Indirect Incentives of Hedge Fund Managers

Jongha Lim
California State University, Fullerton

Berk A. Sensoy
Ohio State University

and

Michael S. Weisbach
Ohio State University, NBER, and SIFR

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Abstract

Indirect incentives exist in the money management industry when good current performance increases future inflows of new capital, leading to higher future fees. We quantify the magnitude of indirect performance incentives for hedge fund managers. Flows respond quickly and strongly to performance; lagged performance has a monotonically decreasing impact on flows as lags increase up to two years. Indirect incentives for the average fund are at least 1.6 times as large as direct incentives from incentive fees and managers' personal stakes in the fund. For new funds, indirect incentives are seven to fourteen times as large as direct incentives. Combining direct and indirect incentives, for each dollar generated for their investors in a given year, manager wealth increases by at least forty-one cents. The performance of older and capacity constrained funds has a considerably weaker impact on future flows, leading to weaker indirect incentives.

Contact information: Jongha Lim, Department of Finance, California State University Fullerton, Fullerton, CA 92834, email: jolim@exchange.fullerton.edu; Berk A. Sensoy, Department of Finance, Fisher College of Business, Ohio State University, Columbus, OH 43210: email: sensoy.4@osu.edu; Michael S. Weisbach, Department of Finance, Fisher College of Business, Ohio State University, Columbus, OH 43210, email: weisbach.2@osu.edu.
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1. Introduction

Hedge fund managers are among the most highly paid individuals today. According to Kaplan and Rauh (2010), the top five hedge fund managers likely earned more than all 500 CEOs of S&P 500 firms in 2007. Therefore, the payoff to becoming a top hedge fund manager is enormous. The logic of Holmström (1999), Berk and Green (2004) and Chung et al. (2012) provides a framework for understanding hedge fund manager's careers: Investors allocate capital to funds based on their perception of the managers' abilities, which is a function of the performance of the fund. Good performance, especially early in one's career, increases a manager's lifetime income not only through incentive fees earned at the time of the performance but also by increasing future flows of new investment to the fund, thereby increasing future fees.

The extremely high level of pay for the top hedge fund managers suggests that the effect of current performance on lifetime income through future flows is likely to be important. However, there are no estimates of its magnitude. For an incremental percentage point of returns to investors, how much additional capital does the market allocate to that particular hedge fund? How much of this additional capital do hedge fund managers end up receiving as compensation in expectation? How does this "expected future pay for today's performance" compare in magnitude with the direct fees from incentive fees that they earn from an incremental return? How do these effects differ across types of funds, and over time for a particular fund?

In this paper, we evaluate the way in which hedge fund investors allocate their capital, the extent that it depends on performance, and the way that this relation affects long-term incentives of hedge fund managers. In a sample of 2,687 hedge funds from 1995 to 2010, we first estimate the relation between hedge fund performance and inflows to the fund. As predicted by learning models of fund allocation and consistent with prior work on mutual funds and private equity funds, this relation is substantially stronger for newer funds, whose managers' abilities the market knows with less certainty. For an average fund, the estimates imply that a ten percentage point incremental return in a given year leads to a 22 percent increase in the fund's assets under management (AUM) from inflows of new investment over the next two years. For a new fund the effect is much larger: every 10 percentage points of return in a fund's first year leads to a 40 percent increase in AUM over the next two years.

The estimates suggest that investors respond remarkably quickly to performance. Estimated using annual data, about half of the increase in AUM occurs in the year of the abnormal performance. Using quarterly or even monthly data, the estimated impact on inflows is strongest for performance in the immediately preceding quarter or month and declines monotonically so that inflows in a particular period are much more affected by recent performance than by performance one to two years prior. In addition, performance has a greater impact on flows for newer funds and funds engaged in more scalable strategies. These results are consistent with the view that investors are continually updating their assessment of managers and adjusting their portfolios accordingly.

The way in which the inflow-performance relation affects managers' compensation depends on the fee structure in hedge funds. Typically, hedge fund managers receive a management fee equal to 2 percent of AUM, together with incentive fees equal to 20 percent of profits above a high water mark (HWM). Good performance increases managers' future incomes because fees will be earned on inflows of new investment, and also because the asset value of existing investors is larger and closer to the HWM.

Our goal is to estimate the indirect incentives of hedge fund managers, that is, the present value of the incremental future fees a fund manager receives due to the increase in AUM that follows incremental performance. Doing so requires a contingent claims modeling framework to accommodate the fact that incentive fees are effectively a portfolio of call options on the fund's assets, where the exercise prices are the HWMs of the different investors in the fund. We use four such models, which allow us to evaluate the sensitivity of the estimates to different modeling frameworks and choices of model parameters.

Our base model is that of Goetzmann, Ingersoll, and Ross (2003, hereafter GIR). GIR provide an analytical formula for calculating the fraction of a dollar invested in the fund that, in expectation, will be received by the fund's managers as compensation over the life of the fund. The other three models incorporate two real-world features that are missing from the GIR model and could have a material impact on a manager's future compensation: future performance-based flows and the manager's endogenous use of leverage in the fund's portfolio. Each of these features leads to greater compensation, and hence greater indirect incentives, than would otherwise be the case.

The second model that we use augments the GIR model to accommodate future performance-based flows. The third model is that of Lan, Wang, and Yang (2013, hereafter LWY), in which the manager can endogenously choose the amount of leverage to use at each point in time. LWY nests as special cases both GIR, whose model assumes no leverage at any time, and Panageas and Westerfield (2009). Finally, we present estimates using an extension of the base LWY model that allows for performance-based flows as well as endogenous leverage.

Each of these models provides an estimate of the present value of managers' compensation per dollar invested in the fund. Together with the flow-performance relations, these estimates allow us to calculate the magnitude of indirect incentives facing hedge fund managers. In other words, for an incremental percentage point of current return, we calculate the present value of the additional lifetime income the fund's managers receive in expectation due to inflows of new investment and the increase in value of existing investors' assets.

As a benchmark for assessing the importance of this indirect pay for performance, we compare its magnitude to the direct performance pay managers receive from incentive fees and changes in the value of their own investment in the fund. We use the Agarwal et al. (2009) contingent-claims framework to estimate the change in the value of managers' current compensation (coming from both incentive fees and the manager's own stake in the fund) for an incremental return.

Our estimates indicate that a one percentage point increment to returns generates, on average, \$378,000 in expected direct incentive pay, consisting of \$195,000 in extra incentive fees and \$183,000 in incremental profits on managers' personal stakes. Using the base-case GIR model with parameter choices that deliver lower-bound estimates, we calculate that managers also receive \$612,000 in expected future fee income, consisting of \$385,000 in future fees earned on the inflows of new investment that occur in response to the incremental performance and \$227,000 in extra future fees earned from the increase in the value of the assets of existing investors in the fund. Because a one-percentage point incremental return is $2.27 million for an average-sized fund in our data, these calculations imply that on average managers receive at least forty-one cents in direct and indirect pay for each incremental dollar earned for fund investors. Moreover, the indirect, career-based incentive effect is at least 1.6 times larger than the direct income managers receive from incentive fees and returns on their personal investments.

This indirect to direct incentive ratio of 1.6 is for the model and parameter choices that lead to the lowest estimate of indirect incentives. With other plausible choices of model and parameters, the ratio is substantially higher. Across all the models and parameter values we consider, the average indirect to direct incentive ratio is 4.1.[1]

Indirect incentives are even larger for young funds. For new funds, we estimate that indirect incentives are seven to fourteen times as large as direct incentives. The importance of indirect incentives declines monotonically as a fund ages as a consequence of the weakening flow-performance relations. However, even for an eleven-year-old fund indirect incentives are about as large as direct incentives. The importance of indirect incentives also depends on the style of the fund. For an average fund following a style unlikely to be capacity-constrained, indirect incentives are four to eight times as large as direct incentives, while they are three to six times as large for a fund that is likely to be constrained and hence unable to grow as much in response to good performance.

Overall, our estimates suggest that regardless of the choice of model or reasonable model parameters, the total incentives facing hedge fund managers are substantial, and much larger than it would seem from direct incentives alone. While direct incentives are themselves substantial, indirect incentives in the hedge fund industry nonetheless comprise the bulk of managers' total incentives.

This paper proceeds as follows. Section 2 discusses the way in which we quantify the direct and indirect components of hedge fund pay for performance. Section 3 describes the data. Section 4 presents estimates of the way in which inflows into hedge funds respond to the funds' performance. Section 5

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[1] Calculating incentives as the change in manager wealth resulting from an incremental dollar earned for fund investors results in very similar estimates of the importance of indirect incentives relative to direct incentives.

estimates the change in hedge fund managers' expected lifetime incomes through the direct and indirect channels in response to a change in performance. Section 6 concludes.

2. Quantifying the Magnitude of Pay for Performance of Hedge Fund Managers

2.1. Direct Pay for Performance

Hedge fund managers' compensation generally consists of management fees that are a percentage of AUM (often around 2%) plus incentive fees, which are a percentage (usually 20%) of profits, or of profits earned above the HWM. In addition, hedge fund managers usually make a personal investment into the fund. The direct pay for performance a manager receives come from the incentive fees and his personal investment in the fund, both of which increase in value with the fund's performance. Quantifying these direct performance incentives is complicated because of the option-like features contained in the hedge fund manager's incentive fee contract. In particular, the incentive fee contract resembles a portfolio of call options, one per investor in the fund. The exercise price of each option is determined by each investor's time of entrance into the fund, the fund's hurdle rate, and the historical HWM level pertaining to the investor's assets. Even if different managers have the same 20% incentive fee rate, the actual direct pay-performance sensitivity they face will vary depending on the distance between the current asset value and the exercise prices of these options.

To estimate the direct pay-performance sensitivity, we use Agarwal et al. (2009)'s total delta approach, which measures the impact of an incremental one percentage point return to fund investors on the value of the manager's incentive fees, plus the increase in the value of the manager's own ownership stake. The total delta of the manager's claim to the fund is equal to the sum of these individual options' deltas plus the delta of the manager's personal stake in the fund. We follow Agarwal et al. (2009) and assume that the manager's initial stake is zero but the stake grows over time as managers reinvest all of their incentive fees back into the fund.[2] Details of this calculation are described in the Appendix.

[2] Assuming instead that the manager's initial stake is 1% or 2% of AUM has only a small impact on estimates of direct incentives.

2.2. Indirect Pay for Performance

In addition to the pay for performance from incentive fees and their own investment in the fund, hedge fund managers' lifetime incomes change with performance through a reputational effect: Good performance increases the market's perception of a manager's ability, leading to higher inflows of new investments to the fund. Ultimately, the fund's managers will receive part of these inflows as future management and incentive fees. In addition, good performance mechanically increases the value of existing investors' stakes in the fund. A portion of this increase will likewise be paid over time in future fees to the fund manager. The expectation of this future income will change with today's performance, leading to what we refer to as indirect incentives.

There are two components that must be known to evaluate the magnitude of these indirect incentives. First, we have to estimate the way in which performance affects expected inflows to the fund. These estimates are discussed in Section 4 below. Second, we must have a model of the present value of the manager's expected lifetime compensation as a fraction of fund assets. This model should predict, for each incremental dollar under management, the increase in the manager's expected compensation over the future lifetime of the fund. We use four such models.

Our base-case model is that of GIR. These authors provide a contingent-claims model of the fraction of fund assets that accrue to the fund manager in expected future compensation. Key features of this framework are that compensation is a fixed management fee plus a percentage of profits above a HWM, the fund's asset value follows a martingale with drift generated by the manager's alpha, investors continuously withdraw assets (e.g., an endowment investor might withdraw 5% per year), and an investor liquidates his or her position following a sufficiently negative return shock (so that expected fund life is finite).

An attractive feature of the GIR model is that a closed-form solution exists. However, the model does not account for all factors that could affect managers' future compensation and thereby indirect incentives. First, the GIR model does not allow the find's asset value to grow through future fund flows, which are not unlikely to be random but likely to be a function of fund performance. Under appropriate assumptions, the effect of such flows in the context of the GIR model is to increase the variance of the fund's AUM.[3] In addition to the baseline GIR estimates, we report estimates from a version of the GIR model in which variance is augmented to account for future fund flows.

A second issue not accounted for by the GIR model is that a fund's portfolio is endogenously chosen, so managers can adjust their portfolios to maximize their incomes given a particular incentive scheme. LWY present a model in which managers can perform such adjustments by leveraging their funds strategically. We use this model as a third way of estimating indirect incentives. Finally, LWY also provide a version of their model that incorporates performance-based fund flows, which we use to provide a fourth set of estimates of indirect incentives.

The use of different models to estimate indirect incentives allows us to gauge the importance of alternative modeling approaches, especially the importance of future fund flows and endogenous portfolio choice in determining the fraction of a fund's value that will ultimately accrue to the managers in future fees.[4] Details of all four models, our choices of model parameters, and the associated calculations are described in the Appendix.

We use each of these models to estimate the present value of the total (management plus incentive) future fees that the manager earns on an extra dollar of AUM. To calculate indirect pay for performance, we multiply this present value by an estimate of the number of extra dollars of AUM that result from a one-percentage point incremental improvement in returns to investors. The latter consists of two parts, the mechanical increase in the value of existing investors' stakes plus incremental inflows of new investment. In this way, the models for a manager's fee value combine with our estimates of the flow-performance relations facing hedge fund managers to provide an estimate of the present value of the

[3] Suppose, as an approximation, that the flow-performance relationship is linear in logs and flows are contemporaneous with returns. Suppose that without flows, the log AUM of the fund would evolve as a martingale as in the GIR model, $s(t+1) = s(t) + e(t+1)$. With performance-based flows, $s(t+1) = s(t) + g\, e(t+1)$, where $g > 1$ captures the flow effect. Therefore, even with performance-based flows, the log AUM would still follow a martingale so the GIR model still applies, but with a higher variance than in the case of no flows. We thank the associate editor for suggesting this argument to us.

[4] In addition to GIR and LWY, there have been a number of other attempts to model managers' claims to hedge funds fees. Important contributions include Panageas and Westerfield (2009), Drechsler (2014), and Guasoni and Obloj (2013).

incremental future revenue that the hedge fund manager expects to earn as a result of a one-percentage point improvement in current net returns.[5]

It is important to note that because the GIR and LWY models estimate present values, no further adjustment for the riskiness of future income is required. Also, the estimates do not require that the manager continue to manage the fund in the future, under the assumption that the present value of the manager's claims to future fee income can be monetized when the manager departs.

3. Hedge Fund Data

Our data come from the TASS database, which covers about 40% of the hedge fund universe (Agarwal et al. (2009)). Summary statistics of key fund characteristics for our sample, reported in Table 1, are very close to those for the sample considered by Agarwal et al. (2009), who merge and consolidate four major databases (CISDM, HFR, MSCI, and TASS). For this reason, we believe that our sample of hedge funds is representative of the hedge fund universe.

Our sample period extends from January 1995 to December 2010. We focus on the post-1994 period because the TASS started reporting information on 'defunct' funds only after 1994.[6] We exclude managed futures/CTAs and funds-of-funds, which have a different treatment of incentive fees and are likely to have different inflow-performance relations than typical individual hedge funds. We also exclude closed-end hedge funds, since subscriptions in these funds are only possible during the initial issuing period and future flows are not possible. This initial filter leaves us with 4,939 open-end hedge funds.[7]

We drop funds for which TASS does not contain information on organizational characteristics such as management fees, incentive fees, and high-watermark provisions. In addition, we consider only

[5] Net returns can be improved either though improved gross returns or lowered costs borne by the fund such as financing costs, security lending fees, and settlement charges. The incentives we measure are therefore incentives to achieve both.

[6] Defunct funds include funds that are liquidated, merged, or restructured as well as those stopped reporting returns to TASS (Fung et al. (2008)).

[7] Some funds are closed to new investors, but unfortunately we do not know whether a particular fund is taking new money at any point in time, so we cannot exclude funds on the basis of this policy. Including closed funds causes us to understate the flow-performance relations for funds that are not closed.

funds with an uninterrupted series of net asset values and returns so that we can calculate inflows. Further, we restrict our sample to funds with at least 12 consecutive monthly returns available during the sample period. If a fund stops reporting returns and then resumes at a future date, we use only the first sequence of uninterrupted data. Finally, we exclude funds with an incentive fee of zero, since there can be no direct pay-for-performance for these funds. Our final monthly sample contains 159,235 fund-month observations for 3,073 individual funds, of which 1,088 are live as of December 2010.

To construct quarterly and annual samples, we further drop all calendar quarters or years that have return information only for a fraction of the period. This sample construction process leaves us with a quarterly sample of 3,073 funds (51,300 fund-quarter observations) and an annual sample of 2,687 funds (10,811 fund-year observations).

Table 1 presents descriptive statistics for the sample of funds in our annual data. Time-varying variables such as annual flows and returns are measured at the fund-year level, and other contractual characteristics such as management and incentive fees rate are measured at the fund level.[8] All time-varying variables except fund age are winsorized at the 1st and 99th percentiles to minimize the effect of outliers.

The mean annual flow is 53.6%, and the median 3.8%, so the distribution is highly skewed. The mean and median annual returns are 11.7% and 9.2%. Both the flows and returns are similar to those in Agarwal et al. (2009), who report mean (median) annual flow of 60.6% (5.9%) and mean (median) annual return of 12.2% (9.7%). However, the average fund size in our sample ($227 million) is about twice the average size reported in Agarwal et al. ($120 million), reflecting the fast growth of the sector as well as the recent trend of raising mega hedge funds.[9]

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[8] TASS provides information on funds' organizational characteristics as of the last available date of fund data. Like most previous studies, we also assume that these organizational characteristics do not change throughout the life of the fund. Agarwal et al. (2009) argue that funds' organizational characteristics are unlikely to change much over time based on their discussions with practitioners, which suggest that if a manager wants to impose new contractual terms, it is easier for him to start a new fund with different terms than to go through the legal complications of changing an existing contract.

[9] According to HFR Industry Reports, by the end of 2010, mega hedge funds collectively managed around 60% of total industry AUM.

The remaining variables reflect time-invariant contractual features. Summary statistics on these characteristics are very close to those reported in other prior studies (e.g., Agarwal et al (2009), Baquero and Verbeek (2009), and Aragon and Nanda (2012)). The management fee is the annual percentage of the AUM received by the manager as compensation and has a sample mean (median) of 1.4% (1.5%). The incentive fee is the annual percentage of positive profits and has a sample mean (median) of 19.3% (20%). High-water mark is an indicator variable that equals one if the fund has a HWM provision, and zero otherwise. About 69.1% of our sample funds have a HWM provision. About 67.7% of our sample funds report that they use leverage, 19.5% are open to public investors, and about a quarter are on-shore funds.

The fee data consist of the fees that are currently publicly quoted by the funds. These data could potentially misrepresent the true fees relevant for our calculations for two reasons: First, funds sometimes provide fee reductions to particular strategic investors that are not reflected in the database (Ramadorai and Streatfield, 2011). While we cannot investigate this possibility directly, it is unlikely to have a significant impact on our estimates. For example, if the true incentive fee (management fee) averaged over all investors is 10% lower than what is reported in the database, our estimates of indirect incentives using the base GIR model would be overstated by about 1% (5%). A second issue is that fees can change over time. Agarwal and Ray (2012) and Dueskar et al. (2012) both find that fee changes are infrequent and tend to reflect past performance when they do occur, so that fee increases follow good performance and decreases follow poor performance. This effect will lead to a small increase in indirect incentives, since good performance today will not only lead to inflows, but to higher proportional fees on those inflows.

We also consider three variables that reflect potential restrictions on the behavior of flows. *Total redemption period* is defined as the sum of the notice period and the redemption period, where the notice period is the time (in years) the investor has to give notice to the fund about an intention to withdraw money from the fund, and the redemption period is the time that the fund takes to return the money after the notice period is over. The *lockup period* is the minimum time in years that an investor has to wait before withdrawing invested money. The *subscription period* is a time delay, measured in years, between investing in a fund and actually purchasing fund shares. In our sample the mean total redemption period, lock-up period, and subscription period are 0.273, 0.247, and 0.089 years, respectively.

4. Estimating the Sensitivity of Fund Inflows to Performance

To understand the impact of performance on fund flows, we employ a Bayesian learning framework that presumes that investors are continually evaluating managers trying to assess their abilities (see Berk and Green (2004) and Chung et al. (2012)). A fund's performance provides information about the manager's ability, so an observation of performance causes investors to update their assessment of his ability and allocate more capital to a fund when the manager's estimated ability increases. These models suggest that investors should update their portfolios relatively quickly. The magnitude of the updates and hence the sensitivity of inflows to performance should depend on the informativeness of the signal relative to the precision of the prior estimate of the fund manager's ability. In addition, the sensitivity of inflows to performance should also depend on the extent to which ability can be scaled to replicate a fund's return distribution on new capital.

Measuring the indirect incentives of hedge fund managers requires an estimate of the relation between fund performance and future inflows. There is a long literature beginning with Ippolito (1992) that estimates this relation to be relatively strong in the mutual fund industry.[10] Similarly, beginning with Kaplan and Schoar (2005) the literature has documented a clear positive relation between performance and inflows in the private equity industry. However, the results for hedge funds are less clear; Goetzmann et al. (2003) find a negative and concave relation while other studies, including Agarwal et al. (2003), Fung et al. (2008), Baquero and Verbeek (2009), and Ding et al. (2009), generally find a positive one.[11]

4.1. Empirical Specification

[10] See Ippolito (1992), Brown, Harlow and Starks (1996), Sirri and Tufano (1998), Chevalier and Ellison (1999), Barclay, Pearson and Weisbach (1998), Del Guercio and Tkac (2002), Bollen (2007), Huang, Wei and Yan (2007), and Sensoy (2009).

[11] Agarwal, Daniel, and Naik (2003) attribute the differences in the results to the changing nature of the hedge fund industry, which has started resembling the mutual fund industry in more recent years.

Consequently, we estimate equations predicting the relation between fund inflows and fund performance. We estimate the following specification:

$$Flow_{i,t} = \beta_0 + \sum_{j=0}^{K} \beta_{1+j}\ Return_{i,t-j} + \gamma X_{t-1} + \lambda Y + Fixed\,effects + \varepsilon_{i,t} \quad , \tag{1}$$

where K equals 2, 11, and 35 for annual, quarterly, and monthly specification, respectively.

Following the literature on flows to mutual funds (for example, Chevalier and Ellison (1997), Sirri and Tufano (1999)) or hedge funds (for example, Goetzmann et al. (2003), Fung et al. (2008), Agarwal et al. (2009)), we compute annual flows of capital into a fund as follows:

$$Flow_{i,t} = \frac{AUM_{i,t} - AUM_{i,t-1}\,(1 + Return_{i,t}\,)}{AUM_{i,t-1}} \ , \tag{2}$$

where $AUM_{i,t}$ and $AUM_{i,t-1}$ are the assets under management of fund *i* at the end of year *t* and *t-1*, respectively, and $Return_{i,t}$ is the net of fee return for fund *i* during year *t*.[12] When considering quarterly or monthly horizons, we compute quarterly or monthly flows in an analogous manner using the *AUM* at the quarter (month) end and quarterly (monthly) returns.

This definition expresses flows as a fraction of beginning-of-period (end of prior period) AUM, which is a natural benchmark from the perspective of a fund manager assessing his or her incentives going forward. For instance, the option deltas that comprise direct incentives are defined in terms of beginning-of-period AUM. An alternative approach to computing fund flows is to scale the denominator of Equation (2) by $(1 + Return_{i,t})$, which expresses flows as a fraction of what end-of-period AUM would have been in the absence of flows. Although this alternative definition is less intuitive for our purpose, Table A3 in the appendix shows that it leads to similar estimates of indirect incentives.

The vector X in Equation (1) consists of time-varying fund characteristics that include lagged flows, the natural logarithm of AUM for fund *i* at *t-1*, the natural logarithm of fund *i*'s age plus one at *t-1*,

[12] This standard method of measuring flows implicitly assumes that flows occur at the end of each period, after fund returns are observed.

and annualized return volatility of fund *i* over the previous 12 months.[13] The vector *Y* includes time-invariant fund characteristics that include the management fee rate, the incentive fee rate, the total redemption period, the lock-up period, the subscription period, and a set of indicator variables that equal one if fund *i* has a HWM provision, if it uses leverage, if it is open to public investors, and if it is an on-shore fund, respectively.

All specifications include fixed effects for the nine styles listed in Table 1 to capture the differences in average flows between funds that have different strategies, and time fixed effects to capture economy-wide shocks. Our main annual specifications also contain time-by-style fixed effects (i.e., the interactions of the style effects and the time effects) to capture any systematic fluctuations in flows to a particular style in a given year. Reported standard errors are robust to heteroskedasticity and account for double clustering by fund and time period.

Rather than ranks or risk-adjusted returns (i.e., alphas) as a measure of performance, our specification is based on absolute returns, because the pecuniary rewards that hedge fund managers receive for good performance are a direct function of absolute returns. We also avoid alphas because of the large amount of noise, and resulting errors-in-variables bias, that would result from attempting to estimate annual alphas using monthly returns in standard models such as the seven-factor model of Fung and Hsieh (2004). However, the time-by-style fixed effects included in our main specifications capture all shocks, observed or unobserved, that are common to funds of a given style in a given year, including the returns to peer funds and inflows to other funds of the same style.[14]

There are a number of reasons why the true relation between performance and inflows could potentially be nonlinear. Extremely good performance could lead investors to update their assessments of managers' abilities disproportionately more than moderately good performance. Investors could

[13] For young funds that have, for example, only one year's worth of return history, we cannot compute lagged returns and flows. In such cases, instead of dropping these young funds from the estimation, we "dummy out" missing lagged variables to retain observations. In other words, we set missing values of lagged flows and returns to zero and include a dummy that indicates missing values.

[14] Time-by-style fixed effects perform the same adjustment as a factor model regression under the assumption that the factor loadings are the same for all funds of a given style within a given time period.

understand the limitations of the scalability of a funds' strategy and refuse to provide capital beyond a certain level regardless of performance. Finally, if funds have a policy of closing to new investors when they reach a certain size, then net relation between inflows and performance would be nonlinear, since flows would be very large up to the point at which the fund closes but small after that. For these reasons, we have estimated specifications that allow for nonlinearities in performance (splines, quadratics, etc.). While there is some evidence of nonlinear effects in the data, they are small in magnitude and have little impact on the estimates obtained with linear specifications. For this reason, we restrict our analysis to linear specifications.

The lack of meaningful flow-performance nonlinearities in our data is consistent with the mixed evidence in the literature on the flow-performance relations facing hedge funds. In particular, Agarwal et al. (2003) find a convex relation similar to that documented for mutual funds. Using a sample of funds of funds, Fung et al. (2008) find a significant relation between past returns and subsequent flows only for 'beta-only' funds, but not for 'have-alpha' funds, which is consistent with concave flow-performance relations in general. Baquero and Verbeek (2009) find a linear relationship but the shape of relation depends on the time horizon being analyzed. Ding et al. (2009) investigate the impact of share restrictions on the flow-performance relation of hedge funds and find a convex relation in the absence of share restrictions, a concave relation in the presence of restrictions, but a linear relation when considering all hedge funds together. Therefore, for the purposes of measuring indirect incentives of hedge fund managers, a linear specification in the flow-performance relations is likely to provide a reasonable approximation.

An issue in designing a specification is the choice of time units. Most of the prior literature uses annual data, estimating the effect of performance in one year on flows in the next.[15] Yet, a learning model like Berk and Green's predicts that investors will update their assessments and change their allocations of capital at the time performance is observed, so current performance influences current

[15] An exception is Baquero and Verbeek (2009), who investigate both quarterly and annual horizons.

flows. Since the appropriate time unit is not obvious, we estimate Equation (1) using annual, quarterly, and monthly data.

4.2. Estimates of the Flow-Performance Relation

We present estimates of the flow-performance relation for our sample of hedge funds in Panel A of Table 2 using annual data, in Panel A of Table 3 using quarterly data, and in Panel B of Table 3 using monthly data. In all specifications, the estimates indicate that there is a strong relation between inflows and performance.

In the annual specification in Panel A of Table 2, we include returns in the current year and the two prior years as independent variables in Column (1). In Column (2) we add a number of fund-level controls. In each specification, the coefficients on returns are all positive and statistically significant in most cases, and decline sharply over time, so the coefficient on contemporaneous returns is the largest. The coefficients on returns lagged one and two years are substantially lower. If we sum the coefficients on the contemporaneous and past returns, the sum in Column (1) is 2.01 and in Column (2) is 2.16. These coefficients imply that a one standard deviation increase in returns (24.6%), will lead to between a 49% and 53% increase in fund size in two years following the return.

Comparable equations using quarterly and monthly data are presented in Panels A and B of Table 3. In each column, the coefficients on lagged performance are positive and statistically significantly different from zero. Moreover, recent performance affects inflows substantially more than performance longer ago. The effect is monotonic using both quarterly and monthly data, so that the coefficient on the most recent prior period's performance is larger than the one on the prior period, which in turn is larger than the period before that; this pattern holds for the six quarters prior to the quarter in question in the quarterly specification and for the 13 months in the monthly specification. In the quarterly specification, performance in the most recent prior quarter has four times as large an effect on inflows as performance in quarter -4, and more than seven times as large an effect as performance in quarter -8. Using monthly data, performance in the most recent prior month has about six times the effect of performance in month -

12 and about 11 times the effect of performance in month -24. These results strongly suggest that investors quickly adjust their assessments of hedge fund managers and consequently their portfolios.

Several other points are worth noting about the equations estimated using quarterly and monthly data. First, the coefficients tend to be small and statistically insignificant for time periods more than two years prior to the period for which inflows are measured, suggesting that focusing on the two or three years prior to any potential inflows is reasonable. Second, the coefficients on contemporaneous returns are smaller than those for returns in the immediately preceding period, suggesting that the large positive contemporaneous coefficient in the equations using annual data are picking up returns in the same year but preceding the potential inflows. Finally, the sum of the coefficients in quarterly and monthly specifications is somewhat smaller than those in the annual specification, totaling between 1.4 and 1.6. However, these equations imply that a one-standard-deviation increase in annual returns (24.6%, or 5.7% per quarter compounded) leads to an increase of 9.3% in quarterly inflows, which when annualized is equivalent to a 42.7% increase, similar to that implied by the annual specifications discussed above.

4.3. Fund Age and Strategy Interactions

Theoretically, a learning framework such as Berk and Green (2004) suggests that the sensitivity of fund flows to performance should depend on the precision of the prior distribution of ability. The precision of the prior distribution is likely to be related to the experience of the fund managers. Intuitively, a more experienced manager is more of a "known quantity", so given an observation of performance, an observer will update their assessment of his ability less than if the same performance were observed from a new manager. In addition, the sensitivity of inflows to performance should depend on the extent to which it is possible to replicate the current distribution of returns if the fund increases in size, in other words, the fund strategy's "scalability". Consistent with these arguments, Chung et al. (2012) use data on private equity funds, and find that the sensitivity of inflows to performance is larger for younger managers than for older ones, and also larger for relatively scalable buyout funds than for venture capital funds that require a substantial investment of personal partner time for each dollar invested.

We first estimate the extent to which the sensitivity of inflows to performance depends on the fund's age. To do so, we estimate Equation (1) using annual data, including interaction terms of the log of the fund's age plus one with prior performance, and present these estimates in Panel B of Table 2. In each estimated equation, the coefficients are negative and are statistically significant for the current period and the period immediately preceding the potential change in inflows. The negative coefficient on the interaction term means that as hedge funds get older, the effect of performance on inflows declines. The coefficients from Column (1) of Panel B of Table 2 imply that a 1.5 year-old fund (the 25th percentile) that has a one standard deviation increase in returns (24.6%) has an extra 62% increase in size over the two years following the increase. In contrast, a 6 year-old fund (the 75th percentile) with the same increase in performance would experience only an extra 23% growth.

A fund's strategy likely affects the sensitivity of inflows to performance because some strategies can be replicated with more capital, while others will face diminishing returns. For example, arbitrage strategies (e.g., Convertible Arbitrage), in which opportunities disappear as they are exploited, are unlikely to be infinitely scalable by nature. Strategies that invest in illiquid assets and have high market impact costs (e.g., Event-driven) are also more likely to face capacity constraints (Getmansky (2005), Aragon (2007), Teo (2009)). On the other hand, strategies that involve liquid instruments (e.g., Long/Short Equity, Equity Market Neutral) are less prone to capacity constraints (Getmansky (2005), Ding et al. (2009)). Ramadorai (2013) finds a negative effect of capacity constraints on hedge fund returns.

To evaluate whether the scalability in fact does affect the way in which fund performance affects inflows, we rely on the classification of Ding et al. (2009), who consider Emerging Market, Fixed-income Arbitrage, Event Driven, and Convertible Arbitrage strategies to be "capacity constrained". The other strategies (Long/Short Equity, Equity Market Neutral, Global Macro, Multi-Strategy, and Others) are classified as "unconstrained".[16] We create a dummy variable equal to one if the fund is capacity

[16] Ding et al. (2009) use the methodology of Getmansky (2005) to determine which strategies experience decreasing returns-to-scale (i.e., concave performance-size relation). Naik et al. (2007) similarly identify four capacity

constrained and zero if it is unconstrained. We interact this variable with the contemporaneous as well as past performance variables, and present the results in Panel C of Table 2. Because this indicator variable is collinear with style and time-by-style fixed effects, we do not include such fixed effects in these specifications.

As with the previous estimates, the coefficients on contemporaneous performance as well as two lags of performance are positive and statistically significantly different from zero. However, the coefficients on these variables interacted with the "Constrained" dummy variable are negative, implying that the strategies we consider to be constrained are less responsive in size to a performance shock.[17] Even though a shock to performance for "constrained" funds would cause the market to update its assessment of the fund managers' abilities, the fact that they are less scalable limits the extent to which investors are willing to change their investments in these funds as a result.

5. Calculating Indirect and Direct Pay for Performance

In this section, we use the models discussed in Section 2 and the Appendix, together with the estimates presented in Section 4, to quantify the magnitude of direct and indirect pay-performance sensitivities facing hedge fund managers. We focus on the estimates from the annual flow-performance specifications because these match the assumed timing of managers' direct incentive payouts.[18] As noted

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constrained strategies (Emerging market, Fixed-income arbitrage, Relative value, Directional) based on a negative relation between past flow and future alphas, although they do not exactly map to the four in Ding et al. due to the different categorizations of strategies used by different databases. These findings are also consistent with practitioners' observations. For example, Commonfund Institute explains that Long/Short Equity and Global Macro are not as capacity-constrained as Convertible Arbitrage, Fixed-income Arbitrage, and Event-driven in which managers try to identify and capture relative pricing inefficiencies between related securities (Commonfund Institute, 2004, "Hedge Fund and Absolute Return Strategies." The report is available at http://www.commonfund.org/ InvestorResources/Publications/Pages/WhitePapers.aspx).

[17] We also estimate the interactive effects of age and strategy with performance on flows using quarterly and monthly data, and obtain similar results. For brevity we do not tabulate these results.

[18] In theory incentive fees can be paid over any predetermined period of time as per an investment agreement. This element of contract is private information, and therefore it is hard to know the exact frequency of incentive fees payment for a particular hedge fund. However, it is generally accepted that incentive fees are paid on an annual basis for typical funds. Consistently, most academic papers assume that incentive fees are accrued monthly but paid annually at the end of each calendar year.

above, the cumulative effect of past performance on flows is similar in monthly and quarterly specifications, so the estimates of indirect pay-performance are not sensitive to this choice.

To calculate direct pay for performance, we follow Agarwal et al.'s (2009) total delta approach using the parameters discussed in Appendix. This approach takes the perspective of a manager at the beginning of the year calculating the sensitivity of his claim to the fund's assets to performance realized over the upcoming year. Based on a set of assumptions discussed in Appendix, we calculate direct incentives arising from each individual investor's assets as well as the manager's personal stake, and then sum them up to reach the total direct pay for performance for each fund-year in our sample. We take the average of these fund-year estimates to be our estimate of typical direct pay-performance sensitivities.

For indirect pay for performance, the coefficients on returns in Table 2 carry the interpretation of incremental inflows as a percentage of beginning-of-period AUM for an incremental percentage point of returns. As previously discussed, we use four models to estimate the fraction of an incremental dollar invested in the fund that accrues to the manager in expected future management and incentive fees: the base GIR model, the GIR model augmented for future performance-based flows, the LWY model (which incorporates endogenous leverage), and the LWY model extended to allow future performance-based flows. For every fund-year, we apply each of the four models to calculate the fraction of each incremental dollar that, in expectation, will accrue to the managers. Then as with the direct pay for performance, we take the average of fund-year estimates to be our estimate of typical indirect pay-performance sensitivities. We do this calculation for a number of alternative parameter choices. Details of each model, parameter choices, and the calculations are provided in the Appendix.

We use common parameters for each model to ensure an apples-to-apples comparison across models. For each of the four models, we calculate indirect incentives using eight different sets of parameters obtained from two different choices of each of three parameters. The three parameters we vary are those that because of their economic interpretation are likely to have a quantitatively important impact on estimates of indirect incentives. A particularly important parameter is b, which represents the minimum asset value relative to the high water mark that the investor will tolerate before withdrawing all his or her money from the fund. If b=0, the fund is not liquidated for a performance-related reason. Positive values of b imply a positive probability of performance-related liquidation each period and therefore a finite expected fund life. We consider b=0.8 as recommended by GIR, which means that a 20% loss results in liquidation of an investor's stake. We also present estimates using b=0.685, which LWY use in their analysis.

Another important parameter is $\delta + \lambda$, which is the fraction of an investor's capital that he or she withdraws each period (year) for exogenous reasons. GIR set this parameter equal to 5%, which corresponds to the typical spending rules of institutional investors such as endowments or pension plans. LWY use 10%, which although too high for such institutions, may be appropriate for other investor types. The higher this parameter, the lower the indirect incentives because higher withdrawal rates mean that new money will stay in the fund for a shorter period of time. We present estimates using both 5% and 10%.

The final parameter we vary is the manager's future expected gross-of-fee risk-adjusted performance, α. Following GIR, we present estimates for $\alpha = 0$ and $\alpha = 3\%$, which correspond to levered values in the LWY framework. LWY calibrate their model to an unlevered $\alpha = 1.22\%$, which is close to a levered value of 3% given typical leverage in the industry. Although assuming a gross-of-fee α of zero is the more conservative choice, it is unlikely to satisfy a rational investor's participation constraint given that fees must be paid.[19]

In both GIR and LWY, α is exogenous and time-invariant. In particular, it is not related to current or future inflows of new investment. If inflows lead to lower future performance, our estimates of indirect pay for performance would be overstated. While Naik et al. (2007), Agrawal et al. (2009) and Fung et al. (2008) do find that inflows result in lower future performance, this relation does not hold in our (more recent) data. Moreover, given the magnitude of such relations identified by prior work, any overstatement

[19] One other parameter of GIR worth mentioning is *c'*, which is the costs and fees allocated to reducing the high-water mark, usually determined by an accounting choice of the fund. GIR effectively assume that it equals 0.05. LWY do not have a comparable parameter in their model, so they effectively assume *c'* = 0. It turns out that having *c'* = 0.05 leads to higher indirect incentives. Since our conclusion is that indirect incentives are relatively large, we set *c'* = 0 with the goal of focusing on "conservative" parameter choices that lead to lower indirect incentives.

of indirect pay for performance is likely to be small. For instance, our estimates of the flow-past performance sensitivity presented in Panel A of Table 2 imply that a one-percentage point incremental return in a given year leads to a 2.16% increase in AUM over the next two years. Accounting for the magnitude of the deleterious effects of flows on future performance estimated by Agrawal et al. (2009) would reduce this estimate by only 0.015% of AUM.

5.1. Estimates of Direct and Indirect Incentives

The estimates of direct incentives are summarized in Panel A of Table 4. These calculations indicate that the expected dollar increase in incentive fees for an incremental percentage point increase in annual net return equals $195,000 (Row 1), or roughly 8.3 cents for every dollar returned to investors (Row 4). This figure is lower than the typical 20% incentive fee rate because the option is generally out of the money. The change in the managers' personal stakes averages $183,000 for an incremental 1% return (Row 2) and 8.2 cents for every dollar returned to investors (Row 5). The total direct incentives average $378,000 for a percentage point increase in fund value (Row 3), or 16.6 cents for each additional dollar created (Row 6).

Panels B through E of Table 4 perform comparable calculations for indirect incentives, using each of the four models to value the fund's future fee income. For example, the estimates in Panel B are from the base case GIR model that does not allow for endogenous portfolio choices or performance-based fund flows. Consider first the estimates reported in Column (1) (with $b = 0.685$, $\alpha = 0\%$, and $\delta + \lambda = 5\%$). These estimates indicate that for a one-percentage-point increase in returns, the incremental future fees from inflows of new investment average $749,000 and incremental future fees from the increase in value of existing assets average $408,000. The total is $1.156 million, which is 3.06 times the direct change in compensation through incentive fees and the managers' personal stakes. Expressed as a fraction of an incremental dollar in the fund, managers receive 31.7 cents from new money and 16 cents from the change in the value of existing assets. Together these effects are 2.88 times the direct incentives managers receive for the same change.[20]

The remaining columns of Panel B present analogous calculations for alternative parameter choices. In general, higher choices of b and of $\delta + \lambda$ reduce the size of indirect incentives, while higher α raises them. Intuitively, a higher b means a lower tolerance for negative return shocks by investors, so in expectation, future fees and hence indirect incentives will be lower when b is higher. Similarly, a higher value of $\delta + \lambda$ means that assets exit the fund more quickly for non-performance related reasons, which effectively shortens a fund's expected life, so future fees will be lower. In contrast, higher α means future returns are expected to be higher, so the likelihood of hitting the liquidation boundary defined by b declines and fees will be percentages of higher asset values, so their expectation increases with α. Nonetheless, regardless of the choice of parameters, indirect incentives are substantially larger than direct incentives, with indirect/direct ratios varying from 1.6 to 6.9.

Considering the other models presented in Panels C, D, and E, it is evident that for any set of parameters, the indirect incentives coming from the alternative models are higher than for the base case GIR model. To understand why, recall that the augmented GIR model and the two LWY models differ from the base case GIR model because they allow for performance-related fund flows and/or portfolio allocations that are chosen endogenously taking account of managers' incentives.

In the case of the augmented GIR model, performance based-flows are isomorphic to an increase in fund volatility. Volatility increases the value of the manager's claim to each incremental dollar in the fund because the manager's incentive fees are options on the fund.[21] Indirect incentives calculated using the augmented GIR model and presented in Panel C are about 24% larger than for the base GIR model when α=0% and about 7% larger when α=3%.

[20] The indirect-to-direct ratios are calculated by dividing average indirect incentives by average direct incentives for both 'per incremental percentage point of returns' and 'per incremental dollar' calculations. The two ratios are not the same because for each fund-year direct and indirect incentives per 1% increase in returns are scaled by (1% of) AUM, which varies by fund-year, to reach direct and indirect incentives per \$1 change to fund value.

[21] In the GIR framework, the standard intuition that volatility increases option value is partially, but not entirely, offset by the fact that greater volatility increases the probability of liquidation given a fixed b.

The LWY model allows the manager to endogenously choose the leverage of the fund in response to incentives. When managers can endogenously adjust their future portfolios, they will do so only when it benefits them, since they have the option of not adjusting their portfolios as a function of their incentives. This effect increases the value to the manager of an incremental dollar in the fund compared to when they do not have this option. Indirect incentives calculated using the LWY model and presented in Panel D range from 4%-31% larger than in the base GIR model, depending on the model parameters.

The LWY model augmented for performance-based fund flows not only allows endogenous allocation, but also allows inflows of new investment in the future if future performance is good. Both channels increase the value to the manager of an incremental dollar in the fund in their own right. They also interact in that with the possibility of future inflows, the manager endogenously takes more risk. This effect is especially strong when α is large, as the downside from risk-taking (hitting the liquidation boundary represented by b) is less likely to occur in this case. Given all of this, indirect incentives from the augmented LWY model presented in Panel E are about 23% higher than in the base-case GIR model when the liquidation threshold is tight (b=0.8). When the liquidation threshold is looser (b=0.685), indirect incentives are about 11% higher compared to the base GIR model for unskilled managers and 95% higher for skilled ones.

Overall, the ratio of indirect to direct incentives varies from 1.6 to 13.1 across the 32 model and parameter combinations examined here, with an average of 4.1. The three alternative models typically deliver estimates of indirect incentives that are roughly 20% higher than the base-case GIR model because allowing for performance-based inflows and endogenous portfolios both increase future payments to fund managers. Regardless of the way one does the calculations, it is evident that indirect incentives are considerably larger than direct incentives for a typical fund. Thus, total managerial incentives in the hedge fund industry are substantially larger than their direct incentives.

5.2. Direct and Indirect Incentives by Fund Age

Panel B of Table 2 documents that the magnitude of the flow-performance relation declines sharply as a fund ages, consistent with the logic of Berk and Green (2004). Since the indirect incentives managers face come in large part because of the influence of returns on flows, it is likely that managers' indirect incentives also decline with a fund's age.

Table 5 examines this hypothesis by calculating indirect incentives for funds of different ages with parameter choices given in column (4) of Table 4 (i.e., b = 0.685, α = 3%, and $\delta + \lambda$ = 10%; these are the parameter choices in LWY). Here, we focus in our discussion on changes in manager wealth per incremental dollar returned to investors because older funds are systematically larger, complicating comparisons across age groups of changes in wealth per incremental percentage point of returns. However, for completeness we report the latter incentive measure as well in Table 5.

Panel A presents the average direct pay for performance for funds of different ages. This panel documents that direct pay for performance increases with fund age. For a new fund, an incremental dollar returned to fund investors results in twelve cents in incremental incentive fees and returns on the manager's personal stake. For a ten-year-old fund, this amount rises to 26 cents. Much of this increase, however, occurs because of our assumption that managers reinvest their fees and so their ownership increases over time. To the extent that managers start their funds with a positive stake and do not reinvest all of their fees, direct pay for performance will not increase as fast as indicated in this table.

Panels B, C, D, and E present estimates of indirect incentives using each of the four models to evaluate the fraction of fund value going to managers in the form of future fees. Regardless of which model one uses, however, indirect incentives change dramatically as a fund ages. For new funds, an incremental dollar returned to investors today results in at least $0.77 in expected future fees. This indirect effect is about seven times as important as the direct effect of performance on current income from incentive fees and gains on the manager's own stake. The indirect effect declines sharply with the fund's age, and is approximately equal to the magnitude of the direct effect after a fund is over 11 years old.

5.3. Direct and Indirect Incentives and Fund Scalability

Indirect incentives result from managers being able to increase their funds' sizes when performance has been good. Their ability to do so depends on the ability of managers to "scale" their investments: Some funds are relatively unconstrained in that they adopt strategies that are “scalable”, implying that the fund can likely invest new capital with the same ex ante return distribution as existing capital. In contrast, other more constrained funds typically cannot accept more capital without significantly reducing expected returns.

Table 6 provides estimates of indirect and direct incentives for funds classified as “Not Capacity Constrained” and “Capacity Constrained” according to the definitions discussed in Section 3. The direct incentives of each type are very similar (16 cents for each incremental dollar returned to investors for not constrained funds compared to 17 cents for constrained funds). The differences in indirect incentives, however, are substantial; 62 cents for each dollar returned to investors for the unconstrained funds compared to 44 cents for constrained funds using the baseline GIR model. This difference implies an average indirect/direct ratio of about 3.8 for the not constrained funds, compared to 2.6 for the constrained funds. Using other models, the indirect/direct ratio ranges between 4.4 and 6.9 for the not constrained funds, while it does between 3.0 and 5.2 for the constrained funds. These differences suggest that indirect incentives are relatively more important in funds adopting more scalable investment strategies.

6. Conclusion

At least since Fama (1980) and Holmström (1999), it has been recognized that managers’ incentives to perform well come not only through direct pay for performance plans, but also through the managerial labor market. The market draws inferences about managers’ abilities from their observed performance and rewards or penalizes them accordingly, providing an additional channel through which managers’ performance can affect their welfare. The money management industry is one place where the managerial labor market can provide substantial incentives, since investors can observe managers’ performance and reallocate capital easily between alternative investments. This paper estimates the magnitude of this effect for hedge fund managers.

Our estimates indicate that indirect incentives are particularly large for hedge fund managers. On average, for an incremental dollar returned to investors, managers' expected lifetime incomes increase by at least forty-one cents, twenty-five cents of which come from indirect incentives arising from their ability to earn fees on the increased AUM that follows incremental performance. The large indirect incentives for hedge fund managers come from the fact that inflows to hedge funds are very sensitive to performance, and the fee structure in hedge funds is such that managers expect to receive a large fraction of each dollar invested in the fund as compensation over time.

The estimates indicate that the allocation process to hedge funds is consistent with the Bayesian learning framework used by Berk and Green (2004) and Chung et al. (2012) to study allocations to mutual funds and private equity funds. First of all, consistent with the notion that investors update their assessment of ability to performance, inflows react to performance quickly. All of the effect of performance on inflows occurs in the two years subsequent to the performance, and within the two-year period, it declines sharply over time. Even using monthly data, the decline in the performance-inflow relation is evident on a month-to-month basis.

Second, the sensitivity of inflows to performance declines for a given fund over time. As a result, indirect pay for performance declines with the age of the fund, becoming smaller than direct pay for performance when a fund is over 11 years old. This pattern is consistent with Bayesian updating, because as a fund ages, its management's ability becomes more of a known quantity, so investors' assessment of it does not change as much for a given observed return.

Third, the performance-inflow relation and indirect pay for performance are larger for funds with strategies that are likely to be replicable for larger quantities of capital. This pattern is again consistent with Bayesian allocation of capital to fund managers, because if the ability of managers to earn returns on new capital in the fund is limited by fund's strategy, then it is rational for investors to allocate less capital to that fund in response to a given return.

Hedge funds managers' interests are generally considered to be well-aligned with those of their investors, because they receive a large part of their compensation in the form of incentive fees and often additionally make a substantial equity contribution to the fund. Yet, the evidence in this paper strongly suggests that indirect incentives are several times more important than these direct incentives. Hedge fund managers' total pecuniary incentives are substantially higher than is implied by their ownership and incentive fee stakes, and consist mostly of indirect incentives. Understanding why hedge funds are structured the way they are, and, more generally, the effects of the very high indirect incentives hedge fund managers face would be excellent topics for future research.

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Table 1. Summary statistics

This table presents descriptive statistics for the sample of 2,687 funds during the sample period of 1995-2010. Time-varying variables are reported at the fund-year level, and other time-invariant contractual characteristics are reported at the fund level. *Annual flow* is the difference between the reported year-end AUM and the year-beginning AUM times (1+Annual Returns), scaled by year-beginning AUM. *Annual returns* are the reported annual net-of-fee returns. *AUM* is the assets under management at the beginning of the year. *Age* is the number of years from the fund's inception date, measured at the beginning of year. *Volatility* is annualized standard deviation of monthly returns estimated over the previous 12 months. All time-varying variables except fund age are winsorized at the 1st and 99th percentiles. *Management fees* are the percentage of the assets charged by the fund as regular fees. *Incentive fees* are the percentage of positive profits received by the manager as performance incentives. *High-water mark* is an indicator variable that equals one if the fund has a high-water mark provision, and zero otherwise. *Leverage* is an indicator variable that equals one if the fund uses leverage, and zero otherwise. *Open-to-public* is an indicator variable that equals one if the fund allows public investment, and zero otherwise. On-shore is an indicator variable that equals one if the fund is domiciled in the U.S., and zero otherwise. *Total redemption period* is the sum of the notice period and the redemption period, measured in years, where the *notice period* is the time the investor has to give notice to the fund about an intention to withdraw money from the fund, and the *redemption period* is the time that the fund takes to return the money after the notice period is over. *Lockup period* is the minimum time in years that an investor has to wait before withdrawing invested money. Lockup period is considered to be zero for the fund that does not have a lock-up provision. *Subscription period* is a time delay, measured in years, between investing in a fund and actually purchasing fund shares. *Constrained* is an indicator variable that equals one if the fund's strategy belongs to Convertible Arbitrage, Fixed Income Arbitrage, Emerging Markets, and Event Driven strategies, and zero otherwise (Ding et al. (2009).

Variable	N	Mean	25^{th} Pctl.	Median	75^{th} Pctl.	SD
Annual flow	10,811	0.536	-0.184	0.038	0.504	1.830
Annual returns	10,811	0.117	0.012	0.092	0.193	0.244
AUM ($M)	10,811	227.2	13.1	45.6	145.5	679.9
Age (years)	10,811	4.238	1.499	3.164	6.000	3.754
Volatility (annualized)	10,811	0.125	0.048	0.090	0.164	0.112
Management fees (%)	2,687	1.4	1.0	1.5	2.0	0.5
Incentive fees (%)	2,687	19.3	20.0	20.0	20.0	3.4
High-watermark provision indicator	2,687	0.691	0.000	1.000	1.000	0.462
Leverage indicator	2,687	0.677	0.000	1.000	1.000	0.468
Open-to-public indicator	2,687	0.195	0.000	0.000	0.000	0.397
On-shore indicator	2,687	0.240	0.000	0.000	0.000	0.427
Total redemption period (years)	2,687	0.273	0.137	0.164	0.329	0.256
Lockup period (years)	2,687	0.247	0.000	0.000	0.000	0.526
Subscription period (years)	2,687	0.089	0.082	0.082	0.082	0.064
Strategy						
Constrained indicator	2,687	0.305	0.000	0.000	1.000	0.460
Constrained=1						
Convertible Arbitrage	2,687	0.035				
Fixed Income Arbitrage	2,687	0.052				
Emerging Markets	2,687	0.121				
Event Driven	2,687	0.098				
Constrained=0						
Equity Market Neutral	2,687	0.069				
Global Macro	2,687	0.081				
Long/Short Equity Hedge	2,687	0.418				
Multi-Strategy	2,687	0.076				
Other	2,687	0.052				

Table 2. Flow-Performance Sensitivity

This table presents OLS estimates of Equation (1) and corresponding *p-values* (in parentheses) using annual data. The dependent variable is *Annual flow*, as defined by Equation (2). The sample period is from 1995 to 2010. See Table 1 for definitions of all independent variables. In Panel B, Equation (1) is augmented to include interaction terms of the log of the fund's age plus one with concurrent as well as prior performance, and in Panel C, to include interaction terms of *Constrained* indicator with performance variables. All specifications in Panel A and B include style fixed effects, year fixed effects, and year-by-style fixed effects. Only year fixed effects are included in Panel C. Standard errors are double clustered by fund and year. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Base-case

	(1)	(2)
Dep.Var. = Annual Flow(t)	coef(p-val)	coef(p-val)
Annual Return(t)	1.119***(0.000)	1.095***(0.000)
Annual Return(t-1)	0.716***(0.000)	0.786***(0.000)
Annual Return(t-2)	0.171(0.106)	0.275***(0.002)
Annual Flow(t-1)		0.053***(0.000)
Log(Age in years +1)		-0.138**(0.012)
Log(AUM(t-1)+1)		-0.212***(0.000)
Annual return volatility		-1.361***(0.000)
Management fee		2.375(0.556)
Incentive fee		0.110(0.836)
High-water mark?		0.133***(0.003)
Leveraged?		0.041(0.246)
Open-to-public?		-0.006(0.905)
Oh-shore?		-0.267***(0.000)
Log(Total redemption period in years +1)		0.418***(0.003)
Log(Lock-up period in years +1)		-0.038(0.524)
Log(Subscription period in years +1)		-0.483(0.183)
Missing Annual Return(t-1)	1.277***(0.000)	1.021***(0.000)
Missing Annual Return(t-2)	0.522***(0.000)	0.139*(0.074)
Missing Annual Flow(t-1)		0.179*(0.056)
Fixed effects		
Style	Yes	Yes
Year	Yes	Yes
Style×Year	Yes	Yes
Number of observations	10,811	10,811
Adjusted R^2	0.163	0.204

Panel B: Age interactions

	(1)	(2)
Dependent variable = Annual flow(t)	coef(p-val)	coef(p-val)
Annual Return(t)*Log(Age in years +1)	-1.294***(0.000)	-1.263***(0.000)
Annual Return(t-1)*Log(Age in years +1)	-0.473*(0.068)	-0.420*(0.083)
Annual Return(t-2)*Log(Age in years +1)	0.237(0.373)	0.294(0.241)
Annual Return(t)	2.874***(0.000)	2.821***(0.000)
Annual Return(t-1)	1.401***(0.001)	1.424***(0.000)
Annual Return(t-2)	-0.353(0.462)	-0.256(0.553)
Annual Flow(t-1)		0.053***(0.000)
Log(Age in years +1)	-0.224**(0.019)	0.005(0.949)
Log(AUM(t-1)+1)		-0.210***(0.000)
Annual return volatility		-1.344***(0.001)
Management fee		2.890(0.452)
Incentive fee		0.042(0.939)
High-water mark?		0.135***(0.004)
Leveraged?		0.044(0.205)
Open-to-public?		-0.002(0.971)
Oh-shore?		-0.275***(0.000)
Log(Total redemption period in years +1)		0.384***(0.008)
Log(Lock-up period in years +1)		-0.028(0.637)
Log(Subscription period in years +1)		-0.407(0.248)
Missing Annual Return(t-1)	1.117***(0.000)	1.058***(0.000)
Missing Annual Return(t-2)	0.098(0.248)	0.074(0.372)
Missing Annual Flow(t-1)		0.156(0.105)
Fixed effects		
Style	Yes	Yes
Year	Yes	Yes
Style×Year	Yes	Yes
Other controls	Yes	Yes
Number of observations	10,811	10,811
Adjusted R^2	0.184	0.217

Panel C: Scalability interactions

	(1)	(2)
Dependent variable = Annual flow(t)	Coef.(p-val)	Coef.(p-val)
Annual Return(t)*Constrained	-0.574**(0.011)	-0.593***(0.004)
Annual Return(t-1)*Constrained	-0.362*(0.065)	-0.428**(0.038)
Annual Return(t-2)*Constrained	-0.014(0.913)	-0.032(0.788)
Annual Return(t)	1.304***(0.000)	1.295***(0.000)
Annual Return(t-1)	0.851***(0.000)	0.968***(0.000)
Annual Return(t-2)	0.167(0.188)	0.301***(0.001)
Constrained?	0.015(0.820)	0.025(0.683)
Annual Flow(t-1)		0.053***(0.000)
Log(Age in years +1)		-0.147***(0.003)
Log(AUM(t-1)+1)		-0.206***(0.000)
Annual return volatility		-1.597***(0.000)
Management fee		1.635(0.687)
Incentive fee		0.199(0.728)
High-water mark?		0.120***(0.005)
Leveraged?		0.041(0.255)
Open-to-public?		-0.002(0.965)
Oh-shore?		-0.239***(0.000)
Log(Total redemption period in years +1)		0.442***(0.001)
Log(Lock-up period in years +1)		-0.042(0.467)
Log(Subscription period in years +1)		-0.471(0.183)
Missing Annual Return(t-1)	1.271***(0.000)	1.025***(0.000)
Missing Annual Return(t-2)	0.537***(0.000)	0.157**(0.025)
Missing Annual Flow(t-1)		0.171*(0.061)
Fixed effects		
Year	Yes	Yes
Other controls	Yes	Yes
Number of observations	10,811	10,811
Adjusted R^2	0.157	0.197

Table 3. Flow-performance sensitivity at higher frequencies

This table presents OLS estimates of Equation (1) and corresponding *p-values* (in parentheses) using higher frequency data. In Panel A, we presents the estimates using quarterly data, and in Panel B, using monthly data. The dependent variable is *Quarterly flow* in Panel A, and *Monthly flow* in Panel B, where flows are defined as in Equation (2). In Panel A (Panel B), a subsample of funds whose subscription period is less than or equal to three (one) months are used. The sample period is from 1995 to 2010. *Other Controls* are those included in Column (2) of Table 2. All specifications include style fixed effects. In Panel A, we also include year-quarter fixed effects, and in Panel B, year-month fixed effects. Standard errors are double clustered by fund and time period. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Quarterly

	(1)	(2)
Dependent variable = Quarterly flow(t)	coef(p-val)	coef(p-val)
Quarterly Return(t)	0.175***(0.000)	0.172***(0.001)
Quarterly Return(t-1)	0.464***(0.000)	0.457***(0.000)
Quarterly Return(t-2)	0.304***(0.000)	0.254***(0.000)
Quarterly Return(t-3)	0.208***(0.000)	0.187***(0.000)
Quarterly Return(t-4)	0.117***(0.000)	0.111***(0.000)
Quarterly Return(t-5)	0.087***(0.002)	0.097***(0.000)
Quarterly Return(t-6)	0.061*(0.059)	0.074**(0.013)
Quarterly Return(t-7)	0.098***(0.000)	0.117***(0.000)
Quarterly Return(t-8)	0.051**(0.013)	0.064***(0.002)
Quarterly Return(t-9)	0.009(0.766)	0.031(0.295)
Quarterly Return(t-10)	-0.005(0.852)	0.026(0.340)
Quarterly Return(t-11)	0.022(0.444)	0.055*(0.053)
Other Controls	No	Yes
Fixed effects		
Style	Yes	Yes
Year-quarter	Yes	Yes
Number of observations	50,333	50,333
Adjusted R^2	0.158	0.190

Panel B: Monthly

Dep.Var. = Monthly Flow(t)	(1) coef(p-val)	(2) coef(p-val)
Monthly Return(t)	-0.040**(0.018)	-0.043**(0.011)
Monthly Return(t-1)	0.174***(0.000)	0.184***(0.000)
Monthly Return(t-2)	0.161***(0.000)	0.141***(0.000)
Monthly Return(t-3)	0.142***(0.000)	0.124***(0.000)
Monthly Return(t-4)	0.132***(0.000)	0.118***(0.000)
Monthly Return(t-5)	0.120***(0.000)	0.107***(0.000)
Monthly Return(t-6)	0.085***(0.000)	0.074***(0.000)
Monthly Return(t-7)	0.078***(0.000)	0.071***(0.000)
Monthly Return(t-8)	0.078***(0.000)	0.072***(0.000)
Monthly Return(t-9)	0.067***(0.000)	0.061***(0.000)
Monthly Return(t-10)	0.055***(0.000)	0.051***(0.000)
Monthly Return(t-11)	0.052***(0.000)	0.050***(0.000)
Monthly Return(t-12)	0.034***(0.007)	0.032***(0.010)
Monthly Return(t-13)	0.029**(0.021)	0.029**(0.017)
Monthly Return(t-14)	0.046***(0.000)	0.048***(0.000)
Monthly Return(t-15)	0.008(0.517)	0.007(0.516)
Monthly Return(t-16)	0.020*(0.076)	0.024**(0.034)
Monthly Return(t-17)	0.030**(0.015)	0.032***(0.008)
Monthly Return(t-18)	0.007(0.576)	0.007(0.532)
Monthly Return(t-19)	0.011(0.307)	0.016(0.143)
Monthly Return(t-20)	0.028***(0.008)	0.031***(0.003)
Monthly Return(t-21)	0.019*(0.058)	0.020**(0.041)
Monthly Return(t-22)	0.016*(0.069)	0.019**(0.036)
Monthly Return(t-23)	0.018**(0.050)	0.021**(0.021)
Monthly Return(t-24)	0.014(0.120)	0.017*(0.068)
Monthly Return(t-25)	0.025**(0.016)	0.029***(0.006)
Monthly Return(t-26)	0.003(0.813)	0.005(0.640)
Monthly Return(t-27)	0.007(0.586)	0.012(0.332)
Monthly Return(t-28)	0.009(0.425)	0.014(0.207)
Monthly Return(t-29)	0.001(0.938)	0.006(0.616)
Monthly Return(t-30)	-0.018(0.130)	-0.011(0.344)
Monthly Return(t-31)	0.014(0.203)	0.023**(0.035)
Monthly Return(t-32)	0.007(0.588)	0.011(0.365)
Monthly Return(t-33)	0.009(0.505)	0.014(0.296)
Monthly Return(t-34)	0.004(0.761)	0.009(0.524)
Monthly Return(t-35)	-0.002(0.881)	0.005(0.690)
Other Controls	No	Yes
Fixed effects		
Style	Yes	Yes
Year-month	Yes	Yes
Number of observations	144,185	144,185
Adjusted R^2	0.105	0.125

Table 4. Direct and indirect pay-for-performance

This table presents estimates of direct and indirect pay-for-performance (incentives). All reported statistics are averages taken over all fund-years in the data. Panel A presents estimates of direct incentives, calculated as described in Section A.1 of the Appendix. Direct incentives are defined as the expected present value dollar change in manager wealth from direct incentive fees plus the manager's ownership stake resulting from an incremental one-percentage-point or one-dollar increase in fund returns. Panels B-E present estimates of indirect incentives, calculated four different ways as described in Section A.2 in the Appendix. Indirect incentives are defined as the expected present value dollar change in manager wealth from future fees earned from inflows of new investment plus the increase in value of existing assets resulting from an incremental one-percentage-point or one-dollar increase in returns to investors. Estimates of indirect incentives are presented for eight combinations of the parameters *b*, α, and $\delta+\lambda$. Parameter definitions are provided in Table A.1 in the Appendix. The number of fund-years used in all columns of Panels A-C is 10,645. The numbers of observations used to estimate the LWY (Panel D) and the extended LWY model (Panel E) are somewhat smaller, because the ODE in Equation (A9) fails to have a numerical solution for certain combinations of parameters. The number of fund-years used in estimation averages 9,773 in Panel D, and 9,918 in Panel E.

	b=0.685				b=0.8			
	α=0%		α=3%		α=0%		α=3%	
	δ+λ=5%	δ+λ=10%	δ+λ=5%	δ+λ=10%	δ+λ=5%	δ+λ=10%	δ+λ=5%	δ+λ=10%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Direct incentives								
Per 1% Increase in Returns ($M)								
(1) Direct effect from incentive fees	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195
(2) Direct effect from managers' personal stake	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183
(3) **Total direct effect**	**0.378**	**0.378**	**0.378**	**0.378**	**0.378**	**0.378**	**0.378**	**0.378**
Per $1 Increase in Returns ($)								
(4) Direct effect from incentive fees	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
(5) Direct effect from managers' personal stake	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082
(6) **Total direct effect**	**0.166**	**0.166**	**0.166**	**0.166**	**0.166**	**0.166**	**0.166**	**0.166**
Panel B: Indirect incentives estimated from the GIR model								
Per 1% Increase in Returns ($M)								
(1) Indirect effect from new money	0.749	0.539	1.721	0.889	0.497	0.385	1.272	0.698
(2) Indirect effect from change in value of existing assets	0.408	0.293	0.888	0.471	0.291	0.227	0.699	0.396
(3) **Total indirect effect**	**1.156**	**0.832**	**2.608**	**1.359**	**0.787**	**0.612**	**1.971**	**1.094**
(4) **Indirect/Direct**	**3.06**	**2.20**	**6.91**	**3.60**	**2.09**	**1.62**	**5.22**	**2.90**
Per $1 Increase in Returns ($)								
(5) Indirect effect from new money	0.317	0.231	0.684	0.368	0.208	0.162	0.494	0.279
(6) Indirect effect from change in value of existing assets	0.160	0.116	0.335	0.183	0.111	0.086	0.261	0.148
(7) **Total indirect effect**	**0.477**	**0.348**	**1.019**	**0.551**	**0.319**	**0.248**	**0.754**	**0.427**
(8) **Indirect/Direct**	**2.88**	**2.10**	**6.15**	**3.33**	**1.93**	**1.50**	**4.55**	**2.58**

	Panel C: Indirect incentives estimated from the GIR model augmented for performance-based flows								
	Per 1% Increase in Returns ($M)								
(1)	Indirect effect from new money	0.955	0.668	1.876	1.000	0.641	0.490	1.339	0.772
(2)	Indirect effect from change in value of existing assets	0.492	0.347	0.937	0.511	0.350	0.269	0.690	0.410
(3)	**Total indirect effect**	**1.447**	**1.015**	**2.813**	**1.511**	**0.990**	**0.759**	**2.029**	**1.181**
(4)	**Indirect/Direct**	**3.83**	**2.69**	**7.45**	**4.00**	**2.62**	**2.01**	**5.37**	**3.13**
	Per $1 Increase in Returns ($)								
(5)	Indirect effect from new money	0.409	0.295	0.762	0.427	0.268	0.208	0.527	0.314
(6)	Indirect effect from change in value of existing assets	0.200	0.145	0.367	0.208	0.136	0.106	0.258	0.157
(7)	**Total indirect effect**	**0.609**	**0.439**	**1.129**	**0.635**	**0.404**	**0.314**	**0.785**	**0.471**
(8)	**Indirect/Direct**	**3.68**	**2.65**	**6.81**	**3.83**	**2.44**	**1.89**	**4.74**	**2.84**
	Panel D: Indirect incentives estimated from the LWY model								
	Per 1% Increase in Returns ($M)								
(1)	Indirect effect from new money	0.841	0.566	2.198	1.118	0.619	0.470	1.349	0.714
(2)	Indirect effect from change in value of existing assets	0.490	0.326	1.226	0.632	0.377	0.281	0.806	0.425
(3)	**Total indirect effect**	**1.331**	**0.893**	**3.424**	**1.751**	**0.996**	**0.751**	**2.156**	**1.139**
(4)	**Indirect/Direct**	**3.52**	**2.36**	**9.07**	**4.64**	**2.64**	**1.99**	**5.71**	**3.02**
	Per $1 Increase in Returns ($)								
(5)	Indirect effect from new money	0.360	0.241	0.842	0.448	0.267	0.201	0.501	0.280
(6)	Indirect effect from change in value of existing assets	0.186	0.124	0.437	0.231	0.141	0.106	0.278	0.151
(7)	**Total indirect effect**	**0.546**	**0.364**	**1.278**	**0.679**	**0.409**	**0.307**	**0.779**	**0.432**
(8)	**Indirect/Direct**	**3.30**	**2.20**	**7.72**	**4.10**	**2.47**	**1.85**	**4.70**	**2.61**
	Panel E: Indirect incentives estimated from the LWY model augmented for performance-based fund flows								
	Per 1% Increase in Returns ($M)								
(1)	Indirect effect from new money	0.841	0.566	3.180	1.725	0.619	0.470	1.521	0.808
(2)	Indirect effect from change in value of existing assets	0.490	0.326	1.780	0.981	0.379	0.283	0.929	0.487
(3)	**Total indirect effect**	**1.331**	**0.892**	**4.960**	**2.706**	**0.998**	**0.753**	**2.451**	**1.295**
(4)	**Indirect/Direct**	**3.52**	**2.36**	**13.14**	**7.17**	**2.64**	**1.99**	**6.49**	**3.43**
	Per $1 Increase in Returns ($)								
(5)	Indirect effect from new money	0.360	0.241	1.271	0.682	0.267	0.201	0.584	0.325
(6)	Indirect effect from change in value of existing assets	0.186	0.124	0.661	0.355	0.141	0.106	0.323	0.175
(7)	**Total indirect effect**	**0.546**	**0.364**	**1.932**	**1.038**	**0.408**	**0.307**	**0.908**	**0.500**
(8)	**Indirect/Direct**	**3.30**	**2.20**	**11.66**	**6.27**	**2.46**	**1.85**	**5.48**	**3.02**

Table 5. Direct and indirect pay-for-performance by age group

This table presents estimates of direct and indirect pay-for-performance (incentives), analogous to Table 4 but broken out by fund age. All reported statistics are averages taken over all funds of a given age. All estimates in this table use parameters b=0.0685, α=3%, and $\delta+\lambda$=10%; these are the parameters chosen by LWY.

	Fund age (years)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	≥15
	Panel A: Direct incentives																
	Per 1% Increase in Returns ($M)																
(1)	Total direct effect	0.17	0.22	0.23	0.28	0.34	0.42	0.50	0.55	0.59	0.78	0.93	1.20	1.44	1.52	0.73	1.14
	Per $1 Increase in Returns ($)																
(2)	Total direct effect	0.12	0.13	0.14	0.15	0.17	0.19	0.20	0.22	0.24	0.24	0.26	0.27	0.28	0.28	0.31	0.32
	Panel B: Indirect incentives estimated from the GIR model																
	Per 1% Increase in Returns ($M)																
(1)	Total indirect effect	1.21	1.25	1.10	1.12	1.05	1.15	1.09	1.12	1.09	1.43	1.53	1.57	1.79	1.58	1.00	0.65
(2)	**Indirect/Direct**	**7.29**	**5.81**	**4.72**	**4.00**	**3.12**	**2.73**	**2.18**	**2.04**	**1.87**	**1.83**	**1.64**	**1.31**	**1.25**	**1.04**	**1.37**	**0.57**
	Per $1 Increase in Returns ($)																
(3)	Total indirect effect	0.77	0.65	0.57	0.51	0.46	0.42	0.38	0.35	0.32	0.31	0.30	0.27	0.26	0.24	0.22	0.17
(4)	**Indirect/Direct**	**6.55**	**5.11**	**4.16**	**3.42**	**2.70**	**2.24**	**1.88**	**1.61**	**1.34**	**1.30**	**1.19**	**1.00**	**0.94**	**0.83**	**0.71**	**0.52**
	Panel C: Indirect incentives estimated from the GIR model augmented for performance-based fund flows																
	Per 1% Increase in Returns ($M)																
(1)	Total indirect effect	1.35	1.41	1.23	1.27	1.17	1.26	1.30	1.21	1.17	1.53	1.62	1.65	1.72	1.56	0.94	0.74
(2)	**Indirect/Direct**	**8.17**	**6.54**	**5.31**	**4.54**	**3.48**	**2.98**	**2.60**	**2.20**	**2.00**	**1.96**	**1.74**	**1.38**	**1.20**	**1.02**	**1.28**	**0.65**
	Per $1 Increase in Returns ($)																
(3)	Total indirect effect	0.90	0.75	0.66	0.59	0.53	0.48	0.44	0.41	0.37	0.35	0.33	0.30	0.28	0.26	0.24	0.21
(4)	**Indirect/Direct**	**7.59**	**5.89**	**4.82**	**3.94**	**3.10**	**2.56**	**2.17**	**1.87**	**1.54**	**1.45**	**1.29**	**1.12**	**1.02**	**0.92**	**0.80**	**0.65**
	Panel D: Indirect incentives estimated from the LWY model																
	Per 1% Increase in Returns ($M)																
(1)	Total indirect effect	1.50	1.58	1.38	1.45	1.37	1.46	1.64	1.56	1.44	1.96	2.05	2.03	2.25	2.03	1.10	0.79
(2)	**Indirect/Direct**	**9.07**	**7.33**	**5.97**	**5.15**	**4.08**	**3.45**	**3.29**	**2.83**	**2.46**	**2.50**	**2.20**	**1.69**	**1.57**	**1.33**	**1.49**	**0.69**
	Per $1 Increase in Returns ($)																
(3)	Total indirect effect	0.93	0.79	0.70	0.63	0.58	0.52	0.49	0.45	0.40	0.40	0.40	0.36	0.34	0.34	0.31	0.23
(4)	**Indirect/Direct**	**7.90**	**6.17**	**5.12**	**4.23**	**3.38**	**2.73**	**2.39**	**2.05**	**1.69**	**1.70**	**1.56**	**1.33**	**1.23**	**1.20**	**1.01**	**0.71**

Panel E: Indirect incentives estimated from the LWY model augmented for performance-based fund flows																	
	Per 1% Increase in Returns ($M)																
(1)	Total indirect effect	2.30	2.44	2.10	2.22	2.12	2.25	2.51	2.49	2.26	3.11	3.19	3.24	3.62	3.13	1.76	1.20
(2)	**Indirect/Direct**	**13.88**	**11.30**	**9.03**	**7.91**	**6.31**	**5.32**	**5.03**	**4.53**	**3.86**	**3.98**	**3.42**	**2.70**	**2.52**	**2.06**	**2.40**	**1.05**
	Per $1 Increase in Returns ($)																
(3)	Total indirect effect	1.41	1.20	1.06	0.96	0.89	0.79	0.75	0.70	0.63	0.62	0.63	0.56	0.55	0.56	0.51	0.36
(4)	**Indirect/Direct**	**11.91**	**9.33**	**7.74**	**6.46**	**5.19**	**4.17**	**3.67**	**3.21**	**2.63**	**2.63**	**2.46**	**2.08**	**1.98**	**1.95**	**1.66**	**1.11**

Table 6. Direct and indirect pay-for-performance by scalability

This table presents estimates of direct and indirect pay-for-performance (incentives), analogous to Table 4 but broken down the scalability of the fund's strategy. "Capacity constrained" strategies are Emerging Market, Fixed-income Arbitrage, Event Driven, and Convertible Arbitrage. All other strategies, Long/Short Equity, Equity Market Neutral, Global Macro, Multi-Strategy, and Others are not considered capacity constrained. All reported statistics are averages taken over all fund-years within a grouping. All estimates in this table use parameters b=0.0685, α=3%, and $\delta+\lambda$=10%; these are the parameters chosen by LWY.

		Not Capacity Constrained	Capacity Constrained
	Panel A: Direct incentives		
	Per 1% Increase in Returns ($M)		
(1)	Total direct effect	0.389	0.355
	Per $1 Increase in Returns ($)		
(2)	Total direct effect	0.164	0.170
	Panel B: Indirect incentives estimated from the GIR model		
	Per 1% Increase in Returns ($M)		
(1)	Total indirect effect	1.570	1.028
(2)	**Indirect/Direct**	**4.03**	**2.90**
	Per $1 Increase in Returns ($)		
(3)	Total indirect effect	0.619	0.442
(4)	**Indirect/Direct**	**3.78**	**2.61**
	Panel C: Indirect incentives estimated from the GIR model augmented for performance-based fund flows		
	Per 1% Increase in Returns ($M)		
(1)	Total indirect effect	1.768	1.113
(2)	**Indirect/Direct**	**4.54**	**3.14**
	Per $1 Increase in Returns ($)		
(3)	Total indirect effect	0.716	0.506
(4)	**Indirect/Direct**	**4.38**	**2.98**
	Panel F: Indirect incentives estimated from the LWY model		
	Per 1% Increase in Returns ($M)		
(1)	Total indirect effect	1.975	1.389
(2)	**Indirect/Direct**	**5.07**	**3.91**
	Per $1 Increase in Returns ($)		
(3)	Total indirect effect	0.744	0.573
(4)	**Indirect/Direct**	**4.55**	**3.38**
	Panel E: Indirect incentives estimated from the LWY model augmented for performance-based fund flows		
	Per 1% Increase in Returns ($M)		
(1)	Total indirect effect	3.046	2.156
(2)	**Indirect/Direct**	**7.83**	**6.08**
	Per $1 Increase in Returns ($)		
(3)	Total indirect effect	1.130	0.884
(4)	**Indirect/Direct**	**6.91**	**5.21**

Appendix

Sections A.1 and A.2 give details of our calculations of direct and indirect incentives, respectively. Section A.3 presents flow-performance estimates and calculations of direct and indirect incentives using the alternative measure of flows discussed in Section 4.

A.1. Calculating direct pay for performance

Our proxy for direct pay for performance is given by total delta, as defined in Argawal et al. (2009). Total delta at a point in time is defined as the expected dollar change in the mankager's wealth for a one percentage point increase in the fund's return over the following year. The total delta can be decomposed into two parts: the portion coming from investors' assets (manager's option delta) and the portion coming from the manger's ownership stake in the fund. The manager's option delta is in turn the sum of the deltas associated with the different investors in the fund, because of the fact that different investors in the fund face different spot prices (*S*) and exercise prices (*X*) depending on the timing of the entrance into the fund. Following Agarwal et al. (2009), for each fund-investor-year we compute the individual option's delta using the Black-Sholes model for a one-year maturity European call option as follows:

$$\textit{Individual Option Delta} = N(Z) \times S \times 0.01 \times k, \tag{A1}$$

where $Z=\{ln(S/X) + T(r+\sigma^2/2)\}/ \sigma T^{0.5}$, *S* is the investor-specific spot price (i.e., the market value of the investor's assets), *k* is the contractual incentive fee rate, and *X* is the investor-specific exercise price. Given the structure of hedge fund contracts, *X* is the high water mark level for the investor's assets (i.e., the historic high that the investor's asset has ever reached since her investment in the fund) if the fund has a high water mark provision, and simply the market value of the investor's assets if the fund has no such provision. In either case, *X* can be increased by a hurdle rate if applicable. Because incentive fees are paid out at the end of each year, *S/X* can never be greater than one. Therefore, *S/X* measures whether the option is at-the-money and if not the degree to which the option is out-of-the-money. *T* is time to maturity of the option (one year in this case). *r* is the natural logarithm of one plus risk-free rate, which is measured as the 12-month LIBOR rate that in effect at the beginning of each year, σ is the annualized standard deviation of monthly (net of fee) returns over the prior calendar year, and $N(.)$ is the standard normal cumulative distribution function.

A complication in computing individual option deltas is that various investors' assets are pooled together for management so they earn the same rate of gross return, but different investors will in general have different spot prices (S) and exercise prices (X) depending on the time in which they entered the fund. Unfortunately, the exact times and prices at which each investor entered each fund are not publicly available. To compute the investor-specific spot price (S) and exercise price (X) for each investor, we make the following assumptions:

1. The first investor enters the fund at the end of year 0 (beginning of year 1). There is no capital investment by the manager at inception. Therefore, the entire assets at inception come from a single investor.
2. All cash flows including fee payments, investors' capital allocation, and manager's reinvestment take place once a year at the end of each calendar year.
3. The exercise price (X) for each option is reset annually at the end of the year and applies to the following calendar year.
4. All new capital inflows come from a single new investor.
5. When capital outflows occur, we adopt the FIFO rule to decide which investor's money leaves the fund. In particular, the asset value of the first investor is reduced by the magnitude of outflow. If the absolute magnitude of outflow exceeds the first investor's net asset value, then the first investor is considered to liquidate her stake in the fund and leave, and the balance of outflow is deducted from the second investor's assets, and so on.
6. The hurdle rate is LIBOR if the fund has a high-water mark provision and 0% otherwise.
7. Managers reinvest all of the incentive fees into the fund.

An algorithm for estimation is as follows:

1. First, we solve the following recursive problem iteratively to back out gross returns (*gross*), using observable information on net-of-fee returns (*net*), assets under management (*AUM*), and the parameters of the compensation contract (*k*,*c*).

$$net_t = \frac{\sum_i \{S_{i,t-1} \times (1+gross_t) - ifee_{i,t} - mfee_{i,t}\} + MS_{t-1} \times (1+gross_t)}{AUM_{t-1}} - 1, \qquad \text{(A2)}$$

where $ifee_{i,t} = Max[(S_{i,t-1} \times (1+gross_t) - X_{i,t-1}), 0] \times k$, $mfee_{i,t} = S_{i,t-1} \times c$, and MS_t denotes the market value of manager's stake in the fund. We start the algorithm with the following initial values:

$$\begin{Bmatrix} S_{1,0} = X_{1,0} = AUM_0 \\ MS_0 = 0 \end{Bmatrix}, \qquad \text{(A3)}$$

2. We update the market value of the manager's stake as follows.

$$MS_t = MS_{t-1} \times (1+gross_t) + \sum_i ifee_{i,t} , \qquad \text{(A4)}$$

3. The new spot price and exercise price of investor *i* are updated recursively as follows:

$$S_{i,t} = S_{i,t-1} \times (1+gross_t) - ifee_{i,t} - mfee_{i,t}$$

$$X_{i,t} = \begin{cases} Max[S_{i,t}, X_{i,t-1}] \times (1+LIBOR), if\ with\ HWM\ provision \\ S_{i,t}, if\ without\ HWM\ provision \end{cases}, \qquad \text{(A5)}$$

4. The net flow into the fund is defined as the difference between the reported value of year-end AUM and the current market value of all existing investors' and the manager's assets.

$$Flow_t = AUM_t - \left(\sum_i S_{i,t} + MS_t \right), \qquad \text{(A6)}$$

If (A6) > 0, then we assume that a new investor enters the fund, with the beginning spot price and exercise price equal to $Flow_t$. If (A6) < 0, then we apply the FIFO rule as described above.

5. Using *S* and *X* for each investor and equation (A1), we compute the delta from each investor's asset, and then sum them up to compute the manager's option delta. The total delta of the fund is

the sum of the manager's option delta and the delta from the manager's stake, which is equal to *0.01*MS_t* because the manager retains all returns from investing his own assets.

A.2. Calculating indirect pay for performance

We employ four different models to compute the present value of the total future fees (both management and incentive fees) per dollar in the fund. Each of these models provides this value as a function of the ratio of the asset value to its HWM; i.e. the stake-to-strike (*S/X*) ratio of the assets, which we denote by *w*. This subsection describes each of these models in turn, and discusses our choices of model parameters (a summary of parameter choices is provided in Table A.1). In addition, it describes the calculations of indirect incentives.

A.2.1.Baseline GIR model

GIR (2003) provide a closed-form solution for the value of total fees as follows:

$$f(w) = \frac{1}{c+\delta+\lambda-\alpha}\left[c + \frac{(\delta+\lambda-\alpha)k + [\eta(1+k)-1]cb^{1-\eta}}{\gamma(1+k)-1-b^{\gamma-\eta}[\eta(1+k)-1]} w^{\gamma-1} - \frac{b^{\gamma-\eta}(\delta+\lambda-\alpha)k + [\gamma(1\_k)-1]cb^{1-\eta}}{\gamma(1+k)-1-b^{\gamma-\eta}[\eta(1+k)-1]} w^{\eta-1}\right], \qquad \text{(A7)}$$

where γ and η are the larger and smaller roots of the following characteristic quadratic equation:

$$\begin{pmatrix}\gamma\\ \eta\end{pmatrix} \equiv \frac{\frac{1}{2}\sigma^2 + c - r - \alpha - c' + g \pm \sqrt{\left(\frac{1}{2}\sigma^2 + c - r - \alpha - c' + g\right)^2 + 2\sigma^2(r + c' - g + \delta + \lambda)}}{\sigma^2}, \qquad \text{(A8)}$$

There are 10 parameters in the valuation equation (A7): *c* and *k* are the contractual management fee and incentive fee rate, respectively; *c'* is the accounting choice of costs and fees allocated to reducing the high-water mark; σ is the volatility of fund returns; *g* is the contractual growth rate in the high-water mark level, which is usually zero or risk-free rate; α is the risk-adjusted expected return on the fund's assets, reflecting manager skill; $\delta+\lambda$ is the total withdrawal rate, which is the sum of the regular payout rate to investors (δ) and the exogenous liquidation probability of the fund (λ); *b* is the lowest acceptable fraction of the high water mark below which the investor loses confidence in the fund and liquidates all of his position. As such, b captures a performance-triggered liquidation boundary.[22] Finally, r is the risk-free interest rate.

We estimate the parameters of Equation (A7) from observable fund level data whenever possible. In particular, for c and k we use individual fund's contractual information available from *TASS*. We compute σ as the annualized standard deviation of monthly returns over the prior calendar year and w for each existing investor is computed based on S and X obtained from the estimation procedure described in A.1. For r, we use the 12-month LIBOR at the beginning of each year.

For the rest of the parameters that are not observable or reasonably estimable, we adopt the baseline parameter values commonly used in the literature: α=0% and 3%; $\delta+\lambda$=5% and 10%; b=0.685 and 0.8; g is assumed to be equal to r if a fund has a HWM provision, and zero otherwise; c' is assumed to be zero.[23] These parameter choices are summarized in Table A.1.

A.2.2. GIR model augmented for performance-based fund flows

One of the limitations of the baseline GIR model is that it does not allow for performance-based fund flows. One way to address this issue is to assume, as an approximation, that the flow-performance relationship is linear in logs and flows are contemporaneous with returns. Without performance-induced flows, the log AUM of the fund would evolve as a martingale, so $s_{t+1}=s_t+e_{t+1}$. With performance-based flows, $s_{t+1}=s_t+g\cdot e_{t+1}$, where g>1 captures the flow effect. The log AUM still follows a martingale. Given these assumptions, the GIR model still applies, but with a higher variance than in the case of no flows.

We implement this approach to incorporating fund flows in the following manner. First, we estimate the relation between $log(AUM_t/AUM_{t-1})$ and $log(1+Return_t)$, controlling for all the other variables

[22] A positive b implies a finite expected fund life. For example, with b=0.8 an investor liquidates his entire stake if it falls in value by 20% from its high water mark.

[23] In the GIR model c' is determined by an unobservable accounting choice. Its value is not explicitly discussed, but $r+c'-g$ is assumed to be 5%, which implies a choice of c'=5% because r always equals g in GIR. In contrast, the LWY model, which we employ to confront the endogenous portfolio allocation problem, does not have this parameter and therefore effectively assumes it equals zero. Since c' cannot be reasonably estimated from the data, and also a positive value for it serves to increase indirect incentives substantially, we follow LWY and assume it equals zero throughout the paper.

used in Table 2 except the lagged return terms. When we estimate this equation, the coefficient on the logged contemporaneous return equals 1.534. Then, at the fund-year level, we multiply the GIR volatility σ by this coefficient to provide a volatility parameter for the GIR model that is likely to reflect performance-based flows. Empirically, the mean volatility is boosted from 12.48% to 19.15%. One complication in using the new volatility parameter is the way it interacts with the liquidation boundary parameter b. Because the increase in volatility is associated with flows and not returns per se, the greater volatility should not result in a greater likelihood of performance-based liquidation. To ensure this does not happen, we lower b such that under the new mean volatility performance-based liquidation is equally likely as before. For example, with b=0.8 (0.685), an investor withdraws all assets following a minus 20.0 (31.5) percent return, which is 1.60 (2.52) standard deviations away from one under the volatility parameter without flows. Now under the new volatility parameter, a 1.60 (2.52) standard deviation drop translates into a minus 30.7 (48.3) percent return, or equivalently b=0.693 (0.517). In summary, relative to the base GIR model, the augmented model multiplies all fund-year level volatility estimates by 1.534 and adjusts b as described above.

A.2.3. Baseline LWY model

Although the GIR framework provides closed-form formulas for the manger's value function, a drawback of the model is that it does not allow the manager to alter his or her portfolio endogenously. However, in practice hedge fund managers have incentives to change their investment strategies and portfolio allocation dynamically to maximize their value function. One way they potentially adjust their portfolios is through the sophisticated use of leverage, dynamically trading off the benefit and the downside risk of leverage by allocating the funds' AUM between the alpha generating strategy and the risk-free asset. To confront this issue, we employ the model provided by LWY (2013), which is a dynamic framework to value a hedge fund manager's compensation contract under the endogenous leverage choice of the manager.[24]

[24] There are other hedge fund valuation models that incorporate endogenous portfolio allocation by hedge fund managers. For example, Panageas and Westerfield (2009) provide closed-form solutions for endogenously

In the baseline LWY setting, the manager's value function *f(w)* solves the following ordinary differential equation (ODE):

$$(\beta - g + \delta + \lambda) f(w) = cw + [\pi(w)\alpha' + r - g - c]wf' + \frac{1}{2}\pi(w)^2 \sigma'^2 w^2 f''(w), \quad \text{(A9)}$$

subject to the boundary conditions:

$$f(b) = 0, \quad \text{(A10)}$$

$$f(1) = (k+1) f'(1) - k, \quad \text{(A11)}$$

The optimal leverage policy *π(w)* is dynamically determined as follows:

$$\pi(w) = \begin{cases} \min\left\{ \dfrac{\alpha'}{\sigma'^2 \psi(w)}, \bar{\pi} \right\}, & \psi(w) > 0, \\ \bar{\pi}, & \psi(w) \le 0, \end{cases} \quad \text{(A12)}$$

where *ψ(w)* is a risk-neutral manager's endogenous risk attitude. Risk attitude *ψ(w)* is in turn defined by:

$$\psi(w) \equiv -\frac{f''(w)}{f'(w)}, \quad \text{(A13)}$$

Relative to the GIR model, the baseline LWY model requires calibrations of three additional parameters – the unlevered alpha (*α'*), the unlevered volatility (*σ'*), and the manager's discount rate (*β*). We equate *β* to *r* by assuming that the manager and the investor use the same discount rate. Following LWY, we adopt the average leverage of 2.13 reported by Ang, Gorovyy, and van Inwegen (2011). The unlevered alphas (*α'*) implied by levered alpha of zero percent and 3 percent are zero and 1.4 percent, respectively. Likewise, the unlevered volatility (*σ'*) is obtained for each fund-year by dividing the

determined hedge fund leverage and valuation in a setting with no performance-induced liquidation boundary (i.e., *b*=0) and no management fees (i.e., *c*=0). Drechsler (2014) also solves for the manager's optimal leverage choice and derives closed-form solutions, albeit by counterfactually assuming management fees as a constant fraction of the HWM, not the AUM. Overall, Drechsler (2014) reaches similar results as LWY when incorporating considerations such as performance-triggered liquidation risk, management fees, and the manager's restart option. We use the LWY model because of its generality: it embeds as special cases both Panageas and Westerfield (2009) and GIR (with leverage exogenously fixed at zero).

estimated annual volatility σ in the data by 2.13.[25] Parameter choices are summarized in Table A.1. In general, the ODE in equation (A9) does not have an analytical solution and must be approximated numerically.

A.2.4. LWY model augmented for performance-based inflows

Neither baseline model of GIR nor LWY includes performance-induced money inflows. However, performance-chasing flows are a feature of the hedge fund industry, as illustrated by our results on the flow-performance relations. LWY provide an extension of their baseline model that does include performance-based fund flows. LWY assume that new money inflows over incremental time interval (t, $t+\Delta t$), and show that dI_t, evolves as follows:

$$dI_t = i[dH_t - (g-\delta)H_t dt], \tag{A14}$$

where i denotes the sensitivity of dI_t with respect to the fund's instantaneous (gross) profits.

Now then the value of total fees $f(w)$ satisfies ODE (A9) subject to the following boundary conditions:

$$f(b) = 0, \tag{A15}$$

$$f(1) = \frac{(k+1)f'(1)-k}{1+i}, \tag{A16}$$

We choose i=0.8, because it is the value suggested by LWY and also in line with the magnitude of flow-performance sensitivity we obtain from the regression.[26] In general, taking a larger value for i leads to a larger $\pi(w)$ and therefore a larger $f(w)$, because the manager becomes less risk-averse when there are more rewards at the upside. Our implementation of the augmented LWY model mirrors that of the baseline LWY model described above.

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[25] The unlevered volatility (σ') is floored and capped at 2.8 percent and 8.4 percent, respectively, because the ODE (A9) cannot be solved when σ' takes an excessively small or large value.

[26] Empirically, i can be interpreted as the sensitivity of inflows to the fund's contemporaneous *gross* returns. However, we can only observe net-of–fees returns from the data. Consider a fund with $S_{t-1}=X_{t-1}$=100 at the beginning of year t. Suppose the fund earned gross returns of 15% over the year t so that S_t=115 at the end of the year (before fees and inflows). Then, with k=20% and c=1.5%, the manager collects 3=15×0.2 in incentive fees and 1.5=100×0.015 in management fees, leading to net-of-fee profits of 10.5. Meanwhile, with i=0.8, the new money inflow is 12=0.8×15. Therefore, the sensitivity of new money inflows to contemporaneous net-of-fee returns is about 1.1, which is of similar magnitude with the coefficient on contemporaneous returns we obtain in Table 2, Panel A.

A.2.5. Calculating indirect incentives

Indirect incentives have two components: future fees earned from the incremental inflows of new investment that follow incremental performance, and future fees earned on the increase in the value of existing investors' stakes that follows incremental performance. The latter component occurs both because the value of existing investors' stakes is higher and also because it moves closer to the applicable HWM.

For the first component, inflows of new investment, the PV of total fees for each dollar of new money coming into the fund, $f(w)_{new}$, can be computed using one of the four valuation models discussed above with w determined as follows:

$$w_{new} = \begin{cases} 1, & \text{if the fund has no hurdle rate} \\ \dfrac{1}{1+r}, & \text{if the fund has hurdle rate} \end{cases}, \tag{A17}$$

Indirect pay-performance coming from new money flows per 1% incremental return is calculated as $f(w)_{new}$ times the sum of regression coefficients on contemporaneous and lagged returns (with appropriate age or strategy interactions) given in Column (2) of the appropriate Panel of Table 2, times 1% of beginning-of-year AUM.

To compute indirect pay-performance from changes in the value of existing investors' stakes, when we use the GIR or augmented GIR model we take the following steps. First, we compute the *f(w)* fraction for each fund-year for *each* existing investor, $f(w_i)_{old}^{base}$, assuming that the fund earns a baseline return equal to the mean return earned by all funds of the same age and investment strategy. To obtain investor-specific w_i under the baseline return, we take each investor's w_i at the beginning of the year (calculated as described in Section A.1 above), multiply by (1+baseline return). Then if the result is less than one and the fund has a HWM provision, w_i is set to the result divided by (1+r); if the result is greater than one and the fund has a HWM, set w_i to $1/(1+r)$;[27] if the fund doesn't have a HWM, set w_i to one. We adjust w_i in this way because if the result is greater than one, then the option becomes in-the-money,

[27] As in A.1 we assume that a fund has a hurdle rate whenever it has a HWM provision.

incentive fees are paid, and the strike resets. We sum these individual investors' *f(w)* fractions over all investors in the fund as follows:

$$f(w)_{old}^{base} = \sum_i x_i f(w_i)_{old}^{base}, \quad where \quad x_i = \frac{S_i}{\sum_i S_i} \quad , \tag{A18}$$

We then redo these calculations for existing investors assuming that the fund earns an additional one-percentage-point return in addition to the baseline return ($f(w)_{old}^{base+1\%}$). Then we estimate the impact of an incremental 1% return on the manager's future pay due to the increase in the asset values of existing investors as the difference between $f(w)_{old}^{base+1\%}$ *×AUM×(1+baseline return+1%)* and $f(w)_{old}^{base}$ *×AUM×(1+baseline return)*.[28]

When we use the LWY or augmented LWY model to compute indirect pay-performance from changes in the value of existing investors' stakes, the calculations are the same as described in the previous two paragraphs with one exception. Because of computational issues involved in solving the ODE (A9) numerically, we instead use a single *w* per fund-year that is equal to the value-weight average *w* of all investors that year rather than fund-year-investor-specific *w* values. This involves only a small approximation given that the illustrations in LWY suggest that *f(w)* is approximately linear for a wide range of *w*.

Finally, indirect incentives per incremental one-dollar increase in fund returns are calculated for each fund-year by dividing indirect incentives per one-percentage-point increase in returns by 1% of beginning-of-year AUM.

A.3. An alternative flow measure

[28] Note that regression estimates are irrelevant for existing investors, since what is being considered here is the increase in asset base due to incremental performance itself, not due to capital inflows resulting from incremental performance.

The results presented in the text use the most common measure of flows in the literature, given by Equation (2). This measure expresses new money flows as a fraction of beginning-of-year AUM. An alternative is to scale this measure by one plus the current year return:

$$Flow_{i,t} = \frac{AUM_{i,t} - AUM_{i,t-1}(1+Return_{i,t})}{AUM_{i,t-1}(1+Return_{i,t})} \quad , \tag{A19}$$

This alternative measure expresses new money flows as a fraction of what end-of-year AUM would have been in the absence of flows. Table A2 shows that under this alternative measure flows are roughly 30% less sensitive to performance than shown in Panel A of Table 2. The coefficient on contemporaneous return, in particular, is diminished in part because contemporaneous return also appears in the denominator of the dependent variable.

Table A3 presents estimates of direct and indirect incentives using this alternative flow measure. The calculations are exactly the same as before except, when calculating indirect incentives from new money flow as described in Section A.2.5, we multiply the appropriate regression coefficients by what end-of-year AUM would have been in the absence of flows instead of by beginning-of-year AUM, to account for the change in denominator of the flow definition.

The results in Table A3 are generally 10%-15% lower than those in Table 4, but the conclusion that indirect incentives are substantial relative to direct incentives is unaffected.

Table A1. Summary of parameter choices

This table summarizes the parameters for the four models used to calculate indirect incentives.

Parameter	Baseline GIR	Augmented GIR	Baseline LWY	Augmented LWY
c	Fund specific	Fund specific	Fund specific	Fund specific
k	Fund specific	Fund specific	Fund specific	Fund specific
σ	Fund-year specific	Fund-year specific	Fund-year specific (unlevered σ=σ/2.13)	Fund-year specific (unlevered σ=σ/2.13)
α	0% , 3%	0% , 3%	0%, 3% (unlevered α=0% / 1.4%)	0%, 3% (unlevered α=0% / 1.4%)
$\delta+\lambda$	5% , 10%	5% , 10%	5% , 10%	5% , 10%
b	0.685 , 0.8	0.517 , 0.693	0.685 , 0.8	0.685 , 0.8
r	LIBOR	LIBOR	LIBOR	LIBOR
g	= LIBOR, if HWM = 0, if no HWM	= LIBOR, if HWM = 0, if no HWM	Equated to r	Equated to r
β	n/a	n/a	Equated to r	Equated to r
c'	0%	0%	n/a	n/a
$w(=S/X)$	Fund-year-investor specific	Fund-year-investor specific	Fund-year specific (weighted average of investor specific w_i)	Fund-year specific (weighted average of investor specific w_i)
i	n/a	n/a	n/a	0.8

Table A2. Flow-Performance Sensitivity, alternative flow measure

This table presents OLS estimates analogous to those in Panel A of Table 2 except using an alternative measure of flows defined in Equation (A19).

	(1)		(2)	
Dep.Var. = Annual flow$_t$, scaled by (1+Annual Return$_t$)	coef	(p-val)	coef	(p-val)
Annual Return(t)	0.657***	(0.000)	0.643***	(0.000)
Annual Return(t-1)	0.551***	(0.000)	0.642***	(0.000)
Annual Return(t-2)	0.112	(0.193)	0.221***	(0.003)
Annual Flow(t-1)			0.047***	(0.000)
Log(Age in years +1)			-0.123**	(0.012)
Log(AUM(t-1)+1)			-0.191***	(0.000)
Annual return volatility			-1.276***	(0.000)
Management fee			1.093	(0.735)
Incentive fee			-0.016	(0.976)
High-water mark?			0.125***	(0.003)
Leveraged?			0.039	(0.236)
Open-to-public?			-0.007	(0.860)
Oh-shore?			-0.238***	(0.000)
Log(Total redemption period in years +1)			0.358***	(0.004)
Log(Lock-up period in years +1)			-0.035	(0.551)
Log(Subscription period in years +1)			-0.341	(0.258)
Missing Annual Return(t-1)	1.108***	(0.000)	0.878***	(0.000)
Missing Annual Return(t-2)	0.452***	(0.000)	0.124*	(0.077)
Missing Annual Flow(t-1)			0.148*	(0.073)
Fixed effects				
Style	Yes		Yes	
Year	Yes		Yes	
Style×Year	Yes		Yes	
Number of observations	10,811		10,811	
Adjusted R^2	0.147		0.188	

Table A3. Direct and indirect pay-for-performance, alternative flow measure

This table presents estimates of direct and indirect incentives analogous to Table 4, using the alternative flow measure defined in Equation (A19).

		b=0.685				b=0.8			
		α=0%		α=3%		α=0%		α=3%	
		δ+λ=5%	δ+λ=10%	δ+λ=5%	δ+λ=10%	δ+λ=5%	δ+λ=10%	δ+λ=5%	δ+λ=10%
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: Direct incentives								
	<u>Per 1% Change in Fund Value ($M)</u>								
(1)	Direct effect from incentive fees	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195
(2)	Direct effect from managers' personal stake	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183
(3)	**Total direct effect**	**0.378**	**0.378**	**0.378**	**0.378**	**0.378**	**0.378**	**0.378**	**0.378**
	<u>Per 1$ Change in Fund Value ($)</u>								
(4)	Direct effect from incentive fees	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
(5)	Direct effect from managers' personal stake	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082
(6)	**Total direct effect**	**0.166**	**0.166**	**0.166**	**0.166**	**0.166**	**0.166**	**0.166**	**0.166**
	Panel B: Indirect incentives estimated from the GIR model								
	<u>Per 1% Change in Fund Value ($M)</u>								
(1)	Indirect effect from new money	0.579	0.418	1.327	0.688	0.383	0.298	0.976	0.539
(2)	Indirect effect from change in value of existing assets	0.408	0.293	0.888	0.471	0.291	0.227	0.699	0.396
(3)	**Total indirect effect**	**0.987**	**0.712**	**2.215**	**1.159**	**0.674**	**0.524**	**1.676**	**0.934**
(4)	**Indirect/Direct**	**2.61**	**1.88**	**5.87**	**3.07**	**1.78**	**1.39**	**4.44**	**2.47**
	<u>Per 1$ Change in Fund Value ($)</u>								
(5)	Indirect effect from new money	0.246	0.180	0.528	0.286	0.161	0.126	0.379	0.215
(6)	Indirect effect from change in value of existing assets	0.160	0.116	0.335	0.183	0.111	0.086	0.261	0.148
(7)	**Total indirect effect**	**0.406**	**0.297**	**0.863**	**0.468**	**0.272**	**0.212**	**0.640**	**0.363**
(8)	**Indirect/Direct**	**2.45**	**1.79**	**5.21**	**2.83**	**1.64**	**1.28**	**3.86**	**2.19**

	Panel C: Indirect incentives estimated from the GIR model augmented for performance-based flows								
	Per 1% Change in Fund Value ($M)								
(1)	Indirect effect from new money	0.741	0.520	1.450	0.776	0.495	0.380	1.030	0.596
(2)	Indirect effect from change in value of existing assets	0.492	0.347	0.937	0.511	0.350	0.269	0.690	0.410
(3)	**Total indirect effect**	**1.233**	**0.867**	**2.386**	**1.287**	**0.845**	**0.649**	**1.720**	**1.006**
(4)	**Indirect/Direct**	**3.26**	**2.30**	**6.32**	**3.41**	**2.24**	**1.72**	**4.55**	**2.66**
	Per 1$ Change in Fund Value ($)								
(5)	Indirect effect from new money	0.318	0.230	0.590	0.332	0.208	0.162	0.405	0.243
(6)	Indirect effect from change in value of existing assets	0.200	0.145	0.367	0.208	0.136	0.106	0.258	0.157
(7)	**Total indirect effect**	**0.519**	**0.375**	**0.956**	**0.540**	**0.343**	**0.267**	**0.664**	**0.400**
(8)	**Indirect/Direct**	**3.13**	**2.26**	**5.77**	**3.26**	**2.07**	**1.61**	**4.01**	**2.41**
	Panel D: Indirect incentives estimated from the LWY model								
	Per 1% Change in Fund Value ($M)								
(1)	Indirect effect from new money	0.653	0.440	1.689	0.864	0.481	0.365	1.035	0.552
(2)	Indirect effect from change in value of existing assets	0.490	0.326	1.226	0.632	0.377	0.281	0.806	0.425
(3)	**Total indirect effect**	**1.143**	**0.767**	**2.915**	**1.496**	**0.858**	**0.646**	**1.842**	**0.977**
(4)	**Indirect/Direct**	**3.03**	**2.03**	**7.72**	**3.96**	**2.27**	**1.71**	**4.88**	**2.59**
	Per 1$ Change in Fund Value ($)								
(5)	Indirect effect from new money	0.281	0.188	0.647	0.347	0.209	0.157	0.383	0.217
(6)	Indirect effect from change in value of existing assets	0.186	0.124	0.437	0.231	0.141	0.106	0.278	0.151
(7)	**Total indirect effect**	**0.467**	**0.311**	**1.084**	**0.578**	**0.350**	**0.263**	**0.661**	**0.368**
(8)	**Indirect/Direct**	**2.82**	**1.88**	**6.54**	**3.49**	**2.11**	**1.59**	**3.99**	**2.22**
	Panel E: Indirect incentives estimated from the LWY model augmented for performance-based fund flows								
	Per 1% Change in Fund Value ($M)								
(1)	Indirect effect from new money	0.653	0.440	2.484	1.330	0.481	0.365	1.170	0.624
(2)	Indirect effect from change in value of existing assets	0.490	0.326	1.780	0.981	0.379	0.283	0.929	0.487
(3)	**Total indirect effect**	**1.143**	**0.766**	**4.264**	**2.311**	**0.860**	**0.648**	**2.099**	**1.111**
(4)	**Indirect/Direct**	**3.03**	**2.03**	**11.29**	**6.12**	**2.28**	**1.72**	**5.56**	**2.94**
	Per 1$ Change in Fund Value ($)								
(5)	Indirect effect from new money	0.281	0.188	0.987	0.527	0.208	0.157	0.449	0.252
(6)	Indirect effect from change in value of existing assets	0.186	0.124	0.661	0.355	0.141	0.106	0.323	0.175
(7)	**Total indirect effect**	**0.467**	**0.312**	**1.648**	**0.882**	**0.350**	**0.263**	**0.772**	**0.426**
(8)	**Indirect/Direct**	**2.82**	**1.88**	**9.95**	**5.33**	**2.11**	**1.59**	**4.66**	**2.57**