	7.73
High *Beta* – Low *Beta*		0.22***	-0.41	-0.63**	1.20	0.99
t-statistic		12.86	-1.56	-2.38	0.20	0.17

Table 9: Funds' Investment Practices, Trading Costs, and Market Beta

This table reports the summary statistics for the investment practice variables obtained from the form N-SAR, and for the difference between fund beta and its stock holdings beta. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1) Alternative practices* indicator equals one if the fund engages in at least one of the activities such as borrowing money, short-selling, or trading options and futures. *(0,1) Options on equities* indicator equals one if the fund trades options on equities. *(0,1) Options on stock indices* indicator equals one if the fund trades options on stock indices. *(0,1) Stock index futures* indicator equals one if the fund trades stock index futures. *(0,1) Options on stock index futures* indicator equals one if the fund trades options on stock index futures. *(0,1) Borrowing money* indicator equals one if the fund borrows money. *(0,1) Short-selling* indicator equals one if the fund engages in short-selling. *(0,1) Fund beta>portfolio beta* indicator equals one if the difference between the fund beta and its stock holdings beta is larger than 0.05.

	(1)	(2)	(3)	(4)
	Full Sample		*Beta*>1	
	Mean	N	Mean	N
(0,1) Alternative practices	0.30	26,830	0.29	13,755
(0,1) Options on equities	0.07	26,830	0.06	13,755
(0,1) Options on stock indices	0.02	26,830	0.01	13,755
(0,1) Stock index futures	0.17	26,830	0.15	13,755
(0,1) Options on stock index futures	0.004	26,830	0.003	13,755
(0,1) Borrowing money	0.08	26,830	0.09	13,755
(0,1) Short-selling	0.03	26,809	0.02	13,750
(0,1) Fund beta>portfolio beta	0.20	69,691	0.25	37,406

Table 10: Relation Between Fund Investment Practices and Market Beta

This table reports the results from regressing fund market betas on indicators for the engagement in alternative investment practices for funds with betas greater than one. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1) Alternative practices* indicator equals one if the fund engages in at least one of the activities such as borrowing money, short-selling, or trading options and futures. *(0,1) Options on equities* indicator equals one if the fund trades options on equities. *(0,1) Options on stock indices* indicator equals one if the fund trades options on stock indices. *(0,1) Stock index futures* indicator equals one if the fund trades stock index futures. *(0,1) Options on stock index futures* indicator equals one if the fund trades options on stock index futures. *(0,1) Borrowing money* indicator equals one if the fund borrows money. *(0,1) Short-selling* indicator equals one if the fund engages in short-selling. *(0,1) Fund beta>portfolio beta* indicator equals one if the difference between the fund beta and its stock holdings beta is larger than 0.05. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Beta*								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(0,1) Alternative practices	-0.01**							
	(0.00)							
(0,1) Fund beta>portfolio beta		0.03***						
		(0.01)						
(0,1) Options on equities			0.01					
			(0.01)					
(0,1) Options on stock indices				0.00				
				(0.02)				
(0,1) Stock index futures					-0.02***			
					(0.01)			
(0,1) Options on stock index futures						-0.06***		
						(0.02)		
(0,1) Borrowing money							0.00	
							(0.01)	
(0,1) Short-selling								-0.01
								(0.02)
Observations	13,721	37,365	13,721	13,721	13,721	13,721	13,721	13,716
R-squared	0.31	0.26	0.31	0.31	0.31	0.31	0.31	0.31
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Internet Appendix

Part A: Theoretical Model Details

A.1 Investor Choice and Fund Assets Under Management

For the model setting outlined in Section 2 of the paper, we examine the investors' investment choices, which ultimately determine the funds' assets under management. We assume that an asset manager j survives in equilibrium only if some investors prefer j over all other managers in the universe.

Investor Choice Without loss of generality, suppose that investor i decides to invest with asset manager j. Then the first order condition for the weight of the risky investment is

$$\widetilde{\omega}_i^j = \frac{\mu_j - \phi_j}{\gamma_i \sigma_j^2}, \tag{A1}$$

and i chooses her investment to be $\omega_i^{j*} = \min\{\widetilde{\omega}_i^j, l\}$ due to the borrowing constraint.

We describe the investor's choice between different asset managers and show first that investors do not invest with asset managers whose fees are too high, either in an absolute sense or relative to other managers. All proofs are provided in Appendix A.4.

Proposition A1. *[Dominated Funds] Investors do not invest into funds j with*

1. $\phi_j \geq \mu_j$ or with
2. $\phi_j > \frac{\beta_j}{\beta_k}\phi_k + \xi(1 - \frac{\beta_j}{\beta_k})$ for a fund k with $\beta_j < \beta_k$.

In Proposition A1, we provide necessary conditions for asset managers to have positive assets under management and to survive in equilibrium. The first part states that no investor is willing to invest with a manager whose expected after-fee excess return $\mu_j - \phi_j$ is smaller or equal zero. In the second part, we lay out the basic logic for our main result. In particular, the fees of asset managers with smaller betas are bounded by the fees of higher-beta managers. For illustration, consider the case in which the CAPM holds in the asset market ($\xi = 0$). In this case, equilibrium fees must be non-decreasing in betas since investors can always synthesize a lower-beta fund by investing in a fund with higher beta and holding a cash position. This argument does not apply the other way round: investors cannot synthesize a high-beta fund by a leveraged investment in a lower-beta fund due to borrowing constraints. As a result, asset managers with low betas cannot charge higher fees than asset managers with higher betas.[24]

We next characterize the investment decision of an individual investor given her risk aversion γ_i. By comparing the levels of utility provided by two funds j and k, with $\beta_j > \beta_k$ and optimal investment weights ω_i^{j*} and ω_i^{k*}, we show that investors prefer fund j over k if their risk aversion is below a certain threshold, which we denote by $\overline{\gamma_{jk}}$. For notational ease, define $\widetilde{\mu_M} = \mu_M - \xi$.

Proposition A2. *[Risk Aversion and Fund Preference] Investor i with borrowing bound l prefers fund j over fund k, with $\beta_j > \beta_k$, if and only if $\gamma_i < \overline{\gamma_{jk}}$, with*

$$\overline{\gamma_{jk}} = \begin{cases} \frac{\beta_j \widetilde{\mu_M} + \xi - \phi_j}{\beta_j^2 \sigma_M^2 l}, & \text{for } \beta_j(\beta_k - \beta_j)^2 \widetilde{\mu_M} = \phi_j \left(\beta_k^2 + \beta_j^2\right) - 2\beta_j^2 \phi_k + \xi(\beta_j^2 - \beta_k^2) \\ 2\frac{\widetilde{\mu_M}(\beta_j - \beta_k) - (\phi_j - \phi_k)}{(\beta_j^2 - \beta_k^2)\sigma_M^2 l}, & \text{for } \beta_j(\beta_k - \beta_j)^2 \widetilde{\mu_M} < \phi_j \left(\beta_k^2 + \beta_j^2\right) - 2\beta_j^2 \phi_k + \xi(\beta_j^2 - \beta_k^2) \\ \frac{\beta_k \beta_j \widetilde{\mu_M} - \sqrt{(\beta_j(\phi_k - \xi) - \beta_k(\phi_j - \xi))(-2\beta_k\beta_j\widetilde{\mu_M} + \beta_j(\phi_k - \xi) + \beta_k(\phi_j - \xi))} - \beta_j(\phi_k - \xi)}{\beta_k^2 \beta_j \sigma_M^2 l}, & \\ & \text{for } \beta_j(\beta_k - \beta_j)^2 \widetilde{\mu_M} > \phi_j \left(\beta_k^2 + \beta_j^2\right) - 2\beta_j^2 \phi_k + \xi(\beta_j^2 - \beta_k^2). \end{cases} \tag{A2}$$

We illustrate this result in Figure A1 and show the combinations of investor risk aversion γ_i and fee ϕ_j for which an asset manager j dominates the market index fund with $\beta_M = 1$ and $\phi_M = 0$. In both plots, the yellow (light, not meshed) area stands for the region in which the asset manager with $\beta = 1.3$ is preferred to the market index fund. Investors with very low risk aversion are willing to pay a lot for leverage and prefer the high-beta asset manager over the market index fund even if the asset manager charges a very high fee. The fee at which the high-beta fund j is preferred declines in investor risk aversion.

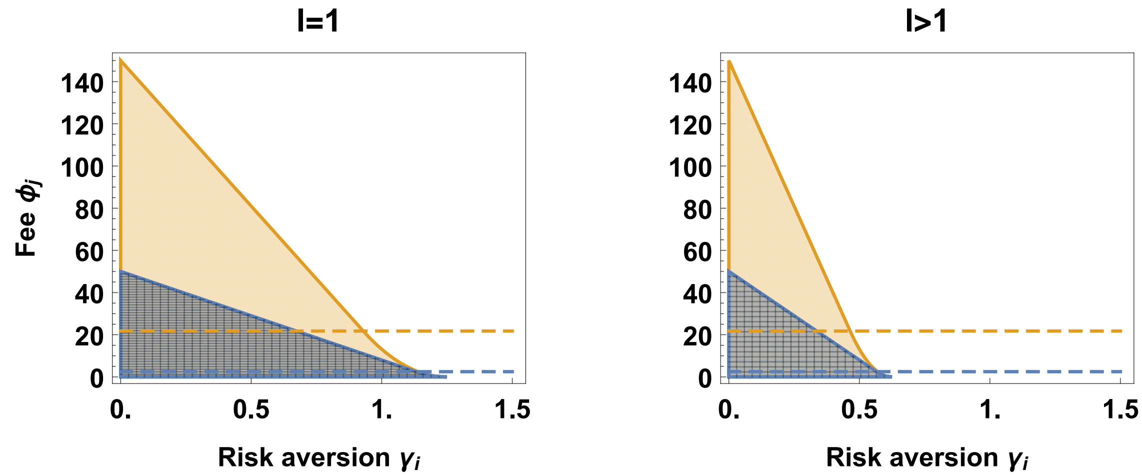
Comparing this to the blue (dark, meshed) area—the region in which an asset manager with lower beta ($\beta = 1.1$) is preferred to the market index fund—highlights the effect on fees across asset managers with different betas. The yellow area overlays the blue area: the manager with $\beta = 1.3$ can set higher fees and still be strictly preferred by some investors over the market index fund. As risk aversion declines, the investor is willing to pay significantly more to the high-beta asset manager even if the low-beta manager is available.

Finally, we graphically illustrate the role of the tightness of leverage constraints. The left plot describes the choice of an investor who faces strict constraints ($l = 1$), while the right plot presents the more relaxed case ($l > 1$). In the strict case, investors cannot obtain

[24] If ξ is substantially greater than zero, the restriction on fees through Condition 2 of Proposition A1 is somewhat relaxed, but we show that in the model equilibrium fees increase in beta particularly for $\beta > 1$.

Figure A1: Risk Aversion, Fund Beta, and Willingness to Pay

This figure presents constellations of investor i's risk aversion γ_i and fund j's fee ϕ_j for which j is preferred over the market index fund with $\beta_M = 1$ and $\phi_M = 0$. The blue (dark, meshed) region presents the relation for a fund with $\beta_j = 1.1$, the yellow (light, not meshed) region presents the relation for a fund with $\beta_j = 1.3$. The left plot describes investors who face strict borrowing constraints, the right plot presents the case of less constrained investors with $l = 2$. The dashed lines stand for the ϕ_j value above which the second case of Proposition A2 applies and the region is linear. Parameters are set according to the CAPM case in Table A1.



leverage by any means. As a result, even investors with moderate risk aversion prefer high-beta asset managers over the market index fund if the fee is not too extreme.

We extend this logic further and show that in equilibrium, investors sort across managers depending on their betas, and the corresponding investor clienteles are formed based on risk aversion.

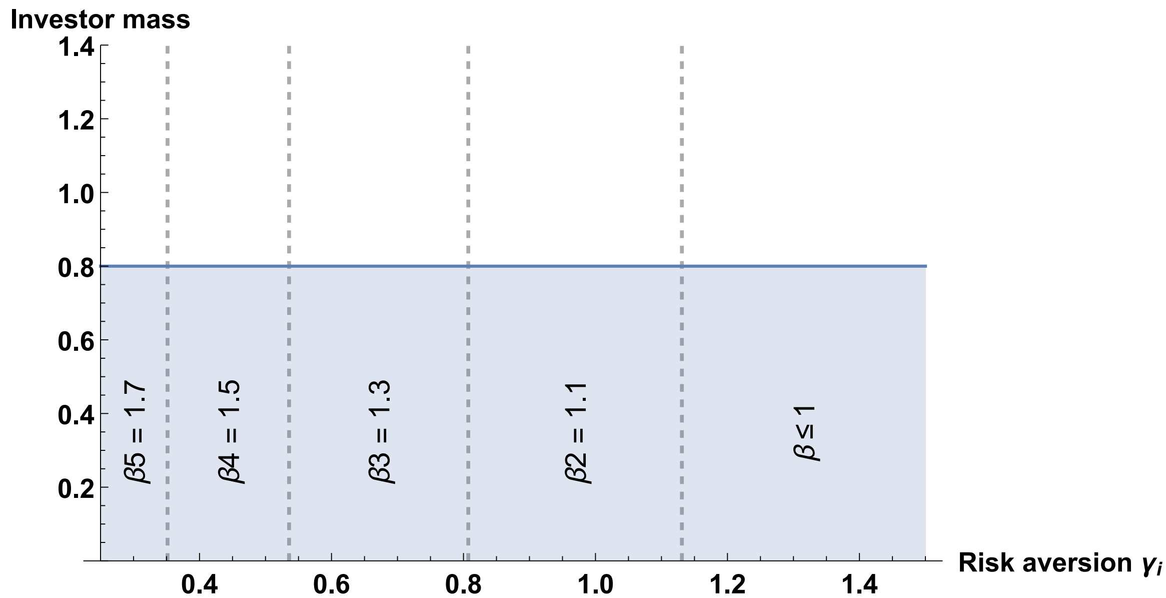
Proposition A3. *[Investor Clienteles] For all funds j_1, j_2, k with $\beta_{j_2} > \beta_{j_1} > \beta_k$, it must be that $\overline{\gamma_{j_2 j_1}} < \overline{\gamma_{j_1 k}}$ and $\overline{\gamma_{j_2 k}} < \overline{\gamma_{j_1 k}}$ in equilibrium. Asset managers with higher betas are chosen by investors with lower risk aversion.*

We illustrate this result in Figure A2. In the equilibrium, asset managers with different betas offer their services to different types of investors. In particular, investors with the lowest risk aversion choose the asset manager with the highest beta, up to a certain cutoff point, after which the second-least risk-averse clientele chooses the fund with the second-highest beta, and so on.

Using the results from Propositions A2 and A3, we can compute the assets under management (AUM) of fund j, dependent on the fee ϕ_j. In particular, the AUM are given

Figure A2: Distribution of Investors across Funds

This figure illustrates how investors sort across asset managers based on their risk aversion γ_i, given four managers with $\beta > 1$, the market index fund with $\beta_1 = \beta_M = 1$, and possible additional funds with $\beta < 1$. Fund fees are set exemplarily to $(\phi_1, \phi_2, \phi_3, \phi_4, \phi_5) = (0, 2.5, 25, 65, 120)$ basis points. All the investors face strict borrowing constraints ($l = 1$). Further parameters are set according to the CAPM case in Table A1.



by

$$AUM_j(\phi_j) = \int_{\overline{\gamma}_{j+1,j}}^{\overline{\gamma}_{j,j-1}} \min\{\frac{\mu_j - \phi_j}{\gamma_i \sigma_j^2}, l\} f(\gamma_i) d\gamma_i, \tag{A3}$$

where the integration bounds are defined in line with Proposition A2, and $f(.)$ is the probability density for the risk aversion in the investor population. We utilize the fact that asset manager j attracts investors whose risk aversion is below the threshold $\overline{\gamma}_{j,j-1}$ at which the manager with the next-lower beta is dominated, but larger than the value $\overline{\gamma}_{j+1,j}$ at which manager j is dominated by the manager with the next-higher beta.

A.2 Equilibrium

An equilibrium is a combination of fees $\phi_0, \phi_1, \ldots, \phi_J$ for the asset managers such that, for optimal investor choices, fee revenues are maximized for all asset managers (according to the optimization problems (1) and (2)). To solve for the model equilibrium explicitly, we need to make an assumption on the probability distribution of γ_i. We assume that γ_i is equally distributed on $[\underline{\Gamma}, \overline{\Gamma}]$. The model can be solved analytically for the first two cases of Proposition A2, in which the risk aversion "cutoff" value $\overline{\gamma_{jk}}$ depends linearly on the fund fees. In the third case, there is a non-linear relation between the fund fees and $\overline{\gamma_{jk}}$ and we can efficiently compute the equilibrium numerically. In the analytical case, the first order conditions obtained from the fund manager optimization problems (2) constitute a linear equation system $A\phi = b$, where ϕ is the vector of all fund fees, and A is a tridiagonal matrix.

Solution for Baseline Case with Four Funds Let us explicitly demonstrate and explore the equilibrium solution for the case of four funds with betas $0 < \beta_0 < \beta_1 = \beta_M = 1 < \beta_2 < \beta_3$, assuming the second case of Proposition A2 and starting with $\xi = 0$ and $\psi = 1$ for ease of exposition. The linear equation system for an arbitrary number of $J + 1$ funds is also provided below. Since there is perfect supply-side competition for market index funds with $\beta_1 = \beta_M = 1$, the index fund fee ϕ_M equals the marginal management cost which is zero. Proposition A1 then implies that for $\xi = 0$ the fee ϕ_0 for the asset manager with $\beta_0 < 1$ is zero too; otherwise, it would always be optimal for investors to invest in the market index fund and cash in order to replicate the fund with β_0 at zero fees. The same argument holds for potential additional asset managers with beta smaller than one, such that fees become flat in betas for $\beta < 1$.

We next solve for the fees ϕ_3 and ϕ_2 of the funds with $\beta_3 > \beta_2 > 1$, which are set by their managers under monopolistic competition. The revenue maximization problems (2), in which we insert the assets under management computed according to (A3) with uniformly distributed γ_i, are obtained as

$$\begin{aligned} &\max_{\phi_2}\ \phi_2 \cdot \frac{1}{\overline{\Gamma} - \underline{\Gamma}} \left(2\frac{\widetilde{\mu_M}(\beta_2 - \beta_M) - (\phi_2 - \phi_M)}{(\beta_2^2 - \beta_M^2)\sigma_M^2} - 2\frac{\widetilde{\mu_M}(\beta_3 - \beta_2) - (\phi_3 - \phi_2)}{(\beta_3^2 - \beta_2^2)\sigma_M^2} \right), \\ &\max_{\phi_3}\ \phi_3 \cdot \frac{1}{\overline{\Gamma} - \underline{\Gamma}} \left(2\frac{\widetilde{\mu_M}(\beta_3 - \beta_2) - (\phi_3 - \phi_2)}{(\beta_3^2 - \beta_2^2)\sigma_M^2} - \underline{\Gamma} \right), \end{aligned} \tag{A4}$$

assuming for now that the investors' borrowing constraints are binding (the non-binding case can be solved along the same lines for linear cases, and numerically otherwise). Given the fees, all investors with low enough risk aversion, down to the lowest risk aversion $\underline{\Gamma}$, prefer the β_3 manager over the β_2 manager. These investors invest with the β_3 manager since there are no managers with higher beta. Another group of investors invests with the β_2 manager. These investors are more risk-averse relative to the first group and prefer the β_2 manager over the β_3 manager. At the same time, these investors still have low enough risk aversion such that they do not invest in the market index fund. The rest of the investors chooses the market index fund. Given the investor demand, the fund managers maximize revenues by setting the appropriate fees.

Taking the derivatives of the fund managers' objective functions by ϕ_2 and ϕ_3, respectively, and setting them to zero, yields the corresponding first order conditions

$$\begin{gathered}2\frac{\widetilde{\mu_M}(\beta_2-\beta_M)-(2\phi_2-\phi_M)}{(\beta_2^2-\beta_M^2)\sigma_M^2}-2\frac{\widetilde{\mu_M}(\beta_3-\beta_2)-(\phi_3-2\phi_2)}{(\beta_3^2-\beta_2^2)\sigma_M^2}=0,\\ 2\frac{\widetilde{\mu_M}(\beta_3-\beta_2)-(\phi_3-2\phi_2)}{(\beta_3^2-\beta_2^2)\sigma_M^2}-\underline{\Gamma}=0.\end{gathered} \tag{A5}$$

Since $\phi_M = 0$, we can solve the given system of two equations for the two fee variables, ϕ_2 and ϕ_3. The solution can be written as

$$\begin{aligned}\phi_2-\phi_M&=\frac{1}{C}(A_1\widetilde{\mu_M}-\frac{1}{2}B_1\underline{\Gamma}\sigma_M^2),\\ \phi_3-\phi_2&=\frac{1}{C}(A_2\widetilde{\mu_M}-\frac{1}{2}B_2\underline{\Gamma}\sigma_M^2),\end{aligned} \tag{A6}$$

where the constants A_1, A_2, B_1, B_2, C are given by

$$\begin{aligned}A_1&=(\beta_2-\beta_M)(\beta_2+2\beta_3-\beta_M),\\ A_2&=(2\beta_3^2-\beta_2^2-\beta_2\beta_3+(\beta_2+\beta_3)\beta_M-2\beta_M^2),\\ B_1&=(\beta_2+\beta_3)(\beta_2-\beta_M)(\beta_2+\beta_M),\\ B_2&=(\beta_2+\beta_3)(2\beta_3^2-\beta_2^2-\beta_M^2),\\ C&=\frac{\beta_3-\beta_2}{4\beta_3^2-\beta_2^2-3\beta_M^2}.\end{aligned} \tag{A7}$$

Note that all the constants are positive since all betas are greater than one and ordered by their magnitudes.

Heterogeneous Borrowing Constraints and "Betting Against Beta" The model solutions with heterogeneous borrowing constraints (i.e., $0 < \psi < 1$) and with a relatively flat security market line in the asset market ("betting-against-beta" case, $\xi > 0$) have the same form as the solution (A6) and can be obtained following analogous calculations. In particular, the solution for general $0 < \psi < 1$ is obtained by replacing $\frac{1}{2}$ with $\frac{\bar{l}}{2(1+(\bar{l}-1)\psi)}$:

$$\begin{aligned}\phi_2-\phi_M&=\frac{1}{C}(A_1\widetilde{\mu_M}-\frac{\bar{l}}{2(1+(\bar{l}-1)\psi)}B_1\underline{\Gamma}\sigma_M^2),\\ \phi_3-\phi_2&=\frac{1}{C}(A_2\widetilde{\mu_M}-\frac{\bar{l}}{2(1+(\bar{l}-1)\psi)}B_2\underline{\Gamma}\sigma_M^2).\end{aligned} \tag{A8}$$

Note that for $\psi = 1$ or $\bar{l} = 1$, we are back to the solution stated in (A6). The $\xi > 0$ case enters the solution through $\widetilde{\mu_M}$ and further requires that we explicitly solve for ϕ_0 along the same lines, as the fee of the β_0 fund is not bounded to zero by ϕ_M in that case.

General Solution for Linear Case If the second case of Proposition A2 applies for all funds and the investors' borrowing constraints are binding, then the first order conditions obtained from the fund manager optimization problems (2) constitute a linear equation system $A\phi = b$, with $\phi = (\phi_0, \phi_1, \ldots, \phi_J)'$ being the vector of fund fees. We explicitly state the matrix A and vector b, considering the case $\xi = 0$ and $\psi = 1$ for ease of exposition. In this case, A is the tridiagonal matrix

$$A = \begin{pmatrix} \frac{2}{\beta_0^2-\beta_1^2} & \frac{1}{\beta_1^2-\beta_0^2} & 0 & \cdots & \cdots & \cdots & 0 \\ \frac{1}{\beta_1^2-\beta_0^2} & \frac{2(\beta_0^2-\beta_2^2)}{(\beta_2^2-\beta_1^2)(\beta_1^2-\beta_0^2)} & \frac{1}{\beta_2^2-\beta_1^2} & \ddots & & & \vdots \\ 0 & \frac{1}{\beta_2^2-\beta_1^2} & \frac{2(\beta_1^2-\beta_3^2)}{(\beta_3^2-\beta_2^2)(\beta_2^2-\beta_1^2)} & \frac{1}{\beta_3^2-\beta_2^2} & \ddots & & \vdots \\ \vdots & \ddots & \frac{1}{\beta_3^2-\beta_2^2} & \ddots & \ddots & \ddots & \vdots \\ \vdots & & \ddots & \ddots & \ddots & \ddots & 0 \\ \vdots & & & \ddots & \ddots & \ddots & \frac{1}{\beta_J^2-\beta_{J-1}^2} \\ 0 & \cdots & \cdots & \cdots & 0 & \frac{1}{\beta_J^2-\beta_{J-1}^2} & \frac{2}{\beta_{J-1}^2-\beta_J^2} \end{pmatrix}, \tag{A9}$$

and

$$b = \begin{pmatrix} \overline{\Gamma}\sigma_M^2/2 - \widetilde{\mu_M}\frac{1}{\beta_0+\beta_1} \\ \mu_M \frac{\beta_2-\beta_0}{(\beta_0+\beta_1)(\beta_1+\beta_2)} \\ \mu_M \frac{\beta_3-\beta_1}{(\beta_1+\beta_2)(\beta_2+\beta_3)} \\ \vdots \\ \widetilde{\mu_M}\frac{1}{\beta_{J-1}+\beta_J} - \underline{\Gamma}\sigma_M^2/2 \end{pmatrix}. \tag{A10}$$

Clearly, the solution of the linear equation system can be obtained analytically for an arbitrary number of funds, as specified by J.

Model Calibration We calibrate the model as specified in Table A1. In particular, we consider different scenarios of "few" funds, "many" funds, as well as more or less leverage-constrained investors and a baseline scenario in which the CAPM holds in the asset market as well as a "betting-against-beta" scenario with a relatively flat security market line.

Table A1: Model Parameters, Borrowing-Constraint Scenarios, and Fund Betas

This table presents the parameters we use to calibrate the model for different scenarios. Parameters describing the expected return and volatility of the stock market are set to the standard values of 5% and 20% per year, respectively. We consider a baseline CAPM case and a betting-against-beta (BAB) case with a flatter security market line. The investors' absolute risk aversion in our calibrated model is uniformly distributed between 0.25 and 1.50. For the investors' borrowing constraints, we consider a "more constrained" scenario in which all investors are strictly borrowing-constrained, and a "less constrained" scenario in which 25% of investors are strictly constrained and 75% can obtain a leverage of 2. We analyze scenarios with "few funds", i.e., two funds with beta greater than one in addition to the market ETF and a fund with beta smaller than one, and "many funds" with six funds overall (four of them with beta greater than one).

Parameter		Value	
Stock market			
Expected stock market return	μ_M	0.05	
Stock market volatility	σ_M	0.2	
		CAPM	BAB
Betting-against-beta parameter	ξ	0.0	0.015
Fund investors			
Highest absolute risk aversion	$\overline{\Gamma}$	1.50	
Lowest absolute risk aversion	$\underline{\Gamma}$	0.25	
		More constrained	Less constrained
Mass of strictly borrowing-constr. investors ($l = 1$)	ψ	1	0.25
Max. leverage for less borrowing-constrained investors	$\bar{l}$	—	2
Fund characteristics			
		Few funds	Many funds
Fund betas	β_0	0.3	0.3
	β_1	1.0	1.0
	β_2	1.3	1.1
	β_3	1.7	1.3
	β_4	—	1.5
	β_5	—	1.7

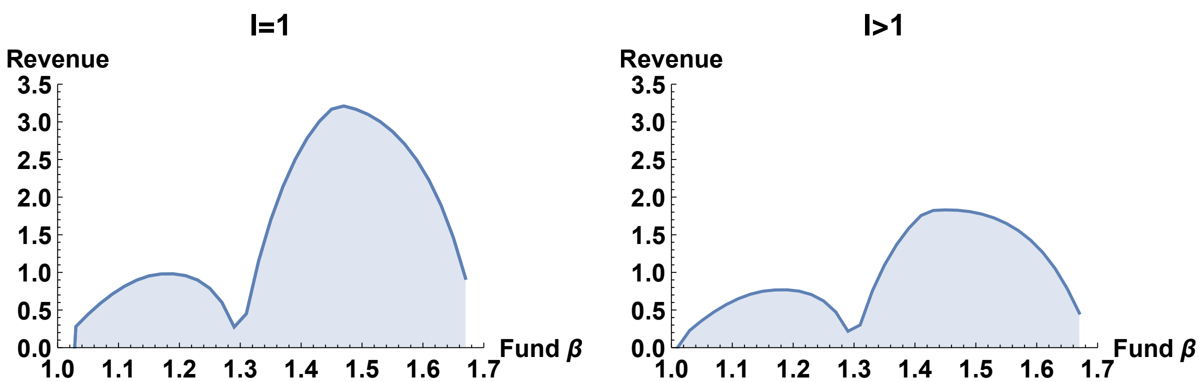
A.3 Model with Fund Entry and Endogenous Beta

Our baseline model considers a setting with a fixed number of funds whose betas are exogenously given. In reality, new asset managers can enter the market and choose their beta optimally to maximize future revenues. We consider an extended version of the model in which new asset managers arrive and choose their beta endogenously. Formally, we amend our model by a time step $t = -1$ in which a new asset manager enters the market and picks her (target) beta. At $t = 0$, all funds (including the new entrant) set their fees under monopolistic competition as in the baseline model, i.e., incumbent asset managers adjust

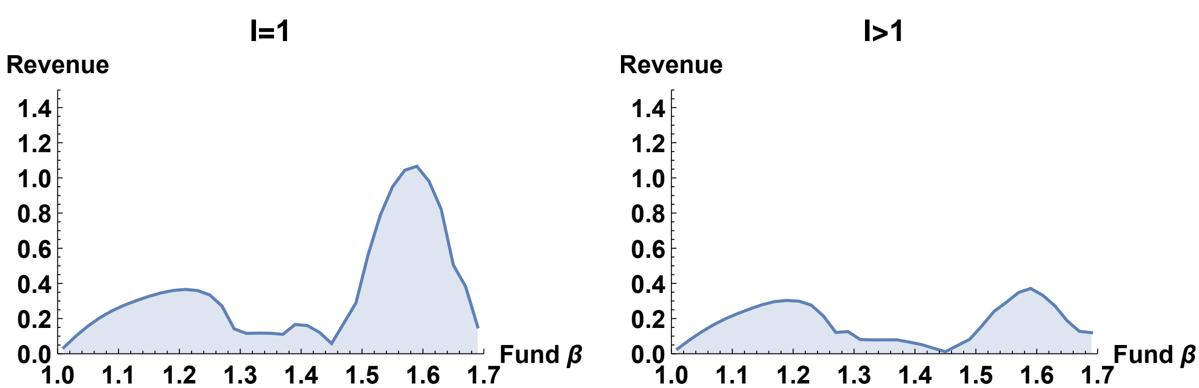
Figure A3: Fund Entry: New Fund's Revenues Dependent on Beta

This figure presents future revenues of a new asset manager entering the market dependent on the new fund's beta. Panel A presents the case of incumbent asset managers with betas in line with the "few funds" case (see Table A1). Panel B considers the case of a second new asset manager entering the market, after the first new asset manager has introduced a fund with an optimally chosen beta of 1.47 in the case of strictly leverage-constrained investors and 1.45 in the more relaxed case. The left plots present the strictly constrained case, the right plots the more relaxed case.

Panel A: Incumbent funds with betas 1.0, 1.3, and 1.7



Panel B: Incumbent funds with betas 1.0, 1.3, 1.47 (for $l = 1$) or 1.45 (for $l > 1$), and 1.7

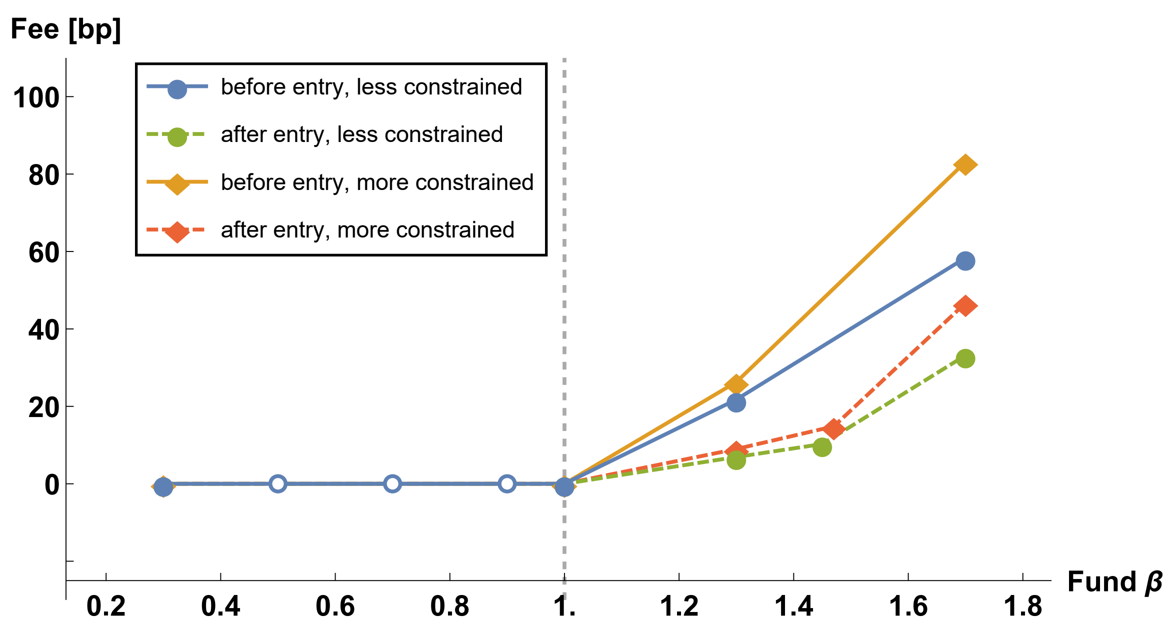


their fees in reaction to the new entrant. The new asset manager takes this competition into account when entering the market at time $t = -1$ and chooses her beta strategically. We can solve this extended model numerically for any given set of funds to determine the endogenous beta of the new entrant.

We demonstrate the endogenous entry decision for the example that the incumbent asset managers are given by the "few funds" case (see Table A1). The new entrant chooses her beta such that future revenues are maximized, given fees and investor shares that are determined under monopolistic competition with the incumbent asset managers. To this end, Panel A of Figure A3 depicts the future revenues of the new asset manager dependent on her choice of beta. The figure reveals that the new entrant's future revenues are lowest for betas close to the incumbents' betas. Second, the entrant can generate large revenues by launching a high-beta fund, and this effect is stronger for the case of more leverage-constrained investors.

Figure A4: Fund Entry: The Relationship between Beta and Fees

This figure presents the model-based relation between fund betas and fees before and after entry of a new fund. The blue line (solid, round markers) stands for the baseline scenario with "few" funds (i.e., two $\beta > 1$-funds, the market ETF, and an arbitrary number of $\beta < 1$-funds) where the parameters are set according to the "less constrained" scenario in Table A1. The green line (dashed, round markers) describes the outcome after a new fund with endogenous beta ($\beta = 1.45$) has entered the market based on this scenario. Similarly, the yellow line (solid, diamond markers) repeats the baseline scenario with "few" funds for the case when all the investors face strict borrowing constraints ($l = 1$), and the orange line (dashed, diamond markers) results from the new fund (with $\beta = 1.47$) entering the market. Hollow circles indicate that in the CAPM case, the fee for any $\beta < 1$ fund is exactly zero. In all scenarios, fund fees result endogenously from the model equilibrium.



Overall, the new fund optimally launches with an endogenously determined beta of 1.47 for the case of strictly leverage-constrained investors, and with almost the same beta (of 1.45) for the less constrained case. We proceed further by considering the case that another new asset manager enters the market, after the first new fund is established. Panel B of Figure A3 depicts this asset manager's future revenues, showing clearly how the previous introduction of the fund with beta of 1.47 or 1.45, respectively, has reshaped the landscape. As a consequence, it has become much less attractive now to introduce a fund in that same area of betas.

Figure A4 illustrates the relation between beta and fees before and after entry of the new fund for both the constrained and the less constrained scenario. The figure shows that fees robustly increase in beta both before and after entry of the new fund for $\beta > 1$. In addition, while we have seen that the endogenous beta of the entrant is virtually the same for the funding-constrained and the less constrained scenario, the resulting fees for beta are notably higher in the more constrained scenario.

A.4 Proofs

We provide the proofs for our theoretical results in the following.

Proof of Proposition A1 Condition 1 of the Proposition follows directly from the investor's optimal investment weight according to equation (A1). For condition 2, compare two different funds k and j with $\beta_k > \beta_j$. Let $\omega_i^{j^*}$ be the optimal allocation for fund j, such that the related utility for investor i is

$$\omega_i^{j^*}(\beta_j(\mu_M - \xi) + \xi - \phi_j) + R_f - \frac{\gamma_i}{2}\omega_i^{j^*2}\beta_j^2\sigma_M^2 \tag{A11}$$

according to (1). We compare this to the utility that fund k provides, which is

$$\omega_i^k(\beta_k(\mu_M - \xi) + \xi - \phi_k) + R_f - \frac{\gamma_i}{2}\omega_i^{k2}\beta_k^2\sigma_M^2. \tag{A12}$$

Now choose the weight of the risky investment for fund k as $\omega_i^k = \omega_i^{j^*}\frac{\beta_j}{\beta_k}$. Then we have $\omega_i^k < \omega_i^{j^*}$ and the related utility is obtained as

$$\omega_i^{j^*}(\beta_j(\mu_M - \xi) + \frac{\beta_j}{\beta_k}(\xi - \phi_k)) + R_f - \frac{\gamma_i}{2}\omega_i^{j^*2}\beta_j^2\sigma_M^2. \tag{A13}$$

Comparing (A11) and (A13), we see that fund k dominates fund j unless the fees fulfill the condition $\xi - \phi_j \geq \frac{\beta_j}{\beta_k}(\xi - \phi_k)$. Therefore, funds with $\phi_j > \frac{\beta_j}{\beta_k}\phi_k + \xi(1 - \frac{\beta_j}{\beta_k})$ are dominated.

Proof of Proposition A2 To prove the Proposition, we simply compare the value of the objective in (1) for two funds j and k with $\beta_j > \beta_k$ for an investor with risk aversion γ_i and borrowing bound l. After inserting the optimal weights $\omega_i^{j^*} = \min\{\frac{\mu_j - \phi_j}{\gamma_i \sigma_j^2}, l\}$ and $\omega_i^{k^*} = \min\{\frac{\mu_k - \phi_k}{\gamma_i \sigma_k^2}, l\}$, the result for the different cases follows from standard calculations.

Proof of Proposition A3 We prove the Proposition by assuming the contrary. Suppose that $\overline{\gamma_{j_2 j_1}} \geq \overline{\gamma_{j_1 k}}$ holds for certain funds j_1, j_2, k with $\beta_{j_2} > \beta_{j_1} > \beta_k$. According to Proposition A2, that means that fund j_2 is preferred over j_1 by all investors with $\gamma_i < \overline{\gamma_{j_2 j_1}}$, and that investors with $\gamma_i \geq \overline{\gamma_{j_1 k}}$ prefer fund k over j_1 or are indifferent between them. As $\overline{\gamma_{j_2 j_1}} \geq \overline{\gamma_{j_1 k}}$, this implies that there is no level of risk aversion for which the corresponding investors prefer fund j_1 over all other funds, such that j_1 does not survive in equilibrium.

Similarly, suppose that $\overline{\gamma_{j_2 k}} \geq \overline{\gamma_{j_1 k}}$ holds for certain funds j_1, j_2, k with $\beta_{j_2} > \beta_{j_1} > \beta_k$. According to Proposition A2, that means that investors with $\overline{\gamma_{j_1 k}} \leq \gamma_i \leq \overline{\gamma_{j_2 k}}$ prefer fund j_2 over k and prefer k over j_1 or are indifferent between them. This implies that the "cutoff" $\overline{\gamma_{j_2 j_1}}$ below which investors prefer j_2 over j_1 lies in $\overline{\gamma_{j_1 k}} \leq \overline{\gamma_{j_2 j_1}} < \overline{\gamma_{j_2 k}}$. Furthermore, investors with $\gamma_i \geq \overline{\gamma_{j_1 k}}$ prefer fund k over j_1 or are indifferent between them. As $\overline{\gamma_{j_1 k}} \leq \overline{\gamma_{j_2 j_1}}$, there is no level of risk aversion for which the corresponding investors prefer fund j_1 over all other funds, such that j_1 does not survive in equilibrium.

As we assume that fund j_1 exists in equilibrium, it follows that $\overline{\gamma_{j_2 j_1}} < \overline{\gamma_{j_1 k}}$ and $\overline{\gamma_{j_2 k}} < \overline{\gamma_{j_1 k}}$ for all funds j_1, j_2, k with $\beta_{j_2} > \beta_{j_1} > \beta_k$.

Proof of Proposition 1 The proof of our main proposition is in great parts given by the derivations provided in Appendix A.2. For the equilibrium fees solution (A8), note that the $\widetilde{\mu_M}$ term is greater than the negative σ_M^2 term in both expressions for all relevant combinations of the given parameters.[25] Therefore, Part (i) of the Proposition directly follows. For (ii), observe that $\frac{\partial \frac{\bar{l}}{2(1+(\bar{l}-1)\psi)}}{\partial \psi} < 0$ and $\frac{\partial \frac{\bar{l}}{2(1+(\bar{l}-1)\psi)}}{\partial \bar{l}} > 0$, from which the result follows. Part (iii) is an immediate implication of part (i), as gross alphas $\alpha_j' = \mu_j - \beta_j \mu_M$ are either zero in the model (for the CAPM case) or themselves falling in betas (for the BAB case).

[25] A sufficient condition is $\underline{\Gamma}\sigma_M^2 < \widetilde{\mu_M}/\beta_3$. In our benchmark calibration (see Table A1), it is $\underline{\Gamma}\sigma_M^2 = 0.01$ and $\widetilde{\mu_M}/\beta_3 = 0.0206$ in the betting-against-beta scenario, comfortably fulfilling this condition. In the CAPM case, $\widetilde{\mu_M}/\beta_3 = 0.0294$.

Internet Appendix

Part B: Supplementary Datasets and Additional Empirical Results

B.1 Supplementary Dataset: Portfolio Characteristics

We use a dataset of fund portfolio holding characteristics to generate proxies for fund management costs in our robustness tests. Using quarterly holdings data from Thomson Reuters, we collect data on portfolio holdings at the end of each quarter and calculate stock characteristics using information from the CRSP and Compustat databases. To match the quarterly reporting of fund holdings, we use portfolio characteristics from the last month of each quarter (i.e., in March, June, September, and December) unless stated otherwise. We aggregate characteristics at the fund-level by value-weighting individual stock characteristics in the fund's portfolio.

We use the proportional effective spread (PES) as a proxy for a stock's trading costs (Lesmond, Schill, and Zhou (2004), Hasbrouck (2009), and Novy-Marx and Velikov (2016)). In each reporting month (again the last month of each quarter) and for each stock in the fund's portfolio, we calculate the daily stock PES using the closing prices as

$$PES_{it} = \frac{2|Price_{it} - 0.5 \times (Bid_{it} + Ask_{it})|}{Price_{it}}. \tag{B1}$$

We use portfolio characteristics from Sheng, Simutin, and Zhang (2020) as proxies for equity valuation costs. Asset tangibility is defined as the ratio of the amount of plant, property, and equipment to the firm's total assets. Asset growth is the natural logarithm of the ratio of total assets at the end of a quarter to total assets at the end of the previous quarter. Operating profitability is the company's revenue reduced by the costs of goods sold and by various expenses (selling, general, administrative, and interest expenses), relative to the firm's book equity (Fama and French (2015)). Analyst coverage is the number of analysts who provide earnings forecasts for a stock. Idiosyncratic volatility is the standard deviation of the residual from the market model. The summary statistics for fund portfolio characteristics are reported in Table B2.

B.2 Supplementary Dataset: Fund Investment Practices

When we examine how funds provide leverage in Section 5, we employ an additional dataset on fund investment practices. To compile this dataset, we collect information from N-SAR filings, which are required for registered investment management companies. The filings are made available by the SEC in a standardized electronic format through the EDGAR database. Item 70 of the N-SAR form provides detailed information on whether the fund has engaged in various investment practices during the reporting period. We collect these filings using an automated scraping algorithm and match them by the fund name to our main fund-level sample. The matching of fund names is done algorithmically and is validated by manual checks.[26]

Overall, 70% of the funds in our main CRSP sample have at least one N-SAR filing matched. N-SAR forms are filed semiannually, and we match the last month of the reporting period to our main sample.[27] We ultimately have 26,831 fund-month observations matched over the period 1995–2016. For the matched funds, we observe one N-SAR filing record per year on average, suggesting a fund-month matching rate of approximately 50%.

We focus on a number of selected investment practices which are associated with leverage. The fund's answers to the questions (Qs) in the N-SAR filings precisely reveal whether the fund engages in these alternative practices. In particular, we follow Warburton and Simkovic (2019) and collect information on whether the fund: (1) borrows money (Q 70.O); (2) engages in short-selling (Q 70.R); (3) trades in options on individual equities or stock indices (Qs 70.B and 70.D); or (4) trades in stock index futures or options on stock index futures (Qs 70.F and 70.H). We create an indicator variable that equals one if the fund engages in any of these alternative investment practices, as well as similarly defined indicator variables for each practice separately.

We also construct an indicator variable which equals one if the difference between the fund's beta and the beta of the stock portfolio is larger than 0.05. We require the

[26] We match fund names based on the Levenshtein distance, a leading string matching metric in computer science. While the algorithm assigns a match to every fund name in principle, we treat entries with a matching score below 95 (out of 100) as unmatched. This strategy ensures that there are no false positive matches. An example for a match with a score of 95 is 'Phoenix Strategic Equity Series Fund: Phoenix-Seneca Equity Opportunities Fund' in CRSP vs. 'PHOENIX STRATEGIC EQUITY SERIES FUND: PHOENIX EQUITY OPPORTUNITIES FUND' in the N-SAR filings.

[27] The N-SAR filings do not specify during which particular months of a reporting period a certain investment practice was used, but funds do not change their investment practices very frequently. For the investment practices of interest, as defined below, the 1-period (half-year) autocorrelation is 0.82, and fund fixed effects explain 71% of the variation. Our results are almost identical when we match the information from an N-SAR filing to *all* months of the reporting period.

difference to be slightly larger than zero due to potential errors in the estimation of betas.[28] A positive difference indicates the presence of instruments other than stocks to lever up fund portfolio, providing another proxy for usage of alternative investment practices. The combined summary statistics for the dataset on investment practices are discussed in great detail in Section 5.1.

[28] The stock betas are estimated using the same procedure as for the fund betas, described in Section 3.2.

B.3 Additional Empirical Results

Table B1: Summary Statistics: Funds at Launch

This table presents summary statistics for the sample of fund-month observations over the period 1991–2016 at the fund share class level at the time of fund launch. The fund characteristics are from the CSRP mutual fund database. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *Gross CAPM alpha* and *Net CAPM alpha* are annualized estimates of the intercept from the market models for fund gross returns and fund net returns, respectively. *Log(TNA)* is the natural logarithm of fund total net assets. *(0,1) Passive fund* indicator equals one if a fund is passively managed. *(0,1) ETF* indicator equals one if a fund is an ETF. *(0,1) Retail fund* indicator equals one if a share class is offered to retail investors.

	N	Mean	SD	5%	25%	50%	75%	95%
Fee (%)	11,520	1.60	0.83	0.29	0.98	1.50	2.22	2.94
Beta	11,520	0.98	0.25	0.52	0.85	0.99	1.12	1.41
Gross CAPM alpha (%)	11,520	1.32	6.05	-6.22	-1.46	0.80	3.62	11.56
Net CAPM alpha (%)	11,520	-0.27	6.00	-8.06	-2.89	-0.61	1.93	9.69
Log(TNA)	11,520	1.56	2.50	-2.30	-0.22	1.71	3.43	5.46
(0,1) Passive fund	11,520	0.08	0.26	0.00	0.00	0.00	0.00	1.00
(0,1) ETF	11,520	0.04	0.19	0.00	0.00	0.00	0.00	1.00
(0,1) Retail fund	11,520	0.59	0.49	0.00	0.00	1.00	1.00	1.00

Table B2: Summary Statistics: Fund Portfolio Characteristics

This table presents summary statistics for fund portfolio characteristics. We aggregate characteristics at the fund level by value-weighting individual stock characteristics in the fund's portfolio. Panel A considers the full sample, Panel B the sample of funds with betas larger than one. *Beta* is an estimate of the slope from the market model for fund returns. *PES* is the proportional effective spread as a proxy for stock trading costs. *Asset tangibility* is the ratio of the amount of plant, property, and equipment to the firm's total assets. *Years since listed* is the number of years since the IPO. *Asset growth* is the natural logarithm of the ratio of total assets at the end of a quarter to total assets at the end of the previous quarter. *Operating profitability* is the company's revenue reduced by the costs of goods sold and by various expenses (selling, general, administrative, and interest expenses), relative to the firm's book equity. *Analyst coverage* is the number of analysts who provide earnings forecasts for a stock. *Idiosyncratic volatility* is the standard deviation of the residual from the market model.

Panel A: All funds	N	Mean	SD	5%	25%	50%	75%	95%
PES	69,737	0.19	0.21	0.04	0.06	0.12	0.24	0.55
Asset tangibility	69,439	0.24	0.11	0.12	0.18	0.22	0.27	0.42
Years since listed	69,244	13.91	4.67	5.93	10.70	13.95	17.12	21.45
Asset growth	69,482	0.03	0.02	-0.01	0.01	0.02	0.04	0.07
Operating profitability	68,976	0.09	0.04	0.03	0.07	0.09	0.11	0.13
Analyst coverage	69,737	12.39	4.01	8.36	10.05	10.89	14.09	20.24
Idiosyncratic volatility	69,684	0.09	0.03	0.05	0.07	0.08	0.10	0.14

Panel B: Funds with *Beta*>1	N	Mean	SD	5%	25%	50%	75%	95%
PES	37,430	0.17	0.19	0.04	0.06	0.11	0.22	0.51
Asset tangibility	37,318	0.22	0.09	0.11	0.17	0.21	0.24	0.34
Years since listed	37,299	13.63	4.25	6.26	10.90	13.69	16.47	20.36
Asset growth	37,331	0.03	0.03	-0.01	0.01	0.03	0.04	0.07
Operating profitability	37,099	0.08	0.03	0.03	0.06	0.08	0.10	0.13
Analyst coverage	37,430	12.45	3.82	8.80	10.13	10.88	14.36	19.96
Idiosyncratic volatility	37,403	0.09	0.03	0.06	0.07	0.09	0.11	0.15

Table B3: Relation between Fund Market Beta, Fund Fees, and Intensity of Fund Offerings

This table presents the results from regressing mutual fund fees on fund market beta and measures of intensity of fund offerings, separately for funds with betas larger than one and smaller than one. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *Number of funds per beta bin* is the number of funds (in thousands) with the value of beta falling into each 0.1 bin (e.g., fund with betas between 0.8–0.9 are in a bin, funds with betas between 1.1–1.2 are in another bin, etc.) in a specific month. *HHI per beta bin* is the TNA-weighted Herfindahl-Hirschman Index (HHI) that is estimated for each 0.1 bin of beta in each month. All the specifications include fund family fixed effects, month fixed effects, and the full set of control variables. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level		Fund level		Share class level		Fund level	
	Beta>1	*Beta*<1	*Beta*>1	*Beta*<1	*Beta*>1	*Beta*<1	*Beta*>1	*Beta*<1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Beta	0.33***	-0.09	0.28***	-0.00	0.52***	0.04	0.39***	0.03
	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)	(0.05)	(0.05)	(0.06)
N of funds per beta bin	-0.04**	0.03**	-0.07	-0.02				
	(0.02)	(0.02)	(0.05)	(0.05)				
HHI per beta bin					-0.29**	0.28*	-0.19*	0.29**
					(0.15)	(0.15)	(0.11)	(0.12)
Observations	511,810	476,797	219,912	218,872	511,810	476,797	219,912	218,872
R-squared	0.48	0.47	0.69	0.66	0.48	0.47	0.69	0.66
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B4: Relation between Fund Market Beta, Fund Fees, and Intensity of Fund Offerings: The Model with Interactions

This table presents the results from regressing mutual fund fees on fund market beta, measures of intensity of fund offerings, and on the interaction between fund market beta and an indicator for beta being greater than one. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1)[Beta>1]* indicator equals one if the fund's beta is greater than one. *Number of funds per beta bin* is the number of funds (in thousands) with the value of beta falling into each 0.1 bin (e.g., fund with betas between 0.8–0.9 are in a bin, funds with betas between 1.1–1.2 are in another bin, etc.) in a specific month. *HHI per beta bin* is the TNA-weighted Herfindahl-Hirschman Index (HHI) that is estimated for each 0.1 bin of beta in each month. All the specifications include fund family fixed effects, month fixed effects, and the full set of control variables. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level	Fund level	Share class level	Fund level
	Full Sample	*Full Sample*	*Full Sample*	*Full Sample*
	(1)	(2)	(3)	(4)
Beta(0,1)[Beta>1]*	0.52***	0.35***	0.49***	0.38***
	(0.11)	(0.10)	(0.09)	(0.08)
Beta	-0.08	-0.01	-0.00	-0.03
	(0.07)	(0.07)	(0.05)	(0.06)
(0,1)[Beta>1]	-0.42***	-0.33***	-0.40***	-0.29***
	(0.11)	(0.11)	(0.09)	(0.08)
N of funds per beta bin(0,1)[Beta>1]*	-0.01	0.10		
	(0.02)	(0.06)		
N of funds per beta bin	0.01	-0.06		
	(0.01)	(0.05)		
HHI per beta bin(0,1)[Beta>1]*			-0.79***	-0.51***
			(0.21)	(0.15)
HHI per beta bin			0.28*	0.27**
			(0.15)	(0.12)
Observations	988,613	438,795	988,613	438,795
R-squared	0.47	0.66	0.47	0.66
Control variables	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes

Table B5: Relation between Fund Market Beta and Fund Fees across Distribution Channels

This table presents the results from regressing mutual fund fees on fund market beta and on the interaction between fund market beta and an indicator for beta being greater than one separately for direct-sold and broker-sold fund share classes. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1)[Beta>1]* indicator equals one if the fund's beta is greater than one. A fund share class is considered *Direct-sold* if it charges no front or back load, and has an annual distribution fee ("12b-1" fee) of no more than 25 basis points; otherwise it is considered *Broker-sold*. All the specifications include fund family fixed effects, month fixed effects, and the full set of control variables. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level					
	Beta>1		*Beta<1*		*Full Sample*	
	Broker-sold	*Direct-sold*	*Broker-sold*	*Direct-sold*	*Broker-sold*	*Direct-sold*
	(1)	(2)	(3)	(4)	(5)	(6)
Beta(0,1)[Beta>1]*					0.37***	0.30***
					(0.09)	(0.07)
Beta	0.45***	0.39***	0.06	0.09	0.02	0.02
	(0.06)	(0.04)	(0.06)	(0.06)	(0.06)	(0.05)
(0,1)[Beta>1]					-0.27***	-0.22***
					(0.09)	(0.07)
Observations	309,159	202,644	291,305	185,480	600,470	388,130
R-squared	0.46	0.71	0.47	0.69	0.46	0.69
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table B6: Relation between Fund Market Beta and Fund Fees: Fund Style Fixed Effects Regressions

This table presents the results from regressing mutual fund fees on fund market beta and fund style fixed effects separately for funds with betas larger than one and smaller than one, and on the interaction between fund market beta and an indicator for beta being larger than one. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1)[Beta>1]* indicator equals one if the fund's beta is greater than one. Fund style fixed effects are defined based on the fund Lipper classification. All the specifications include fund family fixed effects, month fixed effects, and the full set of control variables. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level			Fund level		
	Beta>1	*Beta*<1	*Full Sample*	*Beta*>1	*Beta*<1	*Full Sample*
	(1)	(2)	(3)	(4)	(5)	(6)
Beta(0,1)[Beta>1]*			0.23***			0.14**
			(0.08)			(0.07)
Beta	0.27***	0.02	-0.01	0.21***	0.04	0.03
	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)	(0.05)
Observations	494,236	447,855	942,098	205,488	193,260	398,557
R-squared	0.49	0.52	0.51	0.72	0.72	0.71
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund style fixed effects **(0,1)[Beta>1]*	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table B7: Relation between Fund Market Beta and Fund Fees: Expense Ratios Only

This table presents the results from regressing mutual fund expense ratios on fund market beta separately for funds with betas larger than one and smaller than one, and on the interaction between fund market beta and an indicator for beta being larger than one. *Expense Ratio* is a fund's annual expense ratio. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1)[Beta>1]* indicator equals one if the fund's beta is greater than one. All the specifications include fund family fixed effects, month fixed effects, and the full set of control variables. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Expense Ratio*	Share class level			Fund level		
	Beta>1	*Beta*<1	*Full Sample*	*Beta*>1	*Beta*<1	*Full Sample*
	(1)	(2)	(3)	(4)	(5)	(6)
Beta(0,1)[Beta>1]*			0.37***			0.31***
			(0.07)			(0.07)
Beta	0.43***	0.04	-0.00	0.32***	0.01	-0.04
	(0.05)	(0.05)	(0.05)	(0.03)	(0.05)	(0.05)
(0,1)[Beta>1]			-0.29***			-0.23***
			(0.07)			(0.07)
Observations	511,810	476,797	988,613	219,912	218,872	438,795
R-squared	0.48	0.51	0.49	0.73	0.68	0.69
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table B8: Relation between Fund Market Beta and Fund Fees: Active Funds Only

This table presents the results from regressing mutual fund fees on fund market beta in the sample of active funds, separately for funds with betas larger than one and smaller than one, and on the interaction between fund market beta and an indicator for beta being larger than one. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1)[Beta>1]* indicator equals one if the fund's beta is greater than one. All the specifications include fund family fixed effects, month fixed effects, and the full set of control variables. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level			Fund level		
	Beta>1	*Beta*<1	*Full Sample*	*Beta*>1	*Beta*<1	*Full Sample*
	(1)	(2)	(3)	(4)	(5)	(6)
Beta(0,1)[Beta>1]*			0.44***			0.34***
			(0.09)			(0.09)
Beta	0.49***	0.04	-0.01	0.37***	0.01	-0.04
	(0.06)	(0.07)	(0.05)	(0.05)	(0.07)	(0.06)
(0,1)[Beta>1]			-0.35***			-0.27***
			(0.09)			(0.09)
Observations	479,529	436,025	915,559	197,787	194,707	392,504
R-squared	0.40	0.40	0.39	0.63	0.60	0.60
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table B9: Relation between Fund Market Beta and Fund Fees: Robustness to Trading and Valuation Costs

This table presents the results from regressing fund fees on fund market beta and proxies for trading and valuation costs. The proxies for a fund's trading and valuation costs are obtained by value-weighting individual stock characteristics in the fund's portfolio. All the regressions are estimated for funds with betas larger than one. *Beta* is an estimate of the slope from the market model for fund returns. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *PES* is the proportional effective spread as a proxy for stock trading costs. *Asset tangibility* is the ratio of the amount of plant, property, and equipment to the firm's total assets. *Years since listed* is the number of years since the IPO. *Asset growth* is the natural logarithm of the ratio of total assets at the end of a quarter to total assets at the end of the previous quarter. *Operating profitability* is the company's revenue reduced by the costs of goods sold and by various expenses (selling, general, administrative, and interest expenses), relative to the firm's book equity. *Analyst coverage* is the number of analysts who provide earnings forecasts for a stock. *Idiosyncratic volatility* is the standard deviation of the residual from the market model. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Beta	0.42***	0.42***	0.33***	0.41***	0.40***	0.43***	0.36***	0.34***
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)
PES	0.05							-0.01
	(0.05)							(0.05)
Asset tangibility		-0.13*						-0.10
		(0.07)						(0.07)
Years since listed			-0.01***					-0.01***
			(0.00)					(0.00)
Asset growth				0.52**				0.10
				(0.26)				(0.21)
Operating profitability					-0.35**			-0.16
					(0.17)			(0.16)
Analyst coverage						-0.00		-0.01***
						(0.00)		(0.00)
Idiosyncratic volatility							0.84**	-0.21
							(0.36)	(0.41)
Observations	91,286	91,108	91,095	91,147	90,700	91,286	91,242	90,641
R-squared	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B10: Relation between Fund Market Beta and Tightness of Borrowing Constraints

This table presents information on the average change in fund market beta over constrained and unconstrained periods. We separately report the average changes for funds with beta larger than one and smaller than one. We also present the differences in the averages between constrained and unconstrained periods and the related p-values. The measures of borrowing constraint tightness include the BAB measure from Frazzini and Pedersen (2014), the ICR measure from He, Kelly, and Manela (2017), and the LCT measure from Boguth and Simutin (2018). The sample consists of months when the measure of tightness is either in the first quartile or in the fourth quartile of its distribution across time. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1) Constrained* indicator is defined for each measure separately and equals one if the BAB or ICR measures are in the first quartile of their distributions across time, and if the LCT measure is in the fourth quartile of its distribution across time. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively.

	Change in *Beta*					
Measure of borrowing constraint tightness	BAB		ICR		LCT	
	Beta>1	*Beta*<1	*Beta*>1	*Beta*<1	*Beta*>1	*Beta*<1
(0,1)Constrained=1	-0.0007	0.0006	0.0000	-0.0003	0.0011	0.0005
(0,1)Constrained=0	0.0011	-0.0003	0.0005	0.0005	-0.0009	-0.0005
Difference	-0.0017	0.0009	-0.0005	-0.0008	0.0020	0.0010
p-value	0.4079	0.4663	0.7688	0.3887	0.2803	0.3821

Table B11: Relation between Fund Entries, Exits, and Tightness of Borrowing Constraints

This table presents information on fund entries and exits over constrained and unconstrained periods. We report the average fraction of fund entries and fund exits per period relative to the overall number of funds in that period, separately for funds with beta larger than one and smaller than one. We also present the differences in the averages between constrained and unconstrained periods and the related p-values. The measures of borrowing constraint tightness include the BAB measure from Frazzini and Pedersen (2014), the ICR measure from He, Kelly, and Manela (2017), and the LCT measure from Boguth and Simutin (2018). The sample consists of months when the measure of tightness is either in the first quartile or in the fourth quartile of its distribution across time. *Beta* is an estimate of the slope from the market model for fund returns. *(0,1) Constrained* indicator is defined for each measure separately and equals one if the BAB or ICR measures are in the first quartile of their distributions across time, and if the LCT measure is in the fourth quartile of its distribution across time. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively.

Panel A:	Fraction of Fund Entries					
Measure of borrowing constraint tightness	BAB		ICR		LCT	
	Beta>1	*Beta*<1	*Beta*>1	*Beta*<1	*Beta*>1	*Beta*<1
(0,1)Constrained=1	0.0138	0.0123	0.0105	0.0121	0.0220	0.0213
(0,1)Constrained=0	0.0221	0.0232	0.0232	0.0222	0.0144	0.0149
Difference	-0.0084	-0.0108	-0.0127**	-0.0101*	0.0077	0.0064
p-value	0.2910	0.1289	0.0288	0.0639	0.3708	0.4023

Panel B:	Fraction of Fund Exits					
Measure of borrowing constraint tightness	BAB		ICR		LCT	
	Beta>1	*Beta*<1	*Beta*>1	*Beta*<1	*Beta*>1	*Beta*<1
(0,1)Constrained=1	0.0058	0.0051	0.0076	0.0070	0.0056	0.0050
(0,1)Constrained=0	0.0044	0.0044	0.0040	0.0041	0.0050	0.0041
Difference	0.0014**	0.0007	0.0036***	0.0030***	0.0007	0.0009
p-value	0.0457	0.3572	0.0001	0.0001	0.4912	0.1870

Table B12: Relation between Fund Market Beta and Fund Fees over Time

This table presents the results from regressing mutual fund fees on fund market beta for different sample periods, separately for funds with betas larger than one and smaller than one. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *Beta* is an estimate of the slope from the market model for fund returns. Only the coefficients on *Beta* are reported. All the specifications include fund family fixed effects, month fixed effects, and the full set of control variables. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

y = *Fee*	Share class level		Fund level	
	Beta>1	*Beta<1*	*Beta>1*	*Beta<1*
Sample period	(1)	(2)	(3)	(4)
	Coefficient on *Beta*			
1995–2000	0.33**	-0.11	0.37**	-0.13
	(0.14)	(0.18)	(0.14)	(0.11)
2001–2005	0.32***	0.05	0.37***	-0.00
	(0.08)	(0.08)	(0.09)	(0.10)
2006–2010	0.36***	-0.08	0.37***	-0.21**
	(0.05)	(0.09)	(0.05)	(0.10)
2011–2016	0.57***	-0.02	0.34***	-0.03
	(0.10)	(0.08)	(0.09)	(0.08)