OFR WORKING PAPER
OFFICE OF FINANCIAL RESEARCH

17-07 | December 15, 2017
Revised June 2, 2020

Investor Concentration, Flows, and Cash Holdings: Online Appendix

Mathias S. Kruttli
Board of Governors of the Federal Reserve System
Oxford-Man Institute of Quantitative Finance
mathias.s.kruttli@frb.gov

Phillip J. Monin
Board of Governors of the Federal Reserve System
phillip.monin@frb.gov

Sumudu W. Watugala
Cornell University
sumudu@cornell.edu

Online Appendix for "Investor Concentration, Flows, and Cash Holdings: Evidence from Hedge Funds"

Mathias S. Kruttli, Phillip J. Monin, and Sumudu W. Watugala*

June 2020

1 Herfindahl-Hirschman Index bounds: estimation methodology and results

Throughout the paper we use the five-investor concentration ratio (IC) as our measure of the investor concentration of a hedge fund. This value is reported directly for each hedge fund on Form PF. In addition to IC, we know the total number of investors (N) in the fund from Form ADV. Given IC and N, we first estimate the possible range of the Herfindahl-Hirschman Index (HHI). We then examine the robustness of our results using these bounds.

Given a fund's IC and N, the lower and upper bounds for HHI can be computed using quadratic programming techniques. Proofs are available upon request. The lower bound of HHI is given by

$$HHI_{Min} = 5\left(\frac{IC}{5}\right)^2 + (N-5)\left(\frac{100-IC}{N-5}\right)^2.$$

This is an intuitive result, corresponding to the case in which the fund has the most diversified investor base possible: the top five investors each have an equal share of IC and the rest of the $N-5$ investors each hold an equal share in the remaining $100-IC$.

Next, we compute the upper bound for HHI. Let $i_1, i_2, \ldots, i_N$ be the ordered shares of the investors of the fund, so that i_1 is the largest investor share and i_N is the smallest investor share. It is easily seen that at least one of the top 5 investors must hold at least $\frac{IC}{5}$ of the fund, and

*Kruttli: The Board of Governors of the Federal Reserve System and Oxford-Man Institute of Quantitative Finance. Phone: (202) 530-6214. Email: mathias.s.kruttli@frb.gov. Monin: The Board of Governors of the Federal Reserve System. Phone: (202) 365-1866. Email: phillip.monin@frb.gov. Watugala: Cornell University. Phone: (617) 858-6178. Email: sumudu@cornell.edu. This paper and an earlier version were produced while Monin and Watugala were at the Office of Financial Research.

that it is possible for the top 5 investors to hold equal amounts $\frac{IC}{5}$ in the fund. Thus the maximal possible value for the share of the sixth largest investor is given by $i_6^{Max} = \min\left(\frac{IC}{5}, 100 - IC\right)$. Similarly, at least one of the bottom $N-5$ investors must hold a share of at least $\frac{100-IC}{N-5}$ of the fund. Because i_6 holds the largest share of the bottom $N-5$ investors, it follows that the minimal possible value for i_6 is $i_6^{Min} = \frac{100-IC}{N-5}$. For a given IC, N and value of i_6, one can show that the maximum possible HHI is when i_1 has the largest possible share of IC, i.e., when $i_1 = IC - 4i_6$, and $i_7, i_8, \ldots, i_N$ have the largest possible share that is less than or equal to i_6. We can calculate this largest possible HHI for a given IC, N, and i_6. Formally, this is given by

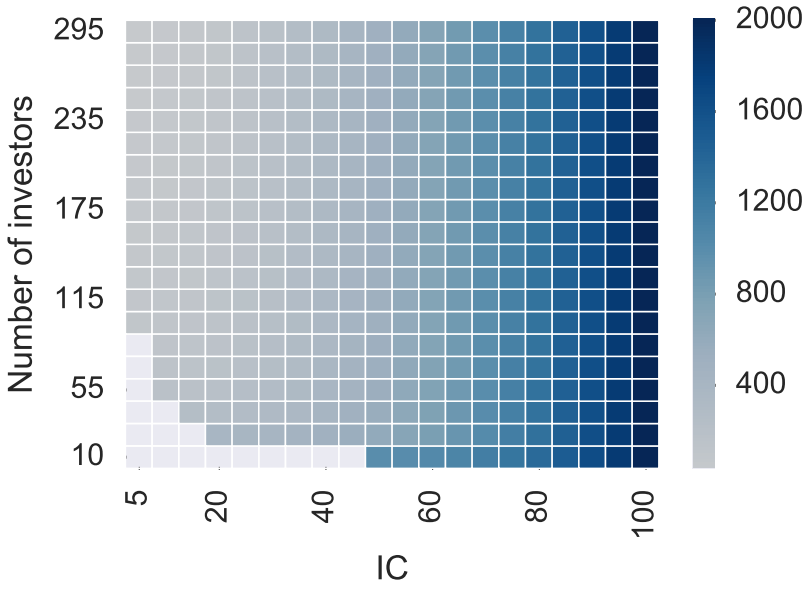
$$h(i_6) = (IC - 4i_6)^2 + 5i_6^2 + \sum_{k=7}^{N} i_k, \quad i_k = \min\left(i_{k-1}, 100 - \sum_{j=1}^{k-1} i_j\right),\ k = 7, \ldots, N.$$

Finally, one can prove that the highest HHI is found at one of the extreme points of i_6. That is,

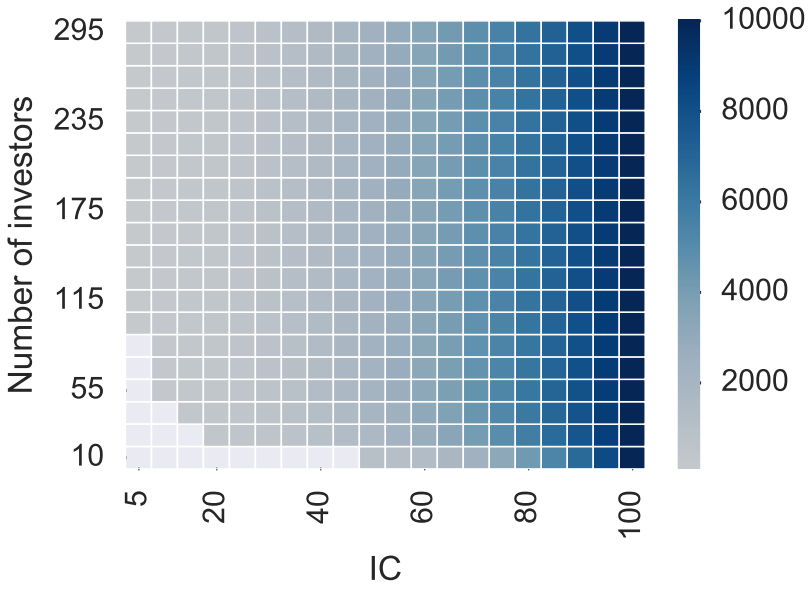
$$HHI_{Max} = \max\left(h(i_6^{Min}), h(i_6^{Max})\right).$$

Figure I show how HHI_{Min} and HHI_{Max} vary with IC and the total number of investors in the hedge fund, N. The gray shaded area in the lower left hand corner correspond to infeasible combinations of IC and N. For very low values of IC, the total number of investors leads to variation in the upper and lower bounds of the HHI. However, as IC increases, the total number of investors provides little additional information regarding the HHI bounds.

We re-estimate the regressions that analyze that effect of IC on cash but use either HHI_{Min} or HHI_{Max} normalized by 100 instead of IC. The results are shown in Table I that include the same regression specifications as Table 3 in the paper. Our results are robust to replacing IC with the HHI lower and upper bounds. The coefficient estimates and their significance are comparable to the coefficient estimates of IC.



(a) Lower bound Herfindahl-Hirschman Index



(b) Upper bound Herfindahl-Hirschman Index

Figure I: Lower and upper bounds of the Herfindahl-Hirschman Index

This figure shows lower and upper bound of the HHI for a given IC and number of investors.

Table I: Herfindahl-Hirschman Index bounds and cash

This table reports the coefficient estimates and t-statistics of the panel regression model given in equation (3) of the paper. The dependent variable is cash normalized by NAV. The IC variable is replaced by HHI lower or upper bounds normalized by 100 and computed as described in Section 1. The remaining independent variables are size, flows, share restriction, financing duration, leverage, and manager stake. The data are quarterly from 2012:Q4 to 2017:Q4. Quarter fixed effects and strategy fixed effects are used where indicated. The standard errors are clustered by quarter and hedge fund. The significance of the coefficient estimate is indicated by * for $p < 0.10$, ** for $p < 0.05$, and *** for $p < 0.01$.

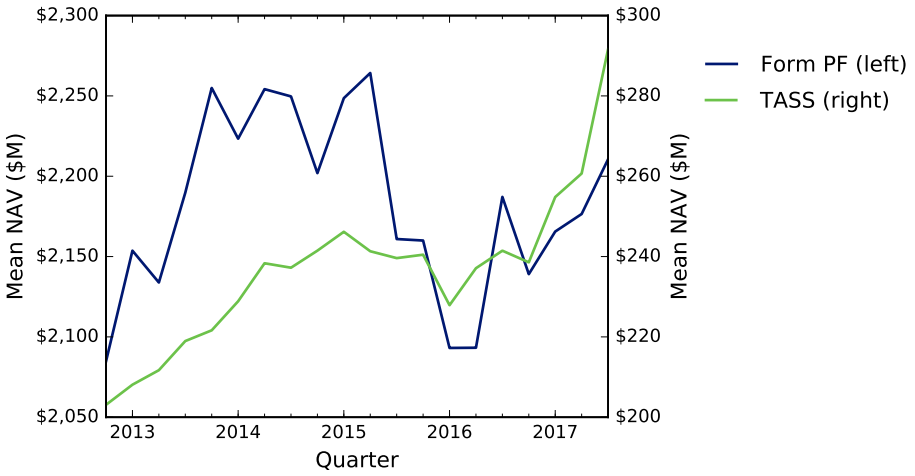
Dependent variable: Cash normalized by NAV, $Cash_{it}/NAV_{it}$				
	(1)	(2)	(3)	(4)
$MinHHI_{it}$	0.619***	0.630***		
	(4.458)	(4.532)		
$MaxHHI_{it}$			0.120***	0.122***
			(4.315)	(4.388)
$log(NAV_{it})$	2.729***	2.743***	2.491***	2.501***
	(4.931)	(4.958)	(4.674)	(4.694)
F_{it}	-0.056*	-0.056	-0.046	-0.045
	(-1.729)	(-1.622)	(-1.418)	(-1.312)
$ShareRes_{it}$	-0.026***	-0.026***	-0.026***	-0.026***
	(-5.013)	(-5.020)	(-5.059)	(-5.065)
$FinDur_{it}$	0.001	0.001	0.001	0.001
	(0.103)	(0.149)	(0.210)	(0.258)
$Leverage_{it}$	1.189***	1.197***	1.191***	1.198***
	(2.604)	(2.625)	(2.605)	(2.625)
$MgrStake_{it}$	-0.073	-0.073	-0.079	-0.079
	(-1.509)	(-1.502)	(-1.635)	(-1.630)
Time FE	No	Yes	No	Yes
Strategy FE	Yes	Yes	Yes	Yes
Observations	12210	12210	12210	12210
Adjusted R^2	0.221	0.222	0.219	0.220

2 Form PF and TASS comparison

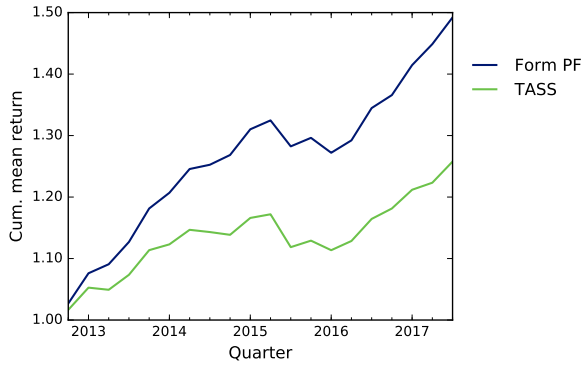
The TASS commercial hedge fund database contains voluntarily reported monthly NAV and net-of-fees returns. In this section, we compare the Form PF and TASS datasets. We use TASS hedge funds that report in US$. In this comparison, there are 1,435 unique funds in the Form PF dataset and 2,727 funds in the TASS dataset.

In Figure II, we plot the size, net-of-fees returns, and flows of hedge funds from the Form PF and TASS datasets. The Form PF hedge funds are on average an order of magnitude larger than the hedge funds that report to TASS. This difference is caused by the fact that only hedge funds of a certain size are required to file Form PF, as discussed in Section 2 of the paper. Moreover, hedge funds that voluntarily report to TASS likely do so for the purpose of advertising themselves to potential investors and attracting new investment. Consequently, the TASS hedge funds tend to be smaller on average. The time-variation of the average NAV is similar for Form PF and TASS hedge funds. Both series increase until 2015 and decrease after that, with the Form PF series being more volatile. For the returns, the cumulative return series correlate strongly, with the returns being higher for Form PF than for TASS hedge funds. For the flows, the cumulative flow series also correlate strongly, with the TASS hedge funds—which are on average an order of magnitude smaller—experiencing more outflows during this period.

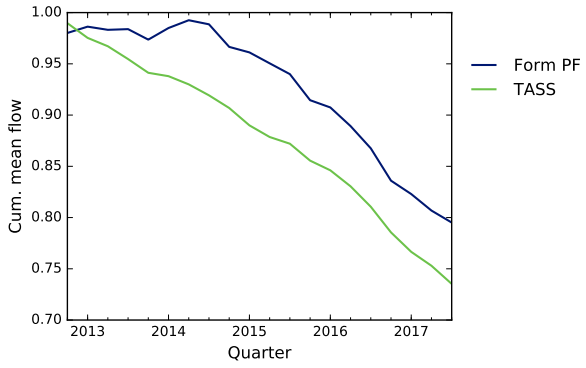
In Figure III, we again compare the size, net-of-fees returns, and flows, of Form PF and TASS hedge funds, but with the TASS hedge funds filtered based on size. Here, we only include TASS hedge funds with NAV equal to or greater than US$500 million. There are 300 such funds in the TASS dataset. The Form PF hedge funds are on average still larger than the hedge funds that report to TASS, which indicates that the larger hedge funds in Form PF do not report to TASS. The cumulative net-of-fees return series and the cumulative flow series of the Form PF hedge funds and the size-filtered TASS hedge funds still correlated strongly. Here, the Form PF hedge funds experience larger outflows than the size-filtered TASS hedge funds. This difference in flows could be due to TASS hedge funds actively trying to attract new investor money by reporting to TASS and marketing themselves to new investors.



(a) Net asset values



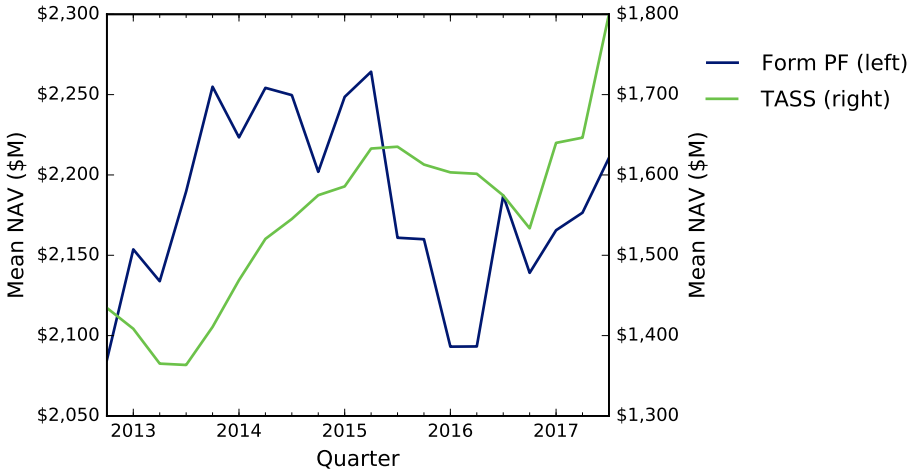
(b) Cumulative net-of-fees returns



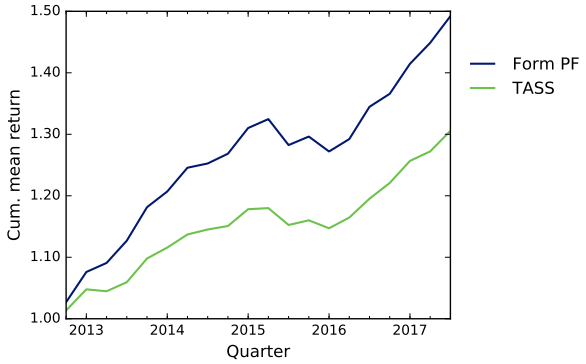
(c) Cumulative flows

Figure II: Form PF and TASS comparison

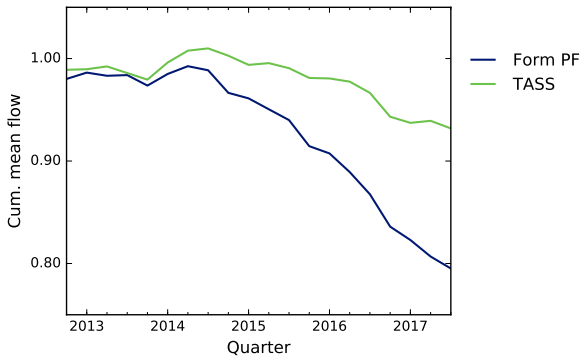
This figure shows the average NAV, the average cumulative net-of-fees returns, and the average cumulative flows of Form PF and TASS hedge funds.



(a) Net asset values



(b) Cumulative net-of-fees returns



(c) Cumulative flows

Figure III: Form PF and TASS comparison, large hedge funds

This figure shows the average NAV, the average cumulative net-of-fees returns, and the average cumulative flows of Form PF and TASS hedge funds. Only TASS hedge funds with a NAV equal to or greater than US$500 million are included.