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Institutional Investors' Investments in Private Equity: The More the Better?

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ABSTRACT

We investigate the scalability institutional investors' private equity returns with respect to the number of investments they make. Using a sample of more than 26,000 buyout and venture investments made by institutional investors between 1991 and 2011, we find that having more overlapping investments within the preceding 10 years is associated with lower returns for buyout funds. Further analyses suggest that this negative relationship is driven by LPs' abilities to conduct due diligence and process soft information from existing investments. These results are robust to alternative explanations based on limited access, risk preferences of investors, and alternative measures of investments and returns, as well as controlling for LP size and LP-fixed effects. Overall, this paper highlights the importance of the channel through which LPs increase their private equity allocations.

JEL classifications: G11, G23, G24

Keywords: institutional investors; private equity; venture capital; buyouts

I. INTRODUCTION

The private equity market has experienced dramatic growth over the last three decades. In 1990, less than $14.5 billion were raised by just over 100 funds. In 2017, over $800 billion of assets were raised by more than 1700 funds. Much of this growth has been driven by institutional investors. For example, endowments consistently allocated more than 20% of their portfolios to private equity between 2015 and 2017,[1] making private equity returns economically important for these institutions' funding levels. Investor attitudes suggest that this trend will continue for at least the near term.[2] A Preqin survey of 550 institutional investors conducted in December 2017 finds that 37% of investors intend to commit more capital to private equity funds than they did in the past year.[3] 53% of those surveyed plan to increase their allocation to the asset class over the long term, whereas only 4% plan to decrease their allocation. As part of increasing their allocations, 35% of investors expect to increase their number of general partner (GP) relationships in the next two years, resulting in more overlapping investments.

In this paper, we investigate the scalability of institutional investors' returns with respect to investing in more funds. Although pensions with larger allocations to private equity may benefit from economies of scale (Dyck and Pomorski, 2015), making more overlapping investments may put downward pressure on returns due to several inherent challenges in private equity investment. One of these challenges is the difficulty in identifying promising opportunities due to the high variation in private equity fund returns. The difference between the returns of top and bottom quartile funds is approximately 19% internal rate of return (IRR) over the years, and returns are noisy in identifying skilled GPs (Korteweg and Sorensen, 2017). As a result, there is also high variation in average returns of limited partners (LPs) (Cavagnaro et al., 2018). Furthermore, given the dispersion and noise of returns, LPs cannot rely on only hard information such as track record to evaluate the GPs' performance. They must conduct rigorous due diligence and make judgements using soft information.[4] Dyck and Pomorski (2015) find that pensions with higher allocations to private equity outperform due to their greater ability to carry out such tasks. However, it is uncertain whether this outperformance could be sustained with more GP partnerships due to the non-mechanical nature of the process. Finally, several studies have documented the so-called money-chasing-deals phenomenon. Returns are generally lower during years in which more money is allocated to private equity (Gompers and Lerner, 2000; Kaplan and Schoar, 2005; Kaplan and Stromberg, 2009). Thus, holding all else equal, increasing allocations to private equity by investing in more funds could result in lower returns.

The challenges described above raise questions about the potential to maintain high returns on an increasing number of overlapping investments. We hypothesize that investing in more overlapping funds, as opposed to making larger investments in the same number of funds, could negatively impact returns by reducing an LP's ability to carry out the requisite information processing for identifying the most promising opportunities. That is, with fixed resources to devote to investment selection, LPs investing in many funds over a short period would have lower returns, on average, than other LPs operating on the same scale with relatively few investments during the same time period.

We use LP investment-level data obtained from Prequin to test whether having more investments in private equity is associated with lower returns. We define the "10-

year investment count" for a given LP's investment in a given fund as the number of investments initiated by that LP within ten years prior to the vintage year for that fund. The ten year window reflects the average lifetime of a fund, from initiation to liquidation, during which time the investment would require attention from the LP. Our hypothesis implies that LP-investments with a higher investment count would have lower returns, on average, than those with a lower investment count. We find that performance is negatively related to the 10-year investment count for buyout funds, but not for venture funds. For buyout funds, the relationship is also significantly concave. The predicted decrease in return associated with increasing the 10-year investment count from one to eight is approximately 0.74% IRR. Additional increases in the 10-year investment count further decrease buyout IRRs, although at a slower rate. These relationships hold when we measure performance both in terms of IRR and fund multiple and when we consider LP's average size-weighted returns for a vintage year.

We then explore whether this negative relationship among buyout funds could be driven by LPs' worse ability to process information when they have more overlapping investments, focusing first on due diligence and then on soft information. If the negative relationship is driven by limitations on LPs' ability to conduct due diligence, then it should be more pronounced among investments that require greater due diligence, such as those in the first fund raised by a new GP or those in which the LP has no previous relationship with the GP. It should also be less pronounced among investments that require less due diligence, such as those in which the LP has invested in a previous fund raised by the same GP. Indeed, we find just such a pattern when we rerun our analysis on these subsets of investments. The results are consistent with the notion that LPs are not able to conduct due diligence as effectively, on average, when they have higher investment counts, leading to lower returns.

To investigate whether making more investments could also harm LPs' abilities to process soft information, we examine LPs' reinvestment decisions.[5] Hochberg et al. (2013) show that LPs capture soft information about GPs' skill from investing in a fund. Presumably, LPs who are better at processing that private, soft information would tend to reinvest in funds that subsequently perform well and abandon those that subsequently perform poorly. Therefore, we follow Lerner et al. (2007) and Sensoy et al. (2014) and study the returns of follow-on funds that LPs either reinvested in or abandoned. We divide our sample of investments into quartiles based the 10-year investment count and examine the average returns of reinvested and abandoned funds for each quartile. We find that, among investments in the top quartile of investment count, the abandoned follow-on funds perform better than the reinvested follow-on funds, on average. This means that LPs with many overlapping investments tend to abandon funds that subsequently do well and reinvest in funds that subsequently do poorly. The pattern is reversed for investments in the bottom quartile of investment count, suggesting that LPs with fewer overlapping investments make better reinvestment decisions. In general, higher 10-year investment counts are associated with worse performance of reinvested funds and better performance of abandoned funds. This pattern holds for all funds, venture funds, and buyout funds. Taken together, these results suggest that LPs with more overlapping investments do worse at processing soft information acquired from existing investments.

It is possible that making more investments helps LPs' future performance by giving them experience and information advantages. Therefore, we re-run our tests using lag investment counts as of prior investments' vintage years. We do not find any evidence that making more investments helps LPs outperform in the future.

We also explore a number of alternative hypotheses and measures related to the empirical patterns we document. For one, since our data does not contain time-varying LP size, we cannot control for size directly in our analyses. To mitigate concerns that the 10-year investment count is merely a proxy for size, we run a correlation analysis for the one year that we do have LP size information. We find that the correlation between size and investment count on this subsample is just 0.38. We further create proxies to capture LP size and the time-varying aspect of it. We find that the negative relationship between investment counts and returns for buyout funds remains significant even after controlling for size proxies.

Differential access could be another alternative explanation for our results. Sensoy et al. (2014) show that LP types are associated with different access to funds, which leads to different LP-type performance. However, it is unlikely that our results are driven by LPs' differential access to high-performing funds because all of our empirical specifications include LP-type fixed effects. In addition, our results using a subsample of first-time funds, which are less likely to have an access problem, show an even larger negative relationship between investment counts and returns for buyout funds.

Our results are also unlikely to be driven by LPs' risk preferences. In addition to controlling for fund risks in our regressions, we follow Andonov et al. (2017) and Cavagnaro et al. (2018) in using a "value-at-risk" analysis to examine the distribution of average excess returns across LP quartiles based on their investment counts. We find very little difference across LP quartiles at the bottom 10% of their buyout return distribution. In other words, LPs with fewer overlapping investments do not experience the lower lows that would be expected if they were achieving their higher average returns by investing in more risky funds.

To absorb other variations at the LP level, we further include LP fixed effects for the subsample of LPs with at least four investments. Our conclusions do not change with the inclusion of these fixed effects. Our results are also robust to using a five year window to measure the investment count, excluding LPs with only one investment, and dropping the financial crisis and post-crisis time period.

This paper relates to previous work on institutional investors' private equity performance. Research on this topic has been limited by data availability, although a few papers have shown that LPs' performances differ systematically. First, Performance differs across LP types. Lerner et al. (2007) find that endowments outperformed in the 1990's, but their outperformance did not last into the 2000's as the industry matured (Sensoy et al., 2014). Hochberg and Rauh (2013) and Andonov et al. (2017) show that public pension funds face more political pressure and receive lower returns. Barber et al. (2018) further show that some LP types are more pressured to invest in impact venture funds that lower their returns. Second, in addition to type, some LPs systematically outperform others due to their skill at targeting funds raised by the best GPs (Cavagnaro et al., 2018). Lastly, large investors are better at conducting due diligence (Da Rin and Phillipou, 2014), and larger pension funds receive higher returns than smaller ones (Dyck and Pomorski, 2014). Our results add to these findings by suggesting that making more overlapping investments is associated with worse returns on buyout funds due to the

impact on LPs' ability to conduct due diligence and process soft information from existing GP partnerships.

More generally, this paper contributes to the literature on investment performance and scale. Studies have found diseconomies of scale in mutual funds and hedge funds (e.g., Chen et al., 2004; Polet and Wilson, 2008; Fung et al., 2008). Although Metrick and Yasuda (2010) find results suggesting that buyout fund returns are more scalable than venture fund returns, Lopez-de-Silanes et al. (2012) show that making more simultaneous investments lowers private equity firms' returns. These paper looks at investments made at the GP level, while our paper is about LP investments. Dyck and Pomorski (2015) find economies of scale for pensions' private equity investments. Our results call into question the scalability of LPs' returns from increasing the number of GP partnerships without devoting more resources to identifying promising investments.

The rest of the paper is organized as follows. Section II describes the sample. Section III presents the main empirical results on investment count and performance. Section IV explores information processing as an explanation for the main results. Section V shows robustness of the results. Section VI concludes and discusses limitations of the study.

II. SAMPLE DESCRIPTION

We construct our sample of investments using data gathered from Preqin. Preqin is a leading source of data on alternative assets and has won several best-data-provider awards. Preqin data on funds and LPs are collected through Freedom of Information Act requests to public LPs and voluntary reporting by GPs and LPs. While Preqin's data on LP investments is incomplete, it includes profiles for over 5,300 institutions actively investing in private equity worldwide. It is also the single most comprehensive data provider on LP investments.[6]

We start with LPs' investments in buyout and venture funds. Preqin's LP-investment data does not contain performance information. Hence we match each LP-investment with fund level data from Preqin and delete observations where the fund IRR is missing. To be consistent with prior research (e.g., Lerner et al., 2007 and Sensoy et al., 2014) and to minimize incomplete coverage, we start our sample in 1991. We delete funds raised after 2011 to allow enough time for returns to be realized. This gives us 26,532 LP investments. We further delete observations with missing fund size. Our final sample includes 26,376 investments made by 1,379 unique LPs.

Table 1 reports summary statistics both at the LP and fund level, for all funds and then for buyout and venture funds separately. Panel A of this table shows the number of observations, mean, median, Q1 (first quartile), and Q3 (third quartile) values of LPs' investments and their performance. On average, LPs make a total of about 19 investments, but the distribution is highly skewed. The first quartile value is 3 and third quartile value is 18. LPs also make more investments in buyout funds than in venture funds. *Total 10* is, for each investment, the total number of other investments made by the same LP within 10 years prior to the vintage year of the given investment. In our sample, LPs have on average about 43 other investments within the 10 years preceding each new investment. The first, second, and third quartiles of *Total 10* are 8, 25, and 59, respectively. These values are very similar when considering buyout and venture funds separately.

Table 1 Summary statistics

Panel A: LP level

	All Funds					Buyout Funds					Venture Funds				
	N	Mean	Median	Q1	Q3	N	Mean	Median	Q1	Q3	N	Mean	Median	Q1	Q3
No. of investments per LP	1,376	19.17	6	3	18	1,207	15.34	6	2	15.5	929	8.58	3	1	8
Total 10	26,376	43.21	25	8	59	18,454	42.46	25	9	58	7,922	44.94	25	8	62
IRR	26,376	12.97	11	4.7	18	18,454	13.80	12.7	8	18.8	7,922	11.04	5.20	-2.8	15.2
Fund multiple	25,889	1.72	1.58	1.26	1.96	18,096	1.71	1.65	1.39	1.99	7,793	1.73	1.31	0.84	1.81
Fund size	26,376	2,332.08	830	332.67	3,024.50	18,454	3,137.87	1641	604.20	4,000	7,922	458.35	300	167	572

Panel B: Fund level

IRR	2,063	13.25	10.5	1.9	19.6	1,160	14.35	13.00	7.1	20.6	903	11.84	5.7	-3.6	17.0
Fund multiple	2,007	1.77	1.77	1.09	2.02	1,130	1.75	1.75	1.33	2.09	877	1.80	1.79	0.8	1.91
Fund size	2,063	760.24	284	125	654.50	1,160	1,158.61	455.9	213.92	1,106.80	903	248.48	162	75	303
No. of LPs	2,063	12.79	8	4	15	1,160	15.91	9	4	19	930	8.78	6	3	12

Panel C: Returns by quartile of 10-year investment count (Total 10)

Total 10 Quartiles	All Funds				Buyout Funds				Venture Funds			
	IRR		Fund Multiple		IRR		Fund Multiple		IRR		Fund Multiple	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Q1	15.05	1.85	12.00	1.65	15.32	1.80	13.60	1.68	14.43	1.98	6.50	1.35
Q2	13.40	1.76	11.10	1.58	13.72	1.70	12.60	1.65	13.10	1.92	5.70	1.33
Q3	12.75	1.68	11.00	1.58	13.15	1.69	12.30	1.65	10.98	1.64	5.10	1.31
Q4	10.66	1.57	10.20	1.55	13.01	1.66	12.10	1.62	5.55	1.38	4.00	1.29

The above table shows characteristics of LPs' investments in all funds, buyout funds, and venture funds separately. Panel A reports the number of observations (*N*), mean, median, first quartile (*Q1*), and third quartile (*Q3*) values of the characteristics at the LP level. *No. of investments per LP* reflects the total number of investments made by each LP. *Total 10* is the total number of investments initiated within the last 10 years of the current investment. IRR is the internal rate of return. Fund multiple is the ratio of the undiscounted sum of distributions to the undiscounted sum of capital calls (i.e., multiple of invested capital). Panel B shows statistics at the fund level. *No. of LPs* is the total number of LPs in each fund. Panel C reports the mean and median values of LPs' investment returns by quartiles based on *Total 10*.

We use two measures of returns: net-of-fees IRR, a standard measure of rate of return used in the industry, and fund multiple, which is the ratio of the undiscounted sum of distributions to the undiscounted sum of capital calls. Not all investments in our sample report fund multiples. Therefore, the number of observations is smaller for fund multiples. The average return of LPs' investments is approximately 12% IRR. This number is very similar to that reported in Cavagnaro et al. (2018), who use the same sample period.

Panel B reports summary statistics at the fund level. Similar to other studies and the numbers reported in panel A, buyout funds in our sample are much larger than venture funds and have higher returns. The average performance of funds in our sample is also close to the performance of all funds with available information in Preqin. This reduces the concern of sample representativeness. There are close to 13 LPs in each fund, on average, but buyout funds on average have close to 16 LPs while venture funds on average have close to 9 LPs per fund. Panel C breaks down returns of LPs' investments by *Total 10* quartiles. For each fund type, both IRR and fund multiples decrease with quartiles of *Total 10*. The difference in average IRR received by first and fourth quartile investors in buyout funds is economically large at 2.31%, and it is even larger for venture funds.

While we have a large sample of LP investments, our data has several limitations. First, we do not have information on gross-of-fees performance or cash flows. Second, Preqin does not contain the complete list of LP investments, even though it is a leading data provider on alternative assets. The data is better for later periods as well as for public LPs such as public pension funds. This limitation applies to all research on LP investments, as there is no complete list of LPs' investments in private equity. Another limitation of our data is that Preqin does not provide commitment data for many of LPs' investments. In our data, 10,569 investments (less than half of the sample) include commitment amount, and these investments are mostly made by public LPs. To avoid having a biased sample, we use fund-level returns instead. Fourth, we do not have time-varying data on LPs' size. We have a snap shot of LPs' assets under management (AUM) as of January 2018. This precludes us from calculating LPs' private equity size for our sample period from 1991 to 2011. Instead, later in the paper, we correlate LPs' 10-year investment counts in 2017 to their AUM to determine whether investment counts captures LP scale. We also check the robustness of our results using size proxies and LP fixed effects in Section V.

III. THE RELATIONSHIP BETWEEN INVESTMENT AND RETURN

Our main analyses concern the relationship between investment count and return on private equity investments. *Total 10*, the 10-year investment count, is used to capture the number of overlapping investments that may require LPs' attention and monitoring. We use log scaling of *Total 10* to normalize the distribution of this variable in our sample.

We consider returns first at the level of each LP-investment. We fit regression models to predict return based on investment count and several control variables. To account for a possibly nonlinear relationship, we include both the logarithm of *Total 10* and its quadratic term in the regression model. We also control for fund size, LP-GP geographical proximity, and fund risk. To absorb vintage year and LP-type variations, we include vintage year fixed effects and LP type (public pension, private pension, endowment, or other) fixed effects in all specifications. We cluster the standard errors by LP to account for systematic differences among LPs in their skill at identifying funds with high return potential (Cavagnaro et al., 2018).[7] We estimate the models on all funds, and buyout and venture funds separately. Importantly, estimates on subsamples still use the full sample to measure investment counts. This ensures that investment count captures the full scope of limitations on LPs' attention due to overlapping investments in private equity.

Coefficient estimates from the regression analysis are shown in Table 2. They show that, among buyout funds, the effect of investment count on return is significantly negative and convex. More precisely, for LPs' buyout investments, when returns are measured by IRR, the coefficient estimate for *Log total 10* is -.94 and its quadratic coefficient is 0.13. Using fund multiples to measure returns, the linear coefficient is -.04 and the quadratic coefficient is .01. This negative, convex, and significant relationship indicates that LPs' buyout fund returns decline with their investment counts, and that the effect slows down for LPs with the highest investment counts.

Given the significant convexity of the relationship between investment count and return, we interpret the magnitude of the effect by the expected difference in IRR (respectively, fund multiple), for different quartiles of the investment count. Based on quartile values in Table 1 and the coefficient estimates in Table 2, an investment in a buyout fund with an investment count of 8 (quartile 1 of investment count) returns 0.74% lower IRR (.028 fund multiple), on average, than an investment in a buyout fund with an investment count of 1, the minimum investment count. In other words, when an LP has made seven investments within the past ten years, their expected return on the next investment is 0.74% IRR lower than it would be if they had not made any investments in the past ten years. Increasing the investment count from 8 to 25 (the median value) reduces return by another 0.32% IRR (.008 fund multiple), on average. Increasing the investment count from 25 to 59 (3rd quartile value) reduces it by yet another 0.20% IRR (.003 fund multiple), on average.[8]

Table 2

The relationship between investment count and return

This table shows regression results relating LPs' investment counts to returns. Analyses were done separately for all funds (columns 1 and 2), buyout funds (columns 3 and 4), and venture funds (columns 5 and 6). Returns are measured by either IRR (odd columns) or fund multiple (even columns). *Log total 10* for a given investment is the logarithm of the number of investments initiated by the LP within 10 years prior to the vintage year of the fund. *Log fund size* is the logarithm of fund size. *Same country indicator* equals one if the LP and the GP are located in the

same country, and zero otherwise. All specifications include vintage year and LP type fixed effects. They also control for fund region focus (country) and whether the GP is located in the US as *Additional fund risk controls*. Results for all funds include fund type fixed effects as well. Coefficient estimates and robust standard errors clustered by LP are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log total 10	0.54	0.06*	-0.94***	-0.04***	1.13	0.13
	(0.44)	(0.03)	(0.28)	(0.01)	(1.00)	(0.08)
Log (total 10)^2	-0.09	-0.01*	0.13***	0.01**	-0.09	-0.01
	(0.07)	(0.00)	(0.05)	(0.00)	(0.15)	(0.01)
Log fund size	0.20	0.00	0.12	-0.00	1.79***	0.06**
	(0.12)	(0.01)	(0.09)	(0.00)	(0.42)	(0.03)
Same country indicator	0.68*	0.06***	0.57*	0.02	0.97	0.13**
	(0.41)	(0.02)	(0.29)	(0.01)	(1.02)	(0.06)
Intercept	30.95***	2.75***	29.04***	2.66***	27.25***	2.50***
	(1.45)	(0.08)	(1.35)	(0.07)	(2.81)	(0.20)
Fund type fixed effects	Yes	Yes	No	No	No	No
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Additional fund risk controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	26,376	25,889	18,454	18,096	7,922	7,793
Adjusted R^2	0.121	0.111	0.173	0.148	0.288	0.236

The same relationship between investment count and return does not hold for venture funds. For venture funds, and for all funds, we find an increasing, concave relationship. However, the effects are not statistically significant except in the case of all funds when returns are measured by fund multiples. One possible reason for this difference between the results for buyout and venture funds is the role of LP size. Dyck and Pomorski (2015) show that size is related to better performance among pensions, and investment count is much more strongly correlated with size for venture funds than it is for buyouts in our sample. Although we do not have LPs' size information for our entire sample period, we use LPs' AUM obtained in January 2018 to measure size as of 2017. Then, we calculate each LPs' 10-year investment count for 2017 as well. The correlation between size and investment count is 0.53 for venture funds and 0.37 for buyouts. This means that venture investments with higher investment counts tend to also be made by larger LPs, and in these cases the benefits of size may outweigh the cost of a high investment count.

The analyses above consider return and investment count separately for each investment by each LP. We also re-estimate the regression model considering each LP's average fund-size-weighted returns for each LP-year. Table 3 shows the results. As before, we find that the relationship between investment count and return is negative and convex for buyout funds but positive and concave for venture funds and for all funds. Interestingly, for buyout funds, although the negative linear effect is even larger than it was when we considered each investment separately, the quadratic effect is large enough that the return reaches its minimum when the investment count is near the median. More

specifically, LPs' average return on buyout investments are lower by 0.91% IRR, on average, in years when they have an investment count of 8 compared to years when they have an investment count of 1. That is an even larger decrease than we saw for the same investment counts based on the coefficients in Table 2. However, going from an investment count of 8 to the median investment count of 25 further decreases average return by just 0.01% IRR, on average, and going from 25 to 59 actually increases return by 0.22% IRR, on average. However, there is still a significant overall decrease of 0.70% IRR relative to the average return in years with an investment count of 1, so the overall effect of investment count is still strongly negative for the range of investment counts in our sample.

Table 3

The relationship between investment count and size-weighted average return

This table shows regression results relating LPs' investment counts with their weighted-average returns for a vintage year. Average returns on investments made in the same vintage year are weighed by fund size. Analyses were done separately for all funds (columns 1 and 2), buyout funds (columns 3 and 4), and venture funds (columns 5 and 6). The dependent variables are either weighted average IRR (odd columns) or weighted average fund multiples (even columns). *US LP indicator* equals one if the LP is located in the US, and zero otherwise. All specifications control for vintage year and LP type. Coefficient estimates and robust standard errors are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log total 10	0.51	0.17***	-1.65**	-0.05	3.88*	0.45***
	(0.83)	(0.06)	(0.69)	(0.03)	(2.25)	(0.17)
Log (total 10)^2	0.06	-0.06***	0.71***	0.02	-0.89	-0.14**
	(0.31)	(0.02)	(0.25)	(0.01)	(0.85)	(0.06)
US LP indicator	-1.64***	-0.04	-1.39***	-0.05**	-0.52	-0.02
	(0.40)	(0.02)	(0.33)	(0.02)	(1.17)	(0.06)
Intercept	34.57***	3.01***	29.07***	2.63***	43.12***	3.38***
	(1.82)	(0.11)	(1.25)	(0.07)	(3.64)	(0.26)
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	8,624	8,513	6,126	6,033	2,493	2,458
Adjusted R^2	0.198	0.166	0.254	0.225	0.388	0.324

IV. INFORMATION PROCESSING

In this section, we investigate whether the negative relationship between investment count and return is related to LPs' ability to process information. The private equity industry is marked by complex contracts with information asymmetry. Returns are also noisy, making it difficult to identify GPs whose returns are likely to persist (Korteweg and Sorensen, 2017). For LPs to maintain high returns in this environment demands

effective processing of information related to the evaluation of potential investments and the monitoring of existing ones. We investigate two dimensions of information processing: due diligence, and soft information acquired from existing investments.

A. Due Diligence

The first aspect of information processing that we consider is due diligence. Although recent work has shown that larger LPs are better at conducting due diligence (Da Rin and Philappou, 2014; Dyck and Pomorski, 2015), the ability to conduct due diligence may deteriorate with more investments that require attention. Lopez-De-Silanes et al. (2015) report such a phenomenon among GPs. They find that investments held at times of a high number of simultaneous investments underperform substantially due to limitations on attention and communication. Here, we test whether the same holds for LPs due to limitations on the ability to conduct due diligence effectively.

Since LPs' ability to conduct due diligence is not observable, we divide our sample into subsets of investments that require either more or less due diligence than normal. In particular, we partition our sample data into two subsamples based on the relationship between the investing LP and the GP who raised the fund. The "new relationship" subsample consists of the investments in which the LP has not previously invested in any other funds raised by the GP. On the other hand, the "existing relationship" subsample consists of the investments in which the LP has previously invested in other funds from the same GP. Presumably, investments in the existing relationship subsample require less due diligence because of the history between the LP and the GP. If a higher investment count leads to lower returns due to a decrease in LPs' ability to conduct due diligence effectively, then the negative effect of investment count on returns should be less pronounced within the existing relationship subsample.

To test this hypothesis, we re-estimate the regression models described in Section III separately on the new relationship and existing relationship subsamples. We also do this separately for buyout and venture funds. To maintain statistical power, we consider investment-level returns rather than fund-size-weighted average LP-year returns. As in Section III, in these and all following subsamples, the investment count is based on the full sample.

Panel A of Table 4 shows the regression results for the existing relationship subsample, while Panel B of Table 4 shows the results for the new relationship subsample. Qualitatively, the results in both panels are similar to what we found in Table 2. The relationship between investment count and return is negative and convex for buyout but not venture returns. However, the relationship is only statistically significant for new-relationship buyout funds (Panel B). It is smaller and not statistically significant for existing-relationship buyout funds (Panel A). This is consistent with the notion that new-relationship funds require more due diligence, and therefore, are more affected by LPs' abilities to carry out this task.

To further investigate the possibility that a higher investment count decreases returns through a reduction in capacity for due diligence, we consider the subset of first-time funds. These are the first funds raised by a new GP partnership. Since the process of vetting a new GP is more difficult than that for a GP with an existing track record, these investments require even more due diligence than other new-relationship funds.[9]

Table 4
Returns on new and existing relationship funds

This table shows regression results relating LPs' investment counts to returns on subsamples of investments in which the LP either has or has not invested previously in a fund raised by the same GP. *Log total 10* and *Log (total 10)*^{2} are calculated using the full sample. Panel A reports results for the subsample of investments in which the LP has previously invested in a fund from the same GP. Panel B reports results for the subsample of investments in which the LP has not previously invested in any other funds raised by the same GP. Analyses were done separately for all funds (columns 1 and 2), buyout funds (columns 3 and 4), and venture funds (columns 5 and 6). Returns are measured by either IRR (odd columns) or by fund multiples (even columns). All specifications include vintage year and LP type fixed effects. Other controls included but not reported in all specifications are identical to those in Table 2. Results for all funds also control for fund type. Coefficient estimates and robust standard errors clustered by LP are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Existing relationship subsample

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log total 10	0.48	-0.05	-0.85	-0.05	1.08	-0.14
	(0.84)	(0.08)	(0.67)	(0.03)	(1.53)	(0.21)
Log (total 10)^2	-0.05	0.01	0.11	0.01	-0.02	0.03
	(0.11)	(0.01)	(0.09)	(0.00)	(0.21)	(0.03)
Fund type fixed effects	Yes	Yes	No	No	No	No
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	9,503	9,367	6,696	6,593	2,807	2,774
Adjusted R^2	0.131	0.212	0.206	0.186	0.319	0.417

Panel B: New relationship subsample

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log total 10	0.51	0.05*	-0.90***	-0.04***	0.72	0.10
	(0.44)	(0.03)	(0.31)	(0.01)	(1.08)	(0.08)
Log (total 10)^2	-0.13*	-0.01**	0.11*	0.00*	-0.09	-0.01
	(0.08)	(0.00)	(0.06)	(0.00)	(0.18)	(0.01)
Fund type fixed effects	Yes	Yes	No	No	No	No
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	16,873	16,522	11,758	11,503	5,115	5,019
Adjusted R^2	0.125	0.108	0.167	0.143	0.289	0.220

We re-estimate our regression model using returns and investment counts for the subsample of LPs' investments in first-time funds. As before, we also consider buyout and venture funds separately. Note that the investment count for each investment still includes all investments initiated in the preceding 10 years, not just those in other first-time funds. The results of the analysis are shown in Table 5.

Table 5
Returns on first-time funds

This table shows regression results relating LPs' investment counts to returns on first-time funds only. First-time funds are the first funds raised by a new GP partnership. Analyses were done separately for all first-time funds (columns 1 and 2), just first-time buyout funds (columns 3 and 4), and just first-time venture funds (columns 5 and 6). *Log total 10* and *Log (total 10)*^{2} are calculated using the full sample. Returns are measured by either IRR (odd columns) or fund multiples (even columns). All variables are defined in previous tables. Other controls included but not reported in all specifications are identical to those in Table 2. Vintage year fixed effects and LP type fixed effects are included in all specifications as well. For all funds, fund type fixed effects are also included. Coefficient estimates and robust standard errors clustered by LP are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log total 10	-0.37	0.09*	-1.90***	-0.06**	0.44	0.24**
	(0.73)	(0.05)	(0.54)	(0.03)	(1.62)	(0.11)
Log (total 10)^2	0.00	-0.01*	0.25***	0.01*	-0.06	-0.03*
	(0.12)	(0.01)	(0.10)	(0.00)	(0.26)	(0.02)
Fund type fixed effects	Yes	Yes	No	No	No	No
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	5,433	5,268	3,420	3,307	2,013	1,961
Adjusted R^2	0.122	0.122	0.149	0.176	0.247	0.193

Consistent with our hypothesis, we find an even stronger negative, convex relationship between investment counts and returns among first-time buyout funds than among all new-relationship buyout funds. When return is measured by IRR, the coefficient estimate for *Log total 10* is equal to -1.90 and is significant at the 1% level. For all new-relationship buyout funds (Panel B of Table 4) the same coefficient estimate was -0.90. The coefficient estimate for *Log (total 10)*^{2} is significantly positive. Both coefficients remain statistically significant when return is measured by fund multiple. In terms of magnitude, based on the coefficient estimates in this table, an investment in a first-time buyout fund when the LP has an investment count of 8 returns 1.51% lower IRR (0.046 lower fund multiple), on average, than an investment in a buyout fund when the LP has an investment count of 1. Going from 8 to the median investment count of 25 reduces return by another 0.66% IRR (0.018 fund multiple), on average, and going from 25 to the Q3 investment count of 59 reduces it by yet another 0.41% IRR (0.011 fund multiple), on average.

As in the case of the full sample, we find mixed results for first-time venture funds and for all first-time funds. When returns are measured by IRR, neither the linear nor quadratic coefficient is statistically significant for either first-time venture funds or all first-time funds. Among first-time venture funds, when returns are measured by fund multiple, the relationship is positive and concave, just as it is for the full sample of venture funds. This is also the case for all first-time funds when returns are measured by fund multiple, although the magnitude of the effect is much smaller, presumably offset by the opposite relationship among first-time buyout funds.

B. Soft Information

Our results thus far are consistent with the notion that making more overlapping investments affects LPs' ability to conduct due diligence to evaluate new funds and partnerships. Another aspect of information processing that could be affected by the number of overlapping investments is utilizing soft information from an existing GP partnership. Hochberg at al. (2013) note that existing investors learn soft information about GPs' skill that is not available to others, and that this information becomes important in evaluating the future prospects of the GPs. Making more overlapping investments that require LPs' attention can potentially affect LPs' ability to evaluate this soft information. To test this possibility, we examine LPs' decision to reinvest or abandon the subsequent funds raised by the same GP partnerships that they currently invest in. If LPs can better utilize acquired soft information, they should reinvest in funds that subsequently do well and abandon those that subsequently do poorly. The opposite should be true if higher investment counts lower LPs' ability to process soft information.

Our analysis proceeds as follows. We divide the full sample of investments into quartiles based on investment count. For example, Q1 contains the investments for which the LPs had the fewest investments in the preceding ten years (i.e., investments with the lowest investment count). For each investment, we consider the return on the follow-on fund raised by the same GP, if one exists. If the same LP reinvested in the follow-on fund, we categorize it as "reinvested." Otherwise, we categorize it as "abandoned." We then separately compute the average returns on reinvested and abandoned funds for each quartile of investment count.[10] This analysis is similar to that used in Lerner et al. (2007) and Sensoy et al. (2014) who evaluate LP-type performance. Table 6 presents the results by LP investment counts.

Table 6
Average returns on abandoned and reinvested funds

	All Funds				Buyout Funds				Venture Funds			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Average IRR												
Reinvested	13.63	12.63	11.85	12.09	13.91	12.55	12.57	12.77	12.88	12.91	10.08	10.77
Abandoned	12.99	12.66	13.74	14.47	13.88	13.37	13.55	14.53	10.67	9.9	14.33	14.31
Average Multiple												
Reinvested	1.57	1.54	1.59	1.56	1.74	1.67	1.65	1.66	1.74	2.04	1.67	1.65
Abandoned	1.74	1.75	1.66	1.66	1.59	1.53	1.56	1.54	1.53	1.56	1.69	1.61

This table shows average returns of LPs' reinvested and abandoned funds. Investments are divided to quartiles based on the investment count of the LP. Investments in the first quartile (*Q1*) have the lowest investment count, and investments in fourth quartile (*Q4*) have the highest investment count. For each investment, the follow-on fund from the same GP is categorized as reinvested if the same LP reinvested in that fund, or abandoned otherwise. *Reinvested* shows the average returns, measured by IRR and fund multiples, of reinvested follow-on funds. *Abandoned* shows the average returns of abandoned follow-on fundsAs the table shows, IRRs of reinvested funds are highest for LPs in the lowest investment count quartile (Q1) and lowest for those in the highest quartile (Q4). This result holds for all funds and for buyout and venture funds separately, and maintains when returns are measured as fund multiples instead of IRR. Most strikingly, the abandoned funds of LPs with the highest investment count perform exceptionally well. For example, for buyout funds, the average IRR of abandoned funds for LPs in the fourth quartile is 14.53%. This is higher than the average IRR of the same LPs' reinvested funds (12.77%) and higher than the average IRR of abandoned funds of LPs in the first quartile (13.88%). The same is true for venture funds as well. These results are consistent with the notion that making more investments hinders LPs' ability to utilize soft information to evaluate GPs' future performance, and may cause LPs to make worse reinvestment decisions.

It is plausible that accessing more information, through the means of investing in more funds, helps LPs learn and gain experience, which can potentially benefit their future performance. To determine whether this is the case, we estimate the relationship between LPs' returns and their lag investment counts from prior investments. Results are reported in Table 7. Panel A shows results for all LP investments. Panel B presents results for the LP-investment year, where each LP's size-weighted average return for the year is used. *Log lag 10* is the total 10-year investment count as of the LPs' previous investment. Both panels show that making more investments does not help LPs outperform in their future investments.

Table 7

The relationship between past investment count and return

This table shows regression results relating LPs' returns to their past investment counts. Analyses were done separately for all funds (columns 1 and 2), buyout funds (columns 3 and 4), and venture funds (columns 5 and 6). *Log lag total 10* is the logarithm of each LP's 10-year investment count as of the LP's previous investment. All specifications include vintage year fixed effects and LP type fixed effects. Regressions for all funds also include fund type fixed effects. Other controls included but not reported are identical to those in Tables 2 and 3. Panel A shows returns from the full sample. Standard errors are clustered by LP. Panel B shows results using weighted-average returns of LPs for each vintage year. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: All returns

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log lag total 10	-0.03	-0.01	-0.47*	-0.03**	-0.21	-0.01
	(0.45)	(0.03)	(0.25)	(0.01)	(0.96)	(0.07)
Log (lag total 10)^2	-0.00	0.00	0.06	0.00*	0.12	0.01
	(0.08)	(0.00)	(0.04)	(0.00)	(0.16)	(0.01)
Fund type fixed effects	Yes	Yes	No	No	No	No
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	24,550	24,121	17,200	16,885	7,350	7,236
Adjusted R^2	0.115	0.113	0.160	0.136	0.294	0.249

Panel B: Weighted-average returns

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log lag total 10	-0.56	-0.06*	-0.44	-0.04*	-0.84	-0.16
	(0.41)	(0.04)	(0.34)	(0.02)	(1.09)	(0.11)
Log (lag total 10)^2	0.20**	0.01**	0.12*	0.01**	0.39*	0.04**
	(0.08)	(0.01)	(0.07)	(0.00)	(0.22)	(0.02)
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	7,266	7,200	5,203	5,146	2,059	2,035
Adjusted R^2	0.201	0.189	0.243	0.220	0.449	0.383

V. ROBUSTNESS CHECKS

Our results in previous sections are consistent with the notion that making more investments depresses LPs' buyout returns, and that this negative relationship is driven by constraints imposed on LPs' ability to process information (i.e., to conduct due diligence and evaluate soft information). In this section, we explore a number of alternative explanations and check the robustness of our results.

A. LP Size

Consistently across analyses, we observe a negative relationship between return and investment count for LPs' buyout investments, but not for their venture investments. As noted before, this difference could be driven by the fact that LP size is more strongly

correlated with investment count among investments in venture funds (r=0.53) than among investments in buyout funds (r=0.37). To further tests this possibility, we re-run the regression analysis with additional control variables to proxy for size. Results are reported in Table 8. We create two size proxies within our data limit. The first proxy is the logarithm of the LP's AUM obtained in January 2018 (Column *Proxy 1)*. This variable remains the same throughout our sample period. The second proxy is time-varying. We divide each LP's AUM by the total number of investments the LP made from 1991 to 2017. Then, for each LP and each year, we multiply this value by the total number of investments the LP made in that year. Assuming that LPs get proportionally larger with each investment, this proxy would capture time-varying changes in LP size. Results for this proxy are reported in Colum *Proxy 2* in Table 8. After controlling for size, neither the linear nor quadratic effect of *Total 10* is significant in any specification for either venture funds or all funds, unlike the results reported in Tables 2 and 3. However, for buyout funds, we continue to observe the same negative relationship between investment count and return.

B. LPs' Access to Funds and Risk Preference

One could argue for access as an alternative explanation for the negative relationship between investment count and return among buyout funds. Successful GPs often restrict access to their funds, resulting in oversubscription of the funds raised. Sensoy et al. (2014) show that LP types differ in their access to funds and that endowments, in particular, have preferential access. Differential access could drive the negative relationship if LPs who cannot get into highest quality funds make more investments to compensate for the lack of access. However, since all of our regressions include LP-type fixed effects, our results should not be driven by differential access between LP types. In addition, we showed previously that the negative relationship is even more pronounced in the subsample of first-time funds (Table 5). First-time funds are generally difficult to raise and therefore, much less likely to have an access problem (Sensoy et al., 2014). Our results for first-time funds suggest that access is an unlikely explanation for the negative relationship between investment count and buyout returns overall.

Table 8
Investment count and IRR with size controls

This table shows the relationship between LPs' investment counts and returns after controlling for LP size. Two proxies are used for size. Columns *Proxy 1* report results using the logarithm of assets under management (AUM) obtained in January of 2018 as a proxy for size. For the second proxy, we divide each LP's AUM by the total number of investments the LP made from 1991 to 2017. We then multiply this number by the total investments made by that LP for each vintage year. Results are reported in Columns *Proxy 2*. Other controls included are the same as those reported in previous tables. Panel A shows returns from the full sample. Standard errors are clustered by LP. Regressions for all funds also include fund type fixed effects. Panel B shows results using weighted-average annual returns of LPs who made more than one investment in a year. Vintage year fixed effects, LP type fixed effects are included in all specifications. Coefficient estimates and robust standard errors are reported. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: All returns

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
	Proxy 1	Proxy 2	Proxy 1	Proxy 2	Proxy 1	Proxy 2
Log total 10	0.58	0.52	-0.87***	-0.89***	1.17	0.96
	(0.45)	(0.46)	(0.29)	(0.28)	(1.02)	(1.04)
Log (total 10)^2	-0.09	-0.08	0.11**	0.12**	-0.02	-0.01
	(0.07)	(0.07)	(0.05)	(0.05)	(0.16)	(0.16)
Fund type fixed effects	Yes	Yes	No	No	No	No
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	25,855	25,855	18,060	18,060	7,795	7,795
Adjusted R^2	0.120	0.120	0.172	0.172	0.287	0.287

Panel B: Weighted-average returns

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
	Proxy 1	Proxy 2	Proxy 1	Proxy 2	Proxy 1	Proxy 2
Log total 5	0.59	0.50	-1.34*	-1.39**	3.63	3.38
	(0.87)	(0.87)	(0.70)	(0.70)	(2.36)	(2.40)
Log (total 5)^2	0.05	0.07	0.58**	0.62**	-0.64	-0.66
	(0.33)	(0.32)	(0.25)	(0.25)	(0.94)	(0.91)
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	8304	8304	5888	5888	2411	2411
Adjusted R^2	0.194	0.194	0.256	0.256	0.383	0.383

We also consider the alternative explanation that investment counts are reflective of risk preferences, and that LPs who prefer less risk tend to invest in more funds and also select lower-risk funds. To the extent that LPs' objectives and risk preferences differ by their types, our results would not be affected by differences in risk preference as we include LP-type fixed effects in all specifications. In addition, we do a "value-at-risk" analysis similar to that used in Andonov et al. (2017) and Cavagnaro et al. (2018). If higher investment counts capture preference for lower-risk funds, we should expect LPs with higher investment counts to invest in less risky funds. Therefore, we look at the distribution of excess returns across investments with different investment counts. If investments with lower investment counts tend to be in riskier funds, then we should see greater variation in performance among investments with low counts than among investments with high counts.

We divide investments to quartiles based on *Total 10*, with the lowest investment counts in the first quartile, and the highest investment counts in the fourth quartile. We then compute the excess return for each fund by adjusting for the average returns of funds raised in the same vintage years, and of funds with the same type, GP's location, and region focus. Table 9 shows percentiles of excess returns within each quartile of investment count.[11] Results for both buyout and venture funds indicate that there is little or no difference between quartiles at the bottom of the excess IRR distribution. In other words, LPs with fewer investments do not experience lower lows, on average, than LPs with more investments. This runs counter to what would be expected if LPs with fewer investments were achieving higher average returns by investing in riskier funds. For buyouts in particular, the first and fifth percentile of excess IRR is identical across the four quartiles of investment count. However, in the full sample and both subsamples, excess returns at the 50th percentile and above are highest in Q1 and lowest in Q4. This is consistent with our finding that higher investment counts are associated with lower returns. What the value-at-risk analysis adds is to show that this finding is not likely to be driven by differences in risk preference. If it were, then we would expect to see both higher highs and lower lows among LPs with fewer investments, with higher returns on average.

Table 9
Investment count and excess IRR distribution

Panel A: All Funds

Investment Count	N	1%	5%	10%	25%	50%	75%	90%	95%	99%
Q1	2628	-4.8	-0.6	2.6	9.3	12.1	17.5	29	29.1	31.4
Q2	2389	-4.8	-0.4	2.4	8.8	11.5	15.6	28	29.1	29.1
Q3	2548	-4.8	0.8	2.6	8.8	10.9	14.4	17.5	23.6	29.1
Q4	2559	-4.8	0.8	2.6	8.8	10.9	14.4	17.5	23.1	29.1

Panel B: Buyout Funds

Investment Count	N	1%	5%	10%	25%	50%	75%	90%	95%	99%
Q1	1883	6.7	8.8	9.3	10.6	13.8	18.6	29	29.1	31.4
Q2	1760	6.7	8	8.8	9.4	13.1	17.5	29	29.1	29.1
Q3	1879	6.7	8.8	8.8	9.4	12.6	15.6	18.9	29	29.1
Q4	1895	6.7	8.8	8.8	9.4	12.8	14.4	19.6	23.6	29.1

Panel C: Venture Funds

Investment Count	N	1%	5%	10%	25%	50%	75%	90%	95%	99%
Q1	745	-6.1	-4.8	-3.4	0.9	3.6	12	24.2	29.8	31.9
Q2	629	-6.1	-4.8	-1.5	0.9	2.8	9.4	18.2	24.2	34.1
Q3	669	-6.1	-4.8	-2.5	0.9	2.8	9.3	12.4	17.2	24.3
Q4	664	-6.1	-3.4	-0.6	0.9	2.8	9.4	13.1	15.3	19.8

This table shows the distribution of excess returns for four quartiles of LPs based on their investment counts. Excess returns are benchmarked IRRs adjusted for average returns of funds raised in the same vintage years, and of funds with the same types, region focus, and GP location. *Q1* represents LPs with the lowest investment counts in the first quartile, and *Q4* represents LPs in the fourth quartile with the highest investment counts.

N shows the number of observations in each quartile. Columns *1% - 99%* present percentile cutoffs for LPs' excess returns. Panel A shows results for all funds. Panel B and C each reports results for buyout funds and venture funds, respectively. As another robustness check to address the concerns that our results could be driven by differences in LP size, access, or risk, we re-run our analyses with LP fixed effects. These effects would absorb these and other unobserved variation at the LP-individual level. To reduce the number of independent variables, we drop LPs with less than four investments from the full sample.[12] The results are reported in Table 10. Interestingly, coefficient estimates for buyouts in this analysis are even larger in magnitude than those reported in Table 2. In other words, after controlling for LP-level variations, and dropping LPs with less than four investments, the negative relationship is even stronger. An increase in investment count from 1 to 8 decreases IRR by 1.95%, and an increase from 8 to 25 decreases IRR by an additional 0.81%. These drops are not only statistically significant but also economically large.

Table 10

The relationship between investment count and return with LP fixed effects

This table shows regression results of LP returns, measured by IRR and fund multiples, and LPs' 10-year investment counts. All variables are defined in Table 2. Every specification includes LP fixed effects, vintage year fixed effects, and LP type fixed effects. Regressions for all funds also include fund type fixed effects. Other controls used are identical to those reported in Table 2: logarithm of fund size, same country indicator, and additional fund risk controls. Coefficient estimates and robust standard errors clustered by fund are reported. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log total 10	-0.94	0.02	-2.49***	-0.10***	0.84	0.22
	(0.83)	(0.05)	(0.61)	(0.03)	(2.07)	(0.16)
Log (total 10)^2	-0.04	-0.01	0.37***	0.01***	-0.38	-0.05
	(0.14)	(0.01)	(0.12)	(0.01)	(0.33)	(0.04)
LP fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Fund type fixed effects	Yes	Yes	No	No	No	No
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	25,505	25,037	17,894	17,545	7,611	7,492
Adjusted R^2	0.153	0.142	0.219	0.201	0.351	0.292

C. Alternative Measures and Sample Period

Our analyses so far have utilized a ten year window for counting the number of overlapping investments. We choose ten years because that is the average lifetime of a fund before it is fully liquidated, and LPs need to continue to monitor the fund and evaluate new information during that period. However, one could argue that a ten-year window is too long because it is more important to monitor a fund during its investment period, which is roughly the first five years of the fund's life. The next five years tends to be the "harvesting" period, during which the fund may not require as much attention from LPs. Therefore, as an alternative to the 10-year investment count, we measure the

five-year investment count as the total number of investments made within five years of the current investments. We repeat our primary analysis on the relationship between investment count and return using the five-year count instead of the ten-year. Results, reported in Table 11, are qualitatively identical to those from the corresponding analysis using the 10-year investment count (Table 2). We continue to observe a negative and convex relationship between investment counts and returns for buyout funds.

Table 11

The relationship between 5-year investment count and return

This table relates returns to LPs' investment counts from the last 5 years to their returns. Returns are measured by either IRR (odd columns) or fund multiples (even columns). *Log total 5* is the logarithm of each LP's total number of investments initiated within the last 5 years of the current vintage year. Other controls included but not reported are identical to those in Tables 2 and 3. Panel A shows returns for all of LPs' investments. Regressions for all funds include fund type fixed effects. Panel B shows results using LPs' weighted-average returns for each vintage year if LPs made more than one investment in that year. Vintage year fixed effects and LP type fixed effects are included in all specifications. Coefficient estimates and robust standard errors are reported. Standard errors shown in panel A are also clustered by LP. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: All returns

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log total 5	0.82*	0.08**	-0.72**	-0.03**	0.95	0.13
	(0.44)	(0.03)	(0.28)	(0.01)	(1.00)	(0.08)
Log (total 5)^2	-0.16**	-0.01**	0.09*	0.00*	-0.06	-0.01
	(0.08)	(0.01)	(0.05)	(0.00)	(0.17)	(0.01)
Fund type fixed effects	Yes	Yes	No	No	No	No
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	26,376	25,889	18,454	18,096	7,922	7,793
Adjusted R^2	0.121	0.111	0.173	0.147	0.288	0.236

Panel B: Weighted-average returns

	All Funds		Buyout Funds		Venture Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	IRR	Multiple	IRR	Multiple	IRR	Multiple
Log total 5	0.15	0.04	-0.84**	-0.04**	1.24	0.11
	(0.44)	(0.03)	(0.38)	(0.02)	(1.19)	(0.08)
Log (total 5)^2	0.08	-0.01	0.22***	0.01***	0.02	-0.01
	(0.09)	(0.01)	(0.08)	(0.00)	(0.26)	(0.02)
Vintage year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
LP type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	8,624	8,513	6,126	6,033	2,493	2,458
Adjusted R^2	0.198	0.166	0.253	0.225	0.389	0.322

We also rerun our results excluding vintage years after 2007, during the financial crisis and post-crisis period, to determine whether the results could be driven by the financial crisis. The results (not reported for brevity) also do not change meaningfully.

One could also argue that LPs may increase the number of investments after poor performance of already invested funds. The typical treatment for this kind of reverse causality is to use lag variables. However, our *Total 10* already includes lag counts from the last 10 years prior to current investments. Therefore, although we cannot completely rule out this possibility, reverse causality is unlikely to drive our results.

VI. CONCLUSION AND DISCUSSION

In this paper, we use a large sample of buyout and venture investments made by institutional investors to study the scalability of LPs' returns with respect to increasing the number of investments. We find that having more overlapping investments within the past 10 years is associated with lower returns for buyout funds. Further analyses suggest that this negative relationship is driven by LPs' abilities to process information. Specifically, our results are consistent with the hypothesis that LPs with more overlapping investments are less able to conduct due diligence, especially on buyout funds, and do worse at processing soft information to evaluate the future prospects of GPs, resulting in worse reinvestment decisions. We also find that making more investments does not help LPs to outperform in the future. These results are robust to alternative explanations based on limited access, risk preferences of investors, and alternative measures of investments and returns, as well as controlling for LP size and LP-fixed effects.

There are several limitations to our data that could potentially affect our analyses. First, we do not have commitment amounts for a majority of our LPs. We also do not have information on co-investment and secondary opportunities. Therefore, we cannot accurately calculate LPs' full returns from private equity investments. It is possible that LPs with more investments have systematically higher returns than what fund-level returns indicate. In addition, our data does not include any information on the organizational structure (i.e., workload, number of employees) of the LPs, as many of them are private institutions. However, we think that robust results with LP-type and LP-fixed effects reduce the concern of not controlling for organizational structure.

It is also worthwhile to note that some may view investment count as a proxy for experience. In that view, it is even more surprising that we find a negative relationship with buyout returns. However, it could help to explain the positive relationship for venture funds. Perhaps experience is more important for venture funds than for buyout funds. However, we get the same qualitative finding with a five-year window.

Overall, results in this paper point to the importance of the channel through which LPs increase their private equity allocation. While private equity has generated higher returns than the public market has, our results suggest that without allocating more resources to information processing, increasing allocation by increasing the number of investments come at the cost of identifying the most promising investment opportunities.

ENDNOTES

1. 2015, 2016, and 2017 NACUBO-Commonfund Study of Endowments.

2. See Preqin 2018 survey and ai-cio article "Preqin: 80% of Institutional Investors Bet on Alternatives" published on March 6, 2018.
3. See the full report at http://docs.preqin.com/reports/Preqin-Investor-Outlook-Alternative-Assets-H1-2018.pdf.
4. According to Preqin's H1 2018 investor survey, LPs examine GPs' track record, investment strategy, investment team, fees/fund terms, and data reporting guidelines when selecting funds.
5. To highlight the importance of reinvestment decisions, Lerner et al. (2007) note that information about the quality of different GPs is difficult to learn and often restricted to existing investors. Lerner and Schoar (2004) also argue that LPs demand information rights in order to make their reinvestment decisions.
6. Two other commercial databases that contain LP investments are VentureXpert from SDC and CapitalIQ. However, neither is dedicated to private equity performance, and the coverage is not as comprehensive as Preqin's. Many LPs' assets under management (AUM) are also not reported in these databases.
7. We also cluster standard errors by fund. Results (available upon requests) are similar.
8. We also run the regressions excluding LPs making only 1 investment. The magnitude of this negative relationship for buyout funds is larger. The relationship remains convex and statistically significant.
9. Anecdotal evidence shows that when evaluating first-time fund managers, LPs perform an extensive due diligence process that covers the firm's strategy, deal sourcing capabilities, track record, team continuity, and back office operations.
10. Note that if two LPs both invested in the preceding fund and one reinvested in the subsequent fund while the other abandoned it, then the return on the subsequent fund would be reflected in both averages. The return on a single fund could appear multiple times in either average depending on how many LPs either abandoned or reinvested in that fund.
11. Results are similar using fund multiples and are not reported for brevity.
12. We do not run LP-fixed effects for LPs' average LP-year returns (i.e., the specifications used in Table 3) because we would have fewer than eight thousand LP-year observations with more than one thousand LPs.

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