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Indirect Incentives of Hedge Fund Managers

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ABSTRACT

Indirect incentives exist in the money management industry when good current performance increases future inflows of capital, leading to higher future fees. For the average hedge fund, indirect incentives are at least 1.4 times as large as direct incentives from incentive fees and managers' personal stakes in the fund. Combining direct and indirect incentives, manager wealth increases by at least \$0.39 for a \$1 increase in investor wealth. Younger and more scalable hedge funds have stronger flow-performance relations, leading to stronger indirect incentives. These results have a number of implications for our understanding of incentives in the asset management industry.

HEDGE FUND MANAGERS ARE AMONG the most highly paid individuals today. Kaplan and Rauh (2010) estimate that, in 2007, the top five hedge fund managers earned more than all S&P 500 firms' CEOs combined. The payoff to becoming a top hedge fund manager is therefore enormous. The logic of Holmstrom (1982), Berk and Green (2004), and Chung et al. (2012) provides a framework for understanding hedge fund managers' careers. Investors allocate capital to funds based on their perception of managers' abilities, which is a function of fund performance. Good performance increases a manager's lifetime income directly, through contractual incentive fees earned at the time of performance. It also increases a manager's lifetime income indirectly, through higher future fees both from increased flows of new investment to the fund and from the mechanical increase in the fund's asset base. The extremely high level of pay for top hedge fund managers thus suggests that indirect incentives are likely to be a significant component of managers' total incentives, particularly early in a manager's career.

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In this paper, we estimate the magnitude of these indirect incentives of hedge fund managers. In particular, we address the following questions. For an incremental percentage point of returns to investors, how much additional capital does the market allocate to that 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 incentive fees that hedge fund managers earn from the incremental returns? How do these effects differ across types of funds, and over time for a particular fund? And what are the implications of the existence of such indirect incentives for hedge fund investors and for our understanding of contracting more broadly?

We first estimate the relation between hedge fund performance and inflows to the fund using a sample of 2,998 hedge funds from 1995 to 2010. 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 the average fund, the estimates imply that a one-percentage-point incremental return in a given quarter leads to a 1.5% increase in the fund's assets under management (AUM) from inflows of new investment over the next three years. For a new fund, the same incremental return results in a 2.1% increase in AUM from inflows. In addition, performance has a greater impact on flows for funds engaged in more scalable strategies. These results are consistent with the view that investors continually update their assessment of managers and adjust 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 1.5% of AUM, together with incentive fees equal to 20% of profits above a high-water mark (HWM). Good performance increases managers' future income because fees will be earned on inflows of new investment, and also because the asset value of existing investors becomes larger and closer to the HWM. Valuing a manager's compensation requires a contingent claims modeling framework to account for the fact that incentive fees are effectively a portfolio of call options on the fund's assets. We use four such models, which allows us to evaluate the sensitivity of the estimates to different modeling frameworks and parameter choices.

The first model that we use is the model 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 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 GIR estimates therefore provide a lower bound on the magnitude of the indirect incentives faced by hedge fund managers.

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. Finally, we present estimates using an extension of the LWY model that allows for performance-based flows as well as endogenous leverage. LWY nests GIR, which assumes no leverage at any time, as a special case so all of our estimates can be thought of as implications of different versions of the LWY model.

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. For an incremental percentage point or dollar of current returns to the fund's investors, 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 the 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 that managers receive from incentive fees and changes in the value of their own investment in the fund. We use the Agarwal, Daniel, and Naik (2009) 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 increase in returns generates, on average, \$331,000 in expected direct incentive pay, consisting of \$142,000 in incremental incentive fees and \$190,000 in incremental profits on managers' personal stakes. Using the GIR model with parameter choices that yield lower-bound estimates, we calculate that managers also receive \$531,000 in expected future fee income, consisting of \$248,000 in future fees earned on the new investment that occurs in response to the incremental performance and \$282,000 in extra future fees earned on the increase in the value of existing investors' assets in the fund. Because a one-percentage-point increase in return is equal to \$2.11 million for an average-sized fund in our data, these calculations imply that on average managers receive 16 cents in direct pay and at least 23 cents in indirect pay for each incremental dollar earned for fund investors. The indirect, career-based incentive effect is thus at least 1.4 times larger than the direct income that managers receive from incentive fees and returns on their personal investments. Again, this indirect-to-direct incentive ratio of 1.4 corresponds to model and parameter choices that lead to a lower bound of estimates of indirect incentives. Under other plausible choices, the ratio would be substantially higher. The average indirect-to-direct incentive ratio is 3.5 across all the models and parameter values we consider.

We next find that indirect incentives are even larger for young funds. For new funds, we estimate indirect incentives to be six to 12 times as large as direct incentives given the parameters used in LWY. The importance of indirect incentives declines monotonically as a fund ages, largely as a consequence of weakening flow-performance relations, but continues to be larger than direct incentives until the fund is at least 15 years old. 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 3.2 to 7.3 times as large as direct incentives, while they are 2.5 to 6.0 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 direct incentives alone would imply. Although direct incentives are themselves substantial, indirect incentives in the hedge fund industry comprise the majority of managers' total incentives.

These estimates of substantial indirect incentives in the hedge fund industry have a number of implications. First, they are potentially important for understanding hedge fund contracting. Hedge fund management contracts are structured in a sophisticated manner, yet, perhaps surprisingly, we find no evidence that direct compensation schemes adjust with the indirect incentives that their managers face. The lack of such adjustment reflects a larger puzzle in our understanding of markets for alternative assets, in that important contractual parameters, most notably the 20% incentive fee, vary little both across asset classes and across funds within asset classes.

Second, institutional investors often state that the financial incentives of a potential asset manager are an important consideration when deciding between alternative managers. Presumably, all of a manager's incentives, including both direct and indirect incentives, matter in making this choice. The results discussed above provide estimates of how indirect and total incentives vary across types of funds and across similar funds of different ages, which should be relevant for potential investors. In addition, indirect incentives vary systematically across types of potential investments. The results here and in Chung et al. (2012) provide estimates of indirect and total incentives for hedge funds and private equity funds. Below, we also provide estimates of indirect incentives for a sample of 11,911 actively managed equity mutual funds over the period 1995 to 2010. These estimates suggest that indirect incentives in mutual funds are substantial, but smaller than those for hedge funds, ranging between 28% and 66% of the hedge fund estimates.

Finally, since Fama (1980) and Holmstrom (1982), incentives generated from managerial career concerns have been an important part of the theory of the firm. However, there are virtually no estimates of their magnitude. The estimates provided here for hedge fund managers are among the first attempts to measure the importance of indirect incentives. The fact that career-generated incentives are so powerful in this industry suggests that they could be equally important in other industries in which they are likely to be harder to estimate.

This paper proceeds as follows. Section I discusses how we quantify the direct and indirect components of hedge fund pay for performance. Section II describes the data. Section III presents estimates of the flow-performance relation. Section IV estimates managers' direct and indirect incentives. Section V discusses implications of our estimates. Section VI concludes.

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

A. Direct Pay for Performance

Hedge fund managers' compensation generally consists of management fees, which are a percentage of AUM (often around 1.5%), 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 in the fund. The direct pay for performance that a manager receives comes from the incentive fees as well as 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 the investor's time of entrance into the fund, the fund's hurdle rate, and the historical HWM level pertaining to the investor's assets. Thus, even if different managers have the same 20% incentive fee rate, their actual direct pay-performance sensitivity 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, Daniel, and Noik's (2009) 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, Daniel, and Naik's (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.[1] Details of this calculation are described in Appendix A.

B. 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 income changes with performance through a reputational effect: good performance increases the market's perception of a manager's ability, leading to higher inflows of new investment to the fund. Ultimately, a fund's managers will receive part of

[1] Assuming instead that the manager's initial stake is 1% or 2% of AUM increases the estimates of indirect incentives by 5% and 10%, respectively, and the estimates of direct incentives by 2% and 5%, respectively. These changes do not affect our conclusion that indirect incentives are large relative to direct incentives.

these inflows as future management and incentive fees. Furthermore, 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 depends on today's performance, leading to what we refer to as indirect incentives.

To evaluate the magnitude of these indirect incentives, we first need estimates of the way in which performance affects expected inflows to the fund. These estimates are discussed in Section III below. We also need a model of the present value of a 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.

The first model is that of GIR. The GIR model leads to the lowest estimates of the sensitivity of future income to today's performance, so it can be thought of as providing a lower bound on our estimates of indirect incentives. The GIR model is a contingent-claims model of the fraction of fund assets that accrue to the fund manager in expected future compensation. Key features of this model 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).

The GIR model does not account for all factors that could affect managers' future compensation and in turn indirect incentives. In particular, the GIR model does not allow the fund's asset value to grow through future performance-based fund flows. 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.[2] For this reason, our second model reports estimates from a variant of the GIR model in which fund variance is augmented.

Another factor not accounted for by the GIR model is the fact that a fund's portfolio is endogenously chosen, with managers adjusting their portfolios to maximize their incomes given a particular incentive scheme. Following LWY, our third model allows managers to perform such adjustments by levering their funds strategically. Given that hedge fund managers typically do use leverage, estimates of indirect incentives that incorporate this feature are likely to be more accurate.

Finally, we present estimates from a fourth model, also introduced by LWY, that augments the basic LWY model to include future performance-based fund flows. Note also that the LWY model nests the GIR model as a special case in

[2] 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 evolves as a martingale as in the GIR model, $s_{t+1} = s_t + e_{t+1}$. With performance-based flows, $s_{t+1} = s_t + ge_{t+1}$, 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.

which leverage is zero, so all four sets of estimates can be viewed as coming from variations of the LWY model.

Using different models to estimate indirect incentives allows us to gauge the importance of different factors, especially the importance of future performance-based fund flows and endogenous portfolio choice, in determining the fraction of a fund's value that will ultimately accrue to managers in future fees.[3] Details on all four models, our choices of model parameters, and the associated calculations are described in Appendix B.

For each of the models above, we 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 incremental dollars of AUM that result from a one-percentage-point increase in returns to investors. The latter increase consists of two parts, namely, 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 together with our estimates of the flow-performance relation facing hedge fund managers provide an estimate of the present value of the incremental future revenue that the hedge fund manager expects to earn as a result of a one-percentage-point improvement in current net returns.[4] This calculation results in an incentive measure denominated in dollars per percentage point change in returns. We also conduct the same calculation for a one-dollar improvement in investor return to obtain a measure in terms of dollars in managerial wealth per dollar returned to shareholders. Both of these measures are commonly used in the literature on manager incentives.

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.

II. Hedge Fund Data

Our data come from the TASS database, which covers about 40% of the hedge fund universe (Agarwal, Daniel, and Naik (2009)). Summary statistics for key sample fund characteristics, reported in Table I, are very close to those for the sample considered by Agarwal, Daniel, and Naik (2009), who merge and consolidate four major databases (CISDM, HFR, MSCI, and TASS). We therefore conclude that our sample of hedge funds is representative of the hedge fund universe.

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

[4] Net returns can be improved either through increased gross returns or decreased 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.

Table I

Summary Statistics

This table presents descriptive statistics for the sample of 2,998 funds during the 1995 to 2010 sample period. Time-varying variables are reported at the fund-quarter level, and other time-invariant contractual characteristics are reported at the fund level. *Quarterly flow* is the difference between the reported quarter-end *AUM* and the quarter-beginning *AUM* times (1 + *Quarterly returns*), scaled by quarter-beginning *AUM*. *Quarterly returns* are the reported quarterly net-of-fee returns. *AUM* is assets under management in millions, measured at the end of each quarter. *Age* is the number of quarters from the fund's inception date, measured at the beginning of each quarter. *Volatility* is the standard deviation of monthly (net-of-fee) returns over the 12 months prior to each quarter, multiplied by the square root of three to arrive at a quarterly figure. All time-varying variables except *Age* are winsorized at the 1st and 99th percentiles. *Management fees* are the percentage of the assets charged by the fund as regular fees in annual terms. *Incentive fees* are the percentage of positive profits received by the manager as performance incentives. *HWM* is an indicator variable that equals one if the fund has a HWM 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 United States, and zero otherwise. *Total redemption period* is the sum of the notice period and the redemption period, measured in quarters, 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 quarters that an investor has to wait before withdrawing invested money. *Lockup period* is considered to be zero for a fund that has no lock-up provision. *Subscription period* is the time delay, measured in quarters, 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*
Quarterly flow (%)	50,333	7.98	−4.13	0.34	10.14	37.01
Quarterly returns (%)	50,333	2.56	−0.91	2.11	5.66	9.05
AUM ($ million)	50,333	210.8	11.0	39.3	130.0	637.0
Age (quarters)	50,333	17.56	6.09	13.19	24.34	15.32
Volatility (%)	50,333	5.33	3.00	4.41	8.04	2.43
Management fees (%, annualized)	2,998	1.5	1.0	1.5	2.0	0.5
Incentive fees (%)	2,998	19.3	20.0	20.0	20.0	3.4
HWM	2,998	0.694	0.000	1.000	1.000	0.461
Leverage	2,998	0.685	0.000	1.000	1.000	0.464
Open-to-public	2,998	0.191	0.000	0.000	0.000	0.394
On-shore	2,998	0.230	0.000	0.000	0.000	0.421
Total redemption period (quarters)	2,998	1.085	0.556	0.667	1.333	1.015
Lockup period (quarters)	2,998	0.974	0.000	0.000	0.000	2.077
Subscription period (quarters)	2,998	0.356	0.333	0.333	0.333	0.190
Style						
Constrained	2,998	0.303	0.000	0.000	1.000	0.460
Constrained = 1						
Convertible Arbitrage	2,998	0.034				
Emerging Markets	2,998	0.120				
Event Driven	2,998	0.096				
Fixed Income Arbitrage	2,998	0.052				
Constrained = 0						
Equity Market Neutral	2,998	0.073				
Global Macro	2,998	0.078				
Long/Short Equity Hedge	2,998	0.420				
Multi-Strategy	2,998	0.077				
Other	2,998	0.049				

Our sample period is from January 1995 to December 2010. We focus on the post-1994 period because TASS started reporting information on "defunct" funds only after 1994.[5] We exclude managed futures/CTAs and funds-of-funds, which have different incentive fees and are likely to have different inflow-performance relations from typical individual hedge funds. We also exclude closed-end hedge funds, as subscriptions in these funds are only possible during the initial issuing period so future flows are not possible. This initial filter leaves us with 4,939 open-end hedge funds.[6]

We drop funds for which TASS does not contain information on organizational characteristics such as management fees, incentive fees, and HWM provisions. In addition, we consider only 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, because there can be no direct pay for performance for these funds.

We conduct the analysis using quarterly data because we wish to include only lagged (not contemporaneous) returns in the flow-performance specifications and to have a relatively short gap between returns and flows.[7] To construct a quarterly sample, we drop all fund-calendar quarters that have return information only for a fraction of the period. We also require that a sample fund have a subscription period less than or equal to three months, so that quarterly inflows are not restricted. This sample construction process leaves us with a sample of 2,998 funds (50,333 fund-quarter observations).

Table I presents descriptive statistics. Time-varying variables such as *Quarterly flow* and *Quarterly returns* are measured at the fund-quarter level, and other contractual characteristics such as *Management fees* and *Incentive fees* are measured at the fund level.[8] All time-varying variables except fund age (*Age*) are winsorized at the 1^{st} and 99^{th} percentiles to minimize the effect of outliers.

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

[6] 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 relation for funds that are not closed.

[7] Prior versions of this paper presented estimates using annual data with contemporaneous annual returns included in the flow-performance specifications (Lim, Sensoy, and Weisbach (2013)). The estimates of indirect incentives using annual data are very close to those reported here.

[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, Daniel, and Naik (2009) argue that funds' organizational characteristics are unlikely to change much over time based on their discussions with practitioners, which suggests 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.

Mean *Quarterly flow* is 8.0%, with a median of 0.3%, so the distribution is highly skewed. Mean *Quarterly returns* is 2.6%; the median is 2.1%. Average fund size (*AUM*) is $210.8 million. The remaining variables reflect time-invariant contractual features. Summary statistics on these characteristics are very close to those reported in prior studies (e.g., Agarwal, Daniel, and Naik (2009), Baquero and Verbeek (2009), Aragon and Nanda (2012)). The variable *Management fees* is the annual percentage of fund assets (*AUM*) received by the manager as compensation and has a sample mean (median) of 1.5% (1.5%). The variable *Incentive fees* is the percentage of profits above the HWM received by the manager as compensation and has a sample mean (median) of 19.3% (20%). Over two-thirds of our sample funds, 69.4%, have a HWM provision, 68.5% report that they use leverage, 19.1% 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 three reasons. First, funds sometimes provide fee reductions to particular strategic investors that are not reflected in the database (Ramadorai and Streatfield (2011)). Although we cannot investigate this possibility directly, it is unlikely to have a major impact on our conclusions. For example, if the true incentive fee (management fee) averaged over all investors were 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) find that fee changes are infrequent and tend to reflect past performance when they do occur, so that fee increases follow good performance and fee decreases follow poor performance. This effect is magnified in indirect incentives, because good performance today leads not only to inflows, but also to higher proportional fees on those inflows. Third, it is possible that there are fee changes unobservable to researchers. To the extent that observable and unobservable fee changes are positively correlated, this possibility leads us to understate indirect incentives.

We consider three variables that reflect potential restrictions on the behavior of flows. First, we use *Total redemption period*, defined as the sum of the notice period and the redemption period, 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. The *Lockup period* is the minimum time that an investor has to wait before withdrawing invested money. The *Subscription period* is the time delay between investing in a fund and actually purchasing fund shares. The mean total redemption period, lock-up period, and subscription period are 1.09, 0.97, and 0.36 quarters, respectively.

III. 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 investors are continually evaluating managers trying to assess their abilities (see Berk and Green (2004), Chung et al. (2012)). A fund's performance provides information about the manager's ability, so an observation of performance will lead investors to update their assessment of his ability and allocate more capital to a fund if their estimate of the manager's ability increases. 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. 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. A long literature beginning with Ippolito (1992) estimates this relation to be relatively strong in the mutual fund industry.[9] It is also positive in the private equity industry (see, e.g., Kaplan and Schoar (2005)). However, the results for hedge funds are less clear. Goetzmann, Ingersoll, and Ross (2003) report a negative and concave relation, whereas other studies, including Agarwal, Daniel, and Naik (2003), Fung et al. (2008), Baquero and Verbeek (2009), and Ding et al. (2009), find a positive one.

A. Empirical Specification

We estimate the following specification:

$$Flow_{i,t} = \beta_0 + \sum_{j=1}^{11} \beta_{0+j}\, Return_{i,t-j} + \gamma X_{t-1} + \lambda Y + Fixed\, effects + \varepsilon_{i,t}, \qquad (1)$$

where $Flow_{i,t}$ represents flows for fund i in quarter t.[10]

Following the literature on flows to mutual funds (e.g., Sirri and Tufano (1998), Chevalier and Ellison (1999)) or hedge funds (e.g., Fung et al. (2008), Agarwal, Daniel, and Naik (2009)), we compute quarterly flows of capital into a fund as follows:

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

where $AUM_{i,t}$ and $AUM_{i,t-1}$ are the AUM of fund i at the end of quarters t and $t-1$, respectively, and $Return_{i,t}$ is the net-of-fee return for fund i in quarter t.

[9] See Brown, Halow, 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).

[10] We restrict our estimates to quarterly specifications, but prior versions of this paper also include annual and monthly specifications, with similar results to those reported below.

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, 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 one plus fund i's age in quarters at $t-1$, and fund volatility over the previous 12 months.[11] The vector Y includes time-invariant fund characteristics that include *Management fees*, *Incentive fees*, *Total redemption period*, *Lockup period*, *Subscription period*, and a set of indicator variables that equal one if the fund has an HWM provision, uses leverage, is open to public investors, and is an on-shore fund. All specifications include fixed effects for the nine styles listed in Table I interacted with calendar quarter fixed effects. These time-by-style effects capture all shocks, observed or unobserved, that are common to funds of a given style in a given quarter, including the returns to peer funds and inflows to other funds of the same style.[12] Reported standard errors are robust to heteroskedasticity and account for double clustering by fund and time period.[13]

B. Estimates of the Flow-Performance Relation

We present estimates of the flow-performance relation in Panel A of Table II. In Column (1), we include returns in the 11 quarters prior to the current quarter. In Column (2), we add a number of fund-level controls. In each specification, the coefficients on returns are positive and statistically significant in most cases, and decline sharply over time, so the coefficient on the most recent quarter's return is the largest. If we sum the coefficients on the 11 prior quarters, the sum in Column (1) is 1.44 and in Column (2) is 1.50. These coefficients imply that a one-standard-deviation increase in returns (9%) will lead to about a 13% increase in fund size.

[11] 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, we "dummy out" missing lagged variables to retain observations. To do so, we set missing values of lagged flows and returns to zero and include an indicator for missing values.

[12] 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.

[13] We focus on linear specifications. Although there is some evidence of nonlinear effects in the data (using splines, quadratics, etc.), they are small in magnitude and have little impact on the estimates obtained with linear specifications.

Table II

Estimates of Flow-Performance Sensitivity

This table presents the OLS coefficient estimates of equation (1) and corresponding standard errors (in parentheses) using quarterly data. The dependent variable is *Quarterly flow*, as defined by equation (2). See Table I for definitions of all independent variables. The sample period is from 1995 to 2010. We only employ the funds with a subscription period less than or equal to three months to avoid quarterly inflows being restricted by subscription periods. Equation (1) is augmented in Panel B to include interaction terms of the log of the fund's age plus one with prior performance, and in Panel C to include interaction terms of *Constrained* with performance variables. All specifications in Panel A and B include style fixed effects, quarter fixed effects, and quarter-by-style fixed effects. Only quarter fixed effects are included in Panel C due to multicollinearity. Standard errors are double clustered by fund and year. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)		(2)	
Dependent var. = Quarterly flow(t)	Coef.	(SE)	Coef.	(SE)
Panel A: Base-case				
Quarterly returns($t-1$)	0.501***	(0.045)	0.496***	(0.043)
Quarterly returns($t-2$)	0.314***	(0.039)	0.263***	(0.036)
Quarterly returns($t-3$)	0.209***	(0.034)	0.190***	(0.028)
Quarterly returns($t-4$)	0.117***	(0.035)	0.111***	(0.030)
Quarterly returns($t-5$)	0.089***	(0.030)	0.098***	(0.027)
Quarterly returns($t-6$)	0.054*	(0.033)	0.066**	(0.030)
Quarterly returns($t-7$)	0.083***	(0.027)	0.103***	(0.025)
Quarterly returns($t-8$)	0.044**	(0.022)	0.060***	(0.022)
Quarterly returns($t-9$)	0.012	(0.029)	0.034	(0.029)
Quarterly returns($t-10$)	−0.010	(0.030)	0.019	(0.029)
Quarterly returns($t-11$)	0.025	(0.027)	0.056**	(0.026)
Quarterly flow($t-1$)			0.158***	(0.008)
Log(Age + 1)			−0.004	(0.005)
Log(AUM($t-1$)+1)			−0.024***	(0.001)
Volatility			−0.141***	(0.037)
Management fees			0.211	(0.386)
Incentive fees			0.005	(0.053)
HWM indicator			0.020***	(0.004)
Leveraged indicator			0.000	(0.004)
Open-to-public indicator			−0.002	(0.005)
On-shore indicator			−0.032***	(0.005)
Log(Total redemption period +1)			0.034***	(0.007)
Log(Lock-up period +1)			−0.005*	(0.003)
Log(Subscription period +1)			−0.023	(0.015)
Indicators for missing lagged returns	Yes		Yes	
Fixed effects				
Style	Yes		Yes	
Quarter	Yes		Yes	
Style × Quarter	Yes		Yes	
Number of observations	50,333		50,333	
Adjusted R^2	0.162		0.194	
F-test for joint significance of	F-stat.	(p-value)	F-stat.	(p-value)
All lagged returns	19.40***	(0.000)	20.77***	(0.000)

(*Continued*)

Table II—*Continued*

	(1)		(2)	
Dependent var. = Quarterly flow(t)	Coef.	(*SE*)	Coef.	(*SE*)
Panel B: Age interactions				
Quarterly returns($t-1$)×Log(Age in quarters+1)	−0.319***	(0.035)	−0.285***	(0.034)
Quarterly returns($t-2$)×Log(Age in quarters+1)	−0.171***	(0.027)	−0.125***	(0.025)
Quarterly returns($t-3$)×Log(Age in quarters+1)	−0.051	(0.036)	−0.033	(0.036)
Quarterly returns($t-4$)×Log(Age in quarters+1)	−0.003	(0.032)	0.001	(0.032)
Quarterly returns($t-5$)×Log(Age in quarters+1)	−0.041	(0.030)	−0.042	(0.029)
Quarterly returns($t-6$)×Log(Age in quarters+1)	0.038	(0.033)	0.040	(0.031)
Quarterly returns($t-7$)×Log(Age in quarters+1)	0.013	(0.033)	0.007	(0.032)
Quarterly returns($t-8$)×Log(Age in quarters+1)	0.033	(0.033)	0.034	(0.033)
Quarterly returns($t-9$)×Log(Age in quarters+1)	0.003	(0.040)	−0.004	(0.040)
Quarterly returns($t-10$)×Log(Age in quarters+1)	0.132***	(0.038)	0.133***	(0.035)
Quarterly returns($t-11$)×Log(Age in quarters+1)	0.018	(0.040)	0.007	(0.041)
Quarterly returns($t-1$)	1.325***	(0.117)	1.233***	(0.113)
Quarterly returns($t-2$)	0.773***	(0.095)	0.602***	(0.087)
Quarterly returns($t-3$)	0.354***	(0.114)	0.287***	(0.110)
Quarterly returns($t-4$)	0.124	(0.112)	0.110	(0.106)
Quarterly returns($t-5$)	0.200**	(0.100)	0.215**	(0.092)
Quarterly returns($t-6$)	−0.067	(0.112)	−0.056	(0.104)
Quarterly returns($t-7$)	0.033	(0.106)	0.079	(0.099)
Quarterly returns($t-8$)	−0.066	(0.107)	−0.046	(0.107)
Quarterly returns($t-9$)	0.004	(0.128)	0.053	(0.127)
Quarterly returns($t-10$)	−0.416***	(0.122)	−0.383***	(0.114)
Quarterly returns($t-11$)	−0.038	(0.126)	0.037	(0.130)
Log(Age + 1)	−0.026***	(0.007)	−0.000	(0.006)
Indicators for missing lagged returns	Yes		Yes	
Other controls	No		Yes	
Fixed effects				
Style	Yes		Yes	
Quarter	Yes		Yes	
Style × Quarter	Yes		Yes	
Number of observations	50,333		50,333	
Adjusted R^2	0.168		0.198	
F-test for joint significance of	F-stat.	(p-value)	F-stat.	(p-value)
All lagged returns	17.88***	(0.000)	15.70***	(0.000)
All age interaction terms	12.14***	(0.000)	10.84***	(0.000)
Panel C: Scalability interactions				
Quarterly returns($t-1$)×Constrained	−0.215***	(0.048)	−0.215***	(0.047)
Quarterly returns($t-2$)×Constrained	−0.096**	(0.043)	−0.078**	(0.039)
Quarterly returns($t-3$)×Constrained	−0.102***	(0.038)	−0.107***	(0.037)
Quarterly returns($t-4$)×Constrained	0.013	(0.034)	0.013	(0.036)
Quarterly returns($t-5$)×Constrained	−0.009	(0.032)	−0.022	(0.032)
Quarterly returns($t-6$)×Constrained	0.026	(0.034)	0.013	(0.034)
Quarterly returns($t-7$)×Constrained	−0.044	(0.036)	−0.057	(0.036)
Quarterly returns($t-8$)×Constrained	0.032	(0.037)	0.033	(0.036)
Quarterly returns($t-9$)×Constrained	−0.085***	(0.030)	−0.090***	(0.031)
Quarterly returns($t-10$)×Constrained	−0.023	(0.036)	−0.007	(0.036)
Quarterly returns($t-11$)×Constrained	−0.007	(0.037)	−0.004	(0.038)

(*Continued*)

Table II—*Continued*

Panel C: Scalability interactions

	(1)		(2)	
Dependent var. = Quarterly flow(t)	Coef.	(*SE*)	Coef.	(*SE*)
Quarterly returns($t-1$)	0.559***	(0.049)	0.554***	(0.046)
Quarterly returns($t-2$)	0.346***	(0.045)	0.291***	(0.040)
Quarterly returns($t-3$)	0.241***	(0.039)	0.224***	(0.032)
Quarterly returns($t-4$)	0.099***	(0.037)	0.095***	(0.034)
Quarterly returns($t-5$)	0.077**	(0.034)	0.094***	(0.030)
Quarterly returns($t-6$)	0.042	(0.040)	0.062*	(0.036)
Quarterly returns($t-7$)	0.101***	(0.032)	0.126***	(0.030)
Quarterly returns($t-8$)	0.034	(0.026)	0.049*	(0.026)
Quarterly returns($t-9$)	0.034	(0.033)	0.060*	(0.033)
Quarterly returns($t-10$)	−0.002	(0.035)	0.028	(0.033)
Quarterly returns($t-11$)	0.015	(0.032)	0.050	(0.031)
Constrained indicator	0.012*	(0.007)	0.010*	(0.006)
Indicators for missing lagged returns	Yes		Yes	
Other controls	No		Yes	
Fixed effects				
Quarter	Yes		Yes	
Number of observations	50,333		50,333	
Adjusted R^2	0.156		0.189	
F-test for joint significance of	F-stat.	(p-value)	F-stat.	(p-value)
All lagged returns	19.80***	(0.000)	20.65***	(0.000)
All scalability interaction terms	4.76***	(0.000)	4.24***	(0.000)

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 her 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."

To evaluate these implications, we estimate the extent to which the sensitivity of inflows to performance depends on the fund's age. To do so, we estimate equation (1), including interaction terms of prior performance plus the log of one plus the fund's age, and present these estimates in Panel B of Table II. In each estimated equation, the sum of the interaction coefficients is negative and the coefficients are jointly statistically significant, with a majority of the effect arising from the two quarters immediately preceding the focal quarter. The negative coefficients on the interaction terms mean that, as hedge funds get older, the effect of performance on inflows declines.

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 (Aragon (2007), Teo (2009), Getmansky (2012)). However, strategies that involve liquid instruments (e.g., Long/Short Equity, Equity Market Neutral) are less prone to capacity constraints. Ramadorai (2013) finds a negative effect of capacity constraints on hedge fund returns.

To evaluate whether scalability affects the flow-performance relation, we rely on the classification of Ding et al. (2009), who consider Convertible Arbitrage, Emerging Market, Event Driven, and Fixed Income Arbitrage strategies to be "capacity constrained." The other strategies (Equity Market Neutral, Global Macro, Long/Short Equity, Multi-Strategy, and Others) are classified as "unconstrained." We create an indicator variable equal to one if the fund is capacity constrained and zero if it is unconstrained. We interact this variable with the past performance variables, and present the results in Panel C of Table II.

As with the previous estimates, the coefficients on lagged performance are positive and statistically significantly different from zero. However, the coefficients on these variables interacted with the "Constrained" indicator variable are negative and statistically significant for the three most recent quarters, implying that the strategies we consider to be constrained are less responsive in size to a performance shock. Even though a shock to performance for "constrained" funds would cause the market to update its assessment of 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.

A caveat to these results is that, if hedge funds misreport their returns, estimates of the flow-performance relation may be biased. In particular, Bollen and Pool (2009) show that the potential for misreporting is strongest when returns are slightly negative. In this case, the relation between flows and true performance would be weaker than the relation between flows and performance reported to the database, leading our estimates of indirect incentives (with respect to true performance) to be overstated. To gauge the magnitude of this effect, we reestimate the flow-performance equations under the assumption that all reported positive returns were accurate but all negative returns were in fact upward-biased by 10%. The resulting coefficients are about 2.6% lower than those reported above, which suggests that misreporting may lead to about a 2.6% overstatement of the part of indirect incentives (reported below) that comes from new inflows.

IV. Calculating Indirect and Direct Pay for Performance

In this section, we use the models discussed in Section I and the Appendices, together with the estimates presented in Section III, to quantify the magnitude of direct and indirect pay for performance sensitivities facing hedge fund managers.

To calculate direct pay for performance, we follow Agarwal, Daniel, and Naik's (2009) total delta approach using the parameters discussed in Appendix A. This approach takes the perspective of a manager at the beginning of the period calculating the sensitivity of his claim to the fund's assets to performance realized over the upcoming period. Based on a set of assumptions discussed in Appendix A, 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 obtain the total direct pay for performance for each fund-quarter in our sample. We take the average of these fund-quarter estimates to be our estimate of typical direct pay for performance sensitivities.

For indirect pay for performance, the coefficients on returns in Table II 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 to account for future performance-based flows, the LWY model (which incorporates endogenous leverage), and the LWY model extended to account for future performance-based flows. For every fund-quarter, we use each of the four models to calculate the fraction of each incremental dollar that, in expectation, will accrue to managers. Then, as with direct pay for performance, we take the average of the fund-quarter estimates to be our estimate of typical indirect pay for performance sensitivities. We repeat this calculation for a number of alternative parameter choices. Details of the models, parameter choices, and calculations are provided in Appendix B.

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 sets of parameters obtained from two 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 our estimates of indirect incentives. A particularly important parameter is b, which represents the minimum asset value relative to the HWM that the investor will tolerate before withdrawing all of his or her money from the fund. If $b = 0$, the fund is never liquidated for poor performance. 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 for exogenous reasons. GIR set this parameter equal to 5% per year, 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 quarterly equivalents of 5% and 10%.

The final parameter that we vary is the manager's future expected gross-of-fee risk-adjusted performance, α. Following GIR, we present estimates for quarterly equivalents of $\alpha = 0\%$ and 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 a typical hedge fund leverage.

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. Although Naik, Ramadorai, and Stromqvist (2007), Agrawal, Daniel, and Naik (2009), and Fung et al. (2008) do find that inflows result in lower future performance, this relation is not apparent in our more recent data. Moreover, given the magnitude of such relations identified by prior work, any overstatement 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 II imply that a one-percentage-point incremental return in a given quarter leads to a 1.5% increase in AUM over the next 11 quarters. Accounting for the magnitude of the deleterious effects of flows on future performance estimated by Agrawal, Daniel, and Naik (2009) would reduce this estimate by only 0.01% of AUM.

A. Estimates of Direct and Indirect Incentives

The estimates of direct incentives are summarized in Panel A of Table III. These calculations indicate that the expected dollar increase in incentive fees for an incremental one-percentage-point increase in quarterly net return equals \$142,000 (Row (1)), or roughly 6.8 cents for every dollar returned to investors (Row (4)). This figure is lower than the typical 20% incentive fee rate because the option is always out of the money (when the option is in the money, the incentive fee is immediately paid and the strike is reset). The change in managers' personal stakes averages \$190,000 for an incremental 1% return (Row (2)) and 9.5 cents for every dollar returned to investors (Row (5)). Total direct incentives average \$331,000 for a one-percentage-point increase in fund value (Row (3)), or 16.3 cents for each additional dollar created (Row (6)).

Panels B through E of Table III 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 leverage or future 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

Table III

Direct and Indirect Pay for Performance

This table presents estimates of direct and indirect pay for performance (incentives) at a quarterly frequency. All reported statistics are averages taken over all fund-quarters in the data. Panel A presents estimates of direct incentives, calculated as described in Appendix A. 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 to E present estimates of indirect incentives, calculated using four different models as described in Appendix B. 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 the 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 $\delta+\lambda$. All parameter choices are provided in Table CI in Appendix C. The number of fund-quarters used in all columns of Panels A to C is 49,776 (557 fund-quarter observations are dropped from the full regression sample, because the sum of the values of all investors' stake is zero for these cases according to the computations described in Appendix A). The number of observations used to estimate the LWY model (Panel D) and the extended LWY model (Panel E) are somewhat smaller, because the ODE in equation (B3) fails to have a numerical solution for certain combinations of parameters. The number of fund-quarters used in estimation averages 49,731 in Panel D and 48,033 in Panel E.

	$b = 0.685$				$b = 0.8$			
	$\alpha = 0\%$		$\alpha = 3\%$		$\alpha = 0\%$		$\alpha = 3\%$	
	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Direct incentives								
Per 1% change in fund value ($M)								
(1) Direct effect from incentive fees	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142
(2) Direct effect from managers' personal stake	0.190	0.190	0.190	0.190	0.190	0.190	0.190	0.190
(3) Total direct effect	0.331	0.331	0.331	0.331	0.331	0.331	0.331	0.331
Per 1$ change in fund value ($)								
(4) Direct effect from incentive fees	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
(5) Direct effect from managers' personal stake	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095
(6) Total direct effect	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163

(*Continued*)

Table III—*Continued*

	$b = 0.685$				$b = 0.8$			
	$\alpha = 0\%$		$\alpha = 3\%$		$\alpha = 0\%$		$\alpha = 3\%$	
	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel B: Indirect incentives estimated from the Goetzmann, Ingersoll, and Ross (GIR, 2003) model								
Per 1% change in fund value ($M)								
(1) Indirect effect from new money	0.482	0.355	1.094	0.589	0.308	0.248	0.689	0.436
(2) Indirect effect from change in value of existing assets	0.449	0.339	0.903	0.517	0.340	0.282	0.671	0.449
(3) Total indirect effect	0.932	0.695	1.998	1.106	0.648	0.531	1.360	0.884
(4) Indirect/direct	2.81	2.10	6.03	3.34	1.96	1.60	4.11	2.67
Per 1$ change in fund value ($)								
(5) Indirect effect from new money	0.228	0.169	0.488	0.272	0.145	0.116	0.305	0.195
(6) Indirect effect from change in value of existing assets	0.193	0.146	0.383	0.222	0.138	0.114	0.269	0.180
(7) Total indirect effect	0.421	0.315	0.871	0.494	0.283	0.230	0.574	0.375
(8) Indirect/direct	2.58	1.93	5.35	3.03	1.74	1.41	3.52	2.30
Panel C: Indirect incentives estimated from the GIR model augmented for performance-based flows								
Per 1% change in fund value ($M)								
(1) Indirect effect from new money	0.545	0.396	1.135	0.622	0.346	0.279	0.701	0.455
(2) Indirect effect from change in value of existing assets	0.474	0.355	0.892	0.518	0.354	0.294	0.642	0.440
(3) Total indirect effect	1.018	0.751	2.028	1.140	0.700	0.573	1.343	0.895
(4) Indirect/direct	3.07	2.27	6.12	3.44	2.11	1.73	4.05	2.70
Per 1$ change in fund value ($)								
(5) Indirect effect from new money	0.257	0.189	0.509	0.289	0.162	0.130	0.312	0.205
(6) Indirect effect from change in value of existing assets	0.208	0.156	0.386	0.228	0.147	0.122	0.263	0.180
(7) Total indirect effect	0.465	0.345	0.895	0.517	0.309	0.252	0.575	0.386
(8) Indirect/direct	2.85	2.12	5.50	3.17	1.90	1.55	3.53	2.37

(*Continued*)

Table III—*Continued*

	$b = 0.685$				$b = 0.8$			
	$\alpha = 0\%$		$\alpha = 3\%$		$\alpha = 0\%$		$\alpha = 3\%$	
	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$	$\delta+\lambda = 5\%$	$\delta+\lambda = 10\%$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel D: Indirect incentives estimated from the Lan, Wang, and Yang (LWY, 2013) model								
Per 1% change in fund value ($M)								
(1) Indirect effect from new money	0.554	0.366	1.337	0.691	0.425	0.315	0.725	0.454
(2) Indirect effect from change in value of existing assets	0.583	0.361	1.245	0.673	0.551	0.387	0.821	0.522
(3) Total indirect effect	1.137	0.727	2.582	1.364	0.976	0.702	1.546	0.976
(4) Indirect/direct	3.43	2.19	7.80	4.12	2.95	2.12	4.67	2.95
Per 1$ change in fund value ($)								
(5) Indirect effect from new money	0.257	0.169	0.575	0.305	0.198	0.146	0.321	0.204
(6) Indirect effect from change in value of existing assets	0.241	0.151	0.498	0.272	0.217	0.153	0.321	0.205
(7) Total indirect effect	0.498	0.320	1.073	0.577	0.415	0.300	0.642	0.408
(8) Indirect/direct	3.05	1.96	6.58	3.54	2.55	1.84	3.94	2.51
Panel E: Indirect incentives estimated from the LWY model augmented for performance-based fund flows								
Per 1% change in fund value ($M)								
(1) Indirect effect from new money	0.554	0.366	2.144	1.148	0.425	0.315	0.925	0.545
(2) Indirect effect from change in value of existing assets	0.583	0.361	2.126	1.152	0.551	0.387	1.053	0.637
(3) Total indirect effect	1.137	0.727	4.270	2.300	0.976	0.702	1.978	1.182
(4) Indirect/direct	3.43	2.19	12.89	6.94	2.95	2.12	5.97	3.57
Per 1$ change in fund value ($)								
(5) Indirect effect from new money	0.257	0.169	0.938	0.495	0.198	0.146	0.402	0.240
(6) Indirect effect from change in value of existing assets	0.241	0.151	0.853	0.453	0.217	0.153	0.404	0.246
(7) Total indirect effect	0.498	0.320	1.791	0.948	0.415	0.300	0.805	0.487
(8) Indirect/direct	3.05	1.96	11.00	5.82	2.55	1.84	4.94	2.99

in returns, the incremental future fees from inflows of new investment average \$482,000 and the incremental future fees from the increase in value of existing assets average \$449,000. The total is \$932,000, which is 2.81 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 22.8 cents from new money and 19.3 cents from the change in the value of existing assets. Together these effects are 2.58 times the direct incentives that managers receive for the same change.[14]

The remaining columns of Panel B present analogous calculations for alternative parameter choices. In general, higher choices of b and $\delta + \lambda$ reduce the size of indirect incentives, while a higher α raises them. Intuitively, a higher b implies 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 nonperformance-related reasons, which effectively shortens a fund's expected life, so future fees will be lower. In contrast, a higher α means that future returns are expected to be higher, so the likelihood of hitting the liquidation boundary defined by b declines and fees will be a percentage 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-to-direct incentive ratios varying from 1.4 to 6.0.

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 those from the base-case GIR model. The augmented GIR model and the two LWY models differ from the base-case GIR model by accounting for future performance-related fund flows and/or portfolio allocations that are chosen endogenously to incorporate managers' incentives.

In the case of the augmented GIR model, future performance-based flows are equivalent 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.[15] Indirect incentives calculated using the augmented GIR model and presented in Panel C are about 9% larger than for the base GIR model when $\alpha = 0\%$ and are about 2% larger when $\alpha = 3\%$.

The LWY model allows the manager to 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. This effect increases the value to the manager of an incremental dollar in the fund compared to when

[14] The indirect-to-direct incentives 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-quarter, direct and indirect incentives per 1% increase in returns are scaled by (1% of) AUM, which varies over time, to reach direct and indirect incentives per \$1 change to fund value.

[15] 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.

they do not have this option. Indirect incentives calculated using the LWY model and presented in Panel D range from 2% to 51% larger than in the base GIR model, depending on the model parameters.

The LWY model augmented for performance-based fund flows accounts not only for endogenous allocation, but also 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. They also interact in that, with the possibility of future inflows, the manager endogenously takes more risk. This effect is especially strong when large α is combined with low b, as the downside from risk-taking (hitting the liquidation boundary represented by b) is less likely to occur in this case. Thus, indirect incentives from the augmented LWY model presented in Panel E are about 39% 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 12% higher compared to the base GIR model for unskilled managers ($\alpha = 0\%$) and 105% higher for skilled ones ($\alpha = 3\%$).

Overall, the ratio of indirect to direct incentives varies from 1.4 to 12.9 across the 32 model and parameter combinations examined here, with an average of 3.5. The three alternative models typically deliver estimates of indirect incentives that are roughly 25% higher than the base-case GIR model because performance-based inflows and endogenous portfolios both increase future payments to fund managers. Regardless of the specific calculations used, it is evident that indirect incentives for most hedge fund managers are considerably larger than their direct incentives.[16]

B. Direct and Indirect Incentives by Fund Age

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

Table IV examines this hypothesis by calculating indirect incentives for funds of different ages with parameter choices given in Column (4) of Table III (i.e., $b = 0.685$, $\alpha = 3\%$, and $\delta + \lambda = 10\%$; these are the parameter choices used by LWY). Here, we focus 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 IV.

Panel A presents the average direct pay for performance for funds of different ages. Direct pay for performance appears to increase with fund age. For a new

[16] Indirect incentives are also large in the case in which the manager has the option to reset the HWM by strategically abandoning the fund and starting a new one. This case can also be accommodated in the LWY framework. The estimates of indirect incentives would fall in between those for the base LWY model and the LWY model augmented for performance-based flows.

Table IV

Direct and Indirect Pay for Performance by Age Group

This table presents estimates of direct and indirect pay for performance (incentives) at a quarterly frequency, similar to Table III but broken down by fund age. Reported statistics are averages taken over all funds of a given age. All estimates in this table use the quarterly equivalent of the parameters $b = 0.685$, $\alpha = 3\%$, 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% change in fund value ($M)																
(1) Total direct effect	0.10	0.15	0.18	0.23	0.29	0.38	0.46	0.51	0.58	0.72	0.85	1.03	1.32	1.28	1.22	1.04
Per 1$ change in fund value ($)																
(2) Total direct effect	0.10	0.11	0.12	0.14	0.16	0.18	0.21	0.23	0.24	0.26	0.28	0.29	0.31	0.32	0.36	0.35
Panel B: Indirect incentives estimated from the GIR model																
Per 1% Change in fund value ($M)																
(1) Total indirect effect	0.59	0.82	0.94	0.98	1.08	1.12	1.22	1.31	1.40	1.63	1.81	2.04	2.27	2.26	1.96	1.50
(2) Indirect/direct	6.05	5.43	5.13	4.27	3.75	2.98	2.63	2.57	2.40	2.27	2.13	1.98	1.72	1.77	1.61	1.44
Per 1$ change in fund value ($)																
(1) Total indirect effect	0.57	0.53	0.50	0.48	0.47	0.45	0.44	0.43	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.39
(2) Indirect/direct	5.51	4.78	4.07	3.33	2.90	2.42	2.09	1.87	1.72	1.59	1.50	1.46	1.34	1.30	1.17	1.10
Panel C: Indirect incentives estimated from the GIR model augmented for performance-based fund flows																
Per 1% change in fund value ($M)																
(1) Total indirect effect	0.62	0.84	0.96	1.00	1.10	1.17	1.27	1.34	1.43	1.71	1.86	2.07	2.33	2.34	2.07	1.53
(2) Indirect/direct	6.31	5.60	5.24	4.35	3.85	3.11	2.73	2.61	2.45	2.39	2.19	2.01	1.77	1.83	1.70	1.47
Per 1$ change in fund value ($)																
(1) Total indirect effect	0.59	0.55	0.53	0.50	0.49	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.43	0.44	0.44	0.40
(2) Indirect/direct	5.76	5.00	4.25	3.48	3.03	2.54	2.19	1.96	1.80	1.68	1.56	1.51	1.39	1.36	1.23	1.13

(Continued)

Table IV—*Continued*

Fund age (years)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	≥15
Panel D: Indirect incentives estimated from the LWY model																
Per 1% change in fund value ($M)																
(1) Total indirect effect	0.71	1.00	1.16	1.19	1.33	1.40	1.54	1.72	1.86	2.03	2.25	2.53	2.88	2.62	2.28	1.72
(2) Indirect/direct	7.28	6.66	6.33	5.15	4.66	3.71	3.32	3.36	3.19	2.83	2.64	2.46	2.18	2.04	1.87	1.66
Per 1$ change in fund value ($)																
(1) Total indirect effect	0.65	0.61	0.59	0.56	0.55	0.53	0.52	0.52	0.51	0.50	0.50	0.51	0.50	0.50	0.50	0.45
(2) Indirect/direct	6.30	5.50	4.74	3.88	3.43	2.88	2.47	2.26	2.07	1.89	1.77	1.74	1.60	1.54	1.41	1.27
Panel E: Indirect incentives estimated from the LWY model augmented for performance-based fund flows																
Per 1% change in fund value ($M)																
(1) Total indirect effect	1.18	1.67	1.91	1.94	2.24	2.35	2.63	3.02	3.27	3.47	3.86	4.34	5.00	4.42	3.82	2.85
(2) Indirect/direct	12.08	11.16	10.49	8.44	7.81	6.26	5.68	5.91	5.61	4.85	4.54	4.21	3.79	3.45	3.13	2.74
Per 1$ change in fund value ($)																
(1) Total indirect effect	1.06	0.98	0.95	0.91	0.91	0.88	0.86	0.87	0.86	0.84	0.84	0.87	0.85	0.85	0.87	0.75
(2) Indirect/direct	10.26	8.90	7.70	6.30	5.67	4.79	4.11	3.81	3.50	3.18	2.98	2.99	2.74	2.64	2.45	2.14

fund, an incremental dollar returned to fund investors results in 10 cents in incremental incentive fees and returns on the manager's personal stake. For a 10-year-old fund, this quantity increases to 28 cents. Much of this increase, however, occurs because of our assumption that managers reinvest their fees, in which case 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 suggested by this table.

Panels B to 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. The estimates for each model imply that indirect incentives decline substantially as a fund ages. For new funds, an incremental dollar returned to investors today results in at least $0.57 in expected future fees. This indirect effect is about six 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, but remains larger than the direct effect even for 15-year-old funds.

C. Direct and Indirect Incentives and Fund Scalability

Indirect incentives result from managers being able to increase their funds' size 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 V provides estimates of indirect and direct incentives for funds classified as "Not Capacity Constrained" and "Capacity Constrained" according to the classifications discussed in Section III.B. The direct incentives of each type are very similar: 16 cents for each incremental dollar returned to investors for unconstrained funds compared to 17 cents for constrained funds. The differences in indirect incentives, however, are substantial: 52 cents for each dollar returned to investors for unconstrained funds compared to 43 cents for constrained funds using the GIR model. This difference implies an average indirect-to-direct incentives ratio of about 3.2 for the unconstrained funds, compared to 2.5 for the constrained funds. Using other models, the indirect-to-direct incentives ratio ranges between 3.4 and 7.3 for the unconstrained funds, and between 2.6 and 6.0 for the constrained funds. Although our proxy for fund scalability is imperfect, these differences suggest that indirect incentives are relatively more important in funds adopting more scalable investment strategies.

The cross-sectional differences in indirect incentives by fund scalability point to broader issues that are likely to affect the scalability of the hedge fund industry, and hence indirect incentives, as a whole. In particular, current trends in industry growth and regulation suggest that it is possible that managers will be less able to effectively deploy additional capital in the future than has been

Table V

Direct and Indirect Pay for Performance by Scalability

This table presents estimates of direct and indirect pay for performance (incentives) at a quarterly frequency, similar to Table III but broken down by 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. Reported statistics are averages taken over all fund-quarters within a grouping. All estimates in this table use the quarterly equivalent of the parameters $b = 0.685$, $\alpha = 3\%$, and $\delta+\lambda = 10\%$; these are the parameters chosen by LWY.

	Not Capacity Constrained	Capacity Constrained
Panel A: Direct incentives		
Per 1% change in fund value ($M)		
(1) Total direct effect	0.340	0.314
Per 1$ change in fund value ($)		
(2) Total direct effect	0.160	0.169
Panel B: Indirect incentives estimated from the GIR model		
Per 1% change in fund value ($M)		
(1) Total indirect effect	1.213	0.862
(2) Indirect/direct	3.57	2.75
Per 1$ change in fund value ($)		
(1) Total indirect effect	0.516	0.427
(2) Indirect/direct	3.23	2.53
Panel C: Indirect incentives estimated from the GIR model augmented for performance-based fund flows		
Per 1% change in fund value ($M)		
(1) Total indirect effect	1.251	0.888
(2) Indirect/direct	3.68	2.83
Per 1$ change in fund value ($)		
(1) Total indirect effect	0.541	0.446
(2) Indirect/direct	3.38	2.64
Panel D: Indirect incentives estimated from the LWY model		
Per 1% change in fund value ($M)		
(1) Total indirect effect	1.475	1.100
(2) Indirect/direct	4.34	3.51
Per 1$ change in fund value ($)		
(1) Total indirect effect	0.597	0.509
(2) Indirect/direct	3.74	3.01
Panel E: Indirect incentives estimated from the LWY model augmented for performance-based fund flows		
Per 1% change in fund value ($M)		
(1) Total indirect effect	2.468	1.887
(2) Indirect/direct	7.26	6.02
Per 1$ change in fund value ($)		
(1) Total indirect effect	0.971	0.854
(2) Indirect/direct	6.08	5.05

Table VI

Direct and Indirect Pay for Performance by Presence of a High-Water Mark

This table presents estimates of direct and indirect pay for performance broken down by the presence of an HWM provision. Reported statistics are averages taken over all funds in a given category. All estimates of indirect incentives are obtained from the base LWY model with parameter values $b = 0.685$, $\alpha = 3\%$, and $\delta+\lambda = 10\%$.

		(1) All funds	(2) Funds with HWM	(3) Funds with no HWM
(1)	Number of observations used in estimation	49,776	35,549	14,227
(2)	AUM ($ million)	213	239	148
Pay for performance per 1% change in fund value ($M)				
(3)	Direct effect from incentive fees	0.142	0.132	0.165
(4)	Direct effect from managers' personal stake	0.190	0.188	0.193
(5)	Total direct effect	0.331	0.320	0.358
(6)	Indirect effect from new money	0.691	0.775	0.483
(7)	Indirect effect from change in value of existing assets	0.673	0.813	0.323
(8)	Total indirect effect	1.364	1.587	0.805
(9)	Indirect/direct	4.12	4.96	2.25
Pay for performance per 1$ change in fund value ($)				
(10)	Direct effect from incentive fees	0.068	0.054	0.105
(11)	Direct effect from managers' personal stake	0.095	0.074	0.146
(12)	Total direct effect	0.163	0.128	0.251
(13)	Indirect effect from new money	0.305	0.310	0.291
(14)	Indirect effect from change in value of existing assets	0.272	0.303	0.195
(15)	Total indirect effect	0.577	0.613	0.486
(16)	Indirect/direct	3.54	4.80	1.94

true in the past (i.e., in our sample period). If so, the flow-performance relation will decline and so will the magnitude of indirect incentives. All of our estimates should be interpreted with this caveat in mind.

D. Direct and Indirect Incentives and High-Water Marks

The importance of indirect incentives could vary across funds depending on the presence of an HWM provision, because of both potential differences in flow-performance sensitivities and the impact of the HWM on fees.

Table VI presents estimates of direct and indirect incentives for funds with and without HWM provisions. We find that funds without HWM provisions have higher direct incentives while funds with HWM provisions have higher indirect incentives. Consequently, funds with HWM provisions have substantially higher indirect-to-direct incentives ratios. For an incremental dollar return to the fund's investors, the indirect-to-direct ratio is 1.94 for funds with no HWM provision and 4.80 for those with HWM, and the difference between the two is statistically significant.

The fact that indirect incentives are substantially higher for funds with HWM complements the finding of Patton, Ramadorai, and Streatfield (2015) that the direction and magnitude of return misreporting is larger for funds with an HWM provision. One reason for this finding could be the higher indirect incentives we document, which suggest greater gains from misreporting.

V. Implications of These Estimates of Indirect Incentives

The existence of large indirect incentives for hedge fund managers has implications for our understanding of a number of issues, including the structure of contracts in hedge funds, the portfolio choices of investors, and contracting beyond the asset management context. In this section, we highlight these implications, their empirical predictions, as well as a number of questions that emerge from our analysis that are potential topics for future research.

A. Implications for Hedge Fund Contracting and Managers' Total Incentives

Hedge fund contracts are set up in a sophisticated manner with a fee structure containing a combination of management fees and incentives that use HWMs that adjust their effective strike price. Presumably, these contracts are designed to solve a principal-agent problem of some sort. Yet, as emphasized by Gibbons and Murphy (1992), what matters in a principal-agent problem is the total pay for performance that agents receive, not the distribution between its direct and indirect components.

A.1. Total Incentives over Time and the Relation between Direct and Indirect Incentives

In the hedge fund industry, our finding that indirect incentives decrease with fund age together with established evidence that explicit contracts tend to be sticky implies that managers' total incentives decline as a fund ages.[17] Whether it is optimal for total incentives to decline, and for contracts to be sticky given declining indirect incentives, is an interesting question for future research. If, as seems likely, attrition in the industry results in more experienced managers being higher quality on average than novice managers, a theory rationalizing these results would need to explain why the process of generating hedge fund returns is such that better managers should receive weaker total incentives.

Although direct incentives in the hedge fund industry do not (given the stickiness of the contracts) appear to increase to compensate for declining indirect

[17] Funds do at times change their fee structure, but such changes are infrequent. Deuskar et al. (2012) report a number of findings about the factors that lead hedge funds to change their fees. None of the findings in Deuskar et al. (2012) suggest that changes in the hedge fund fee structure are driven by a desire to offset changes in indirect incentives faced by fund managers.

Table VII

The Relation between Direct and Indirect Incentives

This table presents the relations between various contractual terms and *Constrained*. OLS coefficient estimates and corresponding standard errors (in parentheses) are reported. The dependent variable is the incentive fee rate and HWM indicator in Columns (1) and (2), respectively. All analyses are conducted at the fund level. Standard errors are clustered by fund inception year. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Incentive fee rate		(2) HWM indicator	
Dependent var.=	Coef.	(*SE*)	Coef.	(*SE*)
Constrained	−0.0020	(0.002)	−0.0394	(0.025)
Log(Inception AUM+1)	0.0008**	(0.000)	0.0121	(0.009)
Leveraged indicator	0.0067***	(0.001)	−0.0136	(0.027)
Open-to-public indicator	0.0024*	(0.001)	0.1287***	(0.031)
On-shore indicator	0.0045**	(0.002)	−0.0571***	(0.019)
Log(Total redemption +1)	−0.0019	(0.003)	0.0163	(0.038)
Log(Lock-up period+1)	0.0003	(0.001)	0.1491***	(0.028)
Log(Subscription period+1)	0.0194***	(0.006)	−0.4330***	(0.099)
Number of observations	2,998		2,998	
Adjusted R^2	0.016		0.072	

incentives as a fund ages, it is possible that contracts signed at fund inception are related to the strength of the indirect incentives that managers face. In particular, because funds with less scalable investment strategies have a weaker flow-performance relation, holding contractual terms fixed, they have weaker indirect and total incentives than funds with more scalable strategies. So we might expect direct contractual incentives to be stronger in less scalable funds to offset the weaker flow-performance relation. Alternatively, it is possible that the type of manager who manages a less scalable fund is more likely to be one whose total incentives should be weaker. In that case, constrained funds could have weaker direct incentives than unconstrained funds.

To evaluate the extent to which contracting adjusts in the presence of indirect incentives, we measure the relation between direct incentives and the scalability of an fund's strategy. Direct incentives are a function of the incentive fee rate, which usually remains constant over the life of the fund. In addition, the presence of an HWM provision mitigates a fund's direct incentives to some extent. Therefore, to assess whether being constrained in its ability to accept capital because of a less scalable strategy affects the direct incentives that a fund provides its managers, we estimate equations predicting both the fund's incentive fee rate and whether a fund employs an HWM. In these equations, we include the indicator variable *Constrained* that equals one if a firm follows a less scalable strategy using the Ding et al. (2009) classification of strategies, as well as other variables that are likely to be associated with a firm's direct incentives.

We present estimates of these equations in Table VII. In neither equation is the estimated coefficient on *Constrained* statistically significant or of meaningful magnitude. Consequently, these estimates suggest that funds do not adjust their direct compensation plans based on the extent to which their managers receive indirect incentives.

The lack of a relation between a hedge fund's contractual fee structure and indirect, market-based incentives reflects a larger puzzle about the structure of compensation in alternative asset classes. Both hedge funds and private equity funds generally use a combination of management fees that are proportional to capital under management and performance fees, which are usually 20% of profits regardless of other factors that ostensibly should affect the magnitude of the profit-sharing percentage. Although the performance fee differs more in the hedge fund industry than in private equity,[18] the fact that hedge funds do not appear to adjust their incentive fees based on indirect incentives that are large in magnitude and have wide variation across funds and over time is difficult to reconcile with extant optimal contracting theories.

A.2. Hedge Fund Managers' Careers and Adverse Consequences of Incentives

The estimates provided above suggest that hedge fund managers' career patterns should be heavily influenced by the returns earned by the fund while they are young and are establishing a reputation. Since young fund managers have limited liability and the option of leaving the industry, the estimates discussed above imply that young hedge fund managers receive extremely large payoffs for good performance but do not fully bear the downside risk from any actions they take. Therefore, we expect the pay of managers who earn high returns to increase substantially while there should be a high exit rate from managers who do not perform well.

These incentives potentially lead to some adverse outcomes for investors. The exit option will lead managers to become prone to increase the risk of the fund, even if doing so comes at a cost to investors. In addition, if young fund managers have the option of taking investments that increase short-term returns at the expense of the long term as suggested by Stein (1989), their incentives to do so are particularly large. Thus, we expect young managers to be more likely to take investments that have payoffs that are observable over shorter horizons than older managers. In addition, to the extent that accounting manipulation or fraud can increase short-term payoffs with any potential cost occurring in the future, we expect to observe such manipulation or fraud more frequently from younger managers. The extent to which indirect incentives lead to these activities that adversely affect investors in practice is unknown.

[18] Gompers and Lerner (1999), Metrick and Yasuda (2010), and Robinson and Sensoy (2013) provide evidence on private equity fund compensation.

B. Implications for Investors

B.1. Differences in Hedge Fund Managers' Incentives

Institutional investors often highlight the importance of the incentives of their fund managers in making their portfolio decisions (see Swenson (2000)). Since indirect incentives are such an important part of hedge fund managers' total incentives, they should be taken into account by investors investing in hedge funds and other kinds of assets. Higher indirect incentives increase the payoff to managers from increasing returns, but also potentially lead them to increase risk and manipulate returns. The estimates presented above suggest that younger funds and funds in more scalable sectors have higher indirect and total incentives. Portfolio theory is not clear on the optimal composition of a portfolio of funds whose incentives are different from one another. However, it does seem clear that the differences in indirect incentives we document are factors that a portfolio manager would like to be aware of when making portfolio allocations to hedge funds.

B.2. Differences in Incentives across Asset Classes

Indirect incentives are present not just for managers of hedge funds, but also for managers of all asset classes. Consequently, total incentives—including both direct and indirect components—are relevant not only for portfolio decisions within a particular asset class, but also for portfolio decisions across different asset classes. Estimates of total incentives facing asset managers are available for some asset classes in addition to hedge funds.

Probably the most important "alternative asset" other than hedge funds is private equity funds. This investment class has very similar direct incentive schemes as hedge funds. In addition, they have substantial indirect incentives: Chung et al. (2012) estimate that private equity fund managers' indirect incentives are approximately the same size as their direct incentives.

Mutual funds are another asset class for which one can measure indirect incentives. An important difference from hedge funds is that mutual funds do not charge incentive fees or carried interest, so direct contractual incentives do not exist. However, the flow-performance relation facing mutual fund managers potentially leads to substantial indirect incentives. To understand how mutual funds and hedge funds compare in terms of the magnitude and importance of indirect incentives, we conduct similar calculations for mutual funds as we do for hedge funds. These calculations also require estimates of the flow-performance sensitivity as well as a valuation model of the mutual fund manager's expected lifetime compensation.

To estimate the flow-performance sensitivity in as comparable a manner as possible to our hedge fund estimates, we construct a sample of mutual funds from the CRSP Survivorship Bias Free Mutual Fund Database over the same 1995 to 2010 period used in the hedge fund sample. Because we focus on flows into actively managed funds, we exclude index funds and exchange-traded funds (ETF). We also exclude fixed income funds, international funds, and sector funds to facilitate comparison with prior literature. We then apply the same filtering rules as we used with hedge funds, that is, we require the availability of contractual information and at least 12 consecutive monthly observations within the sample period. We also drop all fractional quarters.

Our sample consists of 307,079 fund-quarters associated with 11,911 funds. The average mutual fund in our sample contains $322 million in assets and is eight years old. The management fee, defined as the total expense ratio minus the 12B-1 fee, averages 1.1% of total net assets. Further descriptive statistics are provided in Table CII in Appendix C.

We estimate the mutual fund analog of equation (1) using quarterly observations from this mutual fund sample and report the results in Table CIII in Appendix C.[19] In doing so, we omit hedge fund-specific variables such as the incentive fee that are not relevant for mutual funds and include style by quarter fixed effects for mutual fund styles listed in Table CII in Appendix C. We find that the same patterns hold for mutual funds as for hedge funds: the coefficients on past returns are all positive and statistically significant in most cases, and decline almost monotonically over time. The sum of coefficients on past returns is about 1.78 (based on Column (2) of Table CIII), implying that flows are somewhat more responsive to performance in the mutual fund industry than in the hedge fund industry. This pattern may be attributed to the fact that search costs and transaction costs are much lower for mutual funds than for hedge funds, which leads to higher flow-performance sensitivity (Huang, Wei, and Yan (2007)).

We obtain the present value of mutual fund fees per dollar of AUM using the same LWY framework that we use for hedge funds. Within this framework, a mutual fund can be modeled as a fund in which leverage is not allowed and the incentive fee is zero. Therefore, the LWY model with no leverage (equivalent to the GIR model), with the incentive fee rate (k) set to zero, characterizes the present value of fees for a mutual fund. In addition, since mutual funds do not have an HWM provision, the contractual growth rate of HWM (g) is set to zero and the ratio between the investor's wealth and HWM (w) is set to one. For comparison with the hedge fund estimates, we present estimates for the same eight combinations of the parameters b, α, and $\delta + \lambda$. For all other parameters, fund-specific values are used.

Table VIII provides estimates of indirect incentives in mutual funds. In contrast to the hedge fund analyses, we do not compare indirect incentives to direct

[19] We estimate the same linear specification as we used with hedge funds to obtain comparable flow-performance sensitivity estimates. Alternatively, to incorporate the well-documented nonlinearity (convexity) in the flow-performance relation for mutual funds, we estimate a simple piecewise specification that partitions negative returns and positive returns. The resulting flow-performance sensitivity estimate is about 26% larger when returns are positive than what is implied from the linear specification, which leads to 17% larger indirect incentives than those reported in Table VIII. When we take into account convexity effects by including quadratic lagged return terms in the regression, the resulting estimate suggests that indirect incentives are about 13% larger than those reported in Table VIII when evaluated at the 75$^{\text{th}}$ percentile of quarterly returns.

Table VIII
Indirect Pay for Performance for Mutual Funds

This table presents estimates of indirect pay for performance (incentives) for mutual funds at a quarterly frequency, using the LWY model (equivalent to the GIR model under the setup for mutual funds). Within this framework, a mutual fund is a special case in which leverage is not allowed and the incentive fee (k) is zero. Mutual funds have no HWM provision, and therefore the contractual HWM growth rate (g) is set to zero and the ratio between an investor's wealth and HWM level (w) is one at all times. Estimates of indirect incentives are presented for eight combinations of the parameters b, α, and $\delta+\lambda$. All other parameter values are fund-specific. Reported statistics are averages taken over all fund-quarters (307,079) in the data. Flow-performance sensitivity to compute the indirect effect from new money is obtained from the coefficient estimates in Column (2) of Table CIII in Appendix C. Rows (4) and (9) (Rows (5) and (10)) report the magnitude of indirect incentives for mutual funds in comparison to the estimates for hedge funds from the GIR model (LWY model).

	$b = 0.685$				$b = 0.8$			
	$\alpha = 0\%$		$\alpha = 3\%$		$\alpha = 0\%$		$\alpha = 3\%$	
	$\delta+\lambda = 5\%$ (1)	$\delta+\lambda = 10\%$ (2)	$\delta+\lambda = 5\%$ (3)	$\delta+\lambda = 10\%$ (4)	$\delta+\lambda = 5\%$ (5)	$\delta+\lambda = 10\%$ (6)	$\delta+\lambda = 5\%$ (7)	$\delta+\lambda = 10\%$ (8)
Per 1% change in fund value ($ millions)								
(1) Indirect effect from new money	0.392	0.259	0.769	0.367	0.214	0.156	0.414	0.224
(2) Indirect effect from change in value of existing assets	0.221	0.146	0.433	0.206	0.120	0.088	0.233	0.126
(3) Total indirect effect	0.613	0.405	1.202	0.573	0.334	0.243	0.647	0.351
(4) % of the hedge fund estimates from the GIR model	65.8%	58.3%	60.2%	51.8%	51.6%	45.9%	47.6%	39.6%
(5) % of the hedge fund estimates from the LWY model	53.9%	55.7%	46.5%	42.0%	34.3%	34.7%	41.9%	35.9%
Per $1 change in fund value ($)								
(6) Indirect effect from new money	0.139	0.095	0.260	0.133	0.074	0.055	0.136	0.079
(7) Indirect effect from change in value of existing assets	0.078	0.053	0.146	0.075	0.041	0.031	0.076	0.044
(8) Total indirect effect	0.216	0.148	0.406	0.208	0.115	0.086	0.212	0.123
(9) % of the hedge fund estimates from the GIR model	51.4%	47.1%	46.6%	42.1%	40.6%	37.5%	36.9%	32.7%
(10)% of the hedge fund estimates from the LWY model	43.5%	46.4%	37.8%	36.0%	27.7%	28.8%	33.0%	30.0%

incentives. Direct incentives are small in the mutual fund industry because mutual funds do not charge incentive fees and mutual fund manager ownership is typically very small (e.g., Ma and Tang (2014)). In terms of indirect incentives, Table VIII shows that, for an incremental one-percentage-point return to the fund's investors, the manager of an average-sized mutual fund ($322 million) receives as high as $1,202,000 in expected future compensation, which corresponds to 47% of what the LWY model suggests an average hedge fund manager receives under the same parameter assumptions, and 60% of what the GIR model implies for hedge funds. Depending on the parameter choices, the relative magnitude of the indirect effect in mutual funds ranges between 40% and 66% of the hedge fund counterpart within the GIR framework (Row (4)), and between 34% and 56% within the LWY framework (Row (5)). Expressed as a fraction of an incremental dollar return to the fund, mutual fund managers receive 8.6 to 40.6 cents, which corresponds to 33% to 51% of the size of indirect incentives facing hedge fund managers within the GIR framework (Row (9)), and 28% to 46% within the LWY framework (Row (10)). Indirect incentives are substantially smaller in mutual funds than in hedge funds but nonetheless constitute an important component of the incentives motivating mutual fund managers.

C. Implications for Understanding Contracting More Broadly

Ever since Fama (1980) and Holmstrom (1982), it has been recognized that market-based incentives are an important element of corporate governance and also motivate many workers who are not top managers. Yet, while there has been some work estimating their importance for CEOs of large industrial corporations, it is difficult to evaluate their magnitude quantitatively.[20] The estimates provided here for hedge fund managers are some of the first estimates of the importance of indirect incentives for managers other than CEOs of large corporations. The cross-sectional pattern of the estimates is consistent with a Bayesian learning process by which the market provides these incentives.

An open question is the extent to which our estimates compare to market-based incentives of more typical managers. While most managers do not have the upside potential of hedge fund managers, they also do not have direct incentive schemes that are nearly as powerful. Consequently, relative to direct incentive pay, indirect, market-based incentives could potentially be equally or even more important to most workers as they are for hedge fund managers.

VI. Conclusion

Managers' incentives to perform well come not only through direct pay-for performance plans, but also through the managerial labor market. The market

[20] See Boschen and Smith (1995) and Taylor (2013) for evidence of the importance of indirect incentives for CEOs, and Hermalin and Weisbach (2014) for a general discussion of indirect incentives and their measurement.

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 provides 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 income increases by at least 39 cents, 23 cents of which comes from indirect incentives arising from managers' 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 highly 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 existence of substantial indirect incentives facing hedge fund managers has a number of implications. Hedge funds appear to be organized to provide optimal incentives to their managers. Yet, direct incentives do not appear to adjust for differences in indirect incentives across funds or over a fund's life cycle. Investors who care about fund managers' incentives should care about their total incentives, including both direct and indirect components. Both private equity funds and mutual funds also appear to have substantial indirect incentives, although not as large as those facing hedge fund managers. Finally, asset management is but one industry in which it is possible to measure indirect incentives facing managers. Undoubtedly, such incentives are also important for many other types of jobs. Whether indirect incentives are of comparable importance outside of the money management industry would be an excellent topic for future research.

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Appendix A: : Calculating Direct Pay for Performance

Our proxy for direct pay for performance is given by total delta, as defined in Agarwal, Daniel, and Naik (2009). Total delta at a point in time is defined as the expected dollar change in the manager'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—the manager's option delta—and the portion coming from the manager'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 their entrance into the fund. Following

Agarwal, Daniel, and Naik (2009), for each fund-investor-quarter we compute the individual option's delta using the Black-Sholes model for a one-quarter 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 HWM level for the investor's assets (i.e., the historic high that the investor's asset has reached since her investment in the fund) if the fund has an HWM 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 quarter, 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. The variable T is the time to maturity of the option (one quarter in this case), r is the natural logarithm of one plus the risk-free rate, which is measured as the three-month LIBOR rate that is in effect at the beginning of each quarter, σ is the standard deviation of monthly (net-of-fee) returns over the prior 12-month period multiplied by the square root of three to arrive at a quarterly figure, 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 when 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 quarter 0 (beginning of quarter 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 the manager's reinvestment take place once a quarter at the end of each calendar quarter.
3. The exercise price (X) for each option is reset at the end of each quarter and applies to the following quarter.
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 as liquidating her stake in the fund, 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 an HWM provision and 0% otherwise.
7. Managers reinvest all of their 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*):

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

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

$$\begin{Bmatrix} S_{1,0} = X_{1,0} = AUM_0 \\ MS_0 = 0 \end{Bmatrix}. \tag{A3}$$

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

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

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

$$S_{i,t} = S_{i,t-1} \times (1 + gross_t) - ifee_{i,t} - mfee_{i,t}, \tag{A5a}$$

$$X_{i,t} = \begin{cases} \text{Max}[S_{i,t},\ X_{i,t-1}] \times (1 + LIBOR), \text{ if with HWM provision} \\ S_{i,t}, \text{ if without HWM provision} \end{cases}. \tag{A5b}$$

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

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

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 assets, 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.

Appendix B: : Calculating Indirect Pay for Performance

We employ four 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, that is, the stake-to-strike (S/X) ratio of the assets, which we denote by w. This subsection describes each of these models in turn, discusses our choices of model parameters (a summary of parameter choices is provided in Table CI), and describes the calculations of indirect incentives.

B.1. Baseline GIR Model

Goetzmann, Ingersoll, and Ross (2003) provide a closed-form solution for the value of total fees as follows:

$$f(w) = \frac{1}{c+\delta+\lambda-\alpha}\left[c + \frac{(\delta+\lambda-\alpha)k + [\eta(1+k)-1]cb^{1-\eta}}{\gamma(1+k)-1-b^{\gamma-\eta}[\eta(1+k)-1]}w^{\gamma-1} - \frac{b^{\gamma-\eta}(\delta+\lambda-\alpha)k + [\gamma(1+k)-1]cb^{1-\eta}}{\gamma(1+k)-1-b^{\gamma-\eta}[\eta(1+k)-1]}w^{\eta-1}\right], \tag{B1}$$

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

$$\begin{pmatrix}\gamma\\ \eta\end{pmatrix} \equiv \frac{\frac{1}{2}\sigma^2 + c - r - \alpha - c' + g \pm \sqrt{\left(\frac{1}{2}\sigma^2 + c - r - \alpha - c' + g\right)^2 + 2\sigma^2(r + c' - g + \delta + \lambda)}}{\sigma^2}. \tag{B2}$$

There are 10 parameters in the valuation equation (B1): 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 HWM; σ is the volatility of fund returns; g is the contractual growth rate in the HWM level (i.e., hurdle rate), which is usually zero or the risk-free rate; α is the risk-adjusted expected gross-of-fee 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 HWM below which the investor loses confidence in the fund and liquidates all of his position; and r is the risk-free interest rate. The parameter b captures a performance-triggered liquidation boundary. For example, with $b = 0.8$ an investor liquidates his entire stake if it falls in value by 20% from its HWM.

We estimate the parameters of equation (B1) from observable fund-level data whenever possible. In particular, for c and k we use an individual fund's contractual information available from TASS. We compute σ as the square root of three times the standard deviation of monthly returns over the prior calendar year. The value of w for each existing investor is computed based on S and X obtained from the estimation procedure described in Appendix A. For r, we use the three-month LIBOR at the beginning of each quarter.

For the rest of the parameters that are not observable or reasonably estimable, we adopt the quarterly equivalent of the baseline parameter values used in GIR or LWY: $\alpha = 0\%$ and 3%; $\delta + \lambda = 5\%$ and 10%; $b = 0.685$ and 0.8; $g = r$ if a fund has a HWM provision, and zero otherwise; and $c' = 0$.[21] These parameter choices are summarized in Table CI in Appendix C.

B.2. GIR Model Augmented for Performance-Based Fund Flows

One of the limitations of the base-case 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 that 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, $s_{t+1} = s_t + ge_{t+1}$, 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 used in Table II except the lagged return terms. When we estimate this equation, the coefficient on the logged contemporaneous return equals 1.247. Then, at the fund-quarter level, we multiply the GIR volatility σ by this coefficient to provide a volatility parameter for the extended GIR model that is likely to reflect performance-based flows. Empirically, the mean quarterly volatility is boosted from 5.33% to 6.65%. 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 decrease b such that, under the new mean volatility, performance-based liquidation is as likely as before. For example, with $b = 0.8$ (0.685), an investor withdraws all assets following a minus 20.0% (31.5%) return, which is 3.75 (5.91) standard deviations away from one under

[21] 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 does not have this parameter and therefore effectively assumes it is equal to zero. Since c' cannot be reasonably estimated from the data, and a positive value for it serves to increase indirect incentives substantially, we follow LWY and assume that it equals zero throughout the paper.

the volatility parameter without flows. Now, under the new volatility parameter, a 3.75 (5.91) standard deviation drop translates into a minus 24.9% (39.3%) return, or equivalently $b = 0.751$ (0.607). In summary, relative to the base GIR model, the augmented model multiplies all fund-quarter-level volatility estimates by 1.247 and adjusts b as described above.

B.3. Baseline LWY Model

A drawback of the GIR 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 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 address this issue, we employ the model provided by Lan, Wang, and Yang (2013), which is a dynamic framework to value a hedge fund manager's compensation contract under the endogenous leverage choice of the manager.[22]

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

$$(\beta - g + \delta + \lambda)\, f(w) = cw + [\pi(w)\alpha' + r - g - c]wf'(w) + \tfrac{1}{2}\pi(w)^2\sigma'^2 w^2 f''(w), \tag{B3}$$

subject to the boundary conditions

$$f(b) = 0, \tag{B4}$$

$$f(1) = (k+1)\, f'(1) - k, \tag{B5}$$

where α' and σ' represent unlevered alpha and volatility, respectively.

The optimal leverage policy $\pi(w)$ is dynamically determined as follows:

$$\pi(w) = \begin{cases} \min\left\{\frac{\alpha'}{\sigma'^2\psi(w)}, \bar{\pi}\right\}, & \psi(w) > 0 \\ \bar{\pi}, & \psi(w) \le 0 \end{cases}, \tag{B6}$$

[22] 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 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 that management fees are a constant fraction of the HWM, not the AUM. Overall, Drechsler (2014) reaches similar results to 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 as it embeds as special cases both Panageas and Westerfield (2009) and GIR (with leverage exogenously fixed at zero).

where $\psi(w)$ is a risk-neutral manager's endogenous risk attitude. Risk attitude $\psi(w)$ is in turn defined by

$$\psi(w) \equiv -\frac{f''(w)}{f'(w)}. \tag{B7}$$

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 alphas of 0% and 3% are 0% and 1.4%, respectively. Likewise, the unlevered volatility (σ') is obtained for each fund-quarter by dividing the estimated quarterly volatility σ in the data by 2.13.[23] Parameter choices are summarized in Table CI. In general, the ODE in equation (B3) does not have an analytical solution and must be approximated numerically.

B.4. LWY Model Augmented for Performance-Based Inflows

LWY provide an extension of their baseline model that includes future performance-based fund flows. LWY assume that new money arrives over incremental time interval $(t, t + \Delta t)$, and show that dI_t evolves as follows:

$$dI_t = i\left[dH_t - (g - \delta) H_t dt\right], \tag{B8}$$

where $I > 0$ denotes the sensitivity of dI_t with respect to the fund's instantaneous (gross) profits.

Now the value of total fees $f(w)$ satisfies ODE (B3) subject to the following boundary conditions:

$$f(b) = 0, \tag{B9}$$

$$f(1) = \frac{(k+1) f'(1) - k}{1 + i}. \tag{B10}$$

We choose $i = 0.8$ following LWY. In general, 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.

[23] The unlevered volatility (σ') is floored and capped at 1.4% and 4.2%, respectively, because the ODE (B3) cannot be solved when σ' takes an excessively small or large value.

B.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 present value 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:

$$w_{\text{new}} = \begin{cases} 1, & \text{if the fund has no hurdle rate,} \\ \frac{1}{1+r}, & \text{if the fund has a hurdle rate.} \end{cases} \tag{B11}$$

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

To compute indirect pay for performance from changes in the value of existing investors′ stakes, we proceed as follows. First, we compute the $f(w)$ fraction for each fund-quarter for *each* existing investor, $f(w_i)_{old}^{base}$, assuming that the fund earns an 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 quarter (calculated as described in Appendix A) and multiply by (1 + baseline return). Then if the result is less than one and the fund has an 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 $1/(1 + r)$.[24] Finally, if the fund does not have an 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, incentive fees are paid, and the strike resets. We sum these individual investors' $f(w)$ fractions over all investors in the fund as follows:

$$f(w)_{old}^{base} = \sum_i x_i f(w_i)_{old}^{base}, \qquad \text{where } x_i = \frac{S_i}{\sum_i S_i}. \tag{B12}$$

We next rerun 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

[24] As in Appendix A, we assume that an fund has a hurdle rate whenever it has an HWM provision.

existing investors as the difference between $f(w)_{old}^{base+1\%} \times AUM \times (1+baseline\ return + 1\%)$ and $f(w)_{old}^{base} \times AUM \times (1 + baseline\ return)$.

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

Appendix C: Tables

Table CI

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; annual rate/4	Fund specific; annual rate/4	Fund specific; annual rate/4	Fund specific; annual rate/4
k	Fund specific	Fund specific	Fund specific	Fund specific
σ (σ')	Fund-quarter specific; quarterly volatility = standard deviation of monthly returns over the prior 12 month period × $\sqrt{3}$	Fund-quarter specific; quarterly volatility × 1.247	Fund-quarter specific; corresponding unlevered volatility (σ') = quarterly volatility/2.13	Fund-quarter specific; corresponding unlevered volatility (σ') = quarterly volatility/2.13
α (α')	Quarterly equivalent of 0%, 3%	Quarterly equivalent of 0%, 3%	Quarterly equivalent of 0%, 3%; corresponding unlevered alpha (α') = 0%, 1.4%	Quarterly equivalent of 0%, 3%; corresponding unlevered alpha (α') = 0%, 1.4%
$\delta+\lambda$	Quarterly equivalent of 5%, 10%	Quarterly equivalent of 5%, 10%	Quarterly equivalent of 5%, 10%	Quarterly equivalent of 5%, 10%
b	0.685, 0.8	0.607, 0.751	0.685, 0.8	0.685, 0.8
r	3-Month LIBOR	3-Month LIBOR	3-Month LIBOR	3-Month LIBOR
g	$= r$, if HWM $= 0$, if no HWM	$= r$, 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-quarter-investor specific	Fund-quarter-investor specific	Fund-quarter-investor specific	Fund-quarter-investor specific
i	n/a	n/a	n/a	0.8

Table CII

Summary Statistics for the Mutual Fund Sample

This table presents descriptive statistics for the sample of 307,079 fund-quarter observations associated with 11,911 mutual funds during the 1995 to 2010 sample period. Data are obtained from the Center for Research in Security Prices (CRSP) Survivorship Bias Free Mutual Fund Database. Only actively managed, domestic equity funds are considered, excluding index funds, exchange-traded funds, exchange-traded notes, international funds, fixed income funds, and sector funds. *Quarterly flow, Quarterly returns, Age*, and *Volatility* are constructed in the same way as the corresponding variables for hedge funds. *Management fees* are the expense ratio minus 12b1 fees as the percentage of total assets, measured at the end of each quarter. All variables except the style indicator are reported at the fund-quarter level. *Quarterly flow, Quarterly returns*, and *Volatility* are winsorized at the 1^{st} and 99^{th} percentiles.

Variable	*N*	Mean	25^{th} Pctl.	Median	75^{th} Pctl.	*SD*
Quarterly flow (%)	307,079	5.05	−4.95	−0.55	6.66	25.33
Quarterly returns (%)	307,079	1.59	−4.06	2.52	8.00	10.34
AUM ($ million)	307,079	322.2	6.6	38.4	184.7	936.2
Age (quarters)	307,079	31.28	11.44	21.38	37.35	36.13
Volatility (%)	307,079	8.34	5.22	7.60	10.53	4.06
Management fees (%, annualized)	307,079	1.08	0.86	1.05	1.25	0.82
Style						
Large-cap (EDCL)	11,911	0.002				
Mid-cap (EDCM)	11,911	0.108				
Small-cap (EDCS)	11,911	0.171				
Micro-cap (EDCI)	11,911	0.007				
Growth & Income (EDYB)	11,911	0.230				
Growth (EDYG)	11,911	0.438				
Income (EDYI)	11,911	0.030				
Hedged (EDYH)	11,911	0.014				
Dedicated short bias funds (EDYS)	11,911	0.001				

Table CIII

Estimates of Flow-Performance Sensitivity for Mutual Funds

This table presents the OLS coefficient estimates of equation (1) and corresponding standard errors (in parentheses) for the sample of mutual funds over the period 1995 to 2010. The dependent variable is *Quarterly flow*, as defined by equation (2). Style fixed effects, quarter fixed effects, and quarter-by-style fixed effects are included in all models. Standard errors are double clustered by fund and year. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)		(2)	
Dependent var. = Quarterly flow(t)	Coef.	(*SE*)	Coef.	(*SE*)
Quarterly returns(t−1)	0.647***	(0.060)	0.539***	(0.057)
Quarterly returns(t−2)	0.405***	(0.056)	0.284***	(0.051)
Quarterly returns(t−3)	0.252***	(0.046)	0.176***	(0.042)
Quarterly returns(t−4)	0.216***	(0.045)	0.171***	(0.038)
Quarterly returns(t−5)	0.170***	(0.040)	0.125***	(0.034)
Quarterly returns(t−6)	0.135**	(0.053)	0.106**	(0.044)
Quarterly returns(t−7)	0.100**	(0.044)	0.083**	(0.036)
Quarterly returns(t−8)	0.060	(0.044)	0.049	(0.037)
Quarterly returns(t−9)	0.086**	(0.041)	0.078**	(0.034)
Quarterly returns(t−10)	0.114***	(0.040)	0.104***	(0.031)
Quarterly returns(t−11)	0.075*	(0.042)	0.063*	(0.035)
Quarterly flow(t−1)			0.253***	(0.009)
Log(Age + 1)			−0.023***	(0.002)
Log(AUM(t−1)+1)			−0.010***	(0.001)
Volatility			−0.024	(0.059)
Management fees			−0.143	(0.329)
Indicators for missing lagged returns	Yes		Yes	
Fixed effects				
Style	Yes		Yes	
Quarter	Yes		Yes	
Style × Quarter	Yes		Yes	
Number of observations	307,079		307,079	
Adjusted R^2	0.123		0.192	
F-test for joint significance of	*F*-stat.	(*p*-value)	*F*-stat.	(*p*-value)
All lagged returns	20.29***	(0.000)	18.53***	(0.000)

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