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Higher risk, lower returns: What hedge fund investors really earn ☆

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ABSTRACT

The returns of hedge fund investors depend not only on the returns of the funds they hold but also on the timing and magnitude of their capital flows in and out of these funds. We use dollar-weighted returns (a form of Internal Rate of Return (IRR)) to assess the properties of actual investor returns on hedge funds and compare them to buy-and-hold fund returns. Our main finding is that annualized dollar-weighted returns are on the magnitude of 3% to 7% lower than corresponding buy-and-hold fund returns. Using factor models of risk and the estimated dollar-weighted performance gap, we find that the real alpha of hedge fund investors is close to zero. In absolute terms, dollar-weighted returns are reliably lower than the return on the Standard & Poor's (S&P) 500 index, and are only marginally higher than the risk-free rate as of the end of 2008. The combined impression from these results is that the return experience of hedge fund investors is much worse than previously thought.

1. Introduction

Hedge funds have enjoyed spectacular growth over the last two decades, climbing from $38 billion of assets under management in 1990 to $2.48 trillion at the peak in 2007.[1] There are a number of reasons for this success but the most important one is hedge funds' apparent ability to deliver superior performance, e.g., a review in Stulz (2007) finds annual alpha of 3% to 5%. Proponents of hedge funds point out that this superior performance is possible due to their lightly regulated status and the ability to use unconventional investment assets and strategies (e.g., Fung and Hsieh, 1997a). However, there are also reasons for skepticism about hedge funds' actual investor returns. Hedge funds operate in highly competitive markets, where information and trading advantages are unlikely to be maintained for long. Indeed, more recent studies provide a more skeptical view of hedge fund returns, finding smaller and only sporadic alpha (e.g., Fung, Hsieh, Naik, and Ramadorai, 2008; Naik, Ramadorai, and Stromqvist, 2007) or no outperformance at all (e.g., Amin and Kat, 2003; Aragon, 2007; Griffin and Xu, 2009).

We contribute to this debate by providing a novel way to assess the effect of fund flows on actual investor returns. Intuitively, as hedge funds proliferate and grow, deploying larger amounts of capital becomes progressively more difficult and chasing the same investment opportunities yields diminishing returns (see Fung, Hsieh, Naik, and Ramadorai, 2008), implying mediocre performance for the greater mass of investors who joined the funds only after the initially superior performance. This

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study suggests a specific way to operationalize this intuition by distinguishing between the returns of *hedge funds* and the returns of *investors* in these funds. Specifically, the return on hedge funds is given by the buy-and-hold return on the fund, while the return of investors is computed as the dollar-weighted return on the fund. The dollar-weighted return is an internal-rate-of-return (IRR) calculation that views the fund as a time-ordered schedule of signed capital flows; the IRR is the return that solves the discounted sum of these flows to be equal to zero.

The difference between buy-and-hold and dollar-weighted returns is in what is being measured, where the intuition is that one needs the right measure for the right purposes. Buy-and-hold returns are by definition the right measure for most hypothetical trading strategies and alpha investigations that assume buy-and-hold behavior. In our setting, buy-and-hold returns measure the return on the fund, or equivalently, the return for a passive investor who joined the fund at inception and held the same position throughout. This is a poor representation of the return of actual investors in hedge funds, however, because most investors join the funds not only later but in widely uneven bursts of capital contributions. In contrast, dollar-weighted returns are essentially returns that are value-weighted *over time* by the amount of invested capital; thus, dollar-weighted returns properly reflect the effect of the timing and magnitude of fund flows on investor returns. Our expectation is that dollar-weighted effects are possibly rather strong for hedge funds due to the large magnitude and sensitivity of their capital flows.

We use a comprehensive sample combining the Lipper-TASS database and the Center for International Securities and Derivatives Markets (CISDM) database to provide evidence on the properties of dollar-weighted investor returns versus buy-and-hold fund returns for nearly 11,000 hedge funds over 1980–2008. Our main finding is that, depending on specification and time period examined, dollar-weighted returns are on the magnitude of 3% to 7% lower than corresponding buy-and-hold returns. The magnitude of this difference suggests that the consideration of dollar-weighted effects is critical in the evaluation of investor returns; for example, this difference is large enough to reverse the conclusions of existing studies that document outperformance (see Stulz, 2007). The hedge fund performance gap is also much wider than extant evidence of dollar-weighted effects in other investments, e.g., about 1.5% gap for broad stock indexes (see Dichev, 2007) and mutual funds (see Friesen and Sapp, 2007). Turning to benchmarks, we show that the hedge fund portfolio buy-and-hold return over 1980–2008 is 12.6% but the corresponding dollar-weighted return is only 6%, reliably lower than the S&P 10.9% return over the same period, and barely above the 5.6% risk-free rate. Comparing our dollar-weighted wedge to evidence of alpha both in exiting studies and as calibrated in our sample reveals that investors as a class have likely earned negligible alpha after the dollar-weighted adjustment. We also find that dollar-weighted returns are more variable than their buy-and-hold counterparts, suggesting that existing estimates understate the risk of hedge fund investing; however, the volatility effect is economically modest. Summarizing, the combined impression from these results is that the risk-return trade-off for hedge fund investors is much worse than previously thought.

The main results are confirmed in a number of alternative specifications and subsamples, assuring their robustness. We find reliable dollar-weighted effects in all types of hedge funds, for all fund sizes, and for various stratifications on level of management fee, use of leverage, types of investment, and various restrictions on investor capital. We also probe deeper into the nature and causes of dollar-weighted effects in hedge funds. We find that investor capital flows chasing returns is the primary explanation for the dollar-weighted wedge. Looking more closely into this phenomenon, we find return-chasing in both the time-series and the cross-section of funds, where the aggregate time-series effect is the dominant driver.

2. Background, theory, and research design

2.1. Background on hedge fund performance

The rising prominence of hedge funds has prompted a number of studies that investigate their performance and compare it to various benchmarks. This literature identifies several unique difficulties in assessing hedge fund performance. The thorniest problem arises because hedge funds are not required to report their results and thus, all existing evidence is based on self-reported data with attendant self-selection biases, e.g., Fung and Hsieh (1997b), Brown, Goetzmann, and Ibbotson (1999), and Brown, Goetzmann, and Park (2001). Specifically, since poor-performing funds are less likely to report their results, the resulting sample has a bias towards outperforming funds and years, e.g., see Ackermann, McEnally, and Ravenscraft (1999) and Malkiel and Saha (2005). Another difficulty arises because hedge funds often employ sophisticated strategies using derivatives and leverage, which have highly non-linear payoffs, e.g., Agarwal and Naik (2004) and Fung and Hsieh (2001). Thus, historical evidence may be a poor indicator of the underlying risk profile and future performance, a variation on the so-called *peso problem*. Finally, measures of investor returns also have to account for the substantial management fees, typically on the magnitude of 1% to 2% of assets plus 15% to 25% of profits.

Accounting for these difficulties has been challenging but with the proliferation and increasing sophistication of studies, some key themes have emerged. Many studies find that hedge funds earn positive alpha on the magnitude of 3% to 5%, e.g., Ibbotson and Chen (2006), Kosowski, Naik, and Teo (2007), and Brown, Goetzmann, and Ibbotson (1999). Such large-scale evidence of outperformance is rare in the investment world, and is in sharp contrast to the documented experience with mutual funds, for example, which have zero or negative alpha after fees (see Wermers, 2000). Studies have also found some evidence of skill as the origin of this superior

performance; e.g., Titman and Tiu (2009) find that hedge funds that tilt away from systematic factors and embrace more idiosyncratic positions provide better returns.

However, there are also skeptical views about the ability of hedge funds to earn positive alpha, especially in more recent studies. Ackermann, McEnally, and Ravenscraft (1999) find that hedge funds earn higher gross returns than mutual funds but this superiority is dissipated after accounting for all fees. Fung, Hsieh, Naik, and Ramadorai (2008) find only limited and sporadic evidence of alpha for funds-of-funds during 1995–2004, while Bhardwaj, Gorton, and Rouwenhorst (2008) find no alpha for Commodity Trading Advisors (CTAs). At the extreme, Griffin and Xu (2009) and Amin and Kat (2003) document no alpha at all, albeit in relatively small samples. Recent studies also show that hedge fund returns have become increasingly correlated with standard market indexes, e.g., Fung and Hsieh (2007) and Asness, Krail, and Liew (2001), suggesting that the marginal return of investing in hedge funds has declined with the growth of the industry. Consistent with this evidence, Naik, Ramadorai, and Stromqvist (2007) and Zhong (2008) find alpha is still positive but has been steadily declining over time.

This skepticism about hedge fund alpha has been bolstered by research on the relation between fund flows and performance. A number of studies finds that fund flows chase superior past returns (see, e.g., Baquero and Verbeek, 2005; Sirri and Tufano, 1998), while greater fund flows are associated with poor future performance (see Fung, Hsieh, Naik, and Ramadorai, 2008); the combination of these results suggests that many late-arrival investors do not earn the publicized returns on the funds. There are also more positive views of fund flows, e.g., Ding, Getmansky, Liang, and Wermers (2009) find that fund flows earn better returns for funds with no share restrictions. While there are differences in findings, there is little doubt that large capital flows are pervasive in the hedge fund industry, and that there are systematic relations of these flows to fund performance, which possibly create a wedge between fund and investor returns.

This study suggests a new return metric, dollar-weighted returns, which captures the effect of the timing and magnitude of investor capital flows on actual investor returns. Given the magnitude and sensitivity of capital flows in the hedge fund industry, there are reasons to believe that dollar-weighted effects can be a large and even decisive determinant of the actual returns of hedge fund investors.[2] The magnitude of these dollar-weighted effects is also useful as a summary statistic of the effect of fund flows on performance. Essentially, the potential dollar-weighted performance gap is a point estimate of the economic effect of return-chasing and diseconomies of scale on actual investor returns.

2.2. Dollar-weighted returns

For the interested reader, Appendix A provides a primer and stylized examples of the difference between buy-and-hold and dollar-weighted returns. Here, we briefly present the intuition for dollar-weighted effects in the hedge fund setting, followed by a more rigorous exposition and link to the empirical analysis that follows. The chief disadvantage of buy-and-hold returns as a measure of investment performance is that they assume equal-weighting of capital over time. However, investors' actual returns are determined not only by the returns on their investments but also by the amount of invested capital, which changes with capital flows from and into the investment. Hedge funds provide an instructive example, where the typical fund has been a large net recipient of capital over its life; this pattern of flows indicates that investor capital exposure has been gradually increasing over time, and also signifies that later-period returns are more important for the overall investor return than early-period returns. To illustrate, since capital exposure peaked in 2007, hedge fund investors likely fared much worse after the great losses of 2008 as compared to what buy-and-hold metrics would suggest. This intuition can be operationalized by viewing a hedge fund investment as a capital project, where the initial investment and capital contributions are counted as capital inflows, and capital distributions and ending assets-under-management are counted as capital outflows. Solving for the internal rate of return (IRR) of this time-ordered schedule of capital flows yields the dollar-weighted return on this investment, which is also the actual investment experience of the average investor.

To link this intuition to the empirical data and tests that follow, consider that hedge fund capital flows can be computed using the formula

$$\text{Capital flow}_t = \text{AUM}_t - \text{AUM}_{t-1} \times (1+r_t), \tag{1}$$

where r_t is the buy-and-hold return for period t, AUM_t is assets-under-management, and Capital flow_t is the signed capital flow for period t, where positive capital flow signifies fund inflows (investor contribution), and negative capital flows signify fund outflows (investor distributions).[3]

The dollar-weighted return (r_{dw}) is defined as the rate of return that equates the discounted ending asset value to the sum of the initial assets-under-management and the present value of the capital flows realized over the life

[2] Hedge funds are aware of the importance of capital flows, and in fact, contractual restrictions on investor flows are common in the industry, for example, share restrictions, closure to new investments, lock-up and redemption periods, etc. The results in this paper reflect what happens after the effect of these restrictions; of course, if these restrictions did not exist, the identified effects are likely to have been even stronger.

[3] The intuition behind expression (1) is that the change in AUM during a given period can come from only two sources, fund returns and investor capital flows. Thus, for any given period t, capital flows can be imputed from changes in AUM during that period controlling for fund returns. Note also that assets-under-management for hedge funds does not mean gross assets (which can be substantially inflated from using leverage) but the equity interest of investors, i.e., the accounting is on a net basis. Since returns for hedge funds are reported net of management fees, everything is on a "net-net" basis, so the calculation in Eq. (1) correctly imputes investors' capital flows.

of the fund[4]:

$$\frac{\text{AUM}_t}{(1+r_{dw})^t} = \text{AUM}_0 + \sum_{t=1}^{T} \frac{\text{Capital flow}_t}{(1+r_{dw})^t}. \quad (2)$$

The main advantage of the dollar-weighted metric is that it properly reflects the effect of capital flows and changing capital exposure on investor returns. This becomes apparent when one takes the expression for capital flows from Eq. (1), plugs it into the dollar-weighted returns calculation in Eq. (2), and after rearranging, obtains

$$\sum_{t=1}^{T} \frac{\text{AUM}_{t-1}}{(1+r_{dw})^{t-1}} \times r_{dw} = \sum_{t=1}^{T} \frac{\text{AUM}_{t-1}}{(1+r_{dw})^{t-1}} \times r_t. \quad (3)$$

An inspection of Eq. (3) reveals that the dollar-weighted return is an average of the periodic returns, weighted by discounted beginning assets. Thus, essentially, dollar-weighted returns are average returns that are value-weighted *over time*.

The key corollary is that dollar-weighted returns will deviate from buy-and-hold returns if period returns are systematically related to the period's beginning discounted asset holdings. In particular, if returns during periods with high assets are systematically lower than returns of periods with low assets, the dollar-weighted return will be lower than the buy-and-hold return. In other words, if returns are negatively correlated with previous capital inflows, dollar-weighted returns will be lower than buy-and-hold returns. Such negative correlations can be observed when (1) investor capital chases superior past returns (e.g., Sirri and Tufano, 1998; Frazzini and Lamont, 2008), or (2) funds have trouble deploying new capital leading to lower future returns (e.g., Chevalier and Ellison, 1997). Notice that dollar-weighted effects can appear even in the absence of correlations between capital flows and returns. For example, consider steady fund inflows accompanied by falling returns; the result is dollar-weighted returns lower than buy-and-hold returns because capital exposure increases when returns are falling.

Summarizing, buy-and-hold returns reflect the return experience of *funds* or of investors who bought the fund at inception and held it passively throughout its life. Dollar-weighted returns reflect the actual experience of real-life *investors*, who consciously or unconsciously time their capital flows into and out of the funds, and thus, their actual realized return can differ substantially from that of the fund.

Note that dollar-weighted effects exist for most investments including stocks, bonds, mutual funds, real estate, and venture capital; dollar-weighted effects also exist at all levels of aggregation including individual stocks and funds, any-size portfolios of individual investments, and reaching all the way up to broad market indexes and national and world markets. Recent research and practice reflect a growing interest in dollar-weighted effects, and the emergence of some consistent patterns in dollar-weighted vs. buy-and-hold returns. Dichev (2007) finds that dollar-weighted returns are about 1.5% lower than buy-and-hold returns across the top 19 U.S. and international stock markets. Zweig (2002) and Friesen and Sapp (2007) provide evidence that dollar-weighted returns for U.S. mutual funds are typically lower than buy-and-hold returns. In 2006, Morningstar started calculating and publishing dollar-weighted returns for all open-end mutual funds it covers. Morningstar's results also indicate that dollar-weighted returns are systematically lower than buy-and-hold returns for mutual funds, with an average difference of 1.5%. More generally, there is a growing awareness and evidence that the timing of capital flows matters for investor returns, and that average investor timing is poor, e.g., Frazzini and Lamont (2008).

This study advances the existing literature by investigating the magnitude of dollar-weighted vs. buy-and-hold returns for hedge funds. To our knowledge, this has not been done before, while it seems necessary and even critical given the heated debate about whether and how hedge funds benefit investors. Given the nature of hedge funds (extreme and sensitive capital flows), there is possibly a substantial wedge between fund and investor returns. The study also provides evidence on the variability of dollar-weighted vs. buy-and-hold returns because one needs to consider the second moment to fully depict the risk-return trade-off facing hedge fund investors.

3. Main empirical tests

3.1. Data and descriptive statistics

Our sample is based on merged data from two hedge fund databases, Lipper-TASS and CISDM.[5] After eliminating 2,029 duplicate funds, our preliminary sample comprises 18,094 hedge funds and hedge fund-like entities.[6] We use all available data subject to some minimal constraints. The sample starts in 1980 to avoid earlier years with too-few funds. We also require at least ten monthly capital flows to avoid the effect of marginal funds on the results. We only include funds reporting returns net-of-fees, and all calculations of returns and capital flows are done at the monthly level to allow the accurate timing of

[4] One difficulty in computing dollar-weighted returns is multiple roots found when solving the higher-order polynomial, especially when there is a frequent change in the sign of the capital flows. However, cases where the correct root is ambiguous are rare; specifically, less than 1% of the funds have more than one real root with an absolute monthly return value less than 100%. For such cases, we nominate the root with the closest absolute value to the buy-and-hold return as the dollar-weighted return.

[5] Hedge fund databases do not have a common identifier, so proper merging is challenging, here accomplished as follows. First, we match fund names using the SAS, text variable functions. Next, inception date, reporting currency, management fee, fund status, and average AUM are used as additional filters to verify the potential matches. Finally, we manually check each fund-pair to identify false matches.

[6] Strictly speaking, the unit of our analysis is fund-share class. Note that typically funds have multiple share classes to be able to make their offerings in multiple currencies. Since our final sample has only funds reporting in US dollars, the variables fund and share class largely coincide in our sample.

capital flows for the dollar-weighted computation. To preserve comparability for buy-and-hold and dollar-weighted calculations, returns are excluded from the buy-and-hold calculation when assets-under-management is not available, yielding a sample of 13,787 funds.[7] Finally, our tabulated results are based on 10,954 funds reporting in US dollars because computing capital flows for aggregate specifications becomes problematic in the presence of exchange rate fluctuations. Untabulated results at the individual fund level for non-dollar-denominated funds (numbering 2,834) reveal that their dollar-weighted effects are almost the same as those reported in this study.

Table 1 provides descriptive statistics for the test sample, where Panel A contains the results for all available funds (including hedge funds proper, funds-of-funds, etc.), while Panel B contains the results for hedge funds proper only. An inspection of Panel A reveals several observations which are useful for our analysis. Consistent with existing results, our sample reveals a dizzying growth in the number of hedge funds, starting with a low of just 11 in 1980 and hitting a high of 5,938 in 2007. Total assets-under-management also mushroom from a low of $224 million at the beginning of the period to a high of over $1.2 trillion in year 2007, an astounding increase over only 27 years. One reason for this great increase is excellent investment returns, where the compounded value-weighted return over the sample years is 13.8%. However, the compounding of the initial market value at 13.8% over 27 years would have produced an ending value of only $7.3 billion; the difference between this hypothetical number and the actual $1.2 trillion is explained by the effect of massive capital inflows; specifically, the variable *Capital flow/AUM* averages 0.179 over the sample period, i.e., the aggregate capital inflow for each year in our sample averages 18% of beginning AUM. In addition, the standard deviation of the aggregate capital inflow is 17.8%, which confirms our conjecture that hedge fund flows are not only large but extremely variable.[8] The combined impression from these statistics is that even modest correlations between fund flows and returns can produce large dollar-weighted effects, and these effects are likely to be stronger than those shown in existing research.

Note also that investment returns differ substantially between the first and second part of the sample period. The first subperiod, 1980–1994, offers an outstanding annual return of 16.8%, while the second subperiod, 1995–2008, yields only 9.0%. Given the steadily increasing capital exposure of investors over the sample period, the conclusion is that on a capital-adjusted basis, investors must have done considerably worse than what the simple buy-and-hold return measure suggests. The dollar-weighted returns also reflect other less-visible relations between period returns and capital flows, for example, performance-chasing at the individual fund level (which is scattered in calendar time) or diminishing marginal returns from troubles deploying newer assets. Finally, the data in Table 1 indicate a marked reversal of fortune in year 2008. The value-weighted return in 2008 is −0.168, by far the worst in the sample period; coupled with record redemptions of 39%, the ending AUM is only half of what it was at the end of year 2007. The dramatic experience of year 2008 has a pronounced effect on estimates of hedge fund returns, and thus, much of our later tests present results with and without the inclusion of the pivotal year 2008.

The descriptive statistics for hedge funds proper only in Panel B of Table 1 reveal the same pattern of characteristics as for all funds in Panel A. Returns are high throughout the sample period but the average of the first half at 18.7% greatly exceeds the average of 9.5% during the second half. Capital inflows are higher in absolute magnitude at an average of 26.3% and have a higher variability over time. The data for year 2008 exhibit the same dramatic effects, with ending AUM only about half of beginning AUM because of poor returns and massive redemptions.

3.2. Dollar-weighted returns of individual funds

Table 2 provides evidence on buy-and-hold vs. dollar-weighted returns at the level of the individual fund. Panel A provides results for the combined sample that includes all 10,954 hedge funds and hedge fund-like entities. Mean buy-and-hold return across funds is 6.1%, while the mean dollar-weighted return is only 2.9%, implying a statistically significant and economically substantial 3.2% performance gap.[9] Thus, the results in Panel A confirm earlier impressions that actual hedge fund investor returns are considerably lower than existing estimates based on geometric averages. Note that the absolute magnitude of both returns is low, especially compared with the descriptive statistics in Table 1. The poor returns in Table 2 are due to the inclusion of a great multitude of small, short-lived, and poor-performing funds, especially in the most recent years of the sample.

Panel A also presents the dispersion of returns across funds. Since hedge fund investing has a relatively short history and dollar-weighting is a long-horizon time-series phenomenon, there is simply not enough information to

[7] Missing AUM occurs in 15% of the database observations, usually when the fund first appears in the database or when the fund stops reporting. Cases when AUM is missing in the middle of the return series are rare, occurring in 1% of the sample; in such cases, we assume the capital flows are zero.

[8] As a benchmark, consider that the volatility of aggregate capital flows for broad stock markets is on the magnitude of 4% in Dichev (2007).

[9] The test for difference in means is a simple *t*-test. The existing literature has shown a number of non-normalities and dependencies in investment returns, e.g., the literature on stock returns identifies large cross-sectional dependencies and some time-series dependencies, and recommends various ways to adjust the standard errors in statistical testing (Petersen, 2009). We opt for the simple tests in Table 2 for two reasons. First, the cross-sectional dependencies in hedge fund returns are much less important. Hedge fund returns are much less correlated with the broad market, and likely with each other. In addition, the average life span in our sample is six years as compared to a 28-year test period, further decreasing possible cross-sectional effects. Second, we aim to keep things simple, and these results are significant at levels where adjustments are unlikely to change the conclusions. Finally, later in the paper we use bootstrap technology to provide alternative and robust tests of statistical significance.

Table 1
Descriptive statistics: assets-under-management, returns, and capital flows.

The table presents descriptive statistics for all funds including hedge funds, funds-of-funds, CTAs, and CPOs. Total AUM is the sum of assets-under-management for all funds. Buy-and-hold return is the value-weighted buy-and-hold return in that year. Total capital flow is the sum of the monthly capital flows of all funds during the year. Monthly capital flows are computed from the following equation: Capital flow$_t$=AUM$_t$−AUM$_{t-1}\times$(1+return$_t$). The summary statistics in the lower tables are the mean and standard deviation of the annualized buy-and-hold return and the annual capital flows as a percentage of AUM.

Panel A: All 10,954 funds, 1980–2008

Year	No. of funds	Total AUM (in $ million)	Buy-and-hold return (value-weighted)	Capital flow/AUM
1980	11	224	0.138	
1981	14	357	0.332	0.20
1982	22	501	0.262	0.11
1983	28	465	−0.002	−0.07
1984	43	678	0.176	0.23
1985	61	1,006	0.249	0.20
1986	84	1,503	0.052	0.36
1987	121	2,762	0.271	0.38
1988	163	4,487	0.153	0.37
1989	220	6,122	0.139	0.20
1990	319	9,590	0.197	0.28
1991	444	17,182	0.194	0.39
1992	602	26,633	0.107	0.34
1993	871	55,994	0.286	0.53
1994	1,247	71,653	−0.034	0.27
1995	1,573	87,533	0.190	0.07
1996	1,867	119,019	0.196	0.15
1997	2,274	179,649	0.211	0.24
1998	2,624	194,118	−0.001	0.09
1999	2,981	237,563	0.194	0.04
2000	3,306	263,737	0.072	0.04
2001	3,645	320,506	0.049	0.15
2002	4,077	376,286	0.023	0.14
2003	4,606	569,795	0.148	0.28
2004	5,186	810,930	0.076	0.27
2005	5,575	911,029	0.076	0.04
2006	5,682	1,024,239	0.108	0.01
2007	5,938	1,226,008	0.091	0.09
2008	4,202	673,821	−0.168	−0.39

Buy-and-hold return

1980–2008			
Mean	0.130	STD	0.1097
1980–1994			
Mean	0.168	STD	0.106
1995–2008			
Mean	0.090	STD	0.101

Capital flow/AUM

1980–2008			
Mean	0.179	STD	0.178
1980–1994			
Mean	0.271	STD	0.153
1995–2008			
Mean	0.100	STD	0.163

Panel B: All 7,505 hedge funds, 1980–2008

Hedge funds

Year	No. of funds	Total AUM (in $ million)	Buy-and-hold return (value-weighted)	Capital flow/AUM
1980	1	12	0.21	
1981	2	25	0.22	0.51
1982	6	68	0.22	0.70
1983	7	121	0.24	0.36
1984	12	270	0.14	0.66
1985	17	386	0.25	0.19
1986	27	777	0.22	0.54
1987	47	1,326	0.11	0.45
1988	57	2,116	0.19	0.35
1989	89	3,204	0.19	0.28
1990	147	4,917	0.12	0.33
1991	219	9,583	0.25	0.45
1992	324	17,989	0.16	0.50
1993	499	39,409	0.33	0.56
1994	725	51,425	−0.03	0.29

Table 1. (*continued*)

1995	955		63,868	0.20	0.08
1996	1,176		89,097	0.22	0.17
1997	1,503		135,288	0.23	0.23
1998	1,756		143,177	−0.02	0.09
1999	2,038		179,453	0.22	0.04
2000	2,289		198,706	0.07	0.05
2001	2,513		236,886	0.05	0.13
2002	2,796		266,731	0.01	0.11
2003	3,109		386,700	0.16	0.23
2004	3,439		549,502	0.09	0.26
2005	3,719		629,968	0.09	0.05
2006	3,829		718,846	0.12	0.02
2007	3,993		876,091	0.10	0.10
2008	2,913		460,096	−0.20	−0.39

Buy-and-hold return				*Capital flow/AUM*			
1980–2008				1980–2008			
Mean	0.143	STD	0.109	Mean	0.263	STD	0.236
1980–1994				1980–1994			
Mean	0.187	STD	0.082	Mean	0.453	STD	0.148
1995–2008				1995–2008			
Mean	0.095	STD	0.117	Mean	0.098	STD	0.160

estimate meaningful variability using the time-series of dollar-weighted returns. Instead, we use the cross-section of funds to provide an estimate of cross-fund variability of dollar-weighted returns. The cross-fund specification also has a natural real-world investment interpretation—it captures the risk that investors face by choosing one fund versus another to invest in. We examine two indicators of dispersion: first, we look at the standard deviation of returns; second, since hedge fund returns may be not well-behaved, we examine the properties of the full empirical distribution of returns. Panel A reveals that the dispersion of dollar-weighted returns is higher than that of buy-and-hold returns. Specifically, buy-and-hold returns have a standard deviation of 18.7% across funds, while the standard deviation of dollar-weighted returns is 20.2%; the resulting difference of 1.5% is statistically significant but is economically modest. An examination of the percentiles of the empirical distributions of the two return metrics in Panel A confirms impressions from summary mean and standard deviation statistics, and suggests that outliers and other distributional quirks cannot account for the observed results.[10]

As mentioned above, a disadvantage of the results in Panel A is that all funds are weighted equally, while there are great differences in fund capitalization and longevity, with corresponding differences in fund importance to investors. To provide a more apples-to-apples distribution of returns across funds, we investigate two subsamples of funds in Panel B, comprising funds with at least a five-year and ten-year record, respectively. These requirements result in substantially reduced sample sizes but are also more representative of the return experience of the "typical" investor. Since the results are largely the same across these two subsamples, we only discuss the five-year specification. We find that buy-and-hold and dollar-weighted returns are both higher for this specification but the performance wedge remains almost the same at 3.1%. The standard deviation of dollar-weighted returns is again higher than that of buy-and-hold returns and now the difference looks more material both on an absolute basis (2.2%), and especially as compared to the base variability of these larger, more stable funds (about 10% to 12%). Results based on the percentiles of the empirical distribution of returns are consistent with those for the mean and the standard deviation; therefore, for parsimony we omit them for the rest of the table.

Next, we examine the mean returns of individual funds in different subperiods to examine the robustness of our findings to time-series factors. Specifically, we examine returns over early (1980 to 1994) vs. later years (1995 to 2008), and also the effect of excluding the pivotal year 2008. Panel C shows that dollar-weighted returns are lower and more variable than buy-and-hold returns in all of these specifications. As expected, both return estimates are much higher after excluding year 2008 but the dollar-weighted wedge remains largely the same. Panel D of Table 2 provides a breakdown of results by type of fund, including hedge funds proper, funds-of-funds, commodity pool operators, and commodity trading advisors (see Bhardwaj, Gorton, and Rouwenhorst, 2008). There is some variation in the relative magnitude of results across categories but the same basic pattern is largely confirmed.[11] Summarizing, the results for individual funds

[10] In contrast to mutual funds, hedge fund managers and other insiders often have substantial equity stakes in their funds. Thus, our results for investors include all investors rather than just outside investors.

[11] Hedge funds have relatively short lives, where the median age in our sample is six years. Defunct or inactive funds are mostly poorly performing funds that have been shut down; thus, there are systematic differences between active and inactive funds, which are possibly related to differential dollar-weighted effects as well. In untabulated results, however, we find largely the same dollar-weighted effects in a split between active and inactive funds.

Table 2
A comparison of buy-and-hold and dollar-weighted returns: 10,954 individual funds, 1980–2008.

The table shows the distribution of buy-and-hold and dollar-weighted returns at the level of the individual fund. Buy-and-hold return is the geometric average of the individual fund's annual returns. Dollar-weighted return for fund i ($r_{i,dw}$) is the rate of return that equates the discounted ending assets-under-management ($AUM_{i,t}$) to the sum of the initial assets-under-management ($AUM_{i,0}$) and the present value of realized capital flows as follows:

$$\frac{AUM_{i,t}}{(1+r_{i,dw})^t} = AUM_{i,0} + \sum_{t=1}^{T} \frac{\text{Capital flow}_{i,t}}{(1+r_{i,dw})^t},$$

where $\text{Capital flow}_{i,t} = AUM_{i,t} - (1+\text{return}_t)AUM_{i,t-1}$.

Fund-of-funds is an investment fund that invests in other (hedge) funds. CTA (Commodity Trading Advisor) is any person who, directly or indirectly, advises others as to the advisability of buying or selling commodity futures or option contracts. CPO (Commodity Pool Operator) is an individual or firm which operates a commodity pool for the purpose of trading commodity futures or option contracts.

Panel A: Individual fund returns

	All funds (*N*=10,954)			
	Buy-and-hold return (a)	Dollar-weighted return (b)	Difference (a)−(b)	*p*-Value[†]
Mean	0.061	0.029	0.032	<0.001
Std	0.187	0.202	−0.015	<0.001
P1	−0.422	−0.515	0.094	
P10	−0.088	−0.143	0.054	
P25	0.007	−0.024	0.031	
P50	0.063	0.041	0.022	<0.001
P75	0.116	0.093	0.023	
P90	0.190	0.159	0.031	
P99	0.504	0.485	0.019	

Panel B: Individual returns for funds with more than 5- or 10-year history

	Buy-and-hold return (a)	Dollar-weighted return (b)	Difference (a)−(b)	*p*-Value[†]
		Funds with more than 5-year history (N=5,712)		
Mean	0.090	0.060	0.031	<0.001
Std	0.098	0.120	−0.022	<0.001
		Funds with more than 10-year history (N=1,865)		
Mean	0.102	0.072	0.030	<0.001
Std	0.081	0.094	−0.014	<0.001

Panel C: Individual fund returns for different subperiods

	Buy-and-hold return (a)	Dollar-weighted return (b)	Difference (a)−(b)	*p*-Value[†]
		Early periods (1980–1994, N=1,232)		
Mean	0.131	0.093	0.038	<0.001
Std	0.235	0.299	−0.063	<0.001
		Later periods (1995–2008, N=10,923)		
Mean	0.060	0.031	0.029	<0.001
Std	0.188	0.208	−0.020	<0.001
		Excluding 2008 (1980–2007, N=10,744)		
Mean	0.115	0.094	0.021	<0.001
Std	0.195	0.230	−0.035	<0.001

Panel D: Individual fund returns by investment vehicles

	Buy-and-hold return (a)	Dollar-weighted return (b)	Difference (a)−(b)	*p*-Value[†]
		Hedge funds (N=7,505)		
Mean	0.064	0.029	0.035	<0.001
Std	0.200	0.223	−0.023	<0.001
		Funds-of-funds (N=2,111)		
Mean	0.026	0.009	0.017	<0.001
Std	0.105	0.119	−0.015	<0.001
		CTAs and CPOs (N=1,338)		
Mean	0.098	0.059	0.039	<0.001
Std	0.202	0.175	0.027	<0.001

[†] Significance levels are from *t*-tests for differences in means, chi-square test for the standard deviations, and Wilcoxon test for medians.

Table 3
Portfolio buy-and-hold returns and dollar-weighted returns 1980–2008.

The table shows buy-and-hold and dollar-weighted returns for value-weighted portfolios. Buy-and-hold return is the geometric average of the individual year's value-weighted returns over all available funds. Dollar-weighted return (r_{dw}) is the rate of return that equates the discounted ending aggregate assets (AUM_t) to the sum of the initial aggregate assets (AUM_0) and the present value of aggregate realized capital flows. Fund-of-funds is an investment fund that invests in other (hedge) funds. CTA (Commodity Trading Advisor) is any person who, directly or indirectly, advises others as to the advisability of buying or selling commodity futures or option contracts. CPO (Commodity Pool Operator) is an individual or firm which operates a commodity pool for the purpose of trading commodity futures or option contracts.

Panel A: Portfolio returns for all funds

	No. of funds	Buy-and-hold return (a)	Dollar-weighted return (b)	Difference (a) - (b)	*p*-Value[†]
All funds	10,954	0.126	0.060	0.066	0.012
Early periods (1980–1994)	1,232	0.164	0.117	0.048	0.184
Later periods (1995–2008)	10,923	0.086	0.058	0.029	0.003
Excluding 2008 (1980–2007)	10,744	0.138	0.097	0.041	0.068
Excluding backfilled years[a]	5,888	0.117	0.067	0.050	0.030
Excluding first 12 months of returns (Teo, 2009)	10,358	0.124	0.057	0.067	0.024

Panel B: Portfolio returns by investment vehicle

	No. of funds	Buy-and-hold return (a)	Dollar-weighted return (b)	Difference (a)−(b)	*p*-Value[†]
Hedge funds	7,505	0.138	0.061	0.077	0.001
Funds-of-funds	2,111	0.110	0.041	0.069	0.003
CTAs and CPOs	1,338	0.120	0.078	0.042	0.109

[†] Bootstrap test of significance, see text and Appendix B for more details.

[a] Backfilled years are years before each fund started reporting to the database. For each fund in the Lipper-TASS database, we eliminate all returns prior to the start-of-reporting date. Since the start-of-reporting date information is not available for funds in the CISDM database, we exclude all CISDM observations.

show that dollar-weighted returns are reliably lower than buy-and-hold returns on the magnitude of 3%. Dollar-weighted returns also tend to be more variable but this effect is economically modest. These results suggest that hedge fund investors take higher risks and earn lower returns than previously thought.

3.3. Portfolio-level dollar-weighted returns

A shortcoming of the results in Table 2 is the equal-weighting allotted to each fund regardless of length of existence or amount of capital employed. Table 3 addresses this shortcoming using value-weighted portfolio specifications, where buy-and-hold returns are computed as the geometric average of the individual years' value-weighted returns over all available funds. Dollar-weighted returns are computed by aggregating the individual funds' capital flows, and computing an IRR over the initial aggregate assets-under-management, the monthly aggregate capital flows, and the ending aggregate assets of the portfolio of available funds. Because the results in Table 3 properly reflect fund longevity and amount of invested capital, we view them as most representative of the average investor experience and therefore as the main results of the paper.

Panel A in Table 3 exhibits the aggregate results for all funds. While the buy-and-hold return is a solid 12.6%, the dollar-weighted return is only 6.0%, for a very substantial performance gap of 6.6%. We assess the statistical significance of this difference using a bootstrap test. The advantage of bootstrap tests is that they avoid the usual distributional assumptions, which is especially relevant given the properties of hedge fund returns; see Appendix B for an expanded description and explanation. The *p*-value of this test is 1.2% for the aggregate portfolios in Panel A, revealing reliable statistical significance.

Similar to the preceding analyses at the individual fund level, we present results for several subperiods. Buy-and-hold returns are much higher during 1980–1994 than during 1995–2008 but the dollar-weighted wedge is material in both subperiods (4.8% and 2.9%, respectively).[12] As expected, the magnitude of returns is higher when excluding the pivotal year 2008, and the dollar-weighted wedge shrinks from 6.6% to 4%. This evidence suggests that the dramatic events of 2008 had a much worse effect on investors than that suggested by traditional metrics; this is to be expected given that investors' capital exposure peaked in 2007 (see Table 1), exactly the worst time to be heavily invested in hedge funds. Thus, the experience of year 2008 is a vivid illustration of the importance of dollar-weighting. Using buy-and-hold metrics, the 2008 experience looks unpleasant but only mildly so, with average returns declining from 13.8% as of the end of 2007 to 12.6% as of the end of 2008. Dollar-weighting, which properly reflects the peak capital

[12] Note that the dollar-weighted wedge *within* the two subperiods is lower than the one over the whole sample. This happens because dollar-weighting is a time-series phenomenon, and thus, restricting the time-series almost by definition restricts the dollar-weighted wedge as well. The material difference between whole-sample and within-subperiods results indicates that there are material dollar-weighted effects *across* the 1980–1994 and the 1995–2008 subperiods.

exposure of investors as of 2007, paints a much bleaker picture, with average returns declining from a respectable 9.7% to a disappointing 6 percent, not that different from risk-free rates over the 1980–2008 period.

As discussed above, it is well-known that hedge fund data suffer from self-selection biases, where specific examples include incubation bias and backfill bias (see, e.g., Brown, Goetzmann, and Ibbotson, 1999; Fung and Hsieh, 2004). Incubation bias arises because hedge funds rely mostly on internal capital during their early years, and later successful funds attract much outside capital and publicize their returns, while we do not observe the returns of unsuccessful funds. The related backfill bias arises when database providers backfill the returns of newly entering funds, resulting in an inflated estimate of realized returns. It is less clear, however, whether these biases affect just the absolute level of returns or the dollar-weighted wedge as well. We address the incubation and backfill bias in two ways, one quite stringent but perhaps too restrictive, and the second one taking a more moderate path. For the stringent one, we retain only observations for which we are sure there is no backfill problem; specifically, TASS provides a start-of-reporting date and we eliminate all observations before that, while CISDM provides no such date, so we eliminate all CISDM observations. The results in Panel A of Table 3, indicate a dollar-weighted gap of 5.0%, which remains statistically and economically significant. For the more moderate specification, we follow Teo (2009) and drop the first 12 months of available fund returns; the tenor of the results remains unchanged. Thus, incubation and backfill bias seem to have only a minor effect on the calculated dollar-weighted effects.

Panel B in Table 3 breaks down the value-weighted results of Panel A by type of fund. Hedge funds proper are the largest group and also have the highest buy-and-hold returns at 13.8%, while funds-of-funds have the lowest corresponding return at 11.0%. The pattern found for aggregate returns in Panel A is confirmed for the partitions in Panel B, where all subgroups have dollar-weighted returns lower than buy-and-hold returns, and this performance gap is on the magnitude of 4% to 8%, highly significant in bootstrap tests except for the limited sample of CTAs and CPOs.

A chronic difficulty in evaluating hedge fund returns is finding appropriate benchmarks. Hedge funds comprise a number of disparate and sometimes exotic asset classes and strategies, including investing in stocks, real estate, and venture capital, and using options, substantial leverage, and short positions; thus, it is challenging to properly assess their risk profile and the commensurate return (Agarwal and Naik, 2004; Fung and Hsieh, 2004). To some extent, dollar-weighted returns are themselves a natural solution to benchmarking problems because there is no better control for a fund's risk profile than the fund itself. Accordingly, most of the analyses in this study emphasize the comparison between the fund buy-and-hold and dollar-weighted returns, which properly reflects the difference between investment and investor returns.

Hedge fund investments, however, are an organic and interchangeable part of the larger world of possible investments, and thus, some comparison with external benchmarks is warranted. We accomplish this task on two dimensions. First, in Panel A of Table 4 we present a simple comparison of aggregate portfolio dollar-weighted returns (as in Table 3) with returns on the S&P 500 index and the risk-free rate (measured as the one-month T-bill rate). We also include a hypothetical dollar-weighted return using *hedge funds*' pattern of capital flows combined with the return of the S&P 500; the motivation is to provide an "investment alternatives" benchmark for what hedge fund investors would have earned if they had invested in the S&P 500 instead. Given the dramatic effect of year 2008, we present results both including and excluding that year. An examination of the results in Panel A reveals that hedge fund dollar-weighted return at 6.0% is substantially lower than the 10.9% return on the S&P 500 and only marginally higher than the 5.6% risk-free rate of return over 1980–2008. Dollar-weighted returns look better excluding year 2008 but are still reliably within the spread of the risk-free rate and the S&P 500 return. Note that the hypothetical return calculated with hedge fund flows and the S&P 500 returns is 2.1%, the lowest in Panel A. This result confirms earlier impressions that it is not so much the investment but poor capital flow timing which causes the low returns; specifically, poor timing is what causes hedge fund investors to earn lower returns than the funds, and this same timing would have brought them poor returns on the broad stock market as well.

A disadvantage of the analysis in Panel A is that the benchmarks considered there are only a crude reflection of the investment profile of hedge funds. Existing research has developed more sophisticated models of hedge fund benchmarks, and thus better estimates of hedge fund alpha after controlling for exposure to various (risk) factors, e.g., Agarwal and Naik (2004), Edwards and Caglayan (2001), and Fung and Hsieh (2004). Thus, for our second approach we compare hedge fund alpha to the dollar-weighted wedge documented in this study; the intuition is that investors' risk-adjusted return (or net alpha) is really fund alpha minus the dollar-weighted wedge. As discussed above, existing evidence of outperformance suggests hedge fund alpha on the magnitude of 3% to 5%, e.g., Ibbotson and Chen (2006), Kosowski, Naik, and Teo (2007), and Brown, Goetzmann, and Ibbotson (1999). Using our estimate of the dollar-weighted wedge between 3% and 7% suggests that net alpha is close to zero or slightly negative.

To provide a more careful evaluation of this approach in our sample, in Panel B of Table 4 we use the Fama-French three-factor model and the augmented Fung and Hsieh (2004) model[13] in Panel C to estimate hedge fund alphas and the resulting net alphas; the two models seem good complements for our study because the Fama-French model is more generic but available for longer periods, while the Fung-Hsieh model is more

[13] The augmented Fung-Hsieh model includes the seven original factors in Fung and Hsieh (2004) plus the emerging markets factor used in Fung and Hsieh (2006).

Table 4
Comparing hedge fund dollar-weighted returns to various benchmarks.

Panel A presents a comparison of aggregate portfolio dollar-weighted returns with various investment benchmarks. *S&P 500 return* is the annualized value-weighted return of the S&P 500 index (including dividends). *Risk-free rate* is the annualized return of the one-month US Treasury bill. *Dollar-weighted S&P 500 return* is a benchmark dollar-weighted return using the capital flow patterns of hedge fund investors and the value-weighted returns of the S&P 500 index, providing a benchmark return for hedge fund investors, if they had invested in the S&P 500 with the same capital flow patterns.

Panel B and Panel C present risk-adjusted returns of hedge funds using different factor models. *Alphas* are calculated on a monthly basis for each fund and annualized. Factor loadings are estimated by regressing monthly excess returns ($R_{i,t}$) on various factors using a 24-month rolling window. The augmented Fung and Hsieh (2004) factors are S&P 500 return minus risk-free rate (SNPMRF), Wilshire small cap minus large cap return (SCMLC), change in the constant maturity yield of the ten-year Treasury (BD10RET), change in the spread of Moody's Baa—10 year treasury (BAAMTSY), three investment style factors– bonds (PTFSBD), currency (PTFSFX), commodities (PTFSCOM), and the Morgan Stanley Emerging Markets Return index (MSEM) (from Fung and Hsieh 2006).

Panel A: A comparison of dollar-weighted returns with simple investment benchmarks

	Hedge fund dollar-weighted return	S&P 500 return	Risk-free rate	Dollar-weighted S&P 500 return (with hedge fund flows)
1980–2007	0.097	0.131	0.058	0.093
1980–2008	0.060	0.109	0.056	0.021

Panel B: Hedge fund risk adjusted return, Fama-French-three-factor model

$$\textit{Model}: \quad R_{i,t} = \alpha_i + \beta_{i,1}\cdot \mathrm{MKT}_t + \beta_{i,2}\cdot \mathrm{SMB}_t + \beta_{i,3}\cdot \mathrm{HML}_t + \varepsilon_{i,t} \tag{4}$$

	Individual funds		Value-weighted portfolio	
	Mean alpha (annual)	*t*-Statistic†	Alpha (annual)	*t*-Statistic††
1980–2007	0.034	(18.7)	0.056	(1.17)
1980–2008	0.013	(7.40)	0.053	(0.55)

Panel C: Hedge fund risk-adjusted return, augmented Fung and Hsieh 8-factor model

$$\textit{Model}: \quad R_{i,t} = \alpha_i + \beta_{i,1}\cdot \mathrm{SNPMRF}_t + \beta_{i,2}\cdot \mathrm{SCMLC} + \beta_{i,3}\cdot \mathrm{BD10RET}_t + \beta_{i,4}\cdot \mathrm{BAAMTSY}_t + \beta_{i,5}\cdot \mathrm{PTFSBD}_t + \beta_{i,6}\cdot \mathrm{PTFSFX}_t + \beta_{i,7}\cdot \mathrm{PTFSCOM}_t + \beta_{i,8}\cdot \mathrm{MSEM}_t + \varepsilon_{i,t} \tag{5}$$

	Individual funds		Value-weighted portfolio	
	Mean alpha (annual)	*t*-Statistic†	Alpha (annual)	*t*-Statistic††
1996–2007	0.039	(18.8)	0.064	(3.54)
1996–2008	0.026	(23.3)	0.061	(2.64)

† *t*-Statistics for fund alphas are the mean alpha of all funds scaled by the sample standard error (i.e., standard deviation divided by the square root of the number of funds).

†† *t*-Statistics for portfolio alphas are the mean of all non-overlapping alphas in the time-series scaled by the sample standard error (standard deviation divided by the square root of the number of alphas).

comprehensive and specifically developed for hedge funds but because of more stringent data requirements, is available only for the second part of our sample period (1996–2008). We derive risk-adjusted returns by using a time-series regression, where the regression is estimated every month using the past 24 monthly returns to allow factor loadings to vary over time (see Appendix C for details on the estimation for the two models). The regression is run at the individual fund level and also at the value-weighted portfolio level, corresponding to our two main dollar-weighted specifications, at the fund level in Table 2 and at the portfolio level in Table 3.

The results in Table 4, Panels B and C reveal significant mean alphas of 1% to 4% across funds, consistent with comparable evidence in Zhong (2008). Since the corresponding dollar-weighted wedge is on the magnitude of 2% to 4% in Table 2, the combined impression from these results is that net investor alpha is likely close to zero. Portfolio alphas in Panels B and C at 5% to 6% are higher than means over funds, consistent with the value-weighted portfolio specification discounting the poor returns of short-lived, smaller funds. The corresponding value-weighted wedge in Table 3 is also higher, though, on the magnitude of 3% to 7%. Again, the resulting impression is that after accounting for dollar-weighted effects, investors' net alpha is close to zero.

4. Additional results

4.1. Fund characteristics and dollar-weighted returns

In this section, we explore the magnitude of dollar-weighted effects as a function of a number of salient fund characteristics. The goal is to check the robustness of the results and to identify possible environments and fund features where dollar-weighted effects are especially pronounced. For parsimony, we only present the results for hedge funds proper; results for other types of funds and all funds are generally similar. Table 5 presents quintile results by level of fund fees and various contractual provisions restricting investor capital flows. In Panel A, we find some evidence that funds with higher fees earn moderately higher buy-and-hold returns, consistent with Ackermann, McEnally, and Ravenscraft (1999) and Edwards and Caglayan (2001).

Table 5
Management fees, capital restrictions, and dollar-weighted returns: hedge funds only, 1980–2008.

Panel A ranks all funds based on previous year's total management fees (as a percentage of AUM) and rebalances annually into quintiles. Total management fees are defined as the sum of incentive fees and asset management fees. Incentive fees are calculated based on percentage of monthly returns where months with negative returns are assumed to have zero incentive fees. Asset management fees are calculated on a monthly basis as a percentage of the beginning assets-under-management.

Panel B ranks all funds based on contractual provisions restricting investors' capital. Redemption periods are frequencies in which investors are allowed to withdraw their invested capital. Lockups are provisions restricting investors from redeeming any shares for a certain period after the initial investment. Lockup periods of a typical hedge fund range from one to five years, where most funds have a lockup period of less than three years.

Panel A: Portfolio return by previous year's total management fee (N=6,683)

Management fee	Mean [(fee/AUM)] (%)	Buy-and-hold returns	Dollar-weighted returns	Difference	*p*-Value[†]
Q1 (low)	0.43	0.133	0.043	0.091	0.029
Q2	1.01	0.131	0.039	0.091	0.040
Q3	1.32	0.156	0.060	0.096	0.035
Q4	1.66	0.150	0.067	0.083	0.015
Q5 (high)	2.53	0.156	0.075	0.081	0.007
All	1.50	0.137	0.060	0.078	< 0.001

Panel B: Portfolio returns by contractual provisions restricting investor's capital

	No. funds	Buy-and-hold return	Dollar-weighted return	Difference	*p*-Value[†]
			Redemption frequency (*N*=7,098)		
Annual ≤	437	0.140	0.083	0.057	< 0.001
Quarterly ≤ < Annual	3,276	0.143	0.069	0.073	< 0.001
Monthly ≤ < Quarterly	3,108	0.134	0.045	0.089	< 0.001
< Monthly	277	0.119	0.048	0.071	0.002
			Lockup period (*N*=5,891)		
No	3,787	0.129	0.056	0.073	< 0.001
Yes	2,104	0.131	0.067	0.065	< 0.001

[†] Bootstrap test of significance, see text and Appendix B for more details.

This pattern of superior performance for funds with higher fees is preserved in dollar-weighted returns, while the dollar-weighted wedge remains substantial but largely the same across quintiles. Panel B presents results by allowable frequency of redemption (annual, quarterly, monthly) and presence of lock-up period. There is some evidence of superior buy-and-hold performance for funds with the most stringent restrictions on redemptions, consistent with Aragon (2007) and arguments that frequent investor redemptions can be distracting and counter-productive. Interestingly, this pattern is preserved and even magnified in dollar-weighted returns, with the lowest dollar-weighted wedge for funds with the most stringent restrictions. Thus, there is some evidence that limiting capital outflows is in the investors' best interests as well.

In untabulated results, we also explore the effect of fund size and volatility of returns and capital flows on dollar-weighted returns. We confirm Boyson's (2008) finding that smaller funds earn higher buy-and-hold returns, and also find that this pattern is preserved for dollar-weighted returns. The intuition that dollar-weighted effects are likely to be larger for funds with more potential for (bad) capital flow timing is only partially confirmed in the data; we find that the dollar-weighted wedge is larger for funds with high volatility of returns but not for high volatility of fund flows. Summarizing, we find statistically significant and economically substantial dollar-weighted differences for nearly all subsamples explored, which implies that dollar-weighted effects are a pervasive feature of hedge fund data. We find more limited evidence of differential dollar-weighted effects, with funds with high volatility of returns and liberal redemption policies the most prone to poor investor timing.[14]

4.2. What causes the difference between dollar-weighted and buy-and-hold returns?

In this section, we examine more closely the nature and causes of dollar-weighted effects. First, we probe into the origins of the dollar-weighting effect by decomposing the fund-level performance gap into two drivers.[15] As discussed earlier, the dollar-weighted wedge captures the aggregate effect of the hedge fund industry receiving continual infusions of capital while aggregate returns of hedge funds have been going down; this is an aggregate time-series effect. The dollar-weighted wedge also arises because hedge fund investors chase past performance across individual funds; this is a cross-sectional effect. We disentangle the relative magnitude of the two effects by examining the aggregate time-series effect while

[14] In untabulated results, we also look at the returns as a function of hedge fund investment style using the four style groupings in Agarwal, Daniel, and Naik (2009), namely Directional trades, Relative value, Security selection, and Multi-process. While there is a fair amount of variation in buy-and-hold returns across styles, the dollar-weighted wedge is largely the same (6% to 7%), and thus, the ranking on dollar-weighted returns mirrors the ranking on buy-and-hold returns.

[15] We thank the referee for providing this insight.

holding the cross-sectional effect constant. This is accomplished by computing a hypothetical dollar-weighted return where monthly fund flows are assumed to be the same across all funds (as a percentage of beginning AUM), and are equal to the aggregate flow over the aggregate beginning AUM. For each fund, we recalculate the monthly capital flows under this assumption and compute the corresponding hypothetical dollar-weighted return. We measure the aggregate time-series effect as the mean difference between each fund's buy-and-hold return and the hypothetical dollar-weighted return, while the remaining difference between the hypothetical and the actual dollar-weighted return captures the cross-sectional effect.

The results for this decomposition are presented in Table 6. Since the computations are at the fund level, we use the same fund-level sample as in Table 2 for clarity and continuity. Accordingly, the buy-and-hold and dollar-weighted returns are the same as in Table 2, while the hypothetical dollar-weighted return and the decomposition of the dollar-weighted wedge are computed as explained above. We concentrate on the level-of-return results since the dollar-weighted effects for volatility are relatively modest. An examination of Table 6 reveals that both the time-series and the cross-sectional effect play a role in explaining the total dollar-weighted effect. However, the aggregate time-series effect dominates the cross-sectional effect in our sample; the results differ across specifications but the time-series effect is always between about 50% to 75% of the total dollar-weighted effect. This finding is intriguing because it highlights the underappreciated importance of aggregate capital flow effects as compared to the existing literature that emphasizes the flow effects across funds, e.g., Fung, Hsieh, Naik, and Ramadorai (2008).

Next, in Table 7 we provide evidence on the return-chasing vs. return-predicting role of capital flows in explaining the dollar-weighted performance gap. Recall that dollar-weighted returns are lower if beginning (discounted) asset holdings are negatively related to current period returns. This happens when current fund inflows are either positively related to past returns or negatively related to future returns; of course, the converse applies for fund outflows but the exposition emphasizes inflows for parsimony and because they dominate empirically. We explore the relative empirical magnitude of these past/future relations as explanations for the performance gap. Specifically, Table 7 presents the empirical distribution of the correlation of capital flows and past and future

Table 6
The relative roles of cross-sectional vs. time-series effects in explaining the dollar-weighted wedge.

Conditional dollar-weighted returns are hypothetical dollar-weighted returns where monthly fund flows are assumed to be the same across all funds (as a percentage of beginning AUM), and are equal to the aggregate flow over the aggregate beginning AUM. For each fund, we recalculate the monthly capital flows under this assumption and compute the corresponding hypothetical dollar-weighted return. We measure the time-series effect as the difference between each fund's buy-and-hold return and the conditional dollar-weighted return, while the remaining difference between the conditional and the actual dollar-weighted return captures the cross-sectional effect.

	Buy-and-hold return (a)	Dollar weighted return (b)	Conditional dollar-weighted return (c)	Total diff=(a)−(b)	Time-series effect=(a)−(c)	Cross-sectional effect =(c)−(b)
			All funds (1980–2008, N=10,954)			
Mean	0.061	0.029	0.035	0.032	0.026	0.006
			Early periods (1980–1994, N=1,232)			
Mean	0.131	0.093	0.100	0.038	0.031	0.007
			Later periods (1995–2008, N=10,923)			
Mean	0.060	0.031	0.040	0.029	0.020	0.009
			Excluding year 2008 (1980–2007, N=10,744)			
Mean	0.115	0.094	0.104	0.021	0.011	0.010

Table 7
The relative effect of the return-chasing vs. the return-predicting role of capital flows in explaining the dollar-weighted wedge.

Past (future) returns are compounded from monthly value-weighted returns for the year(s) before (following) the capital flow period. Scaled capital flow is the sum of annual capital flows divided by the beginning assets-under-management. Monthly capital flows for each fund are defined as: Capital flow$_t$={AUM$_t$−AUM$_{t-1}$×(1+return$_t$)}.

Correlation of current-year capital flows and past/future year's returns

	Mean	STD	No. of funds	P1	P10	P25	P50	P75	P90	P99
				Pearson correlations of current-year capital flow and past returns						
$t-1$ return	0.18	0.46	8,155	−1.00	−0.50	−0.12	0.24	0.52	0.72	1.00
$t-2$ return	0.12	0.48	6,450	−1.00	−0.56	−0.21	0.17	0.50	0.73	1.00
$t-3$ return	0.10	0.48	5,053	−1.00	−0.59	−0.25	0.13	0.48	0.72	1.00
				Pearson correlations of current-year capital flow and future returns						
$t+1$ return	−0.00	0.48	8,155	−1.00	−0.63	−0.35	−0.02	0.35	0.69	1.00
$t+2$ return	0.01	0.51	6,450	−1.00	−0.67	−0.39	−0.01	0.39	0.74	1.00
$t+3$ return	0.03	0.51	5,054	−1.00	−0.64	−0.37	0.01	0.43	0.76	1.00

returns for all individual funds over three-year horizons. The mean correlation of *Capital flow/AUM* and prior years' return is reliably positive, steadily decreasing from 0.18 to 0.10 as horizons lengthen from $t-1$ to $t-3$. Having in mind that positive investor capital flows signify fund inflows, the documented positive correlation means that hedge fund investors chase returns, consistent with existing evidence like Baquero and Verbeek (2005). In contrast, the mean correlation of scaled capital flows and future years' return is essentially zero in Table 7.[16] Medians and the rest of the empirical distributions show similar patterns for both past and future returns, suggesting that these results are robust.[17] Thus, the dollar-weighted performance gap seems predominantly driven by investors' return-chasing behavior.

5. Conclusion

The returns of hedge fund investors depend not only on the returns of the funds they hold but also on the timing and magnitude of their capital flows into and out of these funds, possibly driving a wedge between fund and investor returns. This study uses dollar-weighted returns (a type of IRR calculation) to derive a more accurate estimate of actual investor returns and compares them to the corresponding buy-and-hold fund returns. Using a comprehensive sample, the main finding is that dollar-weighted investor returns are about 3% to 7% lower than fund returns, depending on specification and time period examined. This difference is economically large, and it is enough to reverse the conclusions of existing studies which show outperformance in hedge fund returns. In addition, the estimated dollar-weighted returns are rather modest in absolute magnitude; for example, they are reliably lower than the returns of broad-based indexes like the S&P 500 and only marginally higher than risk-free rates of return. We also find that dollar-weighted returns are more variable than buy-and-hold returns although the magnitude of this effect is economically modest. Thus, the risk-return profile of hedge fund investors seems much worse than previously thought.

Appendix A. A primer on dollar-weighted returns

Consider the following investment situation, illustrated in Fig. A1. An investor buys 100 shares of the ABC fund at \$10/share at time 0 for an initial investment of \$1,000. The realized return during the first period is 100%, so the investor has \$2,000 at time 1. The investor buys another 100 shares of the fund at time 1, for an additional investment of \$2,000. The realized return during the second period is -50%, and the entire investment is liquidated at time 2, netting total proceeds of \$2,000. The buy-and-hold return on the *fund* over these two periods is 0% because share price doubled and then simply went back to its starting value. The return experience of this *investor*, though, is clearly negative because he invested a total of \$3,000, while he got only \$2,000 out of it. This intuition can be quantified by specifying the timing and signed magnitude of the relevant investor capital flows ($-\$1{,}000$ at time 0, $-\$2{,}000$ at time 1, \$2,000 at time 2) and solving for the internal-rate-of-return (IRR), which makes the algebraic sum of these flows equal to zero; in this case, the solution is -26.7%.

This simple example illustrates the key characteristics of dollar-weighted effects. First, it shows that the return of the investor (the dollar-weighted return) and the return on the investment vehicle (the buy-and-hold return) can be different. Second, it demonstrates that the reason for this difference is the timing and magnitude of the capital flows into and out of the investment. In this case, the investor's timing turned out to be poor because he invested heavily after the initial excellent return and before the subsequent poor return.

For the sake of clarity, we can use the same base data to provide a contrasting example of "good timing," as illustrated in Fig. A2. Assume that the investor still invests \$1,000 at time 0 and \$2,000 at time 1 and the returns during the two periods are still 100% and -50%, the only difference is that now the poor return comes first. Then, the investor finishes the first period with half of \$1,000 plus \$2,000 for a total of \$2,500, which is doubled to \$5,000 by the end of $t+2$. Note that the return on the fund is still 0% but now the investor is clearly ahead because he invested a total of \$3,000 and got \$5,000 out of it. Solving for the IRR obtains 45%, this is the dollar-weighted *investor* return, i.e., the rate at which his initial \$1,000 compounded over two periods, and at which his \$2,000 invested at time 1 grew over one period. The consideration and comparison of these two examples clearly reveal the crucial role of the timing and magnitude of investor capital flows in the determination of investor returns.

The generic nature of the example makes it clear that dollar-weighted effects exist for virtually all investments. The example is about funds but these could be hedge funds or mutual funds and the intuition is exactly the same, and the very same capital flow effects and reasoning apply for analogous situations in stock investments, venture capital, real estate investments, bonds, retirement portfolios, and so on. Note also that dollar-weighted effects exist at all levels of aggregation, from individual investment vehicles like single stocks all the way up to national and world indexes like the S&P 500. The reason is that net capital flows exist at all levels of aggregation, although some individual capital flows may cancel each other in the process of aggregation. For example, if investor A sells IBM stock to investor B, this is a capital inflow to investor A and a capital outflow to investor B, and this transaction will produce separate dollar-

[16] Our finding of no reliable relation between fund flows and future returns occupies a middle ground and suggests a possible reconciliation between Fung, Hsieh, Naik, and Ramadorai (2008) which finds that fund inflows signal deteriorating future performance (negative flow-performance correlation) and Ding, Getmansky, Liang, and Wermers (2009) which finds a "smart money," positive correlation effect. Since our sample is much larger and thus more representative, it is possible that the disparate findings of these two studies are sample or period-specific.

[17] In untabulated results, we find the same patterns for correlations between aggregate capital flows and aggregate past and future returns. We also find no substantial differences in correlation pattern for a split of fund flows into fund inflows vs. fund outflows.

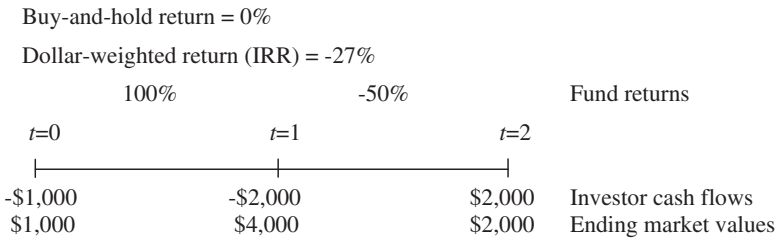

Fig. A1. Bad timing.

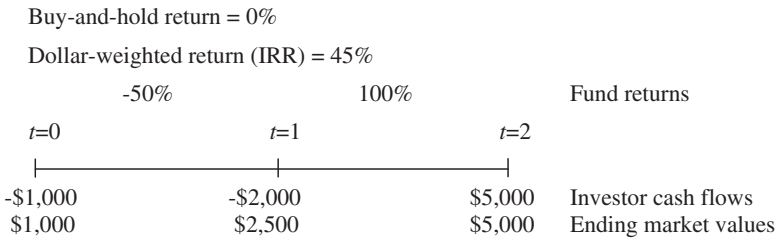

Fig. A2. Good timing.

weighted effects for investors A and B. This transaction will not produce any dollar-weighted effects for IBM investors as a class, though, because investor A's inflow and investor B's outflow cancel each other at this higher level of aggregation. Capital flow effects, however, still exist for IBM investors as a class, e.g., when IBM issues stock or repurchases shares or distributes dividends. Thus, the key consideration in the correct specification and computation of dollar-weighted returns is the proper determination of the relevant capital flows.

Appendix B. Design of the bootstrap test

The intuition for the design of the bootstrap test is that a fund investment is completely determined by the time-ordered vectors of period returns and period signed capital flows. The buy-and-hold calculation essentially assumes that capital flows do not matter for the calculation of returns. In contrast, the point of dollar-weighted returns is that the timing and magnitude of capital flows against the vector of period returns matter for actual investor returns. Thus, we use the observed dollar-weighted return as the test statistic and break the observed empirical association between capital flows and period returns to generate the bootstrap null distribution. Specifically, we keep the ordered vector of scaled capital flows fixed and randomly shuffle the vector of observed returns against it. After the shuffling, the resulting ordered vectors of period returns and scaled capital flows are used to generate the absolute amounts of the implied capital flows and ending market value, which are then used to compute a pseudo dollar-weighted return, which comprises one observation of the null distribution that assumes no relation between capital flows and period returns. Repeating this procedure 1,000 times yields an empirical estimate of the null distribution, and allows us to test the significance of the difference between buy-and-hold and actual observed dollar-weighted returns.

Appendix C. Calculation of risk-adjusted returns

We estimate risk-adjusted returns using the Fama-French three-factor model and the augmented Fung and Hsieh (2004) model. The original Fung-Hsieh model includes seven factors, specifically two equity-based risk factors (the excess return on the S&P 500 index and the spread between the Wilshire small and large cap returns), two bond market-based risk factors (changes in ten-year Treasury yields and the yield spread between the ten-year Treasury bonds and the Moody's Baa bonds), and three investment style factors (the excess returns on portfolios of lookback straddle options on currencies, commodities, and bonds).[18] As suggested in Fung and Hsieh (2006), we add an eighth factor—an emerging market index—to model the dynamical exposures of a typical global/macro hedge fund.

The estimation of each funds' risk-adjusted return is done as follows. At the end of each month, we estimate the following time-series regression using past 24-month returns for each fund,

$$R_{i,t} = \alpha_i + \beta_i' \cdot F_t + \varepsilon_{i,t}, \tag{C.1}$$

where $R_{i,t}$ is the return of fund i in month t in excess of the one-month T-bill return and F_t is the monthly value of different factors. The factor model (C.1) is estimated every month using a 24-month rolling window, allowing fund's exposure to various risk factors to vary over time. Observations with less than 24 months of returns history are dropped from the sample. The risk-adjusted return for

[18] We thank David Hsieh for providing the lookback straddle returns.

fund i in month m ($\hat{\alpha}_{i,m}$) is computed as

$$\hat{\alpha}_{i,m} = R_{i,m} - \hat{\beta}_{i,m} \cdot F_m. \quad \text{(C.2)}$$

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