Peer versus Pure Benchmarks in the Compensation of Mutual Fund Managers*

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Abstract

We examine the role of peer (Lipper manager indices) vs. pure (S&P 500) benchmarks in fund manager compensation. We first model the impact of peer vs. pure benchmarks on manager incentives and then test the model's predictions using a unique hand-collected dataset. We find that 71% of managers are compensated solely or partially based on peer benchmarks. Consistent with the model, funds with peer-benchmarked managers exhibit higher active share, abnormal performance, and advisory fees than those with pure-benchmarked managers. Analyzing investment advisors' choice between benchmark types, we find peer-benchmarking advisors have more sophisticated investors with greater performance sensitivity and are more likely to sell through the direct channel, suggestive of market segmentation.

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I Introduction

Performance evaluation of mutual fund managers has been a subject of enduring interest to financial economists. At the core of this issue is the benchmark against which a manager's investment performance is measured.[1] The literature on portfolio delegation, primarily consisting of theoretical work, focuses almost exclusively on securities market indices as the benchmarks (i.e., pure benchmarks) against which performance is measured.[2] However, benchmarks can also be constructed from groups of funds overseen by peer managers (i.e., peer benchmarks). Brown, Harlow and Starks (1996), for example, find evidence consistent with tournament behavior among fund managers, suggesting that peer comparisons matter. Similarly, Cohen, Coval and Pástor (2005) propose a performance measure that compares a given manager to a composite of comparable managers based on the similarity of their holdings and returns. In spite of the importance of peer manager comparisons suggested by these papers, the literature has largely ignored this benchmarking option albeit practitioners have not. Based on hand-collected data of portfolio manager compensation contracts in the U.S. mutual fund industry, we find that, for approximately 70% of funds, the manager's compensation depends entirely or partly on peer-benchmarked performance. In this paper, we study, for the first time, the choice of peer vs. pure benchmarks in the compensation contracts of individual portfolio managers, and its implications for contact design, portfolio decisions, and fund performance.

As a first step in our analysis, we examine the implications of peer vs. pure benchmarks in a portfolio delegation model that builds on Kapur and Timmermann (2005). In our model, individual portfolio managers are offered a contract with a base salary and variable compensation (the incentive fee). This variable compensation depends on the manager's performance relative to either a peer or pure benchmark. The propor-

[1] There is a large literature on this issue (e.g., Heinkel and Stoughton (1994), Admati and Pfleiderer (1997), Das and Sundaram (2002), Ou-Yang (2003), Basak, Shapiro and Teplá (2006), Binsbergen, Brandt and Koijen (2008), Basak, Pavlova and Shapiro (2008), Li and Tiwari (2009), Gómez and Sharma (2006), Dybvig, Farnsworth and Carpenter (2010), Basak and Pavlova (2013), Gârleanu, Panageas and Yu (2020), Sockin and Xiaolan (2020), and Kashyap, Kovrijnykh, Li and Pavlova (2020)).

[2] For example, in Admati and Pfleiderer (1997), the "... benchmark is equal to the passive portfolio that an uninformed investor would hold..." and in Basak, Pavlova and Shapiro (2008), "...the benchmark ...relative to which her performance is evaluated is a value-weighted portfolio..." The two exceptions are first Kapur and Timmermann (2005) where the manager is evaluated relative to average peer performance, though they do not compare pure vs. peer benchmarks. Second, DeMarzo and Kaniel (2017) study relative performance evaluation contracts when agents have "Keeping up with the Joneses" preferences.

tion of managers compensated relative to either type is exogenously given and managers face portfolio constraints (i.e., the deviation from the benchmark is bounded as in Buffa, Vayanos and Woolley (2019)). Investors decide the optimal incentive fee depending on the type of benchmark employed. Managers then choose their utility-maximizing level of costly (unobservable) effort and their optimal portfolio given the contract.

This theoretical setting allows us to examine how managerial effort and risk-taking, along with fund performance and fee-setting, might differ across the two types of benchmarks. The primary intuition as to why these characteristics might differ has to do with the nature of the benchmarks. While a pure benchmark constitutes an exogenous performance hurdle for managers, the model shows that for peer benchmarks, the manager's active portfolio decision is impounded into the benchmark return (i.e., the peer average).

For managers with a peer benchmark, their active portfolio is shown to be "levered" with respect to the active portfolio of managers with a pure benchmark. This leverage increases with the proportion of peer-benchmarked managers. The peer-benchmarked managers behave, effectively, as if they were more risk tolerant since part of their portfolio risk is hedged when they keep up with the performance of their peers. This hedging feature of peer-based compensation is analogous to the well-documented effect of "Keeping up with the Joneses" preferences on portfolio choice.[3] Because of this externality, peer-benchmarked managers are more aggressive in investing in risky assets. The model shows that risk-neutral fund investors take advantage of this feature of peer-based benchmarks and find it optimal to offer managers compensated with respect to them higher incentive fees than to managers compensated with pure benchmarks.

Our model yields three testable predictions. First, it predicts that in realistic settings (i.e., with portfolio constraints), peer-benchmarked contracts induce greater managerial effort and are associated with higher active share. Second, the model suggests that investors would set higher incentive fee rates for contracts with peer benchmarks. Third, due to the higher effort/portfolio activeness and fees, peer-benchmarked managers have higher expected gross investment performance compared to pure-benchmarked managers.

Using a hand-collected dataset of performance benchmarks in portfolio manager com-

[3]A number of studies show that, when investors are concerned about their consumption relative to that of their peers, the marginal utility of their consumption increases in the aggregate consumption and their portfolio decision corresponds to that of an investor whose risk-aversion coefficient is adjusted downwards. See, for instance, Gali (1994), DeMarzo, Kaniel and Kremer (2004), and Gómez, Priestley and Zapatero (2009, 2016).

pensation contracts in the U.S. mutual fund industry, we empirically test our model's three predictions.[4] For the funds whose managers receive a bonus based on relative performance, investment advisors must disclose the benchmark(s) used to assess the manager's performance. While the SEC requires mutual funds to compare their performance to pure benchmarks only (i.e., "broad-based securities market index") in their prospectus, the investment advisors' choice of benchmarks for determining portfolio manager compensation is not similarly restricted.[5] As a result, the manager compensation benchmark is based on peers performance (hence different from the prospectus benchmark) for many funds.

Our sample of funds consists of 1,043 U.S. domestic equity funds across 153 fund families from 2006 through 2012. We manually collect information on the determinants of the manager's compensation from each fund's Statement of Additional Information (SAI), including the specific benchmarks stated in the contract. We find that to determine the manager's relative performance bonus, 21% of funds in our sample use a peer benchmark (e.g., Lipper Small Cap Growth Fund index[6]), 29% of funds use a pure benchmark (e.g., S&P 500 index), and the remaining 50% of funds use a compensation benchmark comprised of both peer and pure indices. In other words, for about 70% of funds, the manager's compensation depends entirely or partly on the fund's performance relative to the average performance of peer funds from the same investment objective.

We begin our empirical analysis by examining the first prediction of our model: peer benchmarked managers will exhibit greater effort and portfolio activeness. In our analysis, we use three measures of fund activeness that are commonly used in the literature: (i) active share (Cremers and Petajisto (2009)), (ii) tracking error, and (iii) R-squared (Amihud and Goyenko (2013)). We find that peer-benchmarked managers have a higher active share and tracking error, but lower R-squared compared to pure-benchmarked managers, with the differences being both statistically and economically significant. This evidence is consistent with our model's prediction that peer compensation benchmarks can induce

[4]The availability of this data is due to the 2005 SEC regulation that began requiring mutual funds to disclose the determinants of portfolio manager compensation. See Ma, Tang and Gómez (2019) for detailed description of the rule.

[5]For the SEC's requirement on prospectus benchmark, see "CFR Final Rule: Disclosure of Mutual Fund Performance and Portfolio Managers", 1993, Securities and Exchange Commission, CFR Financial Assistance to Individuals, 17 C.F.R. §239, 270, 274 (1993), page 13.

[6]An unmanaged, equally weighted performance index comprised of the 30 largest mutual funds based on fund total net assets in the Lipper Small-Cap classification.

higher managerial effort and exhibit more active portfolio management.

While we are able to test the first prediction directly using our database, because we do not have the actual contracts or dollar amounts paid to portfolio managers, the second prediction regarding higher incentive fees cannot be tested directly. At the same time, the fund-level advisory fee collected by the investment advisor is a reasonable proxy since the compensation paid to the manager by the investment advisor is plausibly funded from that fee revenue. Using advisory fee rates, we find empirical evidence that supports the model's prediction. Namely, funds managed by peer-benchmarked managers, on average, charge 6.3 basis points higher advisory fees than those managed by pure-benchmarked managers. The results further show that the overall expense ratio for peer-benchmarked funds is 18.7 basis points greater than those pure-benchmarked ones. Both of these differences are statistically significant at the 1% level.

To test the thrid prediction about benchmark choice and fund performance, we calculate and compare risk-adjusted returns for funds whose managers are evaluated against either type of benchmark. We use four abnormal performance measures in our analysis: (i) Carhart (1997) four-factor alpha, (ii) prospectus benchmark-adjusted alpha, (iii) DGTW characteristic-adjusted portfolio return (Daniel, Grinblatt, Titman and Wermers (1997)), and (iv) Morningstar ratings. Across all four measures, we find significant outperformance for managers with peer compensation benchmarks compared to those with pure compensation benchmarks. For instance, peer-benchmarked funds outperform by 0.85% (0.49%) annually based on prospectus benchmark-adjusted alpha (four-factor alpha), statistically significant at the 5% level.

While peer or pure benchmarks are exogenously assigned in the model, our empirical observation of both types of benchmarks in practice raises a broader question: how can both types be used in equilibrium? One plausible explanation would be customer heterogeneity and the associated market segmentation. To explore this possible explanation we examine both fund flows and the determinants of an investment advisor's choice between peer- and pure-benchmark manager compensation. The flow results are consistent with such heterogeneity, showing that investors in peer-benchmarked funds are statistically and economically significantly more sensitive to performance than pure-benchmarked managers. In a more direct test of possible market segmentation, we examine the determinants of an investment advisor's choice of peer or pure-benchmark compensation.

We find that peer compensation benchmarks are less likely when the fraction of the fund total net assets (TNA) sold via the broker channel is high. Prior studies have shown that the broker-sold and direct-sold mutual fund distribution channels appear segmented and one characteristic of this segmentation is that investors who purchase broker-sold funds are less performance conscious (e.g., Del Guercio and Reuter (2014)). We also find that peer compensation benchmarks are more likely when the fund has a higher percentage of assets coming from sophisticated investors. Finally, the tests show that advisors that promote internal cooperation (measured by the cooperative incentives index of Evans, Prado and Zambrana (2020)) are also more likely to use pure benchmarks instead of peer benchmarks, which our model suggests provide more competitive incentives. Overall, the differences in investor sophistication and performance sensitivity, the related difference in manager incentive structure and the difference in distribution channel between investment advisors using peer- and pure-benchmarks is suggestive of different underlying advisor business models focusing on different investor segments.

Our paper adds to the extensive literature on managerial incentives in the asset management industry. When it comes to benchmarking in performance evaluation, the literature focuses almost exclusively on pure benchmarks. Our evidence shows that, in practice, peer benchmarks are often used exclusively or partially in fund managers' compensation contracts.[7] One contribution of our study is to develop a model to analyze, for the first time, the difference between pure vs. peer compensation benchmarks. We uncover that peer compensation benchmarks result in an externality in portfolio choice similar to the effect of "Keeping up with the Joneses" preference.

Our empirical evidence on compensation design is also related to other theoretical studies on optimal benchmark design. Several theoretical models predict that consistent with the "informativeness principle" of Hölmstrom (1979), the optimal benchmark should reflect the manager's investment style (e.g., Li and Tiwari (2009) and Gârleanu, Panageas and Yu (2020)). Our empirical evidence supports this prediction. We show that pure benchmarks coincide with prospectus benchmarks, arguably reflecting the fund's

[7]In a related empirical study, Hunter, Kandel, Kandel and Wermers (2014) propose an empirical methodology that uses peer fund performance to increase precision in measuring fund risk-adjusted performance via factor models. Moreover, our study is also related to prior work that studies how to use peer funds to evaluate fund performance in various other settings (e.g., Brown, Harlow and Starks (1996), Chevalier and Ellison (1997), Cohen, Coval and Pástor (2005), and Brown and Wu (2016).)

investment objective and peer benchmarks are clustered by investment style.[8] Additionally, several theoretical models predict that the fund managers compensated with a pure benchmark act more like closet indexers.[9] Our results confirm this prediction and, simultaneously, show that managers compensated relative to peer funds are less likely to behave as closet indexers. Moreover, we find that benchmark choice is related to market segmentation related to investor sophistication and incentive structures of fund management companies.

Finally, our paper contributes to the nascent literature that studies the compensation of individual portfolio managers. To the best of our knowledge, this paper is the first to analyze the choice of performance benchmarks in portfolio manager compensation contracts. The prior literature has focused primarily on the design of the advisory contracts between fund investors and investment advisors due to lack of data on portfolio managers' compensation.[10] A recent study by Ma, Tang and Gómez (2019) analyzes the compensation structures of the individual portfolio managers in the US. A related study by Ibert, Kaniel, Nieuwerburgh and Vestman (2018) examines what factors determine the compensation of mutual fund managers in Sweden. While both of these studies examine determinants of manager compensation, neither examines the important issue of performance benchmark choices. Thus, our paper complements both Ma, Tang and Gómez (2019) and Ibert et al. (2018), and together these three studies offer a more complete picture of compensation contracts of portfolio managers. Relatedly, Lee, Trzcinka and Venkatevan (2019) examine the risk-shifting implications of performance-based compensation contracts, and Evans, Prado and Zambrana (2020) examine competitive and cooperative incentive mechanisms for managers. None of these papers study the benchmark choices between pure vs. peer benchmarks and the implications for portfolio decisions and fund performance, which is the focus of this study.

The remainder of this paper proceeds as follows. Section II introduces the model. Section III describes the data and variable construction. Section IV presents the empirical results. Finally, Section V sets forth our conclusions.

[8]Sensoy (2009) and, more recently, Cremers, Fulkerson and Riley (2021), find evidence consistent with a strategic mismatch between the prospectus benchmark and the fund's investment strategy.

[9]See, e.g., Admati and Pfleiderer (1997), Cuoco and Kaniel (2011), and Basak and Pavlova (2013)).

[10]Among others, Elton, Gruber and Blake (2003) and Golec and Starks (2004) study performance-adjusted advisory fees among U.S. fund advisors. More recently, Servaes and Sigurdsson (2019) analyze these fees among European mutual funds.

II The Model

We first develop a model to analyze the implications of peer versus pure benchmarks in portfolio manager compensation. Kapur and Timmermann (2005) propose a model examining manager compensation when performance is measured relative to peers. We extend the model of Kapur and Timmermann (2005) in several dimensions. First, to better understand the tradeoffs between peer and pure benchmarks, we incorporate in their setting the possibility that managers are compensated relative to an exogenous, pure benchmark. Second, we assume that managers exert costly and unobservable effort which exposes investors to a moral hazard problem they must address in the contract design. Third, we introduce portfolio constraints, i.e., limits to the maximum deviation in portfolio holdings around the benchmark.[11]

A Assets, agents, and information structure

Assume a one-period model where portfolio managers can invest in two assets: a risky stock and a risk-free bond with price 1 and return r. The stock has initial price 1 and final, period-end return $\tilde{P}_1 = \bar{P}_1 + \tilde{\epsilon}$ with $\tilde{\epsilon} \sim N(0, \sigma_\epsilon^2)$. Let us denote $\tilde{K} = \tilde{P}_1 - r$ the excess return on the stock over the bond. $\tilde{K}$ is therefore normally distributed with mean excess return $\bar{K} = \bar{P}_1 - r$ and variance σ_ϵ^2.

There is a continuum of risk-neutral investors over the interval $[0, 1]$, with identical utility functions. Every investor invests in a single fund managed by a risk-averse portfolio manager.[12] The investor and the fund are perfectly aligned. Thus, in our model, we use both terms interchangeably to denote the principal. The manager is the agent. At the beginning of the period, the manager is offered a contract that specifies a fixed salary $I \geq 0$ paid at the end of the period and an incentive fee defined as a percentage $1 \geq \theta \geq 0$ of the fund's value at the end of the period net of the benchmark value.The manager then

[11] The assumption of portfolio constraint is motivated by the fact that in practice, portfolio constraints are common among U.S. mutual fund managers (see, e.g., Almazan, Brown, Carlson and Chapman (2004)).

[12] Because investors can diversify across other managers and strategies while managers cannot, the notion that investors would be more risk tolerant than fund managers seems reasonable. Ideally, we would assume the same utility function for investors and managers, with a higher risk aversion coefficient for the latter. For tractability, however, assuming a risk-neutral principal is common in principal-agent models where, like in ours, the agent's decision space is bounded. See, for instance, Cadenillas, Cvitanić and Zapatero (2004), Jewitt, Kadan and Swinkels (2008), Kadan and Swinkels (2008), and Ju and Wan (2012).

decides whether to accept the contract or not. If she accepts (that is, if her expected utility is higher than the utility of her reservation salary, $U_0 \geq 0$) she puts effort $\alpha \in [0,1]$ before learning a noisy signal s partially correlated with the stock's excess return:

$$\tilde{s} = \tilde{\epsilon} + \tilde{u}, \quad \text{where } \tilde{u} \sim N(0, \tfrac{1-\alpha}{\alpha}\sigma_\epsilon^2) \quad \text{and } E(\tilde{\epsilon}\tilde{u}) = 0. \tag{1}$$

Let $\tilde{K}(\alpha, s)$ denote the stochastic conditional (on effort α and signal s) excess return of the stock. Given (1), $\tilde{K}(\alpha, s)$ is normally distributed with conditional moments:

$$\begin{aligned} E(\tilde{K}(\alpha, s)) &= \bar{K} + \alpha\, s, \\ Var(\tilde{K}(\alpha)) &= (1-\alpha)\sigma_\epsilon^2. \end{aligned} \tag{2}$$

Thus, α determines the signal's precision. The effort choice α is not-observable by the investor. Moreover, it is costly for the manager. Let $c(\alpha)$ denote the effort disutility function. We assume $c(\alpha)$ is increasing and convex in α. Moreover, to prevent corner solutions, we assume that $c'(0) > 0$ and $c'(1) \to \infty$, where $c'(\alpha)$ denotes the partial derivative of the cost function with respect to effort evaluated at α.

B The manager's problem

Upon accepting the contract (I, θ), the manager puts in effort α and receives a common signal s about the stock's excess return. Conditional on the signal and its precision, each manager chooses the number of shares λ of the risky stock that maximizes the expected utility of her period-end compensation. We normalize the investor's initial wealth at the beginning of the period to 1. We assume that investors delegate all their wealth to managers and that managers have no other source of income besides their compensation. Thus, given signal s and effort α, the value of the portfolio at the end of the period can be written as $\tilde{W}(\alpha, s) = \lambda\tilde{K}(\alpha, s) + r$. This represents the fund's net asset value (NAV) at the end of the period. In this model, the fund's NAV increases with the manager's portfolio performance (a function of her effort), but not with flows across funds.

A given percentage $0 < \delta < 1$ of funds compensate managers relative to the average fund performance $\bar{W}$ across all managers. The remaining $1 - \delta$ funds compensate managers relative to a pure, exogenous benchmark that coincides with the fund prospectus benchmark. The pure benchmark holds λ^b shares of the risky stock. Thus, the stochastic value of one unit of wealth invested in the benchmark portfolio at the end of the period is $\tilde{W}^b = \lambda^b \tilde{K} + r$.

Let superscript u denote compensation relative to a pure benchmark. After receiving the contract (I^u, θ^u), a manager rewarded relative to a pure benchmark puts an effort α^u and receives a signal s on the return of the risky asset. She then decides her optimal portfolio $\lambda^u(s)$. Her compensation (conditional on signal s) at period-end is equal to $I^u + \tilde{R}^u(\theta^u, \alpha^u, s)$, with

$$\tilde{R}^u(\theta^u, \alpha^u, s) = \theta^u(\tilde{W}^u(\alpha^u, s) - \tilde{W}^b), \tag{3}$$

where $\tilde{W}^u(\alpha^u, s) = \lambda^u(s)\tilde{K}(\alpha^u, s) + r$.

For peer-benchmarked managers we use superscript e to denote compensation relative to peer performance. After receiving the contract (I^e, θ^e), a manager compensated relative to a peer benchmark puts an effort α^e before receiving a signal s. She then decides her optimal portfolio $\lambda^e(s)$. Her compensation (conditional on signal s) at period-end is equal to $I^e + \tilde{R}^e(\theta^e, \alpha^e, s)$, with

$$\tilde{R}^e(\theta^e, \alpha^e, s) = \theta^e(\tilde{W}^e(\alpha^e, s) - \bar{W}(s)), \tag{4}$$

where $\tilde{W}^e(\alpha^e, s) = \lambda^e(s)\tilde{K}(\alpha^e, s) + r$. $\bar{W}(s) = \bar{\lambda}(s)\tilde{K} + r$ and $\bar{\lambda}(s) = \delta\lambda^e(s) + (1 - \delta)\lambda^u(s)$ represent the peers' average fund performance and the average number of shares, respectively.

Managers are assumed to have identical utility functions with constant absolute risk aversion parameter $\rho > 0$ defined over the (unconditional) stochastic compensation:

$$V(I, \theta, \alpha) = I + E(\tilde{R}(\theta, \alpha)) - \frac{\rho}{2} Var(\tilde{R}(\theta, \alpha)). \tag{5}$$

We follow Buffa, Vayanos, and Woolley (2019) and assume that, for every signal s, the portfolio of both peer- and pure-benchmarked managers cannot deviate more than L from their respective benchmark:

$$\begin{aligned} |\lambda^u(s) - \lambda^b| &\leq L, \\ |\lambda^e(s) - \bar{\lambda}(s)| &\leq L. \end{aligned} \tag{6}$$

We assume $0 < L < \infty$ is exogenous and equal for managers compensated relative to a pure or peer benchmark. This restrictions can also be interpreted in terms of limits to the managers tracking error volatility (TEV).

Consistent with other related papers, we solve this problem recursively. Given the contract, we first solve for the manager's optimal portfolio for each possible signal s and effort α. Then, we estimate the manager's unconditional expected utility across all possible signals and solve for the effort choice that maximizes it.

The following proposition summarizes the main results from this problem.

Proposition 1. *Given the contract (I, θ), a manager with risk aversion ρ chooses, for each signal s, the portfolio $\lambda^e(s) = \bar{\lambda}(s) + \zeta(\theta^e, L, s)$, if she is evaluated relative to the average peer performance, and $\lambda^u(s) = \lambda^b + \zeta(\theta^u, L, s)$, if she is evaluated relative to the performance of the pure benchmark λ^b, with*

$$\zeta(\theta^i, L, s) = \begin{cases} L & \text{if } \frac{\bar{K}+\alpha^i s}{\theta^i \rho(1-\alpha^i)\sigma_\epsilon^2} \geq L, \\ \frac{\bar{K}+\alpha^i s}{\theta^i \rho(1-\alpha^i)\sigma_\epsilon^2} & \text{otherwise}, \\ -L & \text{if } \frac{\bar{K}+\alpha^i s}{\theta^i \rho(1-\alpha^i)\sigma_\epsilon^2} \leq -L, \end{cases} \tag{7}$$

the active portfolio choice for manager $i = \{e, u\}$. The average peer portfolio is

$$\bar{\lambda}(s) = \lambda^u(s) + \frac{\delta}{1-\delta}\zeta(\theta^e, L, s). \tag{8}$$

To understand the intuition behind Proposition 1, notice that, for every signal s, a manager compensated relative to the average performance of her peers must replicate the average portfolio $\bar{\lambda}(s)$. Let us replace the average portfolio (8) into $\lambda^e(s)$:

$$\lambda^e(s) = \lambda^u(s) + \frac{1}{1-\delta}\zeta(\theta^e, L, s). \tag{9}$$

This equation implies that, first, for every signal s, the peer-benchmarked manager must replicate the portfolio $\lambda^u(s)$ chosen by the peers compensated relative to a pure benchmark. Second, the peer-benchmarked manager must invest $\frac{\delta}{1-\delta}\zeta(\theta^e, L, s)$ extra units in the risky stock to keep up with her peers, on top of her active portfolio $\zeta(\theta^e, L, s)$.[13] As a consequence, the active portfolio of a peer-benchmarked manager is *leveraged* by a ratio $1/(1-\delta)$ that increases with the proportion of managers compensated relative to their peers.

[13]Notice that this extra active investment does not arise when the manager is compensated relative to a pure benchmark λ^b since, by definition, this benchmark is independent of the portfolio choice of other managers.

To illustrate this point, assume that only a single manager in the interval $[0,1]$ of managers is compensated relative to her peers, while the rest are compensated relative to a pure benchmark λ^b. In such a case, the proportion of managers compensated relative to the average peer performance is negligible ($\delta \to 0$). To keep up with her peers, this manager replicates the portfolio $\lambda^u(s)$ chosen by the remaining managers plus her active portfolio $\zeta(\theta^e, L, s)$. Thus, since the weight of peer-based managers is virtually zero, there is no additional investment in the active portfolio induced by the peers portfolio choice. In other words, there is no *spill-over effect* from peer investment. In fact, the weight of the active portfolio of the only manager compensated relative to her peers is so small that, on average, every manager chooses the same portfolio ($\bar{\lambda}(s) \to \lambda^u(s)$). Imagine now that $\delta = 40\%$. This means that, for every signal s, 60% of the managers (those compensated relative to a pure benchmark) will choose a portfolio $\lambda^u(s)$ and 40% (those with a peer benchmark) will replicate the same portfolio, $\lambda^u(s)$, to keep up with their peers. Hence, the average portfolio $\bar{\lambda}$(s) replicates $\lambda^u(s)$ as shown in equation (8). Additionally, 40% of the managers will choose an active portfolio $\zeta(\theta^e, L, s)$ that they will leverage by 1/0.6 precisely to keep up with 40% of their peers. In this case, the peers portfolio decision does have a spill-over effect. The average peer portfolio, which includes 40% of the leveraged active portfolio, will hold $0.4/0.6 = 2/3$ of the active portfolio $\zeta(\theta^e, L, s)$.

Plugging the active portfolio (7) into (9), we find:

$$\lambda^e(s) = \lambda^u(s) + \begin{cases} \frac{L}{1-\delta} & \text{if } \frac{\bar{K}+\alpha^e s}{\theta^e \rho(1-\alpha^e)\sigma_\epsilon^2} \geq L, \\ \frac{\bar{K}+\alpha^e s}{\theta^e \rho(1-\delta)(1-\alpha^e)\sigma_\epsilon^2} & \text{otherwise}, \\ -\frac{L}{1-\delta} & \text{if } \frac{\bar{K}+\alpha^e s}{\theta^e \rho(1-\alpha^e)\sigma_\epsilon^2} \leq -L, \end{cases} . \tag{10}$$

Equation (10) shows that, when the manager is compensated relative to her peers, for every signal s, her optimal portfolio is such that she takes $\lambda^u(s)$, chosen by managers compensated relative to a pure benchmark, as her actual benchmark. There are two additional effects on her active portfolio. First, when the portfolio constraints are not binding, the active portfolio is estimated with a risk aversion coefficient adjusted by the percentage δ of managers with peer-based compensation down to $\rho(1-\delta)$. In other words, the spill-over effect of peer-based compensation is akin to an increase in the manager's risk-tolerance. Keeping up with the performance of her peers partially hedges her portfolio risk exposure making the manager, effectively, more risk tolerant. Second, the portfolio constraints become less binding and equal to $\frac{L}{1-\delta}$ and $-\frac{L}{1-\delta}$, respectively. Comparing (7) for $i = u$ with (10), the active portfolio of a manager compensated with respect to her peers is levered by $1/(1-\delta)$ relative to the active portfolio of a manager compensated with respect to an exogenous benchmark λ^b, both within the portfolio boundaries and when the constraints are hit. Also, the leverage effect increases in the proportion of managers compensated relative to peers, δ.

Given a signal s, we define the portfolio's active share as $AS^i(s) = \lambda^i(s) - \lambda^b$ for $i = \{e, u\}$, that is, the deviation of the manager's portfolio share in the stock relative to that of the prospectus benchmark.[14] Given (10), our first empirically testable prediction compares the expected active share of managers compensated with respect to a peer versus pure benchmark.

Prediction 1. *The expected active share (across all possible signals) of a manger compensated with respect to a peer benchmark is higher than the active share of a manager compensated with respect to a pure benchmark.*

How does this "leverage feature" of peer-based benchmarks affect the manager's provision of effort, the optimal contract incentives and, ultimately, fund performance? We investigate these questions next.

For every signal s and the portfolio boundary $L < \infty$, given the contract (I, θ) the manager's stochastic compensation is equal to $I + \tilde{R}(\theta, L, s)$ with

$$\tilde{R}(\theta, \alpha, s) = \tilde{K}(\alpha, s) \times \begin{cases} L\theta & \text{if } \frac{\bar{K}+\alpha s}{\rho(1-\alpha)\sigma_\epsilon^2} \geq L\theta, \\ \frac{\bar{K}+\alpha s}{\rho(1-\alpha)\sigma_\epsilon^2} & \text{otherwise}, \\ -L\theta & \text{if } \frac{\bar{K}+\alpha s}{\rho(1-\alpha)\sigma_\epsilon^2} \leq -L\theta, \end{cases} \tag{11}$$

with $\alpha = \alpha(\theta, L)$, a function of the incentive fee θ and the portfolio constraint L. When the portfolio choice is unconstrained ($L \to \infty$), the manager can adjust the portfolio to reflect her risk aversion and signal's precision for any incentive fee she's offered in the contract, which ultimately, can be undone. This is the *undo effect* studied by Stoughton (1993), Admati and Pfleiderer (1997), and Gómez and Sharma (2006), among others. The following proposition shows that, for $L < \infty$, this is no longer the case.

[14] We assume that (as later confirmed by the data) the prospectus benchmark coincides with the pure compensation benchmark λ^b.

Proposition 2. *Provided that there is an interior solution to the manager's optimal effort problem, for $L < \infty$, the manager's optimal effort $\alpha^i = \alpha(\theta^i, L)$ is an increasing function of the incentive fee θ^i for $i = \{e, u\}$. The effort function is independent of the benchmark composition.*

Proposition 2 shows that the constrained manager's effort is an increasing function of the incentive fee θ but that effort as a function of the incentive fee is the same for both types of benchmarks. In other words, only if managers are given different incentive fees they will choose different levels of effort. Thus, we proceed now to study the optimal contract (including the incentive fee) for both types of benchmarks.

C The investor's problem

With risk-neutral investors, if the manager's effort were independent of the incentive fee (i.e., when $L \to \infty$), it would be optimal to pay the manager no incentive-fee and a flat salary I equal to her reservation salary, regardless of the compensation benchmark. However, when the manager's portfolio is subject to the portfolio constraints in (6), we will show that the optimal incentive fee depends on the choice of compensation benchmark.

If the fund compensates the manager with a salary I and a incentive fee θ relative to the performance of a pure benchmark λ^b, for every signal s, the fund's stochastic NAV (net of fees) at the end of the period will be $\tilde{Q}^u(\theta, L, s) + r - I$, with

$$\tilde{Q}^u(\theta, s) = (\lambda^b + (1-\theta)(\lambda^u(s) - \lambda^b))\tilde{K}(\alpha(\theta, L), s). \tag{12}$$

If the fund compensates the manager with a salary I and a incentive fee θ relative to her average peer performance, the investor's stochastic value net of fees at the end of the period will be $\tilde{Q}^e(\theta, L, s) + r - I$, with

$$\tilde{Q}^e(\theta, s) = (\bar{\lambda}(s) + (1-\theta)(\lambda^e(s) - \bar{\lambda}(s)))\tilde{K}(\alpha(\theta, L), s). \tag{13}$$

We cannot solve explicitly for the manager's optimal contract without assuming an specific effort disutility function. However, we can still compare the optimal incentive fee of both types of benchmarks. We do it in two steps. First, in Lemma 1, we compare the optimal contract of two managers, one compensated relative to her peers and the other with respect to an exogenous benchmark, when the manager evaluated relative to a pure benchmark is subject to less binding portfolio constraints. Second, we tighten the portfolio constraints of this manager back to the original level and compare the effect on the incentive fee.

Lemma 1. *Provided it exists, let* (I^*, θ^e_L) *denote the optimal contract for a manager compensated relative to the average performance of her peers,* $\bar{\lambda}$*, and subject to the portfolio constraint* $|\lambda^e(s) - \bar{\lambda}(s)| \leq L$ *for every signal* s*. Then,* $(I^*, \theta^u_{L/(1-\delta)})$*, with* $\theta^u_{L/(1-\delta)} = (1-\delta)\theta^e_L$*, is the optimal contract for a manager compensated relative to the performance of a pure benchmark* λ^b*, and subject to the portfolio constraint* $|\lambda^u(s) - \lambda^b| \leq \frac{L}{1-\delta}$ *for every signal* s*.*

This lemma shows the implications of the "leverage effect" of peer-based compensation, discussed in equation (10), on the optimal incentive fee. This effect implied that a manager compensated with respect to her peers, effectively, leverages her active portfolio by $1/(1-\delta)$. If we replace the peer-based benchmark with a pure benchmark λ^b and relax the portfolio restrictions precisely by the same percentage up to $L/(1-\delta)$ and $-L/(1-\delta)$, respectively, Lemma 1 shows that the investor's optimal incentive fee would proportionally scaled down by $(1-\delta)$. Why are they not offered the same incentive fee? This result sheds light on the underlying mechanism of peer-based benchmarking. When the manager is offered this type of benchmark, keeping up with the performance of her peers hedges part of her portfolio's risk exposure, making her effectively more risk tolerant. Even when portfolio constraints are relaxed and both managers can effectively take equally extreme portfolios, the manager compensated with respect to a pure benchmark fails to internalize the hedging mechanism for signals within portfolio boundaries since she is not keeping up with the performance of her peers. For signals within the portfolio boundaries, the risk aversion of the peer-based manager becomes $(1-\delta)\rho$. Her incentive fee, according to Lemma 1 is scaled up precisely by the same proportion relative to that of the pure-based manager with relaxed portfolio constraints: $\theta^e_L = \frac{\theta^u_{L/(1-\delta)}}{1-\delta}$.

In Lemma 1, we compare the optimal contract of two managers compensated, respectively, against a peer- and pure benchmark when the portfolio constraints of the latter are loosened by a factor $\frac{1}{1-\delta}$ up to $L/(1-\delta)$ and $-L/(1-\delta)$. Next, building on this lemma, we tighten the portfolio constraints by $(1-\delta)$ for the pure-based manager back to the original limits L and $-L$ and study how this affects the optimal incentive fee. Our second prediction is that, after tightening the portfolio constraints, the optimal incentive fee grows less than proportionally and is lower than the incentive fee offered to the manager compensated relative to her peers' performance.

Prediction 2. *Provided there exists a unique interior solution to the investor's optimal contract, the optimal incentive fee and the manager's effort are higher when she is compensated relative to her peers' average performance,* $\bar{\lambda}$*, than when she is compensated with respect to a pure benchmark,* λ^b*.*

When the manager is compensated relative to her peers' performance, she becomes more active when compared to an identical manager compensated with respect to a pure, exogenous benchmark (Prediction 1). Prediction 2 shows that risk-neutral investors will optimally offer a higher incentive fee to peer-benchmarked managers who are exerting greater effort.

Our third empirical prediction is that, before fees, funds overseen by portfolio managers compensated relative to their peers will, on average, outperform funds whose managers are compensated relative to a pure benchmark. That is, the share (i.e., incentive fee) in the fund's performance is higher for peer-compensated managers but these managers work harder and their funds outperform.

Prediction 3. *On average (across all signals), funds where managers are compensated relative to their peers outperform funds where managers are compensated relative to an exogenous benchmark.*

In the following sections, we test empirically our model's predictions. Namely, funds where managers are compensated relative to their peers performance are expected to show higher active share, larger performance fees, and higher gross performance than funds where managers are compensated relative to a pure, exogenous benchmark index.

III Data, Variables, and Descriptive Statistics

The manager contracting problem characterized above gives us a rich set of predictions that guide our empirical analysis. In this section, we describe the unique data set collected to test these specific hypotheses, the construction of the variables. We then provide descriptive statistics regarding these variables.

A Data

We construct our sample from several data sources. The first data source is the Morningstar Direct Mutual Fund (MDMF) survivorship-bias-free database, which covers U.S. open-end mutual funds and contains information on fund names, tickers, CUSIP numbers, net-of-fee returns, AUM, inception dates, expense ratios, portfolio turnover ratios, investment objectives (i.e. Morningstar Category), Morningstar ratings, fund primary prospectus benchmarks, benchmark portfolio returns, portfolio manager names, advisor names, fund family names, and other fund characteristics.

Our sample consists of actively-managed U.S. diversified domestic equity funds in the MDMF database over the period 2006-2012. We exclude money market funds, bond funds, balanced funds, international funds, sector funds, and fund of funds from the sample. We identify and exclude index funds using fund names and index fund indicators from MDMF database. To address the incubation bias documented in Evans (2010), we drop the first three years of return history for every fund in our sample. Following Elton, Gruber and Blake (2001), Chen, Hong, Huang and Kubik (2004), and Pástor, Stambaugh and Taylor (2015), we further exclude funds with less than $15 million in total net assets. Since multiple share classes are listed separately in the MDMF database, we aggregate the share class-level data to the fund level. Specifically, we calculate fund TNA as the sum of assets across all share classes and compute the value-weighted average of other fund characteristics across share classes.

The second data source is the SEC EDGAR (Electronic Data Gathering, Analysis, and Retrieval) database. In 2005, the SEC adopted a new federal rule that requires mutual funds to disclose the compensation structure of their portfolio managers in the Statement of Additional Information (SAI). The new rule applies to all fund filing annual reports after Feb. 28, 2005. Following the procedures of Ma, Tang and Gómez (2019), we retrieve from EDGAR the SAI for each fund and year in our sample from 2006 to 2012. We then manually collect the information on the structure and the method used to determine the compensation of portfolio managers. Consistent with Ma, Tang and Gómez (2019), about 80% of our sample funds have explicit performance-based incentives in their managers' compensation contracts. For those funds that pay their managers based on investment performance, the SEC requires them to identify any benchmark used to measure performance. We find majority of our sample funds comply with this regulation and disclose a benchmark in the compensation contract. We exclude those funds that do not identify any benchmark in their contract to minimize data error.

Finally, we obtain data on investment advisor characteristics contained in Form ADV from the SEC. Form ADV is the form used by investment advisors to register with the SEC. This form provides information about the advisor's business practices, AUM, clientele, ownership structure, and other advisor-level characteristics. To match the investment advisors of our sample funds to the sample of advisors that filed Form ADV, we use the fund ticker to obtain the SEC File Number, which is a unique identifier that the SEC assigns in Form ADV to each investment advisor.

B Key Variables

B.1 Pure vs. Peer Compensation Benchmarks

For any given fund, there are two different types of benchmarks. The first is the performance benchmark provided in the fund's prospectus, often referred to as their prospectus benchmark. The second is the benchmark provided in the compensation contract of portfolio managers, which is referred to as the compensation benchmark. The choice of prospectus benchmark is constrained by regulation to be a broad-based securities market index.[15] In contrast, there is no such regulation in place regarding performance benchmark in portfolio managers' compensation contracts. That is, the compensation benchmark can be the same as the prospectus benchmark, a broad-based securities market index; alternatively, the compensation benchmark can be an index based on a fund peer group. In the former case, the market index benchmark is used to measure how much value is added by the active management of a portfolio manager relative to the market, while in the latter case, a portfolio manager's investment performance is evaluated against peer funds with similar investment objectives.

While prior research has looked at fund prospectus benchmarks, compensation benchmarks have received little attention due to the lack of data. Based on information we collect from fund SAIs, we use two indicator variables to differentiate the two types of compensation benchmarks: (i) *Pure Benchmark* which equals 1 if in their compensation contract, managers' investment performance is measured relative to a pure market index,

[15]See this weblink for policy regarding fund prospectus benchmarks: `www.sec.gov/rules/final/33-6988.pdf`.

and (ii) *Peer Benchmark* which takes a value 1 if the performance is relative to a peer benchmark.

B.2 Fund Performance

To measure fund performance, we first estimate the factor loadings using the preceding 36 monthly fund returns:

$$R_{i,s} = \hat{\alpha}_{i,t-1} + \sum_{k=1}^{N} \hat{\beta}_{i,k,t-1} F_{k,s} + \epsilon_{i,s}, \qquad s = t-36, ...t-1 \tag{14}$$

where s and t indicate months, i indicates funds, R_i is the monthly excess return of fund i over the one-month T-bill rate, and F is the monthly return of either one factor (corresponding market index or peer group returns) or the four factors of Carhart (1997) (i.e., market, size, book-to-market, and momentum factors). We then calculate monthly out-of-sample alpha as the difference between a fund's return in a given month and the sum of the product of the estimated factor loadings and the factor returns during that month:

$$\alpha_{i,t} = R_{i,t} - \sum_{k=1}^{N} \hat{\beta}_{i,k,t-1} F_{k,t}. \tag{15}$$

The primary performance measures we use in the analysis are prospectus benchmark adjusted alpha (*Prospectus Bench.-Adj. Alpha*) and Carhart (1997) four-factor alpha (Four-Factor Alpha). We also supplement the performance measures using DGTW characteristic-adjusted returns (Daniel et al. (1997)) and Morningstar ratings (*Morningstar Rating*).

B.3 Other variables

Active Share is calculated by aggregating the absolute differences between the weight of a portfolio's actual holdings and the weight of its closest matching index (Cremers and Petajisto (2009)). It captures the percentage of a fund's portfolio that differs from its benchmark index. *Tracking error* is a measure of the volatility of excess fund returns relative to its prospectus benchmark. *R-squared* is calculated as the R-squared of Carhart (1997) four-factor model regressions following Amihud and Goyenko (2013).

Fund Size is the sum of AUM across all share classes of the fund; *Fund Age* is the age of the oldest share class in the fund; *Expense* is determined by dividing the fund's operating expenses by the average dollar value of its AUM; *Turnover* is defined as the minimum of sales or purchases divided by total net assets of the fund; *Net Flows* is the annual average of monthly net growth in fund assets beyond reinvested dividends (Sirri and Tufano (1998)). *Manager Tenure* measures the length of time that a manager has been at the helm of a mutual fund, *Team* is a dummy variable that equals 1 if a fund is managed by multiple managers and 0 otherwise. We describe in detail definitions for all variables in Section A of the Appendix.

C Descriptive Statistics

Our final sample consists of 1,043 unique U.S. domestic equity funds from 153 fund families, covering 6,966 fund-year observations that contain at least one performance benchmark, pure or peer, in the portfolio manager's compensation contract. We report the summary statistics of compensation benchmark variables, fund performance, and other characteristics for our final sample in Table 1.

[Insert Table 1 about here]

We observe that almost all of our sample funds comply with the SEC and report a market index as the prospectus benchmark. Only less than 0.1% of the sample does not have a prospectus benchmark, and we exclude those from our analysis. In addition to the primary prospectus benchmark, 25.6% of our sample funds also have a secondary prospectus benchmark. In terms of the distribution of prospectus benchmark, the most popular market index is S&P 500 (33%) followed by Russell 1000 Growth (8.6%), Russell 1000 Value (8.5%), Russell 2000 (8.5%), and Russell 2000 Growth (5.5%).

As for the compensation benchmarks, 79.1% of the funds contain a broad pure, market index benchmark (e.g., S&P 500 index), and 70.7% contain a peer index (e.g., Lipper Small Cap Growth Fund index). Pure and peer benchmarks are not necessarily mutually exclusive. About 21% of funds in our sample use a peer benchmark , 29% of funds use a pure benchmark , and the remaining 50% of funds use a compensation benchmark comprised of both peer and pure indices. For those with pure benchmarks, except in 37 cases, the market index used in the compensation benchmark coincides with the prospectus benchmark. For those with the peer benchmark, in more than 50% cases, the peer benchmark is clearly specified as one of the Lipper index or Morningstar benchmark, and the rest are reported as "applicable/appropriate peer group". In those instances, we assign a Morningstar or Lipper benchmark based on the stated investment objective of the fund.

Table 2 shows the top 10 benchmarks by the total number of funds in our sample whose managers are compensated relatively to either a pure or a peer benchmark. For those managers compensated relative to a pure benchmark, 24.4% use the S&P 500, while various Russell benchmarks occupy the majority of the top 10 (8 out of 10).[16] For the peer-benchmarked subsample, we see that 17.8% of funds have managers whose compensation is determined by performance relative to the Lipper Large-Cap Core Fund manager benchmark. The peer benchmark list is dominated by Lipper manager benchmark. Only a single Morningstar benchmark (Large-Cap Growth Funds) makes it to the top 10.

[Insert Table 2 about here]

IV Empirical Results

A Fund Activeness and Compensation Benchmarks

The first prediction of our model is that peer-benchmarking induces greater managerial effort and is associated with higher active share/tracking error relative to pure-benchmarking. We test this first prediction empirically by examining whether or not there are differences in portfolio activeness between funds using peer vs. pure compensation benchmarks.

In particular, we carry out a multivariate regression analysis using the following OLS specification:

$$Y_{i,t} = \alpha + \beta Benchmark_{i,t-1} + \gamma Controls_{i,t-1} + \lambda_k + \mu_{i,t}, \tag{16}$$

where the dependent variable $Y_{i,t}$ represents the portfolio activeness of fund i in year t, $Benchmark_{i,t-1}$ represents compensation benchmark variables of fund i at year $t-1$. We also include a comprehensive set of control variables typically associated with fund performance: *Fund Size, Fund Age, Expense, Turnover, Team, Active Share, Family*

[16] For the S&P 500 benchmark, the fraction based on total assets under management is higher because funds with this benchmark tend to have higher TNA.

Size, and *Manager Tenure.* All variables are defined in Section A of the Appendix. We measure all the independent variables as of the previous year-end to address potential reverse causality concerns. To alleviate the concern that some fund categories use certain type of compensation benchmark and, at the same time, exert a positive impact on portfolio activeness, we include fund category × year fixed effects (λ_k). Standard errors are adjusted for heteroscedasticity and clustered at the fund level.

We measure a fund's portfolio activeness using *Active Share* (Cremers and Petajisto (2009)), *Tracking error*, or *R-squared* from the four-factor model (Amihud and Goyenko (2013)). All measures have been widely used in the literature to measure how active portfolio managers are in managing the fund's portfolio. That is, the lower the active share measure and tracking error, or the higher R-squared measure, the more portfolio managers behave like closet indexers in managing the fund's portfolio. Recognizing the important insight that active share, in particular, may be benchmark or investment objective dependent (e.g. Frazzini, Friedman and Pomorski (2016)), we include fund category × year fixed effects to address this dependence.

For each activeness measure, we consider two specifications. In the first specification, both *Pure* and *Peer Benchmark* dummies are introduced simultaneously in the regression.[17] In the second specification, we include the sample funds with either a pure or a peer benchmark but exclude those that have both a pure and a peer benchmark.

The results are reported in Table 3. Consistent with Prediction 1, managers compensated relative to a pure benchmark show lower active share than those compensated relative to a peer benchmark. This is true both when the manager is evaluated, simultaneously, with respect to a peer benchmark (column (1)) and when we compare managers with only peer versus only pure compensation benchmarks (column (4)). In particular, looking at column (4), *Active Share* is 2.5 percentage points lower for portfolio managers compensated relative only to a pure benchmark versus those compensated relative only to a a peer benchmark. The difference statistically significant at the 5% level.

[Insert Table 3 about here]

The results are qualitatively similar when we replace *Active Share* with *Tracking error* or *R-squared* as the dependent variable. Thus, managers evaluated relative to a

[17] Since the two dummy variables are not mutually exclusive as shown in Panel A of Table 1, the specification with both dummies included allows us to estimate the effect of each type of benchmark on portfolio activeness.

pure compensation benchmark on average have a 0.8 percentage point lower *Tracking error* (column (5)) and a 2.6 percentage points higher *R-squared* (column (6)) compared to managers evaluated relative to a peer benchmark. Both differences are statistically significant at the 1% level . These effects are economically large, given that the standard deviations of *Tracking error* and *R-squared* in our sample are 2.6% and 7.4%, respectively. In general, consistent with the theoretical prediction, fund managers compensated relative to a pure market benchmark are less active and choose portfolios that more closely follow their performance benchmarks.

The analysis of the three variables in Table 3 reveals the differences in active management between portfolio managers evaluated relative to a pure versus a peer benchmark. Whether measured by active share, tracking error, or R-squared, compensation with respect to a pure benchmark is associated with lower active management and more closet indexing, which is consistent with the prediction from the theoretical literature (e.g., Admati and Pfleiderer (1997), Cuoco and Kaniel (2011), and Basak and Pavlova (2013)). In contrast, peer-benchmark based compensation is associated with more active management. This evidence jointly suggests that pure benchmarks induce portfolio managers to closet index, while peer benchmarks incentivize portfolio managers to be more active in portfolio management.

B Mutual Fund Fees and Compensation Benchmarks

We now turn our attention to the second prediction of the model, namely the relation between fund fees and compensation benchmarks. Specifically, the model implies that peer-benchmarked managers will receive higher advisory fee rates.

To examine this hypothesis empirically, we replace the dependent variable $Y_{i,t}$ in equation (16) with *Advisory Fee Rate* or *Fund Expense Ratio.* The former captures the advisory fee rate charged by fund advisors for their investment advisory services, while the latter captures the total annual expense ratio of operating a fund. While our model prediction relates specifically to manager compensation, we do not have the actual contracts or dollar amounts paid to managers. Instead, we proxy for this compensation by using the advisory fee received by the investment advisor for managing the fund. Because managers compensation is likely paid from this fee revenue and the advisory fee is separated out in fund disclosures for the express purpose of identifying such revenue, we believe that it is a reasonable proxy. We also repeat the analysis with expense ratios in case manager compensation is paid, in part, from other categories of expense revenue collected by the fund management company. We also include the same controls as in the previous tables. Standard errors are adjusted for heteroscedasticity and clustered at the fund level. The results are reported in Table 4.

[Insert Table 4 about here]

We first analyze fund advisory fees in columns (1) and (3). Our results show that funds using pure compensation benchmarks have lower advisory fee rates compared to funds with peer benchmarks. The difference is 6.3 bps per year and statistically significant at the 1% level. This result is also economically meaningful as it represents a 10% decrease relative to the sample average annual advisory fee rate of 65.5 bps.

We next analyze fund expense ratios in columns (2) and (4). The results are qualitatively similar to that of advisory fees. Funds with pure benchmarks are less expensive by 18.7 bps on average, compared to funds with peer benchmarks. This difference is significant at the 1% level and also economically meaningful considering that the sample average fund expense ratio is 1.1% per year.

Analyzing the control variables, we find that both the *Advisory Fee Rate* and the *Expense Ratio* are negatively associated with *Fund Size* and positively associated with *Turnover* and *Manager Tenure*. That is, as expected, fund fees decrease with fund size and increase with portfolio turnover. Managers with more experience are associated with higher advisory fees and expense ratios. It is worth noting that the lower costs of funds with pure benchmarks are robust after we control for *Manager Tenure*. It suggests that this evidence is not driven by pure-benchmark-based compensation being less expensive because it is offered to less experienced managers, arguably with lower capacity for rent-extraction.[18]

C Pure vs. Peer Relative Benchmark Performance

The final prediction of our model is that peer-benchmarked managers will outperform pure-benchmarked managers. While we test this prediction directly in Table 6, we first examine the mechanism underlying this prediction in Table 5. The outperformance is due

[18]Heinkel and Stoughton (1994) predict that the use of performance-based incentives is positively related to the manager's tenure.

to the manager effort embedded in the peer benchmark, making such a benchmark more difficult to beat. To test this underlying mechanism, we perform an ex ante comparison of each manager's performance relative to both types of benchmarks.

In particular, we use all funds in our initial sample (12,719 observations), with or without a compensation benchmark. Then, for all of them, we assign the prospectus benchmark as the hypothetical pure benchmark, and the appropriate Lipper peer benchmark for their investment style as the hypothetical peer benchmark. We then calculate the benchmark-adjusted return for each fund, netting out the benchmark return from the fund return. We also estimate benchmark-adjusted alpha with respect to each benchmark. Finally, we compare, for each fund, whether their benchmark-adjusted performance is higher relative to pure or peer benchmarks. Since market indices (pure benchmarks) reflect no deduction for fees, expenses, or taxes whereas peer indices do, a fair comparison entails comparing gross-of-fees fund returns to pure benchmark returns, and net-of-fees returns to peer benchmark returns (i.e., average net returns of peers).[19]

[Insert Table 5 about here]

The results are reported in Table 5. We find that a fund's gross excess return (alpha) with respect to the pure benchmark is, on average, 0.75% (0.90%) higher than its net excess return (alpha) with respect to the peer benchmark on an annualized basis. These results suggest that other things equal, peer benchmarks are more difficult to beat than pure benchmarks, consistent with such benchmarks impounding the extra portfolio activeness of managers.

D Compensation Benchmarks and Mutual Fund Performance

The mechanism evidence provided in Table 5 further motivates a test of the primary prediction from our model: peer-benchmarked managers will outperform pure-benchmarked managers due to higher effort/high portfolio activeness. In this section, we empirically test this prediction by comparing the performance of funds whose managers are evaluated against a pure benchmark vs. a peer benchmark.

We estimate a version of equation (16) where the dependent variable $Y_{(i,t)}$ represents the performance of fund i in year t. We use four abnormal fund performance measures

[19] While most fund compensation disclosures in our sample do not specify how expenses are handled in benchmark comparisons, for the small subset that do, the aforementioned treatment is typical.

in our analysis: (i) prospectus benchmark-adjusted alpha, (ii) Carhart (1997) four-factor alpha, (iii) DGTW characteristic-adjusted portfolio return (Daniel et al. (1997)), and (iv) Morningstar Ratings. The independent variables and controls are defined as in equation (16). To alleviate the concern that some fund categories use certain types of compensation benchmarks and, at the same time, exert a positive impact on fund performance, we include fund category $\times$ year fixed effects (λ_k). Standard errors are adjusted for heteroscedasticity and clustered at the fund level.

Similar to Table 3, for each performance measure, we consider two specifications. In the first specification, both *Pure* and *Peer Benchmark* dummies are introduced simultaneously in the regression. In the second specification, we include the sample funds with either a pure or a peer benchmark but exclude those that have both a pure and a peer benchmark.

We report the estimation results in Table 6. In columns (1) and (5), we use the fund's primary prospectus benchmark-adjusted alpha as the measure of fund performance. We find that, as shown in Column (1), funds using a pure compensation benchmark underperform other funds in our sample by 0.41% per year, whereas funds with a peer compensation benchmark outperform the rest of the sample by 0.33% per year, with both the differences being statistically significant at the 5% level. The outperformance of funds with peer compensation benchmarks is confirmed using the sample of funds having only peer or only pure benchmarks. In Column (5) the peer benchmark has a coefficient of 0.85, which suggests that funds with peer benchmarks outperform ones with pure benchmarks by 0.85%, with the difference statistically significant at the 1% level. Given that the sample average prospectus benchmark-adjusted alpha is -0.06% per year, the effects we document in these two columns are economically large.

[Insert Table 6 about here]

The results are very similar when we use the Carhart four-factor alpha to measure fund performance in columns (2) and (6). For instance, as shown in column (6), funds whose portfolio managers are evaluated relative only to a peer benchmark in determining their compensation outperform funds with a pure benchmark by 0.49% per year, with the difference statistically significant at the 1% level. Results are also similar when we measure fund performance using DGTW returns in columns (3) and (7) or Morningstar Ratings in columns (4) and (8). For instance, based on results on DGTW returns in column (7), funds with peer-benchmarked managers outperform those with pure-benchmarked managers by 0.46% per year. Based on results on Morningstar Ratings in column (8), funds with peer-benchmarked managers have a 0.35 higher star compared to those with pure-benchmarked managers. Both differences are economically large and statistically significant at the 5% level or lower. Regarding the control variables, the results are consistent with the patterns documented in the previous literature. For instance, fund performance decreases with fund size and the expense ratio and increases with a fund's active share.

Overall, we find robust evidence that mutual funds that use peer benchmarks in portfolio manager compensation are associated with better performance than those using pure benchmarks. Together with the evidence on portfolio activeness in Table 3, this evidence provides strong support to the predictions of our model.

Taken together, the results of Tables 3-6 strongly support the model's predictions and the underlying intuition. They suggest that when portfolio managers are compensated relative to their peers, the incentives from this "tournament-type" compensation deliver higher fund performance by inducing managers to be more active in their portfolio strategies. The superior performance of these managers is rewarded with higher advisory fees, which is then passed on to fund investors via higher expense ratios. Finally, our evidence shows that investors are still better off even after fees (i.e., with higher net alphas) as the outperformance associated with peer compensation benchmarks is more than the difference in fund fees.

We argue that our results are less likely to be driven by an alternative explanation based on adverse-selection, i.e., more skilled managers are selected by or attracted to funds with peer-based compensation. First, there is limited variation in the type of compensation benchmark across fund managers within the same family. For instance, only 25% of the families exhibit variations across funds on whether to include a peer benchmark in the manager's contract. Second, prior studies have shown that the design of portfolio managers compensation contracts responds more to family features than to managers' characteristics (e.g., Ma, Tang and Gómez (2019) and Ibert et al. (2018)). We investigate the specific determinants of the benchmark choice in compensation contracts in the next section.

E Mutual Fund Flows

Due to its partial equilibrium nature, the model does not address the question of why pure-benchmarked funds hold significant market share despite their inferior performance. We conjecture that a plausible explanation is investor heterogeneity and the associated market segmentation. To test this conjecture, we examine fund flows in this section and the determinants of an investment advisor's choice between peer- and pure-benchmark manager compensation in the next section.

Table 7 reports the OLS estimates of investor flow-performance sensitivity regressions for funds with peer- vs. pure-benchmarked portfolio managers. To ensure a clean comparison, we use the sample of funds with only peer or only pure benchmarks. The dependent variable is monthly net flows as a percentage of fund TNA. We first use the performance rank based on prospectus benchmark adjusted alpha in our analysis in columns (1) to (3). For robustness, we also use the performance rank based on the commonly used Carhart (1997) four-factor alpha in columns (4) to (6). We control for the same set of fund characteristics as in Table 3 and fund category $\times$ year fixed effects in the regressions.

[Insert Table 7 about here]

The estimates in columns (1) and (2) show a positive relationship between past performance and fund flows for the sample of funds with only peer or pure benchmarks. However, the pure-benchmarked funds have less flow-performance sensitivity than the peer-benchmark funds, with the coefficient on past performance being 3.114 in column (1) and 1.819 in column (2). The difference in flow-performance sensitivities between peer- and pure-benchmarked funds is 1.295 and statistically significant at the 5% level. Next, we combine both groups of funds in one regression and run a specification using interaction terms between past performance and an indicator variable for whether or not the fund manager is compensated based only on a peer benchmark. As shown in column (3) of Table 7, the coefficient on the interaction term of past performance times indicator variable of only peer benchmark is positive significant at the 5% level. This finding further confirms a stronger flow-performance sensitivity of peer-benchmarked funds compared to pure-benchmarked funds. We repeat our analysis in columns (1) to (3) using Carhart (1997) four-factor alpha, and find that the results remain qualitatively similar.

This evidence suggests that fund investors are heterogeneous in terms of their flow-performance sensitivity and that funds with peer vs. pure compensation benchmarks possibly cater to a different investor clientele. This clientele segmentation helps explain why money does not flow out of (underperforming) funds where managers are compensated with respect to pure benchmarks and into funds where managerial incentives are based on performance relative to a peer benchmark.

F Determinants of Portfolio Manager Compensation Benchmarks

While the flow results of the previous section are consistent with hetergoeneous investors and the possibility of segmented markets, we further examine this possible explanation from the perspective of an investment advisor. To this end, we analyze the determinants of the investment advisor's choice of portfolio manager compensation benchmarks. While peer or pure benchmarks are exogenously assigned in the model, the empirical observation of both types of benchmarks in practice raises natural questions that what underlying economic forces drive the choice of the benchmarks in portfolio manager compensation. To explore the possible driving forces, we carry out determinant analyses that relate the choices of compensation benchmark to a set of advisor-, manager-, and fund-level features.

In the analysis we are interested in how compensation benchmark choices relate to three dimensions of the investment advisor strategy that relate to segmentation: distribution channel, investor sophistication, and advisor incentive structure. First, we examine the relationship between benchmark choice and the primary distribution channel of the investment advisor as proxied by the percentage of the advisor's assets sold through a no-load or direct channel. Del Guercio and Reuter (2014) document important market segmentation related to distribution channel, with more performance sensitive investors found investing through the direct distribution channel.

Second, we analyze whether benchmark choices are related to investor sophistication as measured by two variables. The first is an indicator variable that equals one if the largest clientele of the fund advisor by percentage AUM are hedge funds based on data collected from Form ADV. Second, we create an indicator variable that equals one if the average investor account size of an investment advisor exceeds $1 million. We choose $1 million as the cutoff to identify investment advisors where the average client is either institutional or high net worth, consistent with greater financial sophistication. If there is a difference in the sophistication level of the average investor of an investment advisor that uses peer-benchmarking relative to pure-benchmarking advisors, this would be a dimension of client segmentation observed in the industry.

Third, a recent study by Evans, Prado and Zambrana (2020) finds that there are cross-sectional variations in the incentive structure of fund families, where some investment advisors have a more competitive incentive scheme, while other investment advisors use more cooperative incentives. They provide evidence that this choice between competitive and cooperative incentives is related to investment advisor strategy regarding market segmentation. Since peer-based benchmark fosters competition rather than cooperation, we expect that families that choose more cooperative incentives to be less likely to use peer-based compensation benchmarks.

To test our hypotheses, we employ the following logistic model to analyze the determinants of the compensation benchmark choices.

$$\begin{aligned} y^*_{i,t} &= \alpha + \beta Determinants_{i,t-1} + \epsilon_{i,t}, \\ y^j_{i,t} &= 1[y^{*j}_{i,y} > 0], \end{aligned} \tag{17}$$

where the dependent variable $y^j_{i,t}$ represents compensation benchmark choice variables, only peer vs. only pure benchmark, of fund i at year t; $Determinants_{i,t-1}$ is a vector of determinant variables including the percentage of no-load funds in the fund's family (*Pct. No Load*), indicator variables for average investor account size exceeding \$1 million (*Avg. Account Size > \$1 mil.*) and the largest investor group of the fund's advisor being hedge fund clients (*Hedge Fund Client*), and the family-level *Net Cooperative Index* of Evans, Prado and Zambrana (2020). We also include the same set of control variables as in Table 3 and category × year fixed effects. To alleviate reverse causality concerns, we lag all determinant and control variables by one year. We adjust standard errors accounting for heteroscedasticity and clustering at the fund level.

We report the estimation results in Table 8. In specifications (1) and (5), we see that investment advisors who predominantly sell through the direct distribution channel are more likely to use peer-benchmarking to determine manager compensation. This is consistent with the results of Del Guercio and Reuter (2014) showing greater performance sensitivity of direct sold investors and segmentation with regards to both channels. In columns (2), (3) and (5), we see that the coefficients on both measures of clientele sophistication are positive and statistically significant at the 5% level or better. This suggests that a peer compensation benchmark is more likely to present when a fund's family is more focused on higher sophistication clients. Given this heterogeneity between investors in peer- and pure-benchmarked funds, this is consistent with higher sophistication clients identifying and investing in higher performing peer-benchmarked funds. Lastly, in specifications (4) and (5), we find that the coefficient on *Net Cooperative Index* is negative and significant at the 1% level. This finding is consistent with the idea that since peer benchmarks generate higher competition incentives, mutual fund families with a greater tendency to promote a cooperative environment are less likely to use such compensation benchmarks. In summary, the above evidence suggests that the usage of peer vs. pure benchmarks is consistent with investor heterogeneity and the associated market segmentation.

[Insert Table 8 about here]

V Conclusion

While the empirical and theoretical literature on asset management has long conflated the incentives of fund managers and the investment advisors they work for, a small but growing literature correctly separates the two and examines the importance of portfolio manager compensation and incentives. In addition to identifying the determinants of fund manager compensation, these papers have begun to explore the implications for fund and advisor outcomes from these different compensation schemes. In this paper, we first model theoretically and then explore empirically the use of peer and pure benchmarks as determinants of fund manager compensation.

The overall picture that emerges after our study provides four important new insights. First, pure vs. peer benchmarks in compensation contracts are fundamentally different. Peer benchmarks induce an important externality in portfolio choice because managers' active portfolio decision is impounded into the benchmark return (i.e., the peer average). Second, due to this externality, peer-benchmarked managers exhibit more active management and deliver superior fund performance. Third, the superior performance is, in part, extracted by investment advisors and shared with their fund manager employees, and, in part, shared with investors in the form of superior net performance of the fund. Fourth, one plausible explanation for the existence of both types of benchmarks in equilibrium is that the markets of fund investors are segmented. Fund investors differ in their level of sophistication and the distribution channel they use. These differences and the associated differences in the underlying business models across advisory firms play an important role in the choice of peer vs. pure benchmarks.

Our study adds to the literature by documenting new evidence on the actual benchmarks used to compensate portfolio managers, and its implications for portfolio decisions and fund performance. Our results also shed light on the determinants underlying the choice of a given benchmark. Investor sophistication and the segmented markets of fund investors may explain the existence of both choices in equilibrium. We believe these findings should guide the modeling of optimal benchmarking in the future.

This paper also has important policy implications. In seeking comment on the original 1993 regulation requiring funds to disclose their prospectus benchmark, some commenters urged the SEC to allow peer group comparisons reported in the prospectus, arguing that such a comparison would be an appropriate performance measure for investors since it would represent the 'true' opportunity cost of the investor (i.e. the performance of the funds they could have selected, but did not). The SEC rejected this idea by suggesting that peer benchmarks could be used to suggest superior performance of the fund when, in fact, the fund had underperformed a market or pure-benchmark. In making this assessment, the SEC clearly indicated their belief that disclosing peer-benchmark relative performance would not be beneficial to investors. Given our evidence on the outperformance of peer-benchmarked managers, it is hard to justify a policy that only allows pure benchmark comparison. Our results, therefore, challenge the SEC's ad hoc restriction on providing only pure-benchmark performance comparisons in fund prospectuses, but not peer-benchmark performance comparisons.

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Table 1 - Summary Statistics

This table reports the sample distribution (Panel A) and summary statistics of the main variables used in this study (Panel B). Our sample includes 6,966 fund-year observations of U.S. actively managed domestic equity mutual funds. In Panel A, we break down the distribution across the two main compensation variables: Peer vs. Pure Benchmark. Peer (Pure) Benchmark takes a value 1 if the manager's performance-based incentive is evaluated relative to a peer (pure) benchmark, and zero otherwise. All variables in Panel B except indicator variables are winsorized at the 1% and 99% levels. All variables are defined in the Appendix of the paper.

Panel A. Sample Distribution across Peer vs. Pure Benchmarks

		Peer Benchmark	
		0	**1**
Pure Benchmark	**0**	–	1,457 (20.9%)
	1	2,041 (29.3%)	3,468 (49.8%)

Panel B. Summary Statistics of Main Variables

				Distribution		
Variables	**N**	**Mean**	**Std. Dev**	**10th**	**50th**	**90th**
Peer Benchmark	6,966	0.707	0.455	0	1	1
Pure Benchmark	6,966	0.791	0.407	0	1	1
Prospectus Bench.-Adj. Alpha	6,716	-0.055	5.326	-5.983	-0.231	6.248
Four-Factor Alpha	6,734	-0.715	5.246	-6.793	-0.621	5.401
DGTW Returns	6,048	0.393	4.996	-5.446	0.225	6.380
Morningstar Rating	6,925	3.139	0.870	2.000	3.042	4.250
Active Share	6,079	75.719	23.033	51.179	81.463	96.536
Tracking Error	6,916	4.202	2.613	1.318	3.779	7.494
R^2	6,480	92.054	7.355	82.350	94.052	99.177
Advisory Fee Rate	6,811	0.655	0.270	0.246	0.698	0.985
Expense Ratio	6,942	1.070	0.409	0.500	1.094	1.568
Flows%	6,966	0.284	3.660	-2.392	-0.446	3.202
Log Fund Size	6,966	19.906	1.606	17.850	19.870	21.985
Log Fund Age	6,966	5.023	0.648	4.159	5.043	5.784
Log Turnover	6,892	3.914	0.973	2.639	4.043	5.004
Performance Adv. Fee	6,966	0.017	0.130	0	0	0
Team	6,949	0.726	0.446	0	1	1
Log Manager Tenure	6,949	3.961	0.808	2.890	4.060	4.890
Log Family Size	6,966	24.087	1.839	21.515	24.518	25.815

Table 2 - Top 10 Pure and Peer Benchmarks

This table reports the summary statistics on the top peer and pure benchmarks disclosed in portfolio manager compensation. We rank all benchmarks based on the number of funds and report the top 10 pure and peer benchmarks in Panel A and B, respectively. We also report for each benchmark the percentage of funds, the total assets under management, and the percentage of the assets in column (3)-(5), respectively.

Panel A. Top 10 Pure Benchmarks

Benchmark	# Funds Rank	# Funds	% Funds	Assets (in billions)	% Assets
S&P 500 Index	1	1,251	24.4%	61,198.8	54.0%
Russell 1000 Growth Index	2	600	11.7%	5,814.1	5.1%
Russell 1000 Value Index	3	585	11.4%	7,043.1	6.2%
Russell 2000 Index	4	364	7.1%	2,567.0	2.3%
Russell 2000 Growth Index	5	326	6.4%	1,062.3	0.9%
Russell Mid-Cap Growth Index	6	287	5.6%	2,162.4	1.9%
Russell 2000 Value Index	7	271	5.3%	1,461.9	1.3%
Russell 3000 Index	8	171	3.3%	2,179.3	1.9%
S&P Mid-Cap 400 Index	9	162	3.2%	4,527.0	4.0%
Russell 3000 Growth Index	10	162	3.2%	1,616.1	1.4%
Total		4,179	81.5%	89,632	79.1%

Panel B. Top 10 Peer Benchmarks

Benchmark	# Funds Rank	# Funds	% Funds	Assets (in billions)	% Assets
Lipper Large-Cap Core Funds	1	807	17.8%	11,827.2	14.1%
Lipper Large-Cap Growth Funds	2	784	17.3%	11,939.3	14.3%
Lipper Large-Cap Value Funds	3	492	10.9%	8,721.5	10.4%
Lipper Mid-Cap Growth Funds	4	446	9.8%	3,996.3	4.8%
Lipper Small-Cap Growth Funds	5	405	8.9%	2,374.3	2.8%
Lipper Small-Cap Core Funds	6	327	7.2%	2,641.8	3.2%
Lipper Mid-Cap Value Funds	7	169	3.7%	2,452.1	2.9%
Lipper Mid-Cap Core Funds	8	161	3.6%	1,482.2	1.8%
Lipper Small-Cap Value Funds	9	138	3.0%	792.5	0.9%
Morningstar Large-Cap Growth Funds	10	114	2.5%	1,326.8	1.6%
Total		3,843	84.8%	47,553.9	56.8%

Table 3 - Compensation Benchmarks and Fund Activeness

This table examines the relation between compensation benchmarks and proxies of fund activeness. We re-estimate table 3 except the dependent variable is Active Share in Column (1) and (4), Tracking Error in Column (2) and (5), and R^2 in Column (3) and (6). Standard errors are adjusted for heteroscedasticity and clustered by fund. t-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

	All Sample			**Only Peer vs. Only Pure**		
Variables	**(1) Active Share**	**(2) Tracking Error**	**(3) R-squared**	**(4) Active Share**	**(5) Tracking Error**	**(6) R-squared**
Peer Benchmark	-1.338	-0.099	0.283	2.532**	0.832***	-2.618***
	(-1.07)	(-0.79)	(0.81)	(2.23)	(5.06)	(-5.04)
Pure Benchmark	-2.714**	-0.840***	2.696***			
	(-2.47)	(-5.70)	(5.51)			
Log(Fund Size)	0.749*	0.133***	-0.219	0.691	0.220***	-0.266
	(1.72)	(2.77)	(-1.53)	(1.25)	(3.30)	(-1.31)
Log(Fund Age)	0.769	-0.064	0.306	-1.427	-0.358***	1.124**
	(1.01)	(-0.69)	(1.01)	(-1.44)	(-2.71)	(2.57)
Expense	20.583***	2.037***	-4.921***	17.130***	1.944***	-4.633***
	(10.25)	(12.46)	(-10.48)	(8.24)	(8.62)	(-7.20)
Log(Turnover)	3.450***	0.181***	-0.104	2.303**	0.077	0.154
	(5.28)	(2.95)	(-0.61)	(2.44)	(0.79)	(0.58)
Team	0.728	-0.171	0.708**	2.845**	-0.264	0.976**
	(0.72)	(-1.53)	(2.14)	(2.23)	(-1.53)	(1.97)
Log(Manager Tenure)	2.635***	0.211***	-0.608***	1.735**	0.203**	-0.742***
	(4.57)	(3.61)	(-3.45)	(2.57)	(2.33)	(-2.83)
Log(Family Size)	-1.033***	-0.103***	0.330***	-1.359***	-0.179***	0.471***
	(-3.28)	(-2.80)	(3.07)	(-3.87)	(-3.65)	(3.24)
Constant	20.671*	0.491	90.483***	53.711***	1.153	84.765***
	(1.91)	(0.50)	(30.05)	(3.94)	(0.84)	(20.13)
MS Category*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,107	5,761	5,629	2,562	2,876	2,815
Adjusted R^2	0.572	0.427	0.396	0.580	0.418	0.396

Table 4 - Compensation Benchmarks and Mutual Fund Fees

This table reports examines the relation between fund fees (advisory fee rate in column 1 and 3, and expense ratio in column 2 and 4) and compensation benchmarks. All variables are defined in Appendix. Standard errors are adjusted for heteroscedasticity and clustered by fund. t-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

	All Sample		Only Peer vs. Only Pure	
Variables	**(1) Advisory Fee Rate**	**(2) Expense Ratio**	**(3) Advisory Fee Rate**	**(4) Expense Ratio**
Peer Benchmark	0.008	0.004	0.063***	0.187***
	(0.49)	(0.16)	(3.32)	(6.37)
Pure Benchmark	-0.048***	-0.174***		
	(-3.02)	(-6.94)		
Log(Fund Size)	-0.010*	-0.053***	-0.004	-0.049***
	(-1.94)	(-6.47)	(-0.53)	(-4.29)
Log(Fund Age)	-0.014	0.064***	-0.026*	0.042*
	(-1.34)	(4.29)	(-1.81)	(1.92)
Log(Turnover)	0.079***	0.114***	0.076***	0.132***
	(11.42)	(10.68)	(7.30)	(8.64)
Team	0.046***	0.056***	0.067***	0.056*
	(3.56)	(2.90)	(3.41)	(1.95)
Log(Manager Tenure)	0.038***	0.027***	0.040***	0.038**
	(5.39)	(2.58)	(3.85)	(2.43)
Log(Family Size)	-0.036***	-0.028***	-0.050***	-0.036***
	(-7.84)	(-4.09)	(-8.56)	(-4.06)
Constant	1.225***	1.894***	1.452***	1.915***
	(10.40)	(11.19)	(8.56)	(7.60)
MS Category*Year FEs	Yes	Yes	Yes	Yes
Observations	5,694	5,803	2,846	2,906
Adjusted R^2	0.358	0.358	0.394	0.375

Table 5 - Pure vs. Peer Benchmark-Adjusted Performance

This table reports the difference between gross returns and pure benchmark returns and the difference between net returns and peer benchmark returns. The comparisons between the two differences are reported in the row below. Panel A presents the results using the simple difference between returns and benchmark returns, and Panel B reports the benchmark adjusted alpha. Column (2) and (3) report the number of observations where fund returns beat or lose the benchmark returns, respectively. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**
		Panel A	
	Bench.-adj Return	**Difference>0**	**Difference<0**
Gross Return—Pure Benchmark Return	0.725%	6,930	5,750
Net Return—Peer Benchmark Return	-0.021%	6,450	6,269
Difference	0.747%***	480	-519
		Panel B	
	Alpha	**Alpha>0**	**Alpha<0**
Gross Return—β*Pure Benchmark Return	0.917%	6,887	4,888
Net Return— β*Peer Benchmark Return	0.020%	6,342	5,871
Difference	0.897%***	545	-983

Table 6 - Compensation Benchmarks and Mutual Fund Performance

This table reports regression results of fund performance on Peer and Pure benchmark and other control variables. Column (1) to (4) include all sample funds and Column (5) to (8) include funds with only peer benchmark or only pure benchmark (i.e., drop all funds with both a peer and a pure benchmark). Fund performance is measured by prospectus benchmark adjusted alpha in Column (1) and (5), four-factor alpha in Column (2) and (6), DGTW returns in Column (3) and (7), and Morningstar Ratings in Column (4) and (8). All variables are defined in the Appendix. Standard errors are adjusted for heteroscedasticity and clustered by fund. T-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5% and 10% level, respectively.

	All Sample				Only Peer vs. Only Pure			
Variables	**(1) Prospectus Alpha**	**(2) Four Alpha**	**(3) DGTW Ret.**	**(4) MS Ratings**	**(5) Prospectus Alpha**	**(6) Four Alpha**	**(7) DGTW Ret.**	**(8) MS Ratings**
Peer Benchmark	0.332**	0.345**	0.223*	0.205***	0.850***	0.486**	0.463**	0.350***
	(2.02)	(2.01)	(1.70)	(4.14)	(3.82)	(2.02)	(2.51)	(5.28)
Pure Benchmark	-0.412**	0.002	-0.197	-0.117**				
	(-2.24)	(0.01)	(-1.27)	(-1.98)				
Log(Fund Size)	-0.192***	-0.264***	-0.099**	0.135***	-0.257***	-0.366***	-0.123*	0.129***
	(-3.24)	(-4.41)	(-2.05)	(8.05)	(-3.06)	(-4.20)	(-1.69)	(5.13)
Log(Fund Age)	0.153	0.236*	0.128	-0.232***	0.088	0.138	-0.020	-0.271***
	(1.28)	(1.96)	(1.28)	(-6.38)	(0.51)	(0.82)	(-0.14)	(-5.16)
Expense	-1.194***	-1.464***	-0.135	-0.434***	-1.830***	-1.978***	-0.339	-0.498***
	(-4.98)	(-6.04)	(-0.74)	(-6.52)	(-5.24)	(-5.69)	(-1.22)	(-5.23)
Log(Turnover)	-0.168**	-0.224***	-0.284***	-0.083***	-0.341**	-0.331**	-0.419***	-0.144***
	(-1.98)	(-2.69)	(-4.18)	(-3.27)	(-2.53)	(-2.42)	(-3.78)	(-3.73)

Team	-0.265	-0.021	-0.084	0.003	0.123	0.404	0.173	0.171***
	(-1.63)	(-0.12)	(-0.62)	(0.06)	(0.50)	(1.60)	(0.79)	(2.94)
Log(Manager Tenure)	0.139	0.034	0.072	0.112***	0.087	0.114	-0.093	0.130***
	(1.44)	(0.37)	(0.87)	(4.47)	(0.60)	(0.82)	(-0.78)	(3.66)
Active Share	0.011***	0.000	0.009***	0.008***	0.015**	-0.001	0.011**	0.006***
	(3.04)	(0.12)	(2.92)	(6.46)	(2.36)	(-0.16)	(2.04)	(3.18)
Performance Adv. Fee	-0.655	-0.585	-0.628	0.037	-0.478	-0.623	-0.429	0.070
	(-1.60)	(-1.13)	(-1.23)	(0.21)	(-1.08)	(-1.12)	(-0.76)	(0.35)
Log(Family Size)	0.109**	0.104**	0.062	-0.026*	0.036	0.085	0.020	-0.038**
	(2.23)	(2.17)	(1.60)	(-1.78)	(0.56)	(1.33)	(0.41)	(-2.01)
Constant	0.776	2.323*	0.634	1.953***	4.857***	6.138***	3.618**	2.667***
	(0.60)	(1.77)	(0.62)	(4.86)	(2.62)	(3.21)	(2.39)	(4.89)
MS Category*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,025	5,036	5,068	5,107	2,510	2,517	2,544	2,562
Adjusted R^2	0.215	0.254	0.244	0.139	0.225	0.226	0.198	0.171

Table 7 - Fund Flows and Performance Rank

This table reports the estimation results of flow-performance relation for funds with peer- vs. pure-benchmarked portfolio managers. The dependent variable is monthly percentage net flow. The main variables of interest include performance rank based on prospectus benchmark adjusted alpha and Four-factor alpha, both interacted with an indicator variable for whether or not the fund manager is compensated based on only peer or only pure benchmarks. The rest control variables are defined in Appendix. Standard errors are adjusted for heteroscedasticity and clustered by fund. T-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

	Only Peer	Only Pure	Only Peer & Only Pure	Only Peer	Only Pure	Only Peer & Only Pure
	(1)	(2)	(3)	(4)	(5)	(6)
	Performance=Prospectus Benchmark Adj. Alpha			Performance=Four-factor Alpha		
Performance Rank	3.114***	1.819***	1.842***	3.846***	2.616***	2.630***
	(9.89)	(4.71)	(4.82)	(9.16)	(5.59)	(5.71)
Peer Benchmark * Performance Rank			1.134**			1.127**
			(2.43)			(2.01)
Peer Benchmark			-0.692**			-0.680**
			(-2.55)			(-2.38)
Log(Fund Size)	-0.130*	-0.197*	-0.152**	-0.0776	-0.204*	-0.128**
	(-1.69)	(-1.91)	(-2.44)	(-0.99)	(-1.96)	(-2.01)
Log(Fund Age)	-0.534***	-1.057***	-0.857***	-0.531***	-1.103***	-0.874***
	(-3.09)	(-5.40)	(-6.45)	(-3.17)	(-5.52)	(-6.55)
Expense	-0.187	-0.601*	-0.406*	-0.0165	-0.622*	-0.386*
	(-0.58)	(-1.92)	(-1.82)	(-0.05)	(-1.95)	(-1.71)
Log(Turnover)	-0.168	0.531***	0.261*	-0.0767	0.492**	0.292**
	((-1.24)	(2.62)	(1.85)	(-0.59)	(2.47)	(2.10)
Team	-0.160	0.00375	-0.0280	-0.168	-0.0173	-0.0353
	(-0.71)	(0.02)	(-0.18)	(-0.75)	(-0.08)	(-0.23)
Log(Manager Tenure)	0.129	0.310**	0.211**	0.0697	0.291**	0.154*
	(1.25)	(2.30)	(2.57)	(0.70)	(2.15)	(1.90)
Log(Family Size)	0.0543	0.0566	0.0377	0.0761	0.0261	0.0267
	(0.78)	(0.97)	(0.88)	(1.14)	(0.44)	(0.63)
Constant	2.226	5.502***	4.672***	0.451	6.771***	4.593***
	(1.22)	(3.22)	(3.88)	(0.24)	(3.65)	(3.67)
MS Category * Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,213	1,657	2,870	1,185	1,618	2,803
Adjusted R^2	0.155	0.119	0.104	0.158	0.128	0.112

Table 8 - Determinants of Portfolio Manager Compensation Benchmarks

This table reports results from a logistic regression of only pure (=0) vs. only peer (=1) compensation benchmark choice on a set of regressors. *Pct. No Load* is defined as the percentage of no-load funds in the fund's family. *Avg. Account Size > $1 mil.* is defined as an indicator variable for average investor account size exceeding $1 million. *Hedge Fund Client* is defined as an indicator variable that takes a value of 1 when the largest investor group of the fund's advisor is a hedge fund, zero otherwise. All other variables are defined in the Appendix. Standard errors are adjusted for heteroscedasticity and clustered by fund. T-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

	Only Peer VS. Only Pure				
	(1)	(2)	(3)	(4)	(5)
Pct. No Load	0.883***				1.311***
	(3.16)				(2.59)
Hedge Fund Client		1.182***			1.715***
		(3.11)			(3.68)
Avg. Account Size>$1 mil.			1.412***		1.743**
			(3.29)		(2.04)
Net Cooperative Index				-2.711***	-2.867***
				(-3.60)	(-3.00)
Log(Fund Size)	0.0626	0.0981	-0.0374	-0.128	-0.154
	(0.74)	(0.94)	(-0.36)	(-1.18)	(-1.04)
Log(Fund Age)	0.427**	0.176	0.381*	0.530**	0.453
	(2.49)	(0.88)	(1.88)	(2.49)	(1.46)
Expense	2.188***	1.052***	1.178***	1.860***	2.179***
	(6.56)	(2.92)	(3.23)	(4.86)	(3.76)
Log(Turnover)	-0.275***	-0.412***	-0.500***	-0.378***	-0.396**
	(-2.62)	(-3.04)	(-3.81)	(-3.13)	(-2.08)
Team	-0.0561	-0.295	-0.297	0.241	0.109
	(-0.30)	(-1.26)	(-1.26)	(1.07)	(0.33)
Log(Manager Tenure)	-0.318***	-0.0784	-0.0828	-0.244*	-0.286
	(-2.98)	(-0.66)	(-0.67)	(-1.96)	(-1.60)
Log(Family Size)	0.156**	-0.0173	0.0912	0.212***	0.191*
	(2.46)	(-0.23)	(1.22)	(2.69)	(1.67)
Category*Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2906	2000	1660	2011	1007
Pseudo R^2	0.103	0.077	0.080	0.113	0.201

Appendix

Appendix A: Variable definitions

Variable	Description
	Key variables
Pure Benchmark	=1 if the portfolio manager has a market index benchmark in her compensation contract based on a fund's Statement of Additional Information (SAI); 0 otherwise.
Peer Benchmark	=1 if the portfolio manager has a peer benchmark in her compensation contract based on a fund's SAI; 0 otherwise.
Prospectus Bench.-Adj. Alpha	Alpha estimated as in Model 1 with prospectus benchmark returns as the factor.
Four-Factor Alpha	Alpha estimated as in Carhart (1997)
Morningstar Rating	The Morningstar Rating is a measure of a fund's risk-adjusted return, relative to similar funds. Funds are rated from 1 to 5 stars, with the best performers receiving 5 stars and the worst performers receiving a single star.
Active Share	Active Share is a measure of the percentage of stock holdings in a manager's portfolio that differs from the benchmark index.
R-squared	It is constructed as the R-squared of Carhart's (1997) four-factor model regressions following Amihud and Goyenko (2013).
Tracking Error	It is a measure of the volatility of excess fund returns relative to its prospectus benchmark
Expense Ratio	Ratio of the fund's annual operating expenses by the average dollar value of its assets under management.
Advisory Fee Rate	The fee fund manager charges to make investment decisions for managing the mutual fund.
Net Flow	Net Flows is the annual average of monthly net growth in fund assets beyond reinvested dividends (Sirri and Tufano, 1998).

Determinant variables	
Net Cooperative Index	A standardized index that measures the fund family net cooperative (cooperative-competitive) incentives as defined in Evans, Prado, Zambrana (2020).
Pct. No Load	Percentage of total assets in no-load funds managed by a fund family.
Avg. Account Size > $1 mil.	=1 if average investor account size exceeding $1 million, 0 otherwise. The average account size at an investment advisor is calculated using the total number of accounts and the total assets managed by an investment advisor taken from Form ADV.
Hedge Fund Client	=1 if the largest investor group of the fund's advisor are hedge fund clients, 0 otherwise. The percentage of total assets managed by an investment advisor from hedge fund is estimated from Form ADV.
Control variables	
Fund Size	Sum of assets under management across all share classes of the fund.
Fund Age	Age of the oldest share class in the fund.
Expense	Ratio of the fund's annual operating expenses by the average dollar value of its assets under management.
Turnover	Fund turnover ratio, computed by taking the lesser of purchases or sales and dividing by average monthly net assets.
Team	=1 if a fund is managed by multiple managers, and 0 otherwise.
Manager Tenure	Average managerial tenure of the portfolio managers of a fund.
Family Size	Sum of assets under management across all funds in the family, excluding the fund itself.

Appendix B: Proofs

Proof of Proposition 1

Given (3) and (5), after putting effort α, for each signal s, managers compensated relative to a pure benchmark solve the following problem

$$\max_{\lambda} \quad I + \theta(\lambda - \lambda^b)E(\tilde{K}(\alpha, s)) - \tfrac{\rho}{2}\theta^2(\lambda - \lambda^b)^2 Var(\tilde{K}(\alpha)). \tag{A1}$$

Analogously, given (4) and (5), after putting effort α, for each signal s, managers compensated relative to a peer benchmark solve the following problem

$$\max_{\lambda} \quad I + \theta(\lambda - \bar{\lambda})E(\tilde{K}(\alpha, s)) - \tfrac{\rho}{2}\theta^2(\lambda - \bar{\lambda})^2 Var(\tilde{K}(\alpha)).$$

The optimal portfolios λ^u and λ^e follow, respectively, from the first order conditions of each problem and the definitions of $E(\tilde{K}(\alpha, s))$ and $Var(\tilde{K}(\alpha))$ in (2). The average portfolio follows from replacing $\lambda^u(s)$ and $\lambda^e(s)$ in $\bar{\lambda} = \delta\lambda^e + (1-\delta)\lambda^u$ and solving for $\bar{\lambda}$.

Q.E.D.

Proof of Prediction 1

Let $\underline{s} = -\frac{\theta L(1-\alpha)\sigma_\epsilon^2 + \bar{K}}{\alpha}$ and $\bar{s} = \frac{\theta L(1-\alpha)\sigma_\epsilon^2 - \bar{K}}{\alpha}$ (we have omitted the superscript e for simplicity). Notice that $\underline{s} = -(\bar{s} + \frac{2\bar{K}}{\alpha}) < 0$. Let $F(S) = \int_{-\infty}^{S} f(s)ds$ for any $S \in \Re$, with $f(s)$ the density function of the signal $\tilde{s} \sim N(0, \frac{\sigma_\epsilon^2}{\alpha})$. Given equation (10), the expected (unconditional) difference in active share between managers compensated with a peer versus pure benchmark $\int_{-\infty}^{\infty} AS^e(s)f(s)ds - \int_{-\infty}^{\infty} AS^u(s)f(s)ds =$

$$\begin{aligned}\int_{-\infty}^{\infty}(\lambda^e(s) - \lambda^u(s))f(s)ds = \; & -\tfrac{L}{1-\delta}F(\underline{s}) + \int_{\underline{s}}^{-\bar{s}} \tfrac{\bar{K}+\alpha^e s}{\theta^e\rho(1-\delta)(1-\alpha^e)\sigma_\epsilon^2} f(s)ds \\ & + \int_{-\bar{s}}^{\bar{s}} \tfrac{\bar{K}+\alpha^e s}{\theta^e\rho(1-\delta)(1-\alpha^e)\sigma_\epsilon^2} f(s)ds + \tfrac{L}{1-\delta}\int_{\bar{s}}^{-\underline{s}} f(s)ds + \tfrac{L}{1-\delta}(1 - F(-\underline{s})).\end{aligned}$$

Given the distribution of the signal, $F(\underline{s}) = 1 - F(-\underline{s})$ and $\int_{-\bar{s}}^{\bar{s}} sf(s)ds = 0$. The previous equation becomes:

$$\begin{aligned}\int_{-\infty}^{\infty}(\lambda^e(s) - \lambda^u(s))f(s)ds = \; & \int_{\underline{s}}^{-\bar{s}} \left(\tfrac{L}{1-\delta} + \tfrac{\bar{K}+\alpha^e s}{\theta^e\rho(1-\delta)(1-\alpha^e)\sigma_\epsilon^2}\right) f(s)ds \\ & + \tfrac{\bar{K}}{\theta^e\rho(1-\delta)(1-\alpha^e)\sigma_\epsilon^2}\int_{-\bar{s}}^{\bar{s}} f(s)ds > 0,\end{aligned}$$

since, given (7), $\frac{\bar{K}+\alpha^e s}{\theta^e \rho(1-\delta)(1-\alpha^e)\sigma_\epsilon^2} > -\frac{L}{1-\delta}$ for all $s > \underline{s}$, and $\int_{-\bar{s}}^{\bar{s}} f(s)ds > 0$.

Q.E.D.

Proof of Proposition 2

For $L < \infty$, the manager's expected utility is a function of θ (we omit the superscript $i = \{u, e\}$ for simplicity):

$$V(I, \theta, \alpha) = I + \int_{-\infty}^{\infty} \left(E(\tilde{R}(\theta, \alpha, s)) - \frac{\rho}{2} Var(\tilde{R}(\theta, \alpha, s)) \right) f(s)ds - c(\alpha), \qquad \text{(A2)}$$

with $\tilde{R}(\theta, \alpha, s)$ as in (11). Notice that, since (11) is independent of the benchmark, so is the function $V(I, \theta, \alpha)$. Given the contract (I, θ), the manager chooses effort $\alpha = \text{argmax}_\alpha V(I, \theta, \alpha)$. Assuming α exists, it must satisfy

$$\begin{aligned} \frac{\partial}{\partial \alpha} V(I, \theta, \alpha) &= 0, \\ \frac{\partial^2}{\partial \alpha^2} V(I, \theta, \alpha) &< 0. \end{aligned} \qquad \text{(A3)}$$

The implicit function theorem allows us to study "locally" the manager's effort as a function of the incentive fee θ. More formally, for every $\hat{\theta} \in (0, 1]$ there is a function $\alpha(\theta, L)$, continuous and differentiable, and an open ball $B(\hat{\theta})$, such that $\alpha(\hat{\theta}, L) = \alpha$ and $\frac{\partial}{\partial \alpha} V(I, \theta, \alpha(\theta, L)) = 0$ for all $\theta \in B(\hat{\theta})$. Taking the first derivative of the last equation with respect to θ and evaluating it at $\hat{\theta}$:

$$\frac{\partial}{\partial \theta} \alpha(\hat{\theta}, L) = -\left(\frac{\partial^2}{\partial \alpha^2} V(I, \hat{\theta}, \alpha) \right)^{-1} \frac{\partial}{\partial \alpha \partial \theta} V(I, \hat{\theta}, \alpha). \qquad \text{(A4)}$$

Given (A3), the corollary is proved is we show that $\frac{\partial}{\partial \alpha \partial \theta} V(I, \hat{\theta}, \alpha) > 0$. It is more convenient to standardize the signal s. Let $z = s \frac{\sqrt{\alpha}}{\sigma_\epsilon}$. z has a standard normal distribution with density function $\phi(z)$ and cumulative distribution function $\Phi(Z) = \int_{-\infty}^{Z} \phi(z)dz$. Given (2) and (A2), the cross-partial derivative $\frac{\partial}{\partial \alpha \partial \theta} V(I, \hat{\theta}, \alpha)$ can be written as

$$\frac{\partial}{\partial\alpha\partial\theta}V(I,\theta,\alpha) = \frac{L\sigma_\epsilon}{2\sqrt{\alpha}}\left[\frac{\phi\left(\frac{L\hat{\theta}\rho(1-\alpha)\sigma_\epsilon^2-\bar{K}}{\sqrt{\alpha}\sigma_\epsilon}\right)}{1-\Phi\left(\frac{L\hat{\theta}\rho(1-\alpha)\sigma_\epsilon^2-\bar{K}}{\sqrt{\alpha}\sigma_\epsilon}\right)} + \frac{\phi\left(-\frac{L\hat{\theta}\rho(1-\alpha)\sigma_\epsilon^2+\bar{K}}{\sqrt{\alpha}\sigma_\epsilon}\right)}{\Phi\left(-\frac{L\hat{\theta}\rho(1-\alpha)\sigma_\epsilon^2+\bar{K}}{\sqrt{\alpha}\sigma_\epsilon}\right)}\right] + \tag{A5}$$

$$L\hat{\theta}\rho\sigma_\epsilon^2\left[\Phi\left(-\frac{L\hat{\theta}\rho(1-\alpha)\sigma_\epsilon^2+\bar{K}}{\sqrt{\alpha}\sigma_\epsilon}\right) + 1 - \Phi\left(\frac{L\hat{\theta}\rho(1-\alpha)\sigma_\epsilon^2-\bar{K}}{\sqrt{\alpha}\sigma_\epsilon}\right)\right] > 0.$$

Replacing (A5) in (A4) it follows that $\frac{\partial}{\partial\theta}\alpha(\hat{\theta}, L) > 0$ for any $\hat{\theta} \in (0, 1]$.

When $L \to \infty$, the manager's compensation in (11) becomes $\tilde{R}(\alpha, s) = \tilde{K}(\alpha, s)\frac{\bar{K}+\alpha s}{\rho(1-\alpha)\sigma_\epsilon^2}$, independent of θ for all signal s.

Proof of Lemma 1

Given the contract (I, θ), for every signal s, $\tilde{Q}^u(\theta, s)$ can be written as (for simplicity, we omit the superscripts u and e unless necessary)

$$\tilde{Q}^u(\theta, s) = (\lambda^b + (1-\theta)\zeta(\theta, L, s))\tilde{K}(\alpha(\theta, L), s), \tag{A6}$$

when the manager is compensated relative to a pure benchmark, and

$$\tilde{Q}^e(\theta, s) = (\lambda^u(s) + (\frac{1}{1-\delta} - \theta)\zeta(\theta, L, s))\tilde{K}(\alpha(\theta, L), s), \tag{A7}$$

when the manager is compensated with respect to the average fund performance, with $\zeta(\theta, L, s)$ as in (7). We multiply $(\frac{1}{1-\delta} - \theta)$ and divide $\zeta(\theta, L, s))$ by $(1-\delta)$. Notice that, given (11), $\tilde{R}(\theta, \alpha(\theta, L), s) = \tilde{R}(\theta_\delta(\theta), \alpha(\theta_\delta(\theta), \frac{L}{1-\delta}), s)$, with $\theta_\delta(\theta) = \theta(1-\delta)$.

Therefore, given the definition of the manager's unconditional expected utility in (A2), $\alpha(\theta, L) = \text{argmax}_\alpha V(I, \theta, \alpha)$ if and only if $\alpha(\theta_\delta(\theta), \frac{L}{1-\delta}) = \text{argmax}_\alpha V(I, \theta_\delta(\theta), \alpha)$. Thus, (A7) becomes

$$\tilde{Q}^e(\theta, s) = \left((\lambda^u(s) + (1-\theta_\delta(\theta))\zeta\left(\theta_\delta(\theta), \frac{L}{1-\delta}, s\right)\right)\tilde{K}\left(\alpha\left(\theta_\delta(\theta), \frac{L}{1-\delta}\right), s\right). \tag{A8}$$

Therefore, when the manager faces the portfolio constraint (6), given contract (I, θ), the risk-neutral investor's unconditional expected utility at the end of the period is

$$U^u(I,\theta,\alpha(\theta,L)) = \\ \int_{-\infty}^{\infty}\left(\lambda^b+(1-\theta)\zeta(\theta,L,s)\right)E(\tilde{K}(\alpha(\theta,L),s))f(s)ds+r-I, \tag{A9}$$

if the manager is compensated relative to a pure benchmark, and

$$U^e(I,\theta,\alpha(\theta,L)) = \\ \int_{-\infty}^{\infty}\left(\lambda^u(s)+(1-\theta_\delta(\theta))\zeta(\theta_\delta(\theta),\tfrac{L}{1-\delta},s)\right)E(\tilde{K}(\alpha(\theta_\delta(\theta),\tfrac{L}{1-\delta}),s))f(s)ds+r-I, \tag{A10}$$

if the manager is compensated relative to the average fund performance.

When the manager compensated with respect to a pure benchmark, the investor solves the following problem:

$$\begin{aligned} \max_{I,\theta} \quad & U^u(I,\theta,\alpha(\theta,L)) \\ \text{s.t.} \quad & \alpha(\theta,L) = \operatorname{argmax}_\alpha V(I,\theta,\alpha), \\ & \theta \geq 0, \\ & 1-\theta \geq 0, \\ & I \geq 0, \\ & V(I,\theta,\alpha(\theta,L)) \geq U_0. \end{aligned} \tag{A11}$$

The corresponding Lagrangian is

$$Ł^u(I,\theta,\mu,\phi,\gamma,\beta) = \\ U^u(I,\theta,\alpha(\theta,L))+\mu\theta+\phi(1-\theta)+\gamma I+\beta(V(I,\theta,\alpha(\theta,L))-U_0). \tag{A12}$$

The first order and slack conditions for the optimal contract are:

$$\frac{\partial}{\partial\theta}Ł^u(I,\theta,\mu,\phi,\gamma,\beta) = \\ \frac{\partial}{\partial\theta}U^u(I,\theta,\alpha)+\frac{\partial}{\partial\alpha}U^u(I,\theta,\alpha)\frac{\partial}{\partial\theta}\alpha(\theta,L)+\mu-\phi=0. \tag{A13}$$

and

$$
\begin{aligned}
\tfrac{\partial}{\partial I}Ł^u(I,\theta,\mu,\phi,\gamma,\beta) = &\quad \gamma - 1 + \beta = 0,\\
\tfrac{\partial}{\partial \mu}Ł^u(I,\theta,\mu,\phi,\gamma,\beta) = &\quad \theta \geq 0,\\
\tfrac{\partial}{\partial \phi}Ł^u(I,\theta,\mu,\phi,\gamma,\beta) = &\quad 1-\theta \geq 0,\\
\tfrac{\partial}{\partial \gamma}Ł^u(I,\theta,\mu,\phi,\gamma,\beta) = &\quad I \geq 0,\\
\tfrac{\partial}{\partial \beta}Ł^u(I,\theta,\mu,\phi,\gamma,\beta) = &\quad V(I,\theta,\alpha) - U_0 \geq 0,
\end{aligned}
$$

Moreover, the solution should satisfy the following slack conditions,

$$
\begin{aligned}
\mu\theta &= 0,\\
\phi(1-\theta) &= 0,\\
\gamma I &= 0,\\
\beta(V(I,\theta,\alpha) - U_0) &= 0,
\end{aligned}
$$

and the non-negativity of the Lagrange multipliers.

If an interior solution ($I^u_{_L} > 0, 1 > \theta^u_{_L} > 0$) exists, then $\mu = \phi = \gamma = 0$, and $\beta = 1$. Thus, the manager's fixed salary $I^u_{_L}$ is such that her expected utility coincides with the utility of her reservation salary: $V(I^u_{_L}, \theta^u_{_L}, \alpha(\theta^u_{_L}, L)) = U_0$.

If the manager is compensated relative to peer average performance, the problem is analogous but with the expected utility function (A9) replaced with (A10). The Lagrangian function becomes $Ł^e(I, \theta_\delta(\theta), \mu, \phi, \gamma, \beta)$. The first order and slack conditions are the same as when the manager is compensated relative to a pure benchmark except (A13) that becomes

$$
\begin{aligned}
&\tfrac{\partial}{\partial \theta}Ł^e(I,\theta_\delta(\theta),\mu,\phi,\gamma,\beta) =\\
&\left(\tfrac{\partial}{\partial \theta_\delta}U^e(I,\theta_\delta,\alpha) + \tfrac{\partial}{\partial \alpha}U^e(I,\theta_\delta,\alpha)\tfrac{\partial}{\partial \theta_\delta}\alpha(\theta_\delta,\tfrac{L}{1-\delta})\right)(1-\delta) + \mu - \phi = 0.
\end{aligned}
\tag{A14}
$$

Let (I^e, θ^e) denote the interior solution (that is, $\mu = \phi = \gamma = 0$) to this problem. λ^b is independent of θ and $\lambda^u(s)$ is independent of θ_δ. Comparing (A9) with (A10) and the first order conditions (A13) and (A14), it follows that $\theta^u_{_{L/(1-\delta)}}$ is the optimal incentive fee in problem (A11) when the manager is compensated relative to a pure benchmark λ^b and subject to the portfolio constraint $|\lambda^u(s) - \lambda^b| \leq \frac{L}{1-\delta}$ if and only if $\theta_\delta(\theta^e_{_L}) = \theta^e_{_L}(1-\delta) = \theta^u_{_{L/(1-\delta)}}$ is the optimal incentive fee in the equivalent problem when the manager is compensated relative to her peers and subject to the portfolio constraint $|\lambda^e(s) - \bar{\lambda}| \leq L$. Moreover, $\tilde{R}(\theta^e_{_L}, \alpha(\theta^e_{_L}, L), s) = \tilde{R}(\theta_\delta(\theta^e_{_L}), \alpha(\theta_\delta(\theta^e_{_L}), \frac{L}{1-\delta}), s) = \tilde{R}(\theta^u_{_{L/(1-\delta)}}, \alpha(\theta^u_{_{L/(1-\delta)}}, \frac{L}{(1-\delta)}), s)$ for every signal s. Given (A2), $\alpha(\theta^e_{_L}, L) = \alpha(\theta^u_{_{L/(1-\delta)}}, \frac{L}{1-\delta})$. Since the solution is interior, $\beta = 1$. This implies $V\left(I^e_{_L}, \theta^e_{_L}, \alpha(\theta^e_{_L}, L)\right) = V\left(I^u_{_{L/(1-\delta)}}, \theta^u_{_{L/(1-\delta)}}, \alpha(\theta^u_{_{L/(1-\delta)}}, \frac{L}{1-\delta})\right) = U_0$. Given (A2), this is satisfied if and only if $I^e_{_L} = I^u_{_{L/(1-\delta)}} = I^*$.

Q.E.D.

Proof of Prediction 2

We have proved that $\theta^e_{_L} = \theta^u_{_{L/(1-\delta)}}$. Next, we show that $\theta^u_{_{L/(1-\delta)}} > \theta^u_{_L}$. First, we prove the following lemma:

Lemma 2. *$\int_{-\infty}^{\infty} \zeta(\theta^i, L, s)(\bar{K} + \alpha^i s) f(s) ds > 0$, for $i = \{e, u\}$.*

The signal is normally distributed, $\tilde{s} \sim N\left(0, \frac{\sigma^2_\epsilon}{\alpha}\right)$, with density function $f(s)$ and cumulative distribution function $F(S) = \int_{-\infty}^{S} f(s)ds$. Let $z = s\frac{\sqrt{\alpha}}{\sigma_\epsilon}$. Then, z has a standard normal distribution with density function $\phi(z)$ and cumulative distribution function $\Phi(Z) = \int_{-\infty}^{Z} \phi(z)dz$.

Let $\underline{s}$ and $\bar{s}$ be defined as in the proof of Prediction 1. We define $\underline{z} = \underline{s}\frac{\sqrt{\alpha}}{\sigma_\epsilon}$ as the standardized $\underline{s}$. Likewise, we define $\bar{z} = \bar{s}\frac{\sqrt{\alpha}}{\sigma_\epsilon}$ the standardized $\bar{s}$. Then, given 7:

$$\begin{aligned}\int_{-\infty}^{\infty} \zeta(\theta, L, s)(\bar{K} + \alpha s) f(s) ds = \quad & -L\int_{-\infty}^{\underline{s}} (\bar{K} + \alpha s) f(s) ds + \int_{\underline{s}}^{-\bar{s}} \frac{(\bar{K}+\alpha s)^2}{\theta\rho(1-\alpha)\sigma^2_\epsilon} f(s) ds \\ & + \int_{-\bar{s}}^{\bar{s}} \frac{(\bar{K}+\alpha s)^2}{\theta\rho(1-\alpha)\sigma^2_\epsilon} f(s) ds \\ & + L\int_{\bar{s}}^{-\underline{s}} (\bar{K} + \alpha s) f(s) ds + L\int_{-\underline{s}}^{\infty} (\bar{K} + \alpha s) f(s) ds.\end{aligned} \tag{A15}$$

It follows immediately that $\int_{\underline{s}}^{-\bar{s}} \frac{(\bar{K}+\alpha s)^2}{\theta\rho(1-\alpha)\sigma^2_\epsilon} f(s) ds > 0$. Moreover, after some simple algebra, we can show that:

$$L\left(\int_{-\underline{s}}^{\infty} (\bar{K} + \alpha s) f(s) ds - \int_{-\infty}^{\underline{s}} (\bar{K} + \alpha s) f(s) ds\right) = 2L\sqrt{\alpha}\sigma_\epsilon \frac{\phi(\underline{z})}{\Phi(\underline{z})} > 0,$$

and

$$\int_{\bar{s}}^{-\underline{s}} (\bar{K} + \alpha s) f(s) ds = \bar{K}(F(-\underline{s}) - F(\bar{s})) + \sqrt{\alpha}\sigma_\epsilon \frac{\phi(\bar{z}) - \phi(-\underline{z})}{\Phi(-\underline{z}) - \Phi(\bar{z})} > 0,$$

since $\underline{s} < \bar{s} = -(\underline{s} + 2\frac{\bar{K}}{\alpha}) < -\underline{s}$ and $\underline{z} < \bar{z} = -(\underline{z} + 2\frac{\bar{K}}{\sqrt{\alpha}\sigma_\epsilon}) < -\underline{z}$. Finally,

$$\int_{-\bar{s}}^{\bar{s}} \frac{(\bar{K}+\alpha s)^2}{\theta\rho(1-\alpha)\sigma_\epsilon^2} f(s)ds = \frac{1}{\theta\rho(1-\alpha)\sigma_\epsilon^2}\left(\bar{K}^2\int_{-\bar{s}}^{\bar{s}} f(s)ds + \alpha^2\int_{-\bar{s}}^{\bar{s}} s^2 f(s)ds + 2\bar{K}\alpha\int_{-\bar{s}}^{\bar{s}} sf(s)ds\right).$$

$\int_{-\bar{s}}^{\bar{s}} f(s)ds > 0$. Given the signal distribution, $\int_{-\bar{s}}^{\bar{s}} sf(s)ds = 0$. Thus, Lemma 2 is proved if we show that $\int_{-\bar{s}}^{\bar{s}} s^2 f(s)ds > 0$. This integral corresponds to the variance of the truncated signal, and is given by

$$\int_{-\bar{s}}^{\bar{s}} s^2\phi(s)ds = \frac{\sigma_\epsilon^2}{\alpha}\left(1 - \frac{2\bar{z}\phi(\bar{z})}{1-2\Phi(-\bar{z})}\right).$$

Thus, $\int_{-\bar{s}}^{\bar{s}} s^2 f(s)ds > 0$ if and only if $\frac{1}{2} - \Phi(-\bar{z}) > \bar{z}\phi(\bar{z})$. Finally,

$$\frac{1}{2} - \Phi(-\bar{z}) = \bar{z}\phi(\bar{z}) + \int_0^{\bar{z}} s^2\phi(z)dz > \bar{z}\phi(\bar{z}).$$

Q.E.D.

Now, notice that $\zeta\left(\theta, \frac{L}{1-\delta}, s\right) = \frac{1}{1-\delta}\zeta\left(\frac{\theta}{1-\delta}, L, s\right)$ and $\alpha\left(\theta, \frac{L}{1-\delta}\right) = \alpha\left(\frac{\theta}{1-\delta}, L\right)$. Therefore:

$$\begin{aligned}
&U^u(I,\theta,\alpha(\theta,\tfrac{L}{1-\delta})) = \\
&\textstyle\int_{-\infty}^{\infty}\left(\lambda^b + \frac{(1-\theta)}{1-\delta}\zeta(\frac{\theta}{1-\delta}, L, s)\right)E(\tilde{K}(\alpha(\frac{\theta}{1-\delta}, L), s))f(s)ds + r - I = \\
&\textstyle\int_{-\infty}^{\infty}\left(\lambda^b + (1-\frac{\theta}{1-\delta})\zeta(\frac{\theta}{1-\delta}, L, s)\right)E(\tilde{K}(\alpha(\frac{\theta}{1-\delta}, L), s))f(s)ds + r - I + \\
&\textstyle\delta\int_{-\infty}^{\infty}\zeta(\theta, \frac{L}{1-\delta}, s)E(\tilde{K}(\alpha(\theta, \frac{L}{1-\delta}), s))f(s)ds.
\end{aligned} \tag{A16}$$

Let $\Psi(\theta, \alpha(\theta, \frac{L}{1-\delta})) = \delta\int_{-\infty}^{\infty}\zeta(\theta, \frac{L}{1-\delta}, s)E(\tilde{K}(\alpha(\theta, \frac{L}{1-\delta}), s))f(s)ds$. Taking the total derivative of (A16) with respect to θ and evaluating it at $0 < \theta^u_{L/(1-\delta)} < 1$ it follows that:

$$\frac{\partial}{\partial\theta}U^u(I,\theta,\alpha(\theta,\tfrac{L}{1-\delta}))\Big|_{\theta=\theta^u_{L/(1-\delta)}} =$$

$$\frac{\partial}{\partial\theta}U^u(I,\tfrac{\theta}{1-\delta},\alpha(\tfrac{\theta}{1-\delta},L))\Big|_{\theta=\theta^u_{L/(1-\delta)}} + \tag{A17}$$

$$\frac{\partial}{\partial\theta}\Psi(\theta,\alpha(\theta,\tfrac{L}{1-\delta}))\Big|_{\theta=\theta^u_{L/(1-\delta)}}.$$

By definition, $\frac{\partial}{\partial\theta}U^u(I,\theta,\alpha(\theta,\tfrac{L}{1-\delta}))\Big|_{\theta=\theta^u_{L/(1-\delta)}} = 0$. Thus, from (A17),

$$\frac{\partial}{\partial\theta}U^u\left(I,\frac{\theta}{1-\delta},\alpha\left(\frac{\theta}{1-\delta},L\right)\right)\Big|_{\theta=\theta^u_{L/(1-\delta)}} = -\frac{\partial}{\partial\theta}\Psi\left(\theta,\alpha\left(\theta,\frac{L}{1-\delta}\right)\right)\Big|_{\theta_L=\theta^u_{L/(1-\delta)}}. \tag{A18}$$

Taking the total derivative of Ψ with respect to θ:

$$\frac{\partial}{\partial\theta}\Psi\left(\theta,\alpha\left(\theta,\frac{L}{1-\delta}\right)\right) = \frac{\partial}{\partial\theta}\Psi\left(\theta,\alpha\right) + \frac{\partial}{\partial\alpha}\Psi\left(\theta,\alpha\right)\frac{\partial}{\partial\theta}\alpha\left(\theta,\frac{L}{1-\delta}\right). \tag{A19}$$

Given (A9):

$$\frac{\partial}{\partial\alpha}\Psi\left(\theta,\alpha\right)\Big|_{\theta=\theta^u_{L/(1-\delta)}} = \frac{\delta\frac{\partial}{\partial\alpha}U^u(I,\theta,\alpha(\theta,\tfrac{L}{1-\delta}))\Big|_{\theta=\theta^u_{L/(1-\delta)}}}{1-\theta^u_{L/(1-\delta)}}. \tag{A20}$$

Given (A13):

$$\frac{\partial}{\partial\theta}\alpha\left(\theta,\frac{L}{1-\delta}\right)\Big|_{\theta=\theta^u_{L/(1-\delta)}} = -\frac{\frac{\partial}{\partial\theta}U^u(I,\theta,\alpha(\theta,\tfrac{L}{1-\delta}))\Big|_{\theta=\theta^u_{L/(1-\delta)}}}{\frac{\partial}{\partial\alpha}U^u(I,\theta,\alpha(\theta,\tfrac{L}{1-\delta}))\Big|_{\theta=\theta^u_{L/(1-\delta)}}}. \tag{A21}$$

Replacing (A20) and (A21) in (A19) and evaluating it at $\theta=\theta^u_{L/(1-\delta)}$:

$$\frac{\partial}{\partial\theta}\Psi\left(\theta,\alpha(\theta,\tfrac{L}{1-\delta})\right)\Big|_{\theta=\theta^u_{L/(1-\delta)}} = \tag{A22}$$

$$\frac{\partial}{\partial\theta}\Psi\left(\theta,\alpha\right)\Big|_{\theta=\theta^u_{L/(1-\delta)}} - \frac{\delta\frac{\partial}{\partial\theta}U^u(I,\theta,\alpha(\theta,\frac{L}{1-\delta}))\Big|_{\theta=\theta^u_{L/(1-\delta)}}}{1-\theta^u_{L/(1-\delta)}}.$$

Given (A9):

$$\delta\frac{\partial}{\partial\theta}U^u(I,\theta,\alpha(\theta,\tfrac{L}{1-\delta}))\Big|_{\theta=\theta^u_{L/(1-\delta)}} = \tag{A23}$$

$$-\Psi(\theta^u_{L/(1-\delta)},\alpha(\theta^u_{L/(1-\delta)},\tfrac{L}{1-\delta})) + (1-\theta^u_{L/(1-\delta)})\frac{\partial}{\partial\theta}\Psi(\theta,\alpha)\Big|_{\theta=\theta^u_{L/(1-\delta)}}.$$

Replacing (A23) in (A22) and (A22) in (A18), it follows that

$$\frac{\partial}{\partial\theta}U^u\left(I,\frac{\theta}{1-\delta},\alpha\left(\frac{\theta}{1-\delta},L\right)\right)\Big|_{\theta=\theta^u_{L/(1-\delta)}} = -\frac{\Psi(\theta^u_{L/(1-\delta)},\alpha(\theta^u_{L/(1-\delta)},\frac{L}{1-\delta}))}{1-\theta^u_{L/(1-\delta)}}. \tag{A24}$$

If there is a unique interior solution θ^u_L to the problem (A11), the second order condition implies $\frac{\partial^2}{\partial\theta^2}U^u(I^u_L,\theta,\alpha(\theta,L))\Big|_{\theta=\theta^u_L} < 0$. Given Lemma 2, $\Psi(\theta^u_{L/(1-\delta)},\alpha(\theta^u_{L/(1-\delta)},\frac{L}{1-\delta})) > 0$. Thus, given (A24), $\frac{\partial}{\partial\theta}U^u\left(I,\frac{\theta}{1-\delta},\alpha\left(\frac{\theta}{1-\delta},L\right)\right)\Big|_{\theta=\theta^u_{L/(1-\delta)}} < 0$. Therefore, $\frac{\theta^u_{L/(1-\delta)}}{1-\delta} > \theta^u_L$, which implies, given Lemma 1, $\theta^e_L > \theta^u_L$. Finally, from Proposition 2, higher incentive fee implies higher effort.

Q.E.D.

Proof of Prediction 3

For a given signal s, the gross performance of a fund that compensates the manager relative to the average peer performance is $\tilde{W}^e(\alpha^e,s) = \lambda^e(s)\tilde{K}(\alpha^e,s)+r$ with $\alpha^e = \alpha(\theta^e_L,L)$. Integrating over s, the unconditional expected gross performance becomes

$$E(\tilde{W}^e(\alpha^e)) = \int_{-\infty}^{\infty}\lambda^e(s)(\bar{K}+\alpha^e s)f(s)ds + r.$$

Given equation (9), we can write the former equation as

$$E(\tilde{W}^e(\alpha^e)) = \int_{-\infty}^{\infty} \left(\lambda^u(s) + \frac{\zeta(\theta^e, L, s)}{1-\delta} \right) (\bar{K} + \alpha^e s) f(s) ds + r. \tag{A25}$$

After some basic algebra, equation (A25) can be written as

$$\begin{aligned} E(\tilde{W}^e(\alpha^e)) &= E(\tilde{W}^u(\alpha^u)) \\ &+(\alpha^e - \alpha^u) \textstyle\int_{-\infty}^{\infty} \lambda^u(s) s f(s) ds + \frac{1}{1-\delta} \int_{-\infty}^{\infty} \zeta(\theta^e, L, s)(\bar{K} + \alpha^e s) f(s) ds, \end{aligned} \tag{A26}$$

with $E(\tilde{W}^u(\alpha^u)) = \int_{-\infty}^{\infty} \lambda^u(s)(\bar{K} + \alpha^u) f(s) ds + r$, the unconditional expected gross performance of a fund whose manager is compensated relative to an exogenous benchmark λ^b; $\alpha^u = \alpha(\theta^u_L, L)$ is the corresponding manager's effort.

From Prediction 2, $\alpha^e > \alpha^u$. Given Lemma 2,

$$\begin{aligned} \int_{-\infty}^{\infty} \lambda^u(s) s f(s) ds = \int_{-\infty}^{\infty} \zeta(\theta^u, L, s) s f(s) ds &> 0, \\ \int_{-\infty}^{\infty} \zeta(\theta^e, L, s)(\bar{K} + \alpha^e s) f(s) ds &> 0. \end{aligned}$$

Then, (A26) implies $E(\tilde{W}^e(\alpha^e)) > E(\tilde{W}^u(\alpha^u))$.

Q.E.D.