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Paying for beta: Leverage demand and asset management fees[☆]

Steffen Hitzemann[a], Stanislav Sokolinski[b,*], Mingzhu Tai[c]

[a] Rutgers Business School, Rutgers University, 100 Rockafeller Road, Piscataway, NJ 08854, USA
[b] Rutgers Business School, Rutgers University, 1 Washington Park, Newark, NJ 07102, USA
[c] Faculty of Business and Economics, The University of Hong Kong, Pokfulam Road, Hong Kong

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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 asymmetric relation between betas and fees also extends to the HML and SMB factors.

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 gross 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. Our basic idea can be illustrated through the following example. Consider two rational investors with different

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* Corresponding author.
E-mail addresses: hitzemann@business.rutgers.edu (S. Hitzemann), ssokolinski@business.rutgers.edu (S. Sokolinski), taimzh@hku.hk (M. Tai).

[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.

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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. 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. Empirically, we find that leverage-based fees are considerable, and they represent an important source of fee variation. At the same time, the total cost of embedded leverage obtained through high-beta funds is at the lower end relative to alternatives, suggesting that asset managers provide leverage at a competitive price.

To sharpen this intuition and to guide our empirical analysis, we present a model 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, 2014; Boguth and Simutin, 2018; Frazzini and Pedersen, 2022), and investors vary in their risk aversion. To focus on 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. Risk-averse investors invest in the combination of a market index fund and the risk-free asset, and do not require leverage. Consequently, fees of asset managers with betas smaller than one do not increase in beta. Even though higher-beta funds can charge higher fees, the asset managers' endogenous betas are quite evenly distributed in equilibrium due to their competition avoidance motive. In particular, some managers address a small clientele of extremely risk-seeking investors by choosing a high beta, while others choose a lower beta at a level where a greater investor clientele outweighs the lower fees.

Our framework delivers three new testable hypotheses. First, we expect to observe an asymmetric relation between market beta and fees. 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, 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 et al., 1972; Frazzini and Pedersen, 2014). As a result, our theory suggests that net-of-fee underperformance is exacerbated for high-beta funds.

We examine these hypotheses in the sample of the U.S. domestic equity mutual funds. Our baseline empirical result is illustrated in Fig. 1. In line with our first hypothesis, fund fees increase with beta when beta is larger than one. 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. Annual fees increase by 32–63 basis points per unit of leverage (when beta increases by one), while the median total fee is 131 basis points in our sample. 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 8.6 basis points in fees, while a similar change in log fund size or log fund age changes fees by 13 basis points and 3 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.

Furthermore, we find that the effect of beta on fees is driven by both cross-sectional and time-series variations. Consistent with our model, high-beta funds set higher fees from their first appearance in the market. At the same time, changes in beta within funds also affect fees, albeit with smaller economic magnitude. Fund fees are highly persistent, but when they change, an increase in beta is followed by an increase in fees for funds with beta greater than one. The entry of new leveraged ETFs also contributes to the time-variation in fees by introducing alternatives for leverage-constrained investors and leading to price competition. An increase of one standard deviation in penetration of leveraged ETFs reduces the effect of beta on fees by 16%. This lends additional support to our main mechanism, suggesting that the provision of leverage is an important dimension of competition in asset management.

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 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 retail investors pay almost twice more per extra unit of leverage, relative to institutional investors. In our second series of tests, we examine the effects of time variation in

[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.

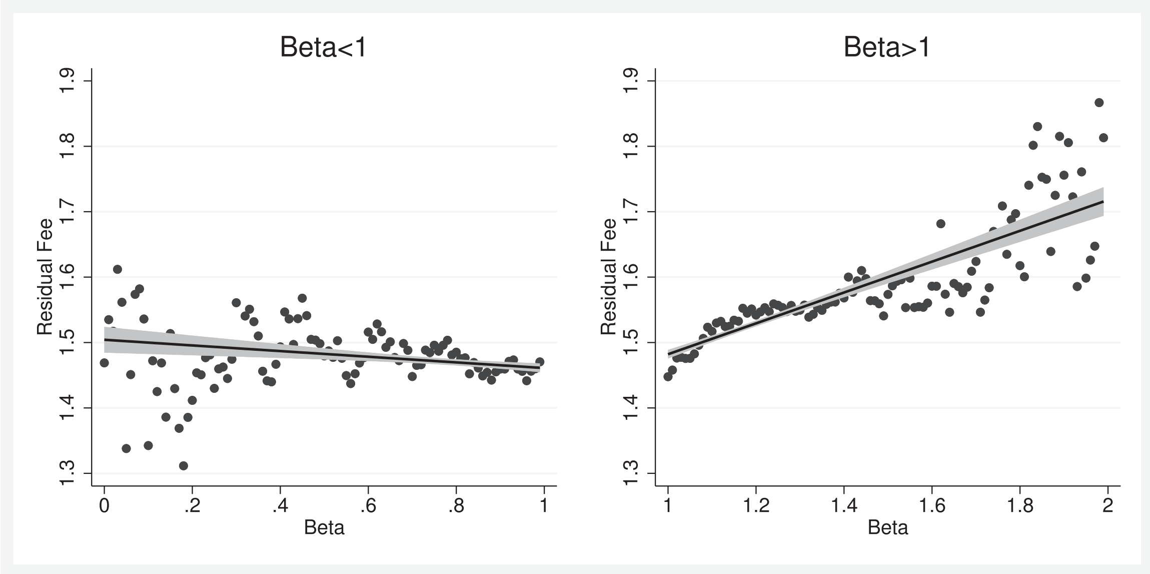

Fig. 1. The empirical relationship between market beta and fees. This figure presents the binscatter plot of residual fees against fund betas separately for funds with betas larger than one and smaller than one. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front 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.

leverage constraints. Since variation in fees within a given fund is limited, we study the cross-section of new funds launched in different periods. We expect the relation between beta and fees to be stronger for funds launched in periods of tight leverage constraints. Using multiple measures of constraints, we find that funds introduced in constrained periods charge roughly twice more per unit of beta relative to funds introduced in less constrained periods.[4]

An increase in demand is expected to produce not only an increase in prices (fees) but also in quantities (assets under management). We thus examine how changes in beta affect fund flows to further test the leverage demand channel. Conditional on fees being unchanged, high-beta funds gain extra flows following an increase in beta, in line with the increased demand from leverage-constrained investors. Specifically, we find that for funds with beta greater than one, a one-unit increase in beta is associated with an increase of 1.8 percentage points (0.62 standard deviations) in fund flows. Additionally, the investors' response is much stronger in periods of tight leverage constraints. Changes in beta do not, on the other hand, induce significant changes in fund flows when beta is smaller than one.

We proceed to examine our third hypothesis and explore the implications for fund net-of-fee performance. Using portfolio sorting, we 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 74 basis points per year. Net alphas of high-beta funds are low due to both high fees (driven by the effect we document in this paper) and low gross-of-fees alphas (driven by the effect of "betting against beta"). These results suggest that demand for leverage plays an influential role in accounting for the poor net-of-fees performance of many equity mutual funds.

We further examine whether the effects of leverage demand extend to investments based on other popular factors such as HML and SMB.[5] Similar to our analysis of the market factor, we ask whether investors are willing to pay extra fees for funds with more extreme factor betas which are not easily attainable through factor-based index funds. For the HML factor, for instance, leverage-constrained investors who are interested in a "deep value" portfolio may be willing to pay higher fees for funds with very high HML betas, which they cannot obtain through value-oriented index funds. Similarly, growth-oriented investors are expected to pay higher fees for funds with very low HML beta. On the contrary, we do not expect investors to pay higher fees for the range of HML betas that can be easily obtained through growth or value index funds. This intuition yields the hypothesis that the relation between factor betas and fees is U-shaped. Our empirical results support the U-shaped relation. In particular, we find that extreme value (growth) funds charge extra 12 (16) basis points per unit of HML beta, while the relation is flat for funds with moderate HML betas. Micro-cap (mega-cap) funds charge an additional 34 (38) basis points in fees per unit of SMB

[4] Our measures include the betting-against-beta (BAB) factor from Frazzini and Pedersen (2014), the intermediary capital ratio (ICR) from He et al. (2017), and the leverage constraint tightness (LCT) measure from Boguth and Simutin (2018).

[5] We thank an anonymous referee for making this suggestion.

beta. These findings suggest that "paying for beta" extends to other factor-oriented investments in a manner consistent with the demand for leverage.

We complete the picture by investigating how high-beta funds obtain leverage, focusing on the market factor as in our main analysis. 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 from N-SAR filings, we show that only 28% of high-beta funds engage in the alternative investment practices associated with leverage. High-beta funds are also as likely to engage in these practices as the rest of the funds, and their betas do 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, 2021). The sensitivity of fees to beta also does not depend on fund investment practices. This suggests that the effect of beta on fees is not driven by the supply side (i.e., how high beta is obtained), but rather by investor demand, consistent with our theory.

We conclude by providing an estimate of the total costs of leverage for high-beta fund investors, which are determined by the combination of extra fees and reduced gross alpha. The portfolio sorting analysis suggests a gross performance loss of 109 basis points per year when beta is increased by one. Together with the extra fee of 32–63 basis points per year, we obtain a total cost of 141–172 basis points per year for one unit of leverage. The cost of leverage embedded in high-beta funds is therefore economically significant, but not higher than for leveraged ETFs (Lu and Qin, 2021; Frazzini and Pedersen, 2022), 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. In important neoclassical models with fully competitive markets and rational investors, asset management fees 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 higher than their risk-adjusted returns.[6] Significant variation in fees exists even among index funds which, by definition, are not expected to deliver above-benchmark performance to their investors (Elton et al., 2004; Hortaçsu and Syverson, 2004). The literature concludes that the large and persistent dispersion in fees cannot be fully rationalized by standard 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 et al., 2021).

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 performance (Del Guercio and Reuter, 2014), and paying for "peace of mind" (Gennaioli et al., 2014; Gennaioli et al., 2015).[7]

Our additional contribution is to link the growing literature on the effects of leverage constraints to the literature on fund fees and performance. Building on the idea of Black (1972), Frazzini and Pedersen (2014) and Frazzini and Pedersen (2022) show that embedded leverage is associated with lower risk-adjusted returns. Our results extend their work, showing that fund investors pay a premium for access to leverage not only in form of lower risk-adjusted returns but also via higher fees. We further document that the leverage-based fees are not limited to leveraged ETFs (Frazzini and Pedersen, 2022), they exist among style-oriented funds, and they significantly vary over time and in the cross-section of investors in a manner consistent with the underlying variation in leverage demand.[8]

Our study is also related to the literature on competition in delegated money management. In addition to the early work by Berk and Green (2004), recent theoretical research includes Cuoco and Kaniel (2011), Pástor and Stambaugh (2012), and Kaniel and Kondor (2013). Christoffersen and Musto (2002), Khorana et al. (2008), Gil-Bazo and Ruiz-Verdú (2009), Sheng et al. (2020), and Cooper et al. (2021) examine the determinants of mutual fund fees empirically.

[6] 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 et al. (2019).

[7] Gennaioli et al. (2014) and Gennaioli et al. (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.

[8] 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 et al., 2019), while returns on leveraged funds can be used to evaluate asset managers' costs of leverage (Lu and Qin, 2021). 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).

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 simultaneously choose their betas and 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.[9] 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.

2.1.1. Asset managers

There is a finite set J of asset managers, each with endogenous market beta β_j. We also assume that there is always an asset manager who offers a market index fund with $\beta_M = 1$. Asset managers charge fees ϕ_j per dollar invested. A fund with beta 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 funding constraints for asset managers (Frazzini and Pedersen, 2014; Boguth and Simutin, 2018).

2.1.2. Investors

There is a unit measure of investors. Investors have constant absolute risk aversion (CARA) preferences and vary in 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, $\omega_i \le l$. 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 $l = \bar{l} > 1$.

2.1.3. 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 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

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

where AUM_j are the assets under management that are allocated to j when her fund has a beta of β_j and she sets the fee 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.[10] All asset managers with betas different from 1 offer differentiated products and engage in monopolistic competition with each other, taking the investors' demand function as given when maximizing revenues. A model equilibrium is a combination of betas β_j and fees ϕ_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).

2.2. Model solution

We solve the model in two steps. First, we solve for equilibrium fund fees conditional on the funds' betas. Second, we solve for the equilibrium betas, given the solution for fees from the first step. Our model characterizes the relation between fund beta and fees in equilibrium, yielding our main result that fees increase in beta for betas greater than one.

2.2.1. Fees conditional on betas

As the first step, we characterize the investors' choice dependent on their risk aversion, given a set of funds with fixed betas. 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 Online 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. Conditional on the funds' beta values, we can efficiently compute the resulting equilibrium fees numerically. An analytical solution for the fees conditional on betas can be obtained for a particular linear case, in which the following proposition

[9] See, for example, Cuoco and Kaniel (2011), Gennaioli et al. (2014), and Gennaioli et al. (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).

[10] 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.

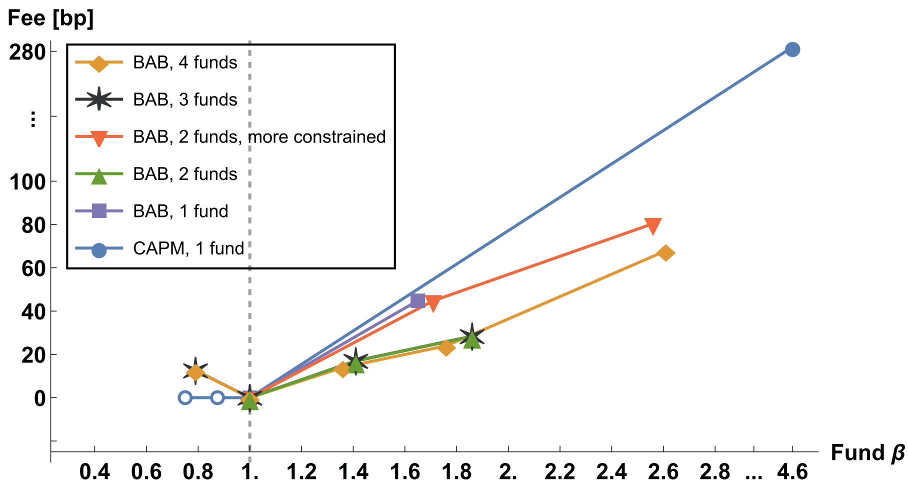

Fig. 2. The theoretical relationship between beta and fees. This figure presents the relation between fund betas and fees as predicted by our model. The blue line with round markers stands for a CAPM scenario with one fund in addition to the market ETF. Hollow circles indicate that in the CAPM case, the fee for any potential $\beta < 1$ fund is exactly zero and funds do not endogenously choose a beta smaller than one. The other lines stand for various BAB scenarios with one (purple line, square markers), two (green line, triangle markers), three (gray line, star markers), or four funds (yellow line, diamond markers) in addition to the market ETF. Parameters are set according to the "less constrained" scenario in Online Appendix Table A1. The orange line (inverse triangle markers) repeats the two funds scenario for the case of "more constrained" investors. In all scenarios, fund betas and fees result endogenously from the model equilibrium, which is computed numerically.

summarizes our main result for the scenario of four asset managers with betas $0 < \beta_0 < \beta_1 = \beta_M = 1 < \beta_2 < \beta_3$.[11]

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.*

2.2.2. Calibrated equilibrium

Based on the solution for equilibrium fund fees conditional on betas, we solve numerically for the full model equilibrium by computing the asset managers' optimal beta choices.[12] We depict the resulting fund betas and their fees for multiple scenarios in Fig. 2. The model is calibrated as specified in Online Appendix Table A1.

Our results show that due to the investors' willingness to pay for leverage, there is an incentive for asset managers to offer high-beta funds. The blue round markers refer to a setting in which the CAPM holds. Funds always choose betas greater than one in this scenario; funds do not choose betas smaller than one as their fees are bounded to zero in the CAPM case.[13] The square, triangle, star, and diamond markers show various BAB scenarios which exhibit a flatter security market line in the asset market. Similar to the CAPM case, all asset managers choose betas greater than one in scenarios featuring one or two funds in addition to the market ETF; in the case of three or four funds, all managers except one choose a beta greater than one. The calibrated equilibrium shows that high-beta funds differentiate themselves from each other to avoid increased competition. As a result, the endogenous fund betas are quite evenly distributed.

Fig. 2 also confirms that in all cases, fund fees increase in fund betas for beta greater than one. Investors with the lowest risk aversion choose the asset manager with the highest beta. Since these investors are willing to pay more for embedded leverage, they pay the highest fee in equilibrium. The next group of investors chooses the asset manager with the second-highest beta and pay a lower fee. More risk-averse investors invest in the market index fund

[11] To solve for the model equilibrium, we assume that γ_i is uniformly 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. We characterize and explore the linear case, for which we can solve for fees analytically, in Online Appendix A.2. We explicitly prove Proposition 1 for this case in Online Appendix A.3.

[12] Technically, we compute equilibrium fees and fund revenues for a dense grid of possible beta choices, given a number of asset managers $|J|$. We calculate the endogenous equilibrium betas by iterating over this grid.

[13] Asset managers tend to choose very high betas in the CAPM case of the calibrated model to benefit from higher fees. The investors' willingness to pay for beta, however, tapers off at the "target beta" of the most risk-seeking constrained investors. Therefore there is no incentive for choosing a beta that exceeds that target beta even if there is no competition from other asset managers, as the simple scenario of one fund in addition to the market ETF nicely illustrates. In the BAB case, the attractiveness of very high betas is counteracted by their lower gross alphas, leading to lower endogenous betas. At the same time, funds with beta smaller than one can also charge non-zero fees in the BAB case due to their greater gross alphas.

with $\beta_M = 1$. For beta smaller than one, fees are bounded to zero by the market index fund and therefore flat in the CAPM case.[14] In the BAB cases, fees of low-beta funds may decline in beta since fund gross alpha declines in beta. 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.

Comparing the green line (triangle markers) and the orange line (inverse triangle markers) shows the implications of tighter leverage constraints. In this case, the willingness to pay for embedded leverage increases for all the investors, and asset managers with betas above one can charge even higher fees. As a result, the scenario of tighter borrowing constraints features higher endogenous betas and an increased slope of the beta-fee relation.

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.

2.3. Testable hypotheses

In our empirical work, we examine three specific hypotheses that are implied by Proposition 1 and our numerical solution of the calibrated model.

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). 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.[15]

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.[16]

The second part of Hypothesis 2 is also implied by Proposition 1(ii). The tightness of leverage constraints varies over time (Frazzini and Pedersen, 2014; He et al., 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.

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). A relatively flat security market line already suggests that high-beta funds have lower gross alpha, which leads to lower net alpha (Black et al., 1972; Frazzini and Pedersen, 2014). However, our model suggests that fees can further reduce net alphas of high-beta funds. As a result, when beta increases, fees are expected to progressively increase the gap between the net and gross alphas.

3. Data and methodology

3.1. Data and variables

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, keep only domestic equity funds using the information on fund investment objectives, and exclude mixed-asset funds.

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.[17]

In our main tests, we build on fund-level data where 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 identify funds and share classes based on the CRSP identifiers. We use share-class-level data in several additional tests to explore share-class-specific features. For parts of our analysis, we also employ a fund launch dataset. To obtain this data,

[14] As discussed, funds do not endogenously choose a beta smaller than one in the CAPM case of our model as the zero fees result in zero potential revenues. Nevertheless, funds with beta smaller than one exist in the data, most likely for reasons that are unrelated to "paying for beta". Our model predicts that their fees are non-increasing in beta.

[15] 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, size, age, and fund family pricing policies (Gil-Bazo and Ruiz-Verdú, 2009; Cooper et al., 2021).

[16] In the context of our 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.

[17] In Online Appendix B.2.4 we show that our results are not sensitive to alternative definitions of fees.

we define the month of a fund's first share class's first appearance in the CRSP database as the month of its launch, and collect the fund data only for this month.

We supplement these data by four additional datasets for various tests: (1) proxies for fund management costs; (2) fund investment practices from N-SAR filings; (3) a sample of leveraged ETFs; and (4) a sample of style-based index funds. We describe and summarize these data in detail in Online Appendix B.1.

3.2. Estimation of betas 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:

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

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, which we annualize and further refer to as an estimate of fund CAPM alpha. We refer to the estimate of β_i^{MKT} as the fund market beta.

For our analysis of the effects of other factor betas in Section 4.5, we estimate the standard 3-factor model:

$$R_{it} - R_{ft} = \alpha_i + \beta_i^{MKT}(R_{Mt} - R_{ft}) + \beta_i^{SMB}R_{SMB,t} + \beta_i^{HML}R_{HML,t} + e_{it}. \tag{4}$$

The returns on the SMB and HML factors are from Kenneth French's website. In most of our analyses, we use estimates from the market model since our focus is on the effects of market beta.[18] We use two variants of the models 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 expense ratio. 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 between 0 and 2.[19]

We present the distribution of the number of funds across market betas in Online Appendix Fig. B1. 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 0.5–1.5.

3.3. Summary statistics

We present the summary statistics for our main variables in Panel A of Table 1. The average annual fee over the sample period is 1.38%, and its standard deviation is 0.69%. The standard deviation of fees within a given fund over time equals only 0.08%, 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 1.31%. The funds at the top 5% of the fee distribution charge a 2.49% fee while the funds at the bottom 5% of the distribution charge only 0.30%.

The average fund market beta equals 1, with a standard deviation of 0.27 and a within-fund standard deviation of 0.06. Similar to fund fees, there is significantly more variation in market beta across funds than within funds. The average gross CAPM alpha equals 1.74% (t-stat = 12.3, with standard errors clustered by month) and the average gross 3-factor alpha is 0.81% (t-stat = 12.5). The average net CAPM alpha equals 0.35%, while the average net 3-factor alpha is -0.57%. Fees thus considerably reduce returns to investors, turning the average alpha negative when factor exposures are taken into account. Passive funds represent 13% of the fund-months in our sample and ETFs represent 7%.[20]

We next examine the relative magnitudes of between-fund and within-fund variation in betas and fees. We report the R-squared from the regressions of variables on fund fixed effects in the last column of Panel A. The time-invariant characteristics drive 89% of the variation in fees and 67% of the variation in market betas. They also explain 86% of the variation in SMB betas and 66% of the variation in HML betas. These results 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.[21]

In Panel B, we present additional descriptive statistics on the persistence of fund-level fees and betas. We calculate the probability that fees or beta experience a certain change within a fund from one month to the next. The results further support the limited time-series variation. For

[18] Our main results are not sensitive to whether we use market beta estimated from the market model or from the 3-factor model. The correlation between fund market betas obtained from the two models is 84%.

[19] 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 or wider range of betas.

[20] We identify passive funds and exchange-traded funds (ETFs) based on the CRSP definitions. We define a fund as passive if its "Index Fund Flag" in the CRSP Database is non-empty. We define a fund as an ETF if its "ETF_ETN Fund Flag" equals "F" (for ETF) or "N" (for ETN). 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 index-linked ETFs. 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.

[21] This is also consistent with the prior evidence on standard deviations across and within funds.

Table 1
Summary statistics. This table presents summary statistics for the sample of fund-month observations over the period 1991–2016 at the fund level in Panel A. The fund characteristics are from the CRSP 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. β^{MKT} is an estimate of the slope from the market model for fund returns. β^{HML} and β^{SMB} are loadings on HML and SMB factors, estimated from the 3-factor model for fund returns. α^{GROSS} and α^{NET} are annualized estimates of the intercept from the market models or from the 3-factor models for fund gross returns and fund net returns, respectively. *TNA* is the fund total net assets. *Age* is the fund age in months. $1_{Passive}$ indicator equals one if a fund is passively managed. 1_{ETF} indicator equals one if a fund is an ETF. *Net flow* is the monthly net fund flow. *N 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 column reports the R^2 of the regressions of variables on fund fixed effects. Panel B presents the probabilities of changes in *Fee* and β^{MKT} across selected magnitudes.

Panel A: Main Variables	N	Mean	SD	Within SD	5%	25%	50%	75%	95%	R^2 - fund FE
Fee (%)	421,180	1.38	0.69	0.08	0.30	0.94	1.31	1.82	2.49	0.89
β^{MKT}	421,180	1.00	0.27	0.06	0.55	0.88	1.01	1.15	1.43	0.67
β^{HML}	417,045	0.04	0.36	0.10	-0.51	-0.19	0.02	0.25	0.68	0.66
β^{SMB}	417,045	0.21	0.36	0.07	-0.24	-0.08	0.12	0.49	0.86	0.86
α^{GROSS} from CAPM (%)	421,180	1.74	6.69	2.22	-5.70	-0.99	1.14	3.88	11.54	0.34
α^{NET} from CAPM (%)	421,180	0.35	6.69	2.20	-7.28	-2.30	-0.13	2.45	10.01	0.34
α^{GROSS} from 3-factor (%)	417,045	0.81	4.75	1.73	-5.50	-1.12	0.60	2.70	7.91	0.38
α^{NET} from 3-factor (%)	417,045	-0.57	4.77	1.73	-7.06	-2.52	-0.56	1.32	6.40	0.38
TNA ($MM)	421,180	1943	8317	79	15	94	354	1262	7157	0.66
Age (months)	421,180	193.29	154.47		62	96	147	225	527	
$1_{Passive}$	421,180	0.13	0.33		0.00	0.00	0.00	0.00	1.00	
1_{ETF}	421,180	0.07	0.25		0.00	0.00	0.00	0.00	1.00	
Net flow	398,975	-0.003	0.029		-0.046	-0.016	-0.005	0.006	0.048	
N of funds per beta bin	421,180	225.83	151.15		20	98	186	358	472	
HHI per beta bin	421,180	0.07	0.09		0.01	0.03	0.05	0.09	0.21	

Panel B: Probability of Change in Fee and Market Beta Within Fund					
$y = Fee$	$\lvert\Delta y\rvert > 0$	$\Delta y < -5\,bps$	$\Delta y < -1\,bps$	$\Delta y > 1\,bps$	$\Delta y > 5\,bps$
	8%	2%	4%	3%	1%
$y = \beta^{MKT}$		$\Delta y < -0.1$	$\Delta y < -0.05$	$\Delta y > 0.05$	$\Delta y > 0.1$
		0.4%	2%	2%	0.5%

fees, there is an 8% probability of any change, and the likelihood of reductions (increases) larger than 5 basis points is only 2% (1%). For betas, changes larger than 0.1 in magnitude are very unlikely. The probability of a 0.1 increase in beta is only 0.5%, and the probability of a 0.1 decline in beta is only 0.4%.

Summary statistics for the share-class-level dataset and the fund launch dataset are provided in Online Appendix Table B1 and Online Appendix Table B2, respectively.

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 a fund's market beta. Our first econometric specification is a panel regression of the form:

$$Fee_{ift} = \gamma_f + \gamma_t + \lambda\beta_{ift}^{MKT} + \rho X_{ift} + e_{ift}. \tag{5}$$

In this regression, Fee_{ift} is the fee for fund i in fund family f in month t, β_{ift}^{MKT} is the fund's 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 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. Our unit of observation is a fund-month. 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 Eq. (5) 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:

$$\begin{aligned} Fee_{ift} = {} & \gamma_f + \gamma_t + \gamma_f \times 1_{\beta_{ift}^{MKT}>1} + \gamma_t \times 1_{\beta_{ift}^{MKT}>1} + \delta\beta_{ift}^{MKT} \times 1_{\beta_{ift}^{MKT}>1} \\ & + \lambda\beta_{ift}^{MKT} + \eta X_{ift} \times 1_{\beta_{ift}^{MKT}>1} + \rho X_{ift} + e_{ift}. \end{aligned} \tag{6}$$

In this specification, $1_{\beta_{ift}^{MKT}>1}$ is an indicator variable which equals one if the fund's market beta is greater than one. We interact $1_{\beta_{ift}^{MKT}>1}$ with all the control variables and fixed effects. The specification therefore fully controls for differences in the effects of control variables across high-beta and low-beta funds which could confound the effects of fund market beta. The coefficient of interest is δ, 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 Fig. 1.

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)–(4) report the results for all funds and columns (5)–(8) report the results for 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. β^{MKT} is an estimate of the slope from the market model for fund returns. $1_{\beta^{MKT}>1}$ indicator equals one if the fund's beta is greater than one. Columns (4) and (8) report the results from piecewise linear regressions which simultaneously estimate the kink point (β^{KINK}) and the coefficients on β^{MKT} and $\left(\beta^{MKT}-\beta^{KINK}\right)\times 1_{\beta^{MKT}>\beta^{KINK}}$ (see Section 4.1.1). $1_{\beta^{MKT}>\beta^{KINK}}$ indicator equals one if the fund's market beta is larger than the identified kink point. α^{GROSS} 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.

y = *Fee*	All funds				Active funds only			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\beta^{MKT}>1$	$\beta^{MKT}<1$	Full Sample	Kink Estimation	$\beta^{MKT}>1$	$\beta^{MKT}<1$	Full Sample	Kink Estimation
β^{MKT}	0.32***	-0.09	-0.09	-0.08*	0.35***	-0.06	-0.06	-0.06
	(0.04)	(0.06)	(0.06)	(0.04)	(0.04)	(0.06)	(0.06)	(0.05)
$\beta^{MKT}\times 1_{\beta^{MKT}>1}$			0.41***				0.41***	
			(0.07)				(0.08)	
β^{KINK}				0.96***				0.96***
				(0.03)				(0.03)
$\left(\beta^{MKT}-\beta^{KINK}\right)\times 1_{\beta^{MKT}>\beta^{KINK}}$				0.34***				0.34***
				(0.06)				(0.07)
α^{GROSS}	0.0039***	0.0024	0.0024	0.0023**	0.0051***	0.0024	0.0024	0.0024*
	(0.0014)	(0.0023)	(0.0023)	(0.0010)	(0.0019)	(0.0027)	(0.0027)	(0.0012)
Observations	215,931	204,970	420,901	420,917	188,621	178,342	366,963	366,977
R-squared	0.77	0.73	0.75	0.73	0.72	0.68	0.70	0.67
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
Control variables $\times 1_{\beta^{MKT}>1}$	No	No	Yes	No	No	No	Yes	No
Fund family fixed effects $\times 1_{\beta^{MKT}>1}$	No	No	Yes	No	No	No	Yes	No
Month fixed effects $\times 1_{\beta^{MKT}>1}$	No	No	Yes	No	No	No	Yes	No

The residual fee is estimated in two steps. First, we regress the fee on the basic control variables and fixed effects as specified in (5), 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 Fig. 1 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.

Columns (1)–(4) of Table 2 present the formal regression results from the entire sample of mutual funds. The estimates in the first two columns confirm the graphical evidence from Fig. 1. 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 2, the top of our trimmed sample distribution, fund fees increase by 32 basis points, which is about a 24% 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 8.6 (0.32×0.27) basis points in fees, while a one-standard-deviation change in log fund size or log fund age changes fees by 13 basis points and 3 basis points, respectively.[22] 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 0.41. This implies that when beta is greater than one, an additional unit of embedded leverage increases fees by 41 basis points relative to the case when beta is less than one.

Our model suggests that the "kink" in the asymmetric fee-beta relation is at a beta of one, which is the theoretical beta of market index funds. While our results are consistent with this view, a remaining concern is that the kink point may be below or above one in the data. To address this concern, we estimate a piecewise linear regression in which the actual kink point in the data (β^{KINK}) is estimated jointly with the slopes based on the following specification:[23]

$$Fee_{ift}=\gamma_f+\gamma_t+\delta\times(\beta^{MKT}_{ift}-\beta^{KINK})\times 1_{\beta^{MKT}_{ift}>\beta^{KINK}}+\lambda\beta^{MKT}_{ift}+\rho X_{ift}+e_{ift}. \tag{7}$$

[22] According to unreported estimates for the corresponding fund characteristics, the regression coefficient is -0.07 for log fund size and 0.04 for log fund age. The standard deviations for these two variables are 1.90 and 0.63, respectively.

[23] Since estimating the piecewise regression with high-dimensional fixed effects is computationally intensive, we follow a two-step estimation procedure. First, we regress Fee_{ift} on the fund family fixed effect γ_f, the month fixed effect γ_t, and the conventional fund characteristics X_{ift} including 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. Then, we use the residuals from the first step as the dependent variable in the second step, in which we conduct a piecewise linear regression that jointly estimates the kink point, the coefficient for beta below and above the kink point, as well as the coefficient on alpha.

The results in column (4) of Table 2 show that the estimate of the kink point is at a beta of 0.96, with a standard error of 0.03 which makes it statistically indistinguishable from a beta of one. This finding is consistent with our theory and the prior results. It is also worth noting that both the average and median beta of S&P 500 index funds in our sample are 0.96 (see Online Appendix Table B4), in line with the estimated kink point.[24] Additionally, the estimated effects of beta on fees for betas above and below the kink point are comparable to the estimates from columns (1) and (2) where we set the kink point to be exactly one. These results suggest that our findings are robust to whether we choose the kink point at a beta of one or allow the data to inform a kink point.

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.

In Online Appendix B.2, we discuss a number of robustness checks for our main results. Our first 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. We show that our results are not driven by the variation in the number of fund offerings with beta. Second, we find that the effects of beta on fees do not vary across distribution channels, suggesting that our results are not confounded by the differences in clienteles across these channels. Third, our findings are largely unaffected by the inclusion of fund style fixed effects in our specifications, implying that the relation between beta and fees does not reflect demand for style investing. Fourth, we show that our results do not depend on how we define fees. Finally, we find that that the effect of beta on fees is not driven by trading or equity valuation costs.

Columns (5)–(8) of Table 2 also show that our results hold in the sample of actively-managed funds, which represent the majority of our observations, suggesting that our results are not driven by a small number of leveraged ETFs and index funds (Frazzini and Pedersen, 2022). Since our subsequent analysis deals with changes in fund beta (which require active investing) as well as implications for fund performance, we focus on actively-managed funds throughout the rest of the paper. Nevertheless, we show in Sections 4.1.3 and 4.5 that the competition from leveraged ETFs and index funds has important effects on the relation between beta and fees.

[24] The betas of S&P 500 index funds do not equal exactly one because the Fama-French market factor is based on the entire CRSP/Compustat universe of stocks.

4.1.2. Cross-sectional and time-series variations

We next examine the roles of cross-sectional and time-series variations in determining the relation between beta and fees. There are two non-mutually exclusive sources of variations. First, high-beta funds can set higher fees from their first appearance in the market, such that the effect of beta on fees is driven by variation across funds. Second, when asset managers adjust a fund's beta over time, they can also adjust its fees accordingly, generating time-series variation in beta and fees within the same fund. While Table 1 shows that time-variation in fees and betas is rather limited, it does not imply that such variation is completely non-existent.

Our first test focuses on variation across funds at the time of fund launch. We conduct our analysis by estimating the specifications from Table 1 for our fund launch sample, and report the results in Table 3. We find that the baseline results hold in the sample of funds at launch with moderately larger economic magnitudes. The increase in fees per unit of beta equals 52 basis points for funds with betas greater than one (column (1)), and it is small and insignificant for funds with betas smaller than one (column (2)). These results suggest that a good degree of the effect of beta on fees is already present since fund launch. This is consistent with our theoretical framework where funds endogenously choose their fees and beta from day one.[25]

We next turn to the variation within funds. Since fund fees do not change frequently, we focus our time-series analysis on the subsample of fund-months in which fees do change relative to the previous month, and ask how these changes correlate with changes in fund beta. We start our investigation by first including fund fixed effects in our baseline panel specification. This new specification effectively controls for all fund-specific time-invariant unobservables, such that the coefficient on beta is now interpreted as the effect of changes in beta over time within the same fund. The results in columns (3) and (4) of Table 3 show that dynamic variation within funds also matters. The effects are consistent with our other results: fees increase in fund beta when beta is greater than one, and they are independent of beta when beta is smaller than one.

In our second test, we use a first-differences specification, directly estimating how changes in fees relate to changes in beta. To account for the stickiness of fees and to reduce noise coming from the estimation of betas, we examine changes at a 12-month horizon in both variables in this specification. We condition our analysis on fees changing at the same 12-month horizon since fees may not change immediately in response to beta changes at a monthly frequency. We find that the first-differences specification delivers qualitatively similar results (columns (5) and (6)).

[25] 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 reasonable estimate for the fund beta at the time of fund launch.

Table 3
Cross-sectional and time-series 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. Columns (1)–(2) show the results from the fund launch sample which consists of the cross-section of funds at the time of their launch. Columns (3)–(6) show the results from the sample which consists of the panel of fund-months that have fee changes in the corresponding period. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. β^{MKT} is an estimate of the slope from the market model for fund returns. α^{GROSS} is an annualized estimate of the intercept from the market model for fund gross returns. ΔFee is the change in *Fee* from month t to month $t+12$. $\Delta\beta^{MKT}$ is the difference between the average β^{MKT} over the upcoming 12 months versus that over the previous 12 months. $\Delta\alpha^{GROSS}$ is the difference between the average α^{GROSS} over the upcoming 12 months versus that over the previous 12 months. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

Sample:	Fund Launch		Conditional on Fee Changing			
y =	*Fee*	*Fee*	*Fee*	*Fee*	ΔFee	ΔFee
	(1)	(2)	(3)	(4)	(5)	(6)
	$\beta^{MKT} > 1$	$\beta^{MKT} < 1$	$\beta^{MKT} > 1$	$\beta^{MKT} < 1$	$\beta^{MKT} > 1$	$\beta^{MKT} < 1$
β^{MKT}	0.52***	0.07	0.11**	0.02		
	(0.12)	(0.15)	(0.06)	(0.05)		
α^{GROSS}	0.0158***	0.0195***	0.0041*	-0.0061**		
	(0.0031)	(0.0044)	(0.0023)	(0.0029)		
$\Delta\beta^{MKT}$					0.04**	0.01
					(0.02)	(0.03)
$\Delta\alpha^{GROSS}$					-0.0016**	-0.0029***
					(0.0007)	(0.0008)
Observations	992	1485	14,535	14,062	127,055	123,992
R-squared	0.62	0.56	0.90	0.91	0.23	0.23
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	No	No	No	No
Fund fixed effects	No	No	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

In sum, the baseline "paying for beta" effect is driven by both the relation between betas and fees across funds as well as the dynamic relation through changes within the same fund. We note that the economic magnitude of the effect is noticeably smaller in the time-series tests when compared to the baseline estimation or the sample of funds at launch.[26]

4.1.3. Effects of leveraged funds entry

Our model suggests that competition among high-beta mutual funds can be another source of time-series variation in the relation between beta and fees. We expect that funds will charge less per unit of beta if the competition intensifies.[27] We examine this additional dynamic implication using the introduction of leveraged index-linked funds as a source of competition. Lu and Qin (2021) find that fund families started introducing these funds in the mid-2000s in response to increasing demand for leveraged investments.

To conduct this analysis, we collect data on leveraged funds using the sample from Lu and Qin (2021). This procedure generates a sample of 108 leveraged funds launched between 2006 and 2015. We introduce two measures of penetration of leveraged funds at the monthly level. Our first measure is the share of leveraged funds' AUM in the total AUM of index funds. This measure reflects the availability of leveraged index-based funds relative to all index funds. Our second measure is the number of leveraged index funds as a share of the total number of index funds available. We interact these measures with fund beta and add the interaction variables to our baseline specification. The coefficient on the interaction between the measure of penetration and fund beta captures the effect of penetration on the relation between beta and fees.

The results in Table 4 confirm our hypothesis. Columns (1) and (2) show that the penetration of leveraged funds reduces the effect of beta on fees for funds with beta greater than one. An increase of one standard deviation in penetration reduces the effect of beta on fees by 10% (if measured by relative number of funds) to 16% (if measured by relative AUM).[28] For funds with beta less than

[26] We also note that the second time-series test yields a smaller economic magnitude than the first one. This is because the second specification does by design not capture the longer-term effects of beta changes on fees.

[27] While leveraged ETFs typically deliver a specified multiple of the underlying index return on a daily basis, they are not perfectly suited for achieving the desired leverage over medium and long-term horizons. Therefore, it is not expected that the introduction of leveraged ETFs entirely drives out the demand of leverage-seeking investors for high-beta funds.

[28] When measured by the relative number of funds, the standard deviation for leveraged ETF fund penetration is 5 percentage points, suggesting that a one-standard-deviation increase in the relative number of leveraged ETF funds reduces the effect of beta on fees by $0.01 \times 5 = 0.05$, which is about 10% of the baseline effect (which is 0.50). When measured by the relative AUM of funds, the standard deviation for leveraged ETF fund penetration is 0.4 percentage points, suggesting that a one-standard-deviation increase in the relative AUM of leveraged ETF funds reduces the

Table 4
Relation between fund market beta and fund fees around leveraged ETF entries. This table reports the results from regressing mutual fund fees on fund market beta and its interactions with measures of monthly penetration of leveraged ETFs (*%Leveraged ETFs*). In columns (1) and (3), *%Leveraged ETFs* is the share of leveraged funds' AUM in the total AUM of index funds. In columns (2) and (4), *%Leveraged ETFs* is the number of leveraged index funds as a share of the total number of index 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. β^{MKT} is an estimate of the slope from the market model for fund returns. α^{GROSS} 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.

y = *Fee*	(1)	(2)	(3)	(4)
	By *AUM*	By *Number*	By *AUM*	By *Number*
	$\beta^{MKT} > 1$	$\beta^{MKT} > 1$	$\beta^{MKT} < 1$	$\beta^{MKT} < 1$
$\beta^{MKT} \times$ %Leveraged ETFs	-0.17**	-0.01**	-0.11	0.01*
	(0.08)	(0.005)	(0.08)	(0.004)
β^{MKT}	0.45***	0.50***	0.00	-0.14*
	(0.07)	(0.07)	(0.07)	(0.08)
α^{GROSS}	0.0053***	0.0054***	0.0024	0.0024
	(0.0020)	(0.0020)	(0.0027)	(0.0027)
Observations	188,621	188,621	178,342	178,342
R-squared	0.72	0.72	0.68	0.68
Control variables	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes

one, there is no effect of leveraged funds' penetration on the relation between beta and fees when penetration is measured by the share of AUM (column (3)). When we measure it by the share of funds, the estimated effect has the opposite sign, with very small economic and statistical significance (column (4)).

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 using our share class sample, introducing indicator variables that equal one if a share class is offered to retail or institutional investors, respectively.[29] We add these variables to our baseline specification from Eq. (5), interacting them with market beta to evaluate the relation between beta and fees for different investor clienteles.

We present the results in Table 5, starting with funds with betas greater than one in column (1). The coefficient on the interaction between market beta and the indicator for retail share classes equals 0.37, while the coefficient on the interaction between market beta and the indicator for institutional shares equals 0.21. As a result, retail investors pay an extra 16 basis points in fees per unit of beta. This implies that when a share class is offered to retail investors, the fund charges them 76% more (0.16/0.21) for the same increase in beta relative to institutional investors. The estimated coefficients remain virtually unchanged when we control for fund performance (column (2)). The tests for differences in the coefficients show that the difference in fees between the share classes is statistically significant at the 1% level. Consistent with our framework, columns (3) and (4) show that there is no effect of beta on fees for funds with beta less than one, neither for retail nor for institutional share classes.

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 et al. (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

effect of beta on fees by $0.17 \times 0.4 = 0.07$, which is about 16% of the baseline effect (which is 0.45).

[29] 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.

Table 5
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 indicators for retail and institutional 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. β^{MKT} is an estimate of the slope from the market model for fund returns. α^{GROSS} is an annualized estimate of the intercept from the market model for fund gross returns. 1_{Retail} indicator equals one if a share class is offered to retail investors. $1_{Institutional}$ indicator equals one if a share class is offered to institutional investors. The tests for differences between coefficients and their p-values are reported. *,**, 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*	(1)	(2)	(3)	(4)
	$\beta^{MKT} > 1$	$\beta^{MKT} > 1$	$\beta^{MKT} < 1$	$\beta^{MKT} < 1$
$\beta^{MKT} \times 1_{Retail}$	0.37***	0.39***	-0.10*	-0.07
	(0.04)	(0.04)	(0.05)	(0.05)
$\beta^{MKT} \times 1_{Institutional}$	0.21***	0.23***	-0.05	-0.03
	(0.06)	(0.06)	(0.06)	(0.06)
1_{Retail}	0.69***	0.69***	0.94***	0.93***
	(0.07)	(0.07)	(0.06)	(0.06)
α^{GROSS}		0.0060***		0.0045***
		(0.0019)		(0.0016)
Tests for differences between coefficients				
$\beta^{MKT} \times 1_{Retail} - \beta^{MKT} \times 1_{Institutional}$	0.16***	0.16***	-0.04	-0.04
p-value	0.00	0.00	0.47	0.51
Observations	489,569	489,569	420,848	420,848
R-squared	0.71	0.71	0.70	0.70
Control variables	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes

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 new indicator variables that equal one if a period is defined as constrained or unconstrained. We add these variables to our main specifications and interact them with market beta to evaluate the effects of time variation in borrowing constraints on the relation between beta and fees.

Since time-variation in fees is limited and sticky as shown in Tables 1 and 3, we use the fund launch sample. We exploit the variation across funds with different launch time, 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.

We present the results in Table 6, starting with the BAB factor as a measure of borrowing constraint tightness in column (1). The coefficient on the interaction between market beta and the indicator for constrained periods equals 0.66, statistically significant at the 1% level. The coefficient on the interaction between market beta and the indicator for unconstrained periods equals 0.31, statistically indistinguishable from zero. The p-value of the test of differences in coefficients equals 3%. These results suggest that funds introduced in constrained periods, as measured by the BAB factor, additionally charge roughly twice more (0.66/0.31) per unit of beta relative to funds introduced in unconstrained periods.

The results for the ICR and LCT measures are similar to the results based on the BAB factor (columns (2) and (3)). According to the ICR-based results, funds introduced in constrained periods again additionally charge two times more (0.75/0.38) per each unit of beta. The effect of beta on fees for constrained periods as measured by LCT equals 0.61 and is much larger relative to unconstrained periods (0.38). We note, however, that the difference in the coefficients for the LCT measure is not statistically significant. This possibly reflects a small sample size (350 observations) and limited statistical power to reject the null.

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

4.3. Response of fund flows

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 effect of fund beta on quantities, in addition to the effect on prices documented above. Specifically, we ask whether an increase in fund beta leads to fund inflows. If leverage-constrained investors prefer high-beta funds, then an increase in beta is expected to generate an increase in flows if fund fees stay the same. To test this implication, we evaluate the effects of changes in beta

Table 6
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 et al. (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. β^{MKT} is an estimate of the slope from the market model for fund returns. α^{GROSS} is an annualized estimate of the intercept from the market model for fund gross returns. $1_{Constrained}$ 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. $1_{Unconstrained}$ indicator equals one minus $1_{Constrained}$. The tests for differences between coefficients and their p-values are reported. *,**, 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)
$\beta^{MKT} \times 1_{Constrained}$	0.66***	0.75***	0.61**
	(0.14)	(0.19)	(0.25)
$\beta^{MKT} \times 1_{Unconstrained}$	0.31	0.38***	0.38
	(0.19)	(0.13)	(0.36)
α^{GROSS}	0.0126***	0.0165***	0.0096
	(0.0041)	(0.0032)	(0.0065)
Tests for differences between coefficients			
$\beta^{MKT} \times 1_{Constrained} - \beta^{MKT} \times 1_{Unconstrained}$	0.35**	0.36**	0.23
p-value	0.03	0.04	0.59
Observations	595	599	350
R-squared	0.64	0.70	0.59
Control variables	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes

on fund flows, conditional on no simultaneous changes in fees. We set up a panel regression of the form:

$$Net\,flow_{i,t+1} = \gamma_i + \gamma_t + \lambda \Delta Beta_{i,t} + \rho X_{it} + e_{i,t+1}, \qquad (8)$$

where $Net\,flow_{i,t+1}$, 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 with an addition of fund fees. Standard errors are double-clustered by fund family and month. We estimate this specification in the sample of fund-months with no fee changes.

The results in Table 7 support our hypothesis. For funds with beta greater than one, a one-unit increase in beta is associated with an increase of 1.8 percentage points in fund flows (column (1)). The standard deviation of net flows amounts to 2.9 percentage points, indicating that the economic magnitude of this effect is non-negligible. There is no significant effect of changes in beta on flows for funds with beta smaller than one (column (2)). These results are consistent with the underlying variation in investor demand: when leverage-constrained investors can obtain a higher beta for the same fee, they increase their fund holdings.

We next test whether high-beta funds experience higher net flows immediately after borrowing constraints tighten. Similar to our tests on fees from Section 4.2.2, we add interactions between changes in beta and indicator variables for constrained and unconstrained periods, using the same measures of leverage constraint tightness. As fund flows vary significantly over time for a given fund as opposed to fees, which show much less time variation, we can take full advantage of within-fund variation in flows for these tests. The results in columns (3)–(5) consistently support the leverage demand channel, further strengthening the evidence on fees from Table 6. High-beta funds exhibit higher net flows in constrained periods across all the measures. The estimated effects are large and statistically significant at the 1–5% levels for constrained periods, while being small and insignificant for unconstrained periods. The differences between the coefficients are large and statistically significant for the BAB and LCT measures.

In sum, our findings in Tables 3, 6, and 7 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 prices and quantities (fund AUM) among all the funds. In a series of additional tests, we examine a

Table 7
Relation between fund market beta, net fund flows, and tightness of borrowing constraints. This table reports the results from regressing net fund flows on changes of fund market beta. *Net Flow* is the net fund flow in a given month, andthe sample consists of fund-months with no fee changes. $\Delta\beta^{MKT}$ is the monthly change in the estimate of the slope from the market model for fund returns. $\Delta\alpha^{GROSS}$ is the monthly change in the annualized estimate of the intercept from the market model for fund gross 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. In columns (3)–(5) we further interact $\Delta\beta^{MKT}$ with measures of borrowing constraint tightness, including the BAB measure from Frazzini and Pedersen (2014), the ICR measure from He et al. (2017), and the LCT measure from Boguth and Simutin (2018). All the regressions in columns (3)–(5) are estimated for funds with betas larger than one, and 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. $1_{Constrained}$ 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. $1_{Unconstrained}$ indicator equals one minus $1_{Constrained}$. The tests for differences between coefficients and their p-values are reported. *,**, 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*	Baseline		Measure of borrowing constraint tightness		
	$\beta^{MKT}>1$	$\beta^{MKT}<1$	$\beta^{MKT}>1$		
			BAB	ICR	LCT
	(1)	(2)	(3)	(4)	(5)
$\Delta\beta^{MKT}$	0.018***	0.007			
	(0.007)	(0.010)			
$\Delta\beta^{MKT}\times 1_{Constrained}$			0.024**	0.015**	0.035***
			(0.010)	(0.007)	(0.012)
$\Delta\beta^{MKT}\times 1_{Unconstrained}$			-0.008	0.013	-0.006
			(0.016)	(0.025)	(0.018)
$\Delta\alpha^{GROSS}$	0.0021***	0.0031***	0.0022***	0.0020***	0.0020***
	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Fee	-0.003***	-0.002	-0.002*	-0.002	-0.004**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Tests for differences between coefficients					
$\Delta\beta^{MKT}\times 1_{Constrained}-\Delta\beta^{MKT}\times 1_{Unconstrained}$			0.032*	0.001	0.041**
p-value			0.09	0.97	0.04
Observations	162,476	153,302	81,632	79,588	66,378
R-squared	0.16	0.18	0.18	0.20	0.19
Control variables	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes

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 in favor of these additional mechanisms (see Online Appendix Tables B11 and B12).[30]

4.4. Implications for fund net performance

We next 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 among funds with 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. The results are presented in 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 27 basis points.

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 et al., 1972; Frazzini and Pedersen, 2014). The difference in gross alphas between high-beta funds and low-beta funds equals -47 basis points. 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 -74 basis points.

These findings suggest that two mechanisms can jointly explain why net alpha declines with beta: (1) the leverage

[30] 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 beta by 0.001 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.

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. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. β^{MKT} is an estimate of the slope from the market model for fund returns. α^{GROSS} and α^{NET} are annualized estimates of the intercept from the market models for fund gross returns and fund net returns, respectively. R^{NET} is the annualized monthly fund return net-of-fees. R^{GROSS} is the sum of R^{NET} and *Fee*. The t-statistics for tests of differences between the averages are reported. *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively.

Quintile	(1) β^{MKT}	(2) *Fee*	(3) α^{GROSS}	(4) α^{NET}	(5) R^{GROSS}	(6) R^{NET}
(1) Low β^{MKT}	1.03	1.45	1.13	-0.32	9.12	7.66
(2)	1.09	1.51	1.19	-0.32	8.87	7.37
(3)	1.16	1.57	0.87	-0.70	9.20	7.64
(4)	1.26	1.63	0.85	-0.78	9.66	8.03
(5) High β^{MKT}	1.46	1.72	0.66	-1.06	9.65	7.92
(5) - (1)		0.27***	-0.47*	-0.74***	0.53	0.26
t-statistic		17.54	-1.75	-2.82	0.09	0.04

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 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.

4.5. Evidence from other factors

We next examine how the effects of leverage demand extend to other factor betas in addition to a fund's market beta. We focus on the HML and SMB factors because they represent the basis of many popular style-based investment strategies and because mutual fund investors care about fund exposure to these factors (Barber et al., 2016; Berk and van Binsbergen, 2016). Similar to our core analysis of the market factor, we ask whether other factor-oriented constrained investors are also willing to pay extra fees for funds with more extreme betas that are not easily attainable through the corresponding factor-based index funds. We expect fees to increase with the absolute value of factor beta when the factor beta is taking on extreme values. When the factor beta is very high (low), we therefore expect to observe a positive (negative) relation between factor beta and fees. However, when the factor beta is in the intermediate range that could be achieved by a combination of risk-free assets and corresponding factor-based index funds (i.e., when the factor beta is between 0 and that of a typical factor-based index fund), we expect to observe a weaker or even a flat relation. Accordingly, we hypothesize that the overall relation between factor betas and fees is U-shaped.

To test this hypothesis, we first construct an additional dataset of index funds which are based on size and value factors. We conduct a search of words such as "large", "small", "value", "growth", "small cap", "large cap", "micro cap" in the names of all index funds from the CRSP Mutual Fund Database. Based on the fund names, we classify index funds into four categories: value, growth, small cap, and large cap. The resulting fund factor betas are consistent with the name-based classification. The median HML beta for value index funds equals 0.32, while the median HML beta for growth index funds equals -0.27. Small cap index funds have a median SMB beta of 0.83, while large cap index funds have a median SMB beta of -0.15 (see Online Appendix Table B4 for details).

We next estimate the effect of factor betas on fees across different ranges of the respective factor beta, using the following methodology. For the HML factor, we use the following four ranges:

- $\beta^{HML} < \hat{\beta}^{HML}_{growth\,index}$ (extreme growth)
- $\hat{\beta}^{HML}_{growth\,index} < \beta^{HML} < 0$
- $0 < \beta^{HML} < \hat{\beta}^{HML}_{value\,index}$
- $\beta^{HML} > \hat{\beta}^{HML}_{value\,index}$ (extreme value)

By $\hat{\beta}^{HML}_{value\,index}$ we denote the median HML beta of value index funds in each period, and $\hat{\beta}^{HML}_{growth\,index}$ denotes the median HML beta of growth index funds in each period. The median betas of index funds are calculated separately for each month such that these cut-offs are time-varying, reflecting the introduction of passively-managed investment products that allow investors to access new ranges of beta. Thus, our estimation accounts for dynamic variations in the relationship between factor betas and fees due to changes in the penetration of the corresponding factor-based index funds. For the SMB factor, we analogously use the following ranges: $\beta^{SMB} < \hat{\beta}^{SMB}_{large\,index}$ ("mega" caps),

$\hat{\beta}^{SMB}_{large\,index} < \beta^{SMB} < 0$, $0 < \beta^{SMB} < \hat{\beta}^{SMB}_{small\,index}$, and $\beta^{SMB} > \hat{\beta}^{SMB}_{small\,index}$("micro" caps).

We consider several econometric specifications to identify the effects of factor betas on fees, controlling for the effects of other factors. In our baseline test, we use the following specification:

$$Fee_{ift} = \gamma_f + \gamma_t + \lambda \beta^{FACTOR}_{it} + \gamma Z^{MKT}_{it} + \rho X_{it} + \epsilon_{ift}. \qquad (9)$$

In this specification,

$$Z^{MKT}_{it} = \left[1_{\beta^{MKT}>1}, 1_{\beta^{MKT}>1} \times \beta^{MKT}, 1_{\beta^{MKT}<1} \times \beta^{MKT}\right],$$

and β^{FACTOR}_{it} is the fund's HML or SMB beta. Z^{MKT}_{it} includes a dummy variable which indicates if the market beta is greater than one ($1_{\beta^{MKT}>1}$) and its interactions with market beta. This set of variables allows to control for our baseline non-linear effects of market beta on fees. The rest of the variables are the same as in the main specification from Eq. (5), with both the fund's CAPM gross alpha and its 3-factor gross alpha included as control variables. We estimate Eq. (9) separately for each of the four ranges of factor betas.

In our second test, we further control for the non-linear effects of the other factor beta. For example, when we test for the effects of HML beta, we control for the effects of SMB beta. In particular, we add a vector Z^{SMB}_{it} which includes four dummy variables indicating the four ranges of SMB beta as well as the four interaction variables between β^{SMB}_{it} and each of these dummies. This allows us to fully control for the effects of SMB beta on fees, conditional on the different ranges. When we test for the effects of SMB beta, we use an analogous specification where Z^{HML}_{it} fully controls for the non-linear effects of HML beta.[31]

We start by plotting the residual fees from Eq. (9), using the same approach as in Fig. 1. Fig. 3 shows that fees sharply increase with the absolute value of HML beta (upper panel) and SMB beta (lower panel) when the factor beta is in the very high or low ranges. In line with our hypothesis, factor betas and fees exhibit a U-shaped relation, consistent with leverage-constrained investors paying higher fees for funds with extreme factor exposures.

Panel A of Table 9 reports the regression results for the relationship between HML factor beta and fees. The baseline results are reported in columns (1), (3), (5), and (7). The relation between HML beta and fees is significantly negative for $\beta^{HML} < \hat{\beta}^{HML}_{growth\,index}$ and significantly positive for $\beta^{HML} > \hat{\beta}^{HML}_{value\,index}$. The magnitudes of the coefficients are smaller relative to those from the regressions of fees on market beta, but they are economically meaningful. In particular, investors are willing to pay 16 basis points in fees for one unit of beta for extreme growth funds, and 12 bps for extreme value funds. In the intermediate range of HML betas, the relation between HML beta and fees is insignificant and economically weaker, which is consistent with the presence of the U-shaped relationship. Columns (2), (4), (6), and (8) show that the results are robust to further controlling for SMB factor exposure.

We next repeat the exercise for the SMB factor. The results in Panel B of Table 9 are also consistent with higher willingness to pay for leverage for extreme SMB betas. The baseline results in columns (1), (3), (5), and (7) show that investors who seek to lever up their investment in large-cap stocks ($\beta^{SMB} < \hat{\beta}^{SMB}_{large\,index}$) pay 38 basis points per unit of SMB beta, and those who invest in small-cap stocks ($\beta^{SMB} > \hat{\beta}^{SMB}_{small\,index}$) pay 34 basis points. For $0 < \beta^{SMB} < \hat{\beta}^{SMB}_{small\,index}$, the relation between SMB beta and fees is positive but much smaller in magnitude relative to $\beta^{SMB} > \hat{\beta}^{SMB}_{small\,index}$. For $\hat{\beta}^{SMB}_{large\,index} < \beta^{SMB} < 0$, the effect of SMB beta on fees is insignificant. This suggests that the relation becomes flatter for less extreme values of betas, again consistent with the U-shaped relationship. We obtain very similar results when further controlling for the effects of HML beta in columns (2), (4), (6), and (8).

The combined evidence supports the idea that leverage-constrained investors are willing to pay higher fees for accessing portfolios with more extreme values of HML and SMB betas.[32] Consequently, our findings on the effects of market beta on fees generally extend to the HML and SMB factors.

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 our analysis by investigating how high-beta funds obtain leverage and by providing back-of-the-envelope 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. We focus on the effects of market beta, which is in the center of our analysis.

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. Using N-SAR reports, Almazan et al. (2004) document a rich variation in investment practices across the U.S. mutual funds. We follow their approach by using the N-SAR sample (described in Online Appendix B.1.2) to examine which practices are employed by mutual funds to obtain leverage.

We present the summary statistics for fund investment practices in Table 10. Only 29% of the sample funds em-

[31] In our baseline test, the market beta is estimated using the CAPM model and we include the CAPM alpha. This specification allows us to examine the effect of factor betas while controlling for the effect of market beta exactly in line with Table 2. In the second test, we use the market beta estimated from the 3-factor model and only control for the 3-factor alpha such that all the betas and alpha are simultaneously estimated from the same 3-factor model. Our results do not depend on which market beta we control for and on whether CAPM alpha is included as a control variable or not.

[32] Murray (2020) finds a rather flat relation between HML and SMB betas and expected returns in the stock market. Our result comes on top of this effect, reducing the net performance of funds with extreme HML and SMB betas.

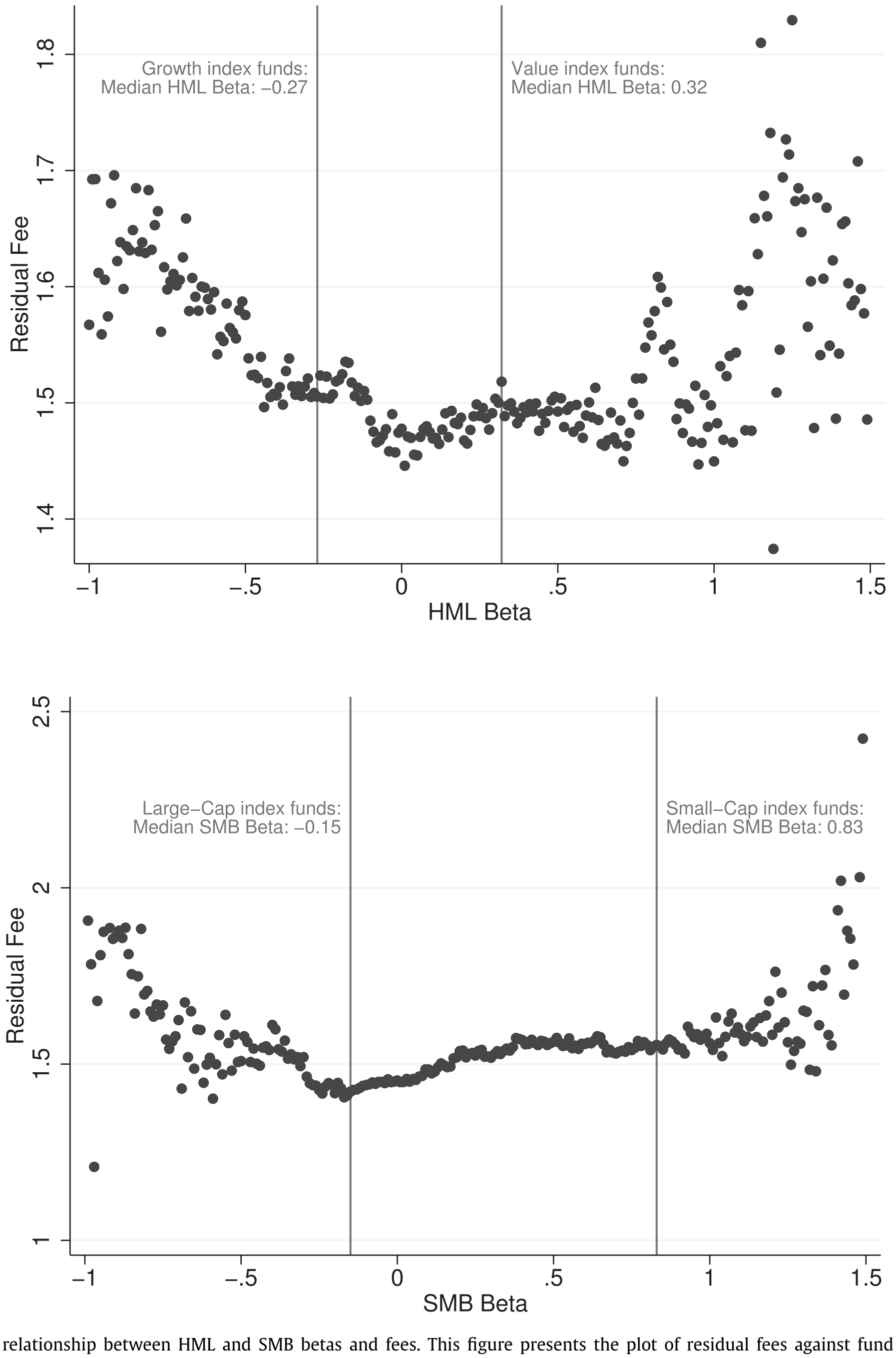

Fig. 3. The empirical relationship between HML and SMB betas and fees. This figure presents the plot of residual fees against fund HML and SMB betas. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. *HML Beta* is an estimate of the loading of fund returns on the HML factor. *SMB Beta* is an estimate of the loading of fund returns on the SMB factor. Betas are estimated from the 3-factor model. *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 vertical lines represent the median HML betas of value and growth index funds, and the median SMB betas of small-cap and large-cap index funds, respectively.

ploy 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 (13%), borrowing money (9%), and trading options on equities (8%). The fraction of funds engaged in each of the other practices is below 4%. 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 28%, which is approximately the same as in the entire sample. A similar pattern holds for each investment practice separately: the difference in the

Table 9

Relation between fund beta and fund fees: HML and SMB factors. This table reports the results from regressing mutual fund fees on fund factor betas. Panel A reports the results for HML beta and Panel B reports the results for SMB beta. The regressions are estimated across four different ranges of factor betas. *Fee* is the sum of the fund annual expense ratio and one-seventh of the sum of the front load and the back load. β^{SMB} and β^{HML} are loadings on the HML and SMB factors, estimated from the 3-factor model for fund returns. $\hat{\beta}^{HML}_{growth}$ and $\hat{\beta}^{HML}_{value}$ are median HML betas for growth and value index funds in each period. $\hat{\beta}^{SMB}_{large}$ and $\hat{\beta}^{SMB}_{small}$ are median SMB betas for large-cap and small-cap index funds in each period. Columns (1), (3), (5), and (7) report the results from the baseline specification and columns (2), (4), (6), and (8) report the results for the specifications which further control for non-linear effects of the other factor (see Section 4.5). *,**, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. Standard errors double-clustered by fund family and month are in parentheses.

Panel A: HML

$y = Fee$	$\beta^{HML} < \hat{\beta}^{HML}_{growth}$		$\hat{\beta}^{HML}_{growth} < \beta^{HML} < 0$		$0 < \beta^{HML} < \hat{\beta}^{HML}_{value}$		$\beta^{HML} > \hat{\beta}^{HML}_{value}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
β^{HML}	Baseline	SMB Controls	Baseline	SMB Controls	Baseline	SMB Controls	Baseline	SMB Controls
	-0.16***	-0.15***	-0.10	-0.09	-0.00	-0.02	0.12**	0.12**
	(0.07)	(0.06)	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)	(0.05)
Observations	64,064	65,211	105,166	105,239	140,582	140,613	54,448	54,450
R-squared	0.76	0.76	0.72	0.73	0.69	0.70	0.72	0.73
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

Panel B: SMB

$y = Fee$	$\beta^{SMB} < \hat{\beta}^{SMB}_{large}$		$\hat{\beta}^{SMB}_{large} < \beta^{SMB} < 0$		$0 < \beta^{SMB} < \hat{\beta}^{SMB}_{small}$		$\beta^{SMB} > \hat{\beta}^{SMB}_{small}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
β^{SMB}	Baseline	HML Controls	Baseline	HML Controls	Baseline	HML Controls	Baseline	HML Controls
	-0.38***	-0.42***	0.17	0.13	0.16***	0.19***	0.34**	0.32**
	(0.12)	(0.12)	(0.12)	(0.12)	(0.03)	(0.03)	(0.15)	(0.14)
Observations	36,442	36,133	88,482	88,408	213,401	212,714	28,353	28,264
R-squared	0.79	0.79	0.71	0.72	0.69	0.69	0.77	0.77
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

fraction of funds engaged in a practice between the entire sample and the sample of high-beta funds is 2% or lower for all the 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 last row in Table 10 shows that only 26% 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.

We next 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. We report the results in Table 11. 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 (3)). The usage of stock index futures or options on them is associated with marginally smaller betas (columns (6) and (7)). These results again indicate that a fund's engagement in alternative investment practices is largely unrelated to an increased fund beta. We conclude that 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, 2021).[33]

In our model, the relation between beta and fees is not driven by potential costs associated with the provision of leverage. Our effect arises from the demand side (i.e., the willingness of investors to pay for beta) and does not rely on the supply-side effects (i.e., how the leverage is obtained by the funds). The N-SAR data allows us to empirically examine this mechanism by testing whether the relation between beta and fees depends on how funds obtain leverage. If the relation between beta and fees were to come from the supply side (say, from differences in fund

[33] While our full sample of U.S. equity mutual funds contains 4775 funds, the number of leveraged ETFs in the comprehensive sample compiled by Lu and Qin (2021) amounts to 269 funds.

Table 10

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. β^{MKT} is an estimate of the slope from the market model for fund returns. $1_{Alternative\ practices}$ 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. $1_{Options\ on\ equities}$ indicator equals one if the fund trades options on equities. $1_{Options\ on\ stock\ indices}$ indicator equals one if the fund trades options on stock indices. $1_{Stock\ index\ futures}$ indicator equals one if the fund trades stock index futures. $1_{Options\ on\ stock\ index\ futures}$ indicator equals one if the fund trades options on stock index futures. $1_{Borrowing}$ indicator equals one if the fund borrows money. $1_{Short-selling}$ indicator equals one if the fund engages in short-selling. $1_{\beta^{MKT}_{fund} > \beta^{MKT}_{fund\ portfolio}}$ 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		$\beta^{MKT} > 1$	
	Mean	N	Mean	N
$1_{Alternative\ practices}$	0.29	20,717	0.28	11,203
$1_{Options\ on\ equities}$	0.08	20,716	0.07	11,203
$1_{Options\ on\ stock\ indices}$	0.02	20,717	0.01	11,203
$1_{Stock\ index\ futures}$	0.13	20,717	0.13	11,203
$1_{Options\ on\ stock\ index\ futures}$	0.00	20,717	0.00	11,203
$1_{Borrowing}$	0.09	20,717	0.10	11,203
$1_{Short-selling}$	0.04	20,703	0.02	11,197
$1_{\beta^{MKT}_{fund} > \beta^{MKT}_{fund\ portfolio}}$	0.22	58,103	0.26	31,527

management costs), it could be affected by how funds obtain leverage. Importantly, we do not need to assume a priori which investment practices are more expensive than others. For example, it is unclear whether trading derivatives is more expensive than trading high-beta stocks. If any differences in fund management costs between investment practices drive the effect of beta on fees, this would suggest an additional supply-side effect beyond our baseline demand-driven effect.

We estimate our main specification adding interactions of fund beta with variables that capture the usage of alternative investment practices from Table 10. We also add an extra variable *Number of Alternative Practices* which captures the number of alternative investment practices employed by the fund. A significant coefficient on the interactions would suggest that the beta-fee relation varies across funds with different investment practices, in support of supply-side effects. The results in Table 12 show that the relation between beta and fees does not depend on fund investment practices. The coefficient on beta itself is positive and significant, in line with the baseline effect. However, the coefficients on all the interactions are economically small and statistically insignificant. These results suggest that the relation between betas and fees is primarily shaped by investors' demand for leverage rather than by supply-side effects.

Table 11

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. β^{MKT} is an estimate of the slope from the market model for fund returns. $1_{Alternative\ practices}$ 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. *Number of Alternative Practices* is the total number of alternative practices employed by the fund. $1_{Options\ on\ equities}$ indicator equals one if the fund trades options on equities. $1_{Options\ on\ stock\ indices}$ indicator equals one if the fund trades options on stock indices. $1_{Stock\ index\ futures}$ indicator equals one if the fund trades stock index futures. $1_{Options\ on\ stock\ index\ futures}$ indicator equals one if the fund trades options on stock index futures. $1_{Borrowing}$ indicator equals one if the fund borrows money. $1_{Short-selling}$ indicator equals one if the fund engages in short-selling. $1_{\beta^{MKT}_{fund} > \beta^{MKT}_{fund\ portfolio}}$ 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.

$y = \beta^{MKT}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$1_{Alternative\ practices}$	-0.01**								
	(0.00)								
Number of Alternative Practices		-0.01**							
		(0.00)							
$1_{\beta^{MKT}_{fund} > \beta^{MKT}_{fund\ portfolio}}$			0.03***						
			(0.01)						
$1_{Options\ on\ equities}$				0.00					
				(0.00)					
$1_{Options\ on\ stock\ indices}$					0.02				
					(0.02)				
$1_{Stock\ index\ futures}$						-0.02***			
						(0.01)			
$1_{Options\ on\ stock\ index\ futures}$							-0.06***		
							(0.02)		
$1_{Borrowing}$								-0.01	
								(0.01)	
$1_{Short-selling}$									0.01
									(0.01)
Observations	11,163	11,163	31,503	11,163	11,163	11,163	11,163	11,163	11,157
R-squared	0.41	0.41	0.34	0.41	0.41	0.41	0.41	0.41	0.41
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 12
Relation between fund market beta, fund fees, and funds' investment practices. This table reports the results from regressing fund fees on fund market betas and their interactions with measures of engagement in alternative investment practices for funds with betas 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. β^{MKT} is an estimate of the slope from the market model for fund returns. $1_{Alternative\ practices}$ 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. *Number of Alternative Practices* is the total number of alternative practices employed by the fund. $1_{\beta^{MKT}_{fund} > \beta^{MKT}_{fund\ portfolio}}$ 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 = *Fee*	(1)	(2)	(3)
β^{MKT}	0.42***	0.41***	0.30***
	(0.08)	(0.08)	(0.06)
$\beta^{MKT} \times 1_{Alternative\ practices}$	-0.11		
	(0.09)		
$1_{Alternative\ practices}$	0.12		
	(0.11)		
$\beta^{MKT} \times Number\ of\ Alternative\ Practices$		-0.06	
		(0.07)	
$Number\ of\ Alternative\ Practices$		0.07	
		(0.08)	
$\beta^{MKT} \times 1_{\beta^{MKT}_{fund} > \beta^{MKT}_{fund\ portfolio}}$			-0.04
			(0.05)
$1_{\beta^{MKT}_{fund} > \beta^{MKT}_{fund\ portfolio}}$			0.05
			(0.06)
Observations	11,163	11,163	31,503
R-squared	0.80	0.80	0.73
Control variables	Yes	Yes	Yes
Fund family fixed effects	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes

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.

We first develop a simple analytical formula to calculate the implied costs based on our estimates. In particular, the estimate of the coefficient on beta from the regression of fees on beta can serve as an estimate of the cost of leverage for fund investors that arises from paying higher fees for high-beta funds. On top of the higher fees comes the extra cost in form of lower risk-adjusted performance of higher-beta funds. To see this, consider an investor who seeks to make a leveraged investment. Assume the cost of leverage to be R_l. If the investor seeks to attain beta $\hat{\beta} > 1$, she can borrow and make a leveraged investment in the market index fund with a beta of one. If the index fund charges a fee $f_{\beta=1}$ and has an expected gross return of $R_{\beta=1}$, the expected net return on the investor's portfolio is

$$R_{borrow} = \hat{\beta} R_{\beta=1} - f_{\beta=1} - (\hat{\beta} - 1) R_l. \tag{10}$$

If the investor instead buys a mutual fund with beta $\hat{\beta}$, fee $f_{\beta=\hat{\beta}}$, and expected gross return $R_{\beta=\hat{\beta}}$, her expected net return is:

$$R_{high\ beta} = R_{\beta=\hat{\beta}} - f_{\beta=\hat{\beta}} = \alpha + \hat{\beta} R_{\beta=1} - f_{\beta=\hat{\beta}}, \tag{11}$$

where α is the fund's market-adjusted performance. By equating the returns between the alternatives, we can recover the implied cost of leverage R_l. If $R_{borrow} = R_{high\ beta}$, we have:

$$R_l = \frac{f_{\beta=\hat{\beta}} - f_{\beta=1}}{\hat{\beta} - 1} - \frac{\alpha}{\hat{\beta} - 1}. \tag{12}$$

The implied cost of leverage consists of two parts: higher fees per unit of beta and the difference in performance per unit of beta. The first part can be estimated using our regression of fees on beta (Table 2). In particular, the estimate of the coefficient on beta (λ) is the slope of the linear relationship between beta and fees when other determinants of fees are held fixed. Alternatively, we can examine the differences in fees between high- and low-beta fund portfolios (Table 8) per unit of beta.

We combine these estimates with the differences in performance to provide "back-of-the-envelope" estimates of the total cost of leverage from investing in high-beta funds, and compare our results to other studies. In terms of fees, our baseline regression estimate shows an increase of 32 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 27 basis points in fees when beta increases by 0.43, from 1.03 (quintile (1)) to 1.46 (quintile (5)). This implies a fee of 63 basis points for one unit of leverage (27/0.43). The combination of these estimates suggests an extra fee of 32–63 basis points per year for an extra unit of leverage.[34] The difference in gross alphas between the bottom and top beta quintiles amounts to 47 basis points, suggesting a performance loss of 109 basis points per year when beta is increased by one (47/0.43). 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 141–172 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 (2021).[35] 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, 2022) to 127 basis points (Lu and Qin, 2021). Compared to these benchmarks, the fee of 32–63 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 141–172 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.[36] 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.

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 managers 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.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jfineco.2022.04.002.

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[34] In line with the baseline estimates, we mostly obtain regression-based cost estimates in the range of 32–75 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 Online Appendix Table B13).

[35] Lu and Qin (2021) calculate the performance loss as a difference in performance between leveraged ETFs and index ETFs.

[36] 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.

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