Performance Persistence in Private Equity Funds

Ji-Woong Chung[1]
The Chinese University of Hong Kong

This version: July 25, 2011

Abstract

Performance persistence in the private equity industry is short lived. Current fund performance is positively and significantly associated with the performance of the first follow-on fund, but not with that of subsequent funds. In addition, the commonality of market conditions between two successive funds largely explains performance persistence, and capital chases past performance and excessive fund growth, conditional on past performance, erodes performance and persistence. The findings are not conclusive about whether general partners have proprietary skills but have important implications for investors in the private equity industry in their capital allocation decision.

[1] Contact information: Department of Finance, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong. E-mail: jwchung@baf.cuhk.edu.hk. I thank Mike Weisbach, Berk Sensoy, Paul Malatesta, Otso Manninen for helpful comments as well as seminar and conference participants at Ohio State University, Chulalongkorn Accounting and Finance Symposium, Coller Institute of Private Equity at London Business School, Shanghai Winter Finance Conference, University of Hong Kong, and EFM Symposium at York University.

1. Introduction

Does the past performance of private equity funds contain information about future performance? If so, how much information is contained? How strong and persistent is the relationship between current and future fund performance? What economic factors explain this relationship? What implications does this relationship have for investors in private equity? This paper provides empirical answers to these questions.

While many studies examine whether performance persists in the mutual fund and hedge fund industries, which are important asset classes of institutional investors, few studies investigate the issue in the context of private equity funds. Recently, Kaplan and Schoar (2005) document strong persistence of private equity fund performance. They ascribe this persistence to the differential and proprietary skills of funds' general partners (GPs), leaving the puzzling question of why GPs do not appropriate more rents from investors by, for example, charging higher fees. Several subsequent studies, such as Glode and Green (2008), Hochberg, Ljungqvist, and Vissing-Jorgensen (2010), and Marquez, Nanda, and Yavuz (2010), attempt to rationalize this phenomenon.

Obviously, whether, how, and the degree to which performance persists are important questions for investors in private equity funds. The answers to these questions will affect limited partners' (LPs) investment strategies, their relationship with GPs, and the terms of the contract between the two parties. Given the importance of the subject from both practical and academic perspectives, a more thorough study is needed to shed light on the aforementioned unanswered questions; the form, the strength, and the economic magnitude of performance persistence in the private equity industry is still unknown.

This paper examines performance correlation between a current fund and its immediate follow-on fund, as well as the subsequent second and third follow-on funds. I employ methodologies typically found in the mutual fund literature: contingency table tests and cross sectional regressions of future fund performance on current performance. To quantify the economic magnitude of performance persistence, I also measure and compare the future performance of quartile portfolios ranked on past performance.

I find that, consistent with some previous studies,[2] current fund performance is significantly and positively related to the performance of the next fund for both buyout and venture capital funds. However, current fund performance is not strongly correlated with the second or third follow-on funds. Although in some tests buyouts funds exhibit a statistically significant persistence between current and the second follow-on funds, this persistence is not economically large. The difference in median values between first quartile portfolio (best performing funds) and fourth quartile portfolio (worst performing funds) formed based on initial performance is 35.7%. But the difference shrinks to 13.6% and 2.6% for the first and second follow-on funds, respectively. For venture capital funds, the corresponding differences are 34.5%, 16%, and 2.5%, respectively. The other empirical tests of performance persistence also suggest that persistence is found only between current and the first follow-on funds for both buyout and venture capital funds. Currently best and worst performing funds perform similarly in their second and third follow-on funds. Therefore, performance persistence is short lived, and, interestingly, performance converges across funds over time.

What are the implications of this finding for investors in the private equity industry? First, the transient performance persistence raises doubt as to whether private equity partnerships have differential skills enabling them to maintain consistent performance. Second, LPs should be careful in using information contained in the second or prior funds because this information has very likely become stale. Typically, a private equity firm raises a follow-on fund three to five years after a preceding fundraising. In other words, at the time of a fundraising, investors cannot fully evaluate the performance of the most recently raised fund, although the interim performance may have valuable information about the final performance at the end of a fund's life.[3] Therefore, investors are likely to base their investment decision

[2] For example, Kaplan and Schoar (2005), Phalippou (2010), Phalippou and Gottschalg (2009), and Axelson, Jenkinson, Stromberg, and Weisbach (2010) document a statistically significant association between the current and first follow-on fund performance.

[3] For example, Chung, Sensoy, Stern, and Weisbach (2010) document that the correlation between the interim IRR at the time of a follow-on fund raising and the final IRR ranges from 40% to 60%, depending on specification and fund type. Kaplan and Schoar (2005) also document a correlation of more than 90% between the fifth year IRR and the realized IRR. Similarly, Preqin Private Equity Spotlight (February 2010) also find that "interim performance

on the performance information contained in the several preceding funds. However, my finding suggests that the second or prior funds' performance can be a misleading indicator of future performance.[4]

Next, I investigate why performance persists transiently. Specifically, can we even ascribe the short-run persistence to private equity partnerships' skills? Two potential explanations are studied. First, I examine the effect of the common market environment on persistence. Since a private equity fund's life is about ten years, and a follow-on fund is usually raised three to five years after a proceeding fund raising, successive funds share several years of an overlapping investment period during which the common economic condition or shocks can influence the performance of preceding and following funds simultaneously. Therefore, the similarity of market conditions and the length of the overlapping investment period of successive funds can affect persistence. The extent to which the common market condition explains the short-run persistence will counter the view that private equity partnerships have differential skills. Second, I consider the effect of capital flows on persistence. As Berk and Green (2004) argue in the context of the mutual fund industry if investors of private equity direct capital to those managers with a higher past performance and if the inflow of capital is associated with a decline in future performance, performance persistence will disappear even if fund managers have unique skills. Hence, I examine whether and the extent to which capital flows conditional on past performance affect performance persistence.

Consistent with the first hypothesis, I find that the longer the time gap (the number of years elapsed) between two consecutive fund raisings, the weaker the performance persistence. In other words, as the duration of overlapping investment periods becomes shorter, there is less of a performance correlation between current and follow-on funds. On average, a one standard deviation increase in the number of years between two successive funds leads to a 0.124 (or 39%) decrease in performance persistence. However, I find this evidence only for buyout funds.

---

measures from as early as the fourth year of a fund's life give a strong indication of the fund's likely fund performance."

[4] Investors' ability to obtain soft information about GPs' skill and expected performance which is not reflected in the hard information would mitigate this problem.

The paper documents more direct evidence that the commonality of macroeconomic conditions increases the performance correlations of successive funds. The performance of private equity funds is largely affected by the entry as well as exit market condition. Specifically, I find that similar market conditions measured by GDP growth, stock market performance, and Treasury bill yields over two successive funds' lives increase performance persistence. For example, a one standard deviation increase in the measure of GDP growth dissimilarity between the investment periods of two consecutive funds explains about 33% of performance persistence between two neighboring buyout funds.

Next, I show that better performing funds raise larger follow-on funds than their worse performing counterparts, confirming the findings of several previous studies such as Kaplan and Schoar (2005) and Chung, Berk, Stern, and Weisbach (2010). However, funds that grow more subsequently underperform. The return-chasing-capital phenomenon is more pronounced for buyout funds, and the diminishing returns to capital inflows are found only among venture capital funds.

Importantly, capital flows conditional on performance reduce performance persistence albeit only for venture capital funds. A one standard deviation increase in fund growth eliminates performance persistence almost completely among venture capital funds. After controlling for capital flows venture capital funds exhibit stronger performance correlation between two successive funds: the point estimate of performance persistence increases from 0.239 to 0.409 and that of current and the second follow-on funds increases from an insignificant 0.09 to a significant 0.268. On the other hand, the same numbers are unchanged for buyout funds.

The asymmetry between buyout and venture capital funds in terms of the effect of capital flows on performance persistence is consistent with the view that the venture capital industry is labor-intensive while the buyout industry is capital-intensive. In other words, in managing portfolio companies of a venture capital firm, fund managers provide not only capital but also various kinds of resources such as industry networks and management skills. An increase in fund size which will in turn increase either the target size or the number of investments will require a greater amount of management care. To the extent that the resources of a venture capital firm are not quickly or readily scalable, capital inflows will likely

lead to a decline in performance. This pattern is similar to that of mutual funds (Sirri and Tufano (1998), Lynch and Musto (2003), Chen, Hong, Huang, and Kubik (2004)) as well as hedge funds (Fung, Hsieh, Niak, and Ramadorai (2008)), in that LPs direct more capital toward funds with superior performance and funds face decreasing returns to capital inflows.

Some argue that venture capital funds exhibit stronger performance persistence than buyout funds because buyout funds tend to grow their fund size more "excessively" than their venture capital counterparts (e.g. Metrick and Yasuda (2010)). However, my findings suggest that buyout funds can scale up fund size more readily because the negative effect of larger size on performance is smaller for them than venture capital funds. In addition, I find that in fact performance persistence is stronger for buyout funds than venture capital funds especially during earlier years of the sample period (for funds raised before 1996) without controlling for the effect of capital flows. These findings imply that buyout funds are more scalable due to a more scalable production process compared to venture capital funds.

The overall evidence suggests that the performance of buyout funds persists longer than venture capital funds. However, this persistence is not economically large and the persistence appears to be largely explained by common market conditions facing neighboring funds. This result does not support the view that buyout funds have differential and proprietary skills. On the other hand, the performance of venture capital funds persists only for the short run. The short-run persistence is explained by market commonality of successive funds, however, to a lesser degree compared to buyout funds. The short-run persistence of venture capital funds seems to be largely driven by excessive capital flows conditional on past fund performance. After taking into account the effect of capital flows, venture capital funds exhibit a similar degree of performance persistence as buyout funds. According to the Berk and Green (2004) model, the return-chasing capital and diminishing returns to capital flows do not necessarily contradict the view that venture capital partnerships have differential ability.

Hence, if there is any, it is likely that venture capital fund managers have more proprietary skill than buyout fund managers. At any rate, the findings bear important implications for investors in the private equity industry in their investment decision-making.

As mentioned, a few studies have examined performance persistence in the private equity industry. The pioneering work by Kaplan and Schoar (2005) documents slightly stronger performance persistence of private equity funds than what this paper finds. They find a statistically significant association between current fund and the second previous fund performances. I investigate this discrepancy in Section 3 in detail, and it seems the difference comes from different sample period. While Kaplan and Schoar (2005) studies funds raised before 1996, this study examines funds raised before 2005. When I restrict the sample to those funds raised before 2000, I find stronger persistence among buyout funds.[5] One likely explanation is that substantial capital inflows into the private equity industry may competition for assets and this, in turn, undermines private equity firms' ability to sustain their performance. In fact, capital inflows into the private equity industry explode since the late 1990s (see Figure 1) which coincides with the end of the Kaplan and Schoar's sample period. Consistent with this explanation, I find that the total amount of capital raised in the year when a fund is raised has a negative relation with the performance of the fund. In addition, when the total committed capital in the industry increases (or decreases) from preceding fund raising to the next fund raising, performance persistence declines.

Another closely related study is Phalippou (2010), which examines performance persistence and flow-performance relationship in the venture capital industry. He finds an interesting cross sectional difference between better performing funds and worse performing counterparts: better performing funds exhibit no performance persistence and large flow-performance sensitivity. Under the assumption that investors of better performing funds are more skilled which can be arguably supported by Lerner, Schoar, and Wongsunwai (2007), his findings suggest that more sophisticated investors better utilize available information about the quality of private equity partnerships and allocate capital accordingly, therefore eliminate performance persistence. He also documents weaker performance persistence than that of

[5] I also use funds raised before 1996 following Kaplan and Schoar. But due to small sample size I find performance persistence only between current and the first following funds.

Kaplan and Schoar (2005) after properly taking into account the overlapping investment durations between two successive funds.

As mentioned, several studies such as Glode and Green (2008), Hochberg, Ljungqvist, and Vissing-Jorgensen (2010), and Marquez, Nanda, and Yavuz (2010) attempt to rationalize strong performance persistence in private equity funds documented by Kaplan and Schoar (2005). The same underlying assumption of these three studies is the diseconomies of scale (i.e. fund size). Glode et al. (2008) and Hochberg et al. (2010) assume that incumbent LPs have information (over outside potential LPs) which can be used to lever their bargaining power against GPs, and prevent excessive fund inflows. Marquez et al. (2010) argue GPs have an incentive to limit fund size in order to attract better quality portfolio firms. Though these studies certainly capture important features of the private equity industry, further investigation is warranted to incorporate the empirical findings in this study: why private equity funds have become more difficult to sustain their performance? Is it due to increased bargaining power of GPs over LPs? Is it due to heightened competition among private equity funds for target assets? Then how do we reconcile the two explanations?

The current study contributes to this literature by showing detailed dynamics – duration and form – of performance persistence, identifying novel and important economic determinants of performance persistence in private equity funds – common market conditions and fund growth conditional on past performance, and by documenting the asymmetric characteristics of persistence and the determinants of between buyout and venture capital funds.

The next section briefly describes the data. Section 3 tests performance persistence and examines the dynamics of it. Also potential survivorship bias and sample selection bias of the database are discussed. Section 4 investigates the causes of performance persistence in the short run and Section 5 concludes.

2. Data

The paper employs fund-level data such as vintage year, funds' IRRs, and fund size provided by Preqin. I consider buyout and venture capital funds, two main asset classes of private equity. For funds raised before 2005, the total number of buyout (venture capital) funds is 1,549 (3,470), from which 722 (2,960) funds report IRRs. In later analyses I estimate the relation between current and follow-on fund performance. Sometimes multiple funds are raised by the same private equity partnership usually targeting different investors or geographic focus. I exclude these funds primarily because it is difficult to define which fund is a preceding or following one.[6] For each preceding fund, I consider whether a follow-on fund can be observed in the database. I define a follow-on fund as the next fund raised by the same partnership. Thus each preceding fund has at most one follow-on fund. If a fund does not have a follow-on fund, it is not included in the analysis. Lastly, I drop funds that were raised after 2005 to eliminate the potential bias that results from using the interim IRRs of unrealized (unliquidated) funds.

Table 1 reports the descriptive statistics on fund performance and fund size by fund type (buyout or venture capital) and by vintage year group. Fund size information is available in Preqin for most funds: about 90% of funds report fund size data. However, performance data (IRR or multiples) is missing for the majority of the funds in Preqin.

An alternative database to Preqin is Thomson Venture Economics (TVE) where performance data are available, but the database does not disclose fund identify (e.g. fund name), making it impossible to track performances of the same partnership. However, several studies (e.g. Hochberg, Ljungqvist, and Vissing-Jorgensen (2010), Kaplan and Schoar (2005), Metrick and Yasuda (2010), Phalippou and Gottschalg (2008)) obtain this proprietary data and examine private equity performance. Overall, the total number of funds with performance data in Preqin (1,731 with 1,019 venture capital funds and 722 buyout funds up until 2005) exceeds that of Phalippou and Gottschalg (1,328 funds during 1980-1993 in their

[6] Alternatively, I aggregate funds in a given year and compute the fund-size-weighted IRR when a private equity firm raises multiple funds in a given year, and include these funds in the analyses. The results are similar regardless of the inclusion of these funds.

Table 2), Kaplan and Schoar (1,077 funds during 1980-1997 in their Table V), or Hochberg et al. (1,007 during 1980-2006 in their Table 1 only for venture capital funds). However, when I restrict my sample from Preqin to the 1980-1993 or 1980-1997 period, the number of funds with performance data is respectively 399 and 710. Hence, Preqin consists more of recent funds especially raised from the late 1990s and early 2000s compared with TVE. But as I discuss further in Section 3.4.1 the relevant sample size, i.e. funds reporting at least two successive performance data, is comparable.

During the whole sample period, the time series averages of performance of buyout and venture capital funds are 15.76% and 14.42%. The averages during the 1980-1997 period are 22.08% for buyout and 22.65% for venture capital funds comparable to those reported by Kaplan and Schoar (17.86% for buyout and 22.38% for venture capital funds). Therefore, the buyout fund sample during the 1980-1997 period in this study (274 funds) contains more of better performed funds compared to that in Kaplan and Schoar (333 funds).

Figure 1 plots fund performance and committed capital by vintage year. The time trend of committed capital is similar to that in other studies (e.g. Acharya et al. (2009), Stromberg, (2009)) that use a different database (e.g. Venture Economics or Capital IQ); there are peaks in fund raising in 2000 and 2007, and after the financial crisis in 2007, there is a large drop in fund raising activities in the private equity industry.

Table 1 shows venture capital funds' underperformance since the late 1990s: the mean and median IRR are both close to zero. This does not seem due to the fact that many of the recently raised funds are not yet completely liquidated (i.e. not completely realized),[7] as, even when only liquidated (realized) funds are included, I find a similar trend, i.e. venture capital performance is substantially poorer post-2000 than it was in previous years. On the other hand, buyout funds' performance is relatively stable

[7] Industry practitioners often show concern about the poor performance of venture capital in recent years given its level of risk taking. See, for example, an article by Ray Maxwell (http://altassets.net/private-equity-features/article/nz18642.html) or one by Claire Miller (http://www.nytimes.com/2009/07/07/technology/start-ups/07venture.html).

throughout the sample period except in the late 1990s. For the funds raised from 1995 to 1999, the IRRs remain in the neighborhood of 10%, a half of what it is before and after that period.

The unconditional time series correlations between average IRRs and total committed capital are -50% for buyout and -54% for venture capital funds. Funds which are raised during a "boom" period during which large capital flows into the industry tend to underperform. This strong reciprocal relationship between performance and capital flows suggests that greater competition in the industry deteriorates performance by, for example, driving up the cost of investments (Kaplan and Stein, 1993) or that funds tend to make investments of worse quality during a boom period if a private equity investment opportunity set is limited.

Time series of venture capital and buyout fund performance in Figure 1 also reveals that buyout funds' returns exhibit more co-movement than venture capital funds' returns. The standard deviation of buyout funds is almost half of that of venture capital funds: 23.4 versus 50.1%. This implies that buyout funds may be more simultaneously affected by certain common factors than venture capital funds are and that venture capital investments are riskier.

3. Testing Performance Persistence

I examine whether private equity partnerships of better (worse) performing funds tend to continue to outperform (underperform) others in subsequent funds. To this end, I first compute the conditional probability that a partnership's subsequent funds will either stay in the same performance quartile as the current funds, or move into one of the other three quartiles (Section 3.1). If the funds in one portfolio tend to stay in the same portfolio, this will suggest that there is persistence in performance. Second, Section 3.2 examines performance persistence in a multivariate regression framework, which will show whether performance persists after controlling for relevant variables. Lastly, in Section 3.3, I form quartile performance portfolios by ranking the current fund performance and tracing the subsequent performance

of the initial performance quartile portfolios. Observing the subsequent performance will enable us to gauge the economic magnitude of performance persistence.

The following analyses use unadjusted IRRs while also in the appendices and in some tables, providing results using benchmark adjusted IRRs.[8] The styles used to form the benchmark portfolio are vintage year, geographic focus, and stage/investment type (early stage, later stage, expansion, or buyout). The benchmark adjusted IRRs are the raw IRRs minus the median IRRs of the benchmark portfolio.

3.1. Transitional Probabilities

This section examines whether there is any association between current and future fund performance using contingency table tests. Table 2 reports transitional probabilities, i.e. the conditional probability that a partnership's subsequent funds will either stay in the same performance quartile as the current funds, or whether it will move into one of the other three quartiles. The transitional probabilities will sum up to 100% across the rows of the tables. If funds tend to stay in the same performance quartile over time, this would suggest that relatively better (worse) performing funds will tend to better (worse) perform in the future.

I compute transitional probabilities from the current fund performance quartile into the first through third follow-on fund performance quartiles to see how long performance would persist. I use

[8] I use unadjusted IRRs, as opposed to risk adjusted IRRs, as a measure of private equity performance. Obviously, it is difficult to know what kind of risks and how much risk private equity investments are exposed to. The kinds of investments made by a fund are not known, nor are the risk characteristics of those investments, as this information is not readily publicly available. Unfortunately, the literature has yet to develop a systematic way of estimating the cost of capital of private equity funds. I therefore do not attempt to adjust for risk. Alternatively, I can adjust investment returns by benchmarking based on a fund's investment characteristics (as Daniel, Grinblatt, Titman, and Wermers (1997) do for mutual funds). For example, private equity investment returns can be adjusted by the portfolio returns of other private equity funds with similar industry and geographic focus and so on. This style adjustment is cumbersome to implement, however, because, unlike mutual funds, there are small number of funds in the market, which limits the number of style dimensions that can be controlled for. But, unlike other studies where the measurement of performance of private equity funds is a central question (e.g., Kaplan and Schoar (2005), Phalippou, and Gottschalg (2009)), the focus of this study is estimating the performance persistence within a private equity partnership. Even though a partnership may change their strategies (and risk taking accordingly) over time, to the extent that investment risks and characteristics of the funds by the same private equity partnership do not change substantially over time, whether to use raw or risk-adjusted performance measure would be less of a concern to this study.

unadjusted IRR as a measure of performance (reported in Table 2); the results using benchmark adjusted IRRs are reported in Appendix A.

The probabilities that current funds in the top-performing portfolio (1st quartile in the row heading) stay in the top-performing portfolio in their follow-on funds (1st quartile in the column heading) are 42.03% and 36.26% for buyout and venture capital funds, respectively. If the observed probabilities are close to the expected probabilities, then the current performance and follow-on performance can be considered independent. But the observed probabilities are substantially greater than the expected probabilities, which are 22.44% and 23.54% for buyout and venture capital funds,[9] respectively. The worst performing portfolio (4th quartile) also tends to continue to subsequently underperform. The conditional probability that current funds in the 4th quartile portfolio stay in the same quartile is about 46% for both buyout and venture capital funds; these figures are almost twice as large as the expected probabilities which are about 24% for both buyout and venture capital funds. The Chi-square tests also reject the null hypothesis of no association between current and follow-on fund performance at the one percent significance level. Therefore, there is a strong relative persistence from current fund performance to the first follow-on fund performance.

The second and third sub-panels of Panel A and B also examine transitional probabilities from the current fund to the second and third follow-on funds. Here I do not find strong evidence that funds in one performance quartile tend to remain in the same performance quartile later. The results are similar when using benchmark adjusted IRRs instead of unadjusted IRRs especially for buyout funds in Appendix A. The Chi-square statistics for the transition from the current performance to the second follow-on fund performance is marginally significant for venture capital funds. Although the Chi-square statistics for the transition from the current performance to the third follow-on fund performance is significant at the 5%

[9] For example, if the transition from current to follow-on quartiles is independent, then we expect that 15.26 funds (=68/303*68; 68 is the column total of the 1st quartile funds in the next period and 303 is the total number of funds) will stay in the 1st quartile in the next period out of 68 buyout funds in the initial 1st quartile portfolio. Hence, the expected probability is 22.44% (=15.26/68).

level for venture capital funds, the distribution of the observed probabilities shows that the significance is not due to funds' staying in the same quartile portfolio.

In sum, even though there is some performance persistence from the current funds to the immediately following funds, performance persistence substantially declines thereafter. I confirm this result below using different methodologies.

3.2. Multivariate regression

Next, I show the association of current and future fund performance in a multivariate regression framework. Current fund performance is regressed on the performance of the first, second, and third previous funds. Specifically I estimate the following regression equation:

$$(IRR)_t = \alpha + \beta\,(IRR)_{t-\tau} + \mathbf{Z}_t\mathbf{\Delta} + \varepsilon_t, \qquad (1)$$

where τ is 1, 2, or 3 and $t-\tau$ denotes the τ-th previous funds. The IRRs are logarithmized. $\mathbf{Z}_t$ includes a list of control variables: the current fund size, sequence number of the current fund, and dummy variables for vintage year. If the coefficient estimate of β is positive and significant, this would suggest that past fund performance contains information about future performance. In other words, funds which performed better (worse) than the average will continue to perform better (worse) .

In Table 3, Panel A reports the estimates for buyout and Panel B for venture capital funds. Column (1) through (5) do not include control variables and columns (6) through (10) include control variables which may influence fund performance; the results using benchmark adjusted IRRs are reported in Appendix B.

A 1% increase in the first previous fund performance is associated with a 39 (25) basis point higher performance in the current fund for buyout (venture capital funds). For buyout funds, a fund with 1% higher performance in the second previous fund is associated with a 21 basis point higher performance in the current fund. In the case of venture capital funds, current fund performance is not

strongly associated with the second previous funds. The coefficient estimates monotonically decline as two funds are further apart in sequence.

Columns (4) and (5) include the performance of several preceding funds all together, therefore they require that a private equity partnership raise at least three and four successive funds and disclose performance data for those funds. When two or three previous funds are included in the models together, only the first preceding fund's performance is statistically significantly associated with the current fund's performance. When all three preceding funds are included, buyout funds exhibit a very high correlation between two successive funds: the coefficient estimate is 0.844 in column (5). But this is not the case for venture capital funds. Again the coefficient estimates for the second and third pervious funds' performance are not statistically significant. This is not due to a high correlation between the first and previous funds as I find that even when the second or third previous funds are included separately, the current and second or third preceding funds' performances are not significantly related among these funds. Therefore, the funds which continue to survive (i.e. continue to report performance information) show somewhat weaker persistence even though the historical average performance of longer surviving funds are higher as reported in Table 4. For a partnership with longer history, the first preceding fund's performance is, on average, the only informative predictor of follow-on fund performance. When benchmark-adjusted IRRs are used in the analysis (see Appendix B), the duration of persistence is slightly shorter for buyout funds.

The point estimates are not much different in magnitude when other variables are controlled in models (6) through (10). The R squares do not increase much by including these control variables. In general, smaller funds and more matured funds tend to outperform though statistical significance is small.

Performance persistence lasts for only one "period" for venture capital funds And the persistence tends to last little longer for buyout funds. However, this statistical significance somewhat overstates the economic significance as I discuss in the next section. In Section 4.1 and 4.2, I also show this persistence can be largely explained by common market condition under which successive funds are managed. In

addition, Section 4.4 shows that the performance persistence of venture capital funds increases conditional on relevant factors.

3.3. Subsequent performance of initial performance quartile

Lastly, I examine subsequent fund performance by quartile portfolio formed based on current fund performance. Table 4 reports the results using unadjusted IRRs. In each year, I rank funds by their performance (based on IRRs) and form quartile portfolios, with 1 being the best performing portfolio and 4 being the worst performing portfolio. Then I compute the average and median IRRs of the first through third follow-on funds of each initial performance quartile portfolio. In doing so, I can examine the magnitude of performance persistence. As seen in Figure 1, performance of private equity funds varies substantially by vintage year. Therefore, it is reasonable here to adjust raw IRRs with vintage year benchmark IRRs or to use IRR rankings among funds raised in the same year instead of the raw IRRs in order to mitigate this "vintage effect." The results are qualitatively identical regardless of different performance measures employed. See Appendix D for the results using benchmark adjusted IRRs.

In Table 4, the column headed with “F” reports the mean and median IRRs of current funds which are used to form the quartile portfolio. The column headings “F+t” where t=1, 2, or 3 report the mean and median IRRs of the t-th follow-on funds of the funds in each initial quartile portfolio. Panel A reports the results for buyout funds, and Panel B for venture capital funds. In the first sub-panel A.1 and B.1 (first five rows) of each panel, the mean and median IRRs are computed using all funds with performance data available. Since performance reporting is not compulsory, performance data are often intermittently reported. To see whether funds’ survivor into the database affects the results, I also require that funds have first through third follow-on fund performance data; I report the results in the sub-panels A.2 through A.4 and B.2 through B.4 using this sample. For example, sub-panel A.4 requires that a buyout partnership raise the first, second, and third follow-on funds and that IRR data is reported for all those follow-on funds.

For buyout funds (Panel A), the average (median) IRR of the currently top performing portfolio (Portfolio 1) is 39.7% (33.1%) (see column “F”); that of the bottom performing portfolio (Portfolio 4) is -

4.08% (-2.6%). The differences in means and medians between the two most extreme portfolios are statistically significant (see row "1-4"). In the case of the first follow-on fund performance (column "F+1"), the mean (median) of the initially top performing portfolio drops to 24.65% (19.7%) and that of the initially bottom performing portfolio increases to 7.1% (6.1%). Again, the difference in performance between top and bottom portfolios is statistically significant. However, the economic magnitude of the difference substantially shrinks from one fund to the immediately subsequent follow-on fund. The median difference in performance between top and bottom performing funds drops from 35.7% to 13.6%, almost by 60%, from the current period to the next period. The differences between the best and worst portfolios are not statistically significant at all for the second and third follow-on funds. This result is also true for venture capital funds except in sub-panel B.1 where the difference between the top and bottom portfolio of the second follow-on funds is statistically significant at the 10% level. By the time the third follow-on funds are raised, the initially best and worst performing fund portfolios are indistinguishable in terms of performance. Graphs A and B of Figure 2 plot the median of current and subsequent funds' IRRs by initial quartile portfolios. The performance convergence across portfolios over time can be clearly observed. For funds that survive (i.e. report performance data) through their third follow-on funds (in sub-panels A.4 and B.4), I find a similar result.

If better performing funds are more likely to raise follow-on funds or if they are more likely to disclose performance, I expect to see increases in performance as longer survival is required, i.e. in moving from sub-panels A.2 (or B.2) to A.4 (B.4) in Table 4. This is true. The average IRRs of current funds are 20.04, 24.18, and 29.43% when requiring funds to have the first, second, and third follow-on funds, respectively, for buyout funds (Panel A) and 22.3, 28.1, and 35.76%, respectively, for venture capital funds (Panel B). However, the same dynamic over time – performance convergence across quartile portfolios – is still found.

3.4. Robustness of the results

3.4.1. Different screens, sub-sampling, specifications, and performance measures

I repeat the analyses using different methodologies and sub-samples. First, I redo the analyses by excluding the top and bottom performing portfolios because, as Figure 2 shows, the long-run performance convergence appears to occur only for the top and bottom quartile portfolios. I find that the persistence is weaker among funds in the second and third quartile portfolios. Second, I repeat the analyses using IRR rankings (among funds raised in the same vintage year) instead of IRRs to further eliminate the vintage year effect, i.e. the phenomenon that private equity performance is sensitive to when a fund was raised. Third, I use quintile or decile performance portfolios instead of quartile portfolios to see whether the arbitrarily chosen number of portfolios affects the results (especially in Table 2 and 4). But I still find the similar results with these alternative test specifications.

The result that performance persistence is short-living may seem to be at odds with that of Kaplan and Schoar (2005). Kaplan and Schoar's Table VII (using Public Market Equivalent as a performance measure) and VIII (using IRR) report a statistically significant relation between a fund's current performance and that of its second previous fund. However, they do not find a strong correlation between current fund performance and the second previous fund performance when buyout and venture capital funds are separately estimated in Table VII. This is consistent with the results in Table 3 in this study. When they use IRR and estimate buyout and venture capital funds separately in Panel B of Table VIII, they find a statistically significant relation between current performance and the second previous fund's performance in some model specifications. Therefore, based on multivariate tests, although the findings in Kaplan and Schoar and this study are not very different, the former documents slightly stronger performance persistence than the latter does.

To understand the source of this discrepancy, I compare the sample of Kaplan and Schoar and that of this study. First, Kaplan and Schoar exclude funds with less than $5 million of committed capital in 1990 dollars whereas I do not. There are only 12 such funds (2 buyout and 10 venture capital funds) among funds that are eventually entered into the analysis. Besides, excluding them does not change the results quantitatively and qualitatively. Second, their primary measure of performance is the public market equivalent (PME) which is the ratio of discounted cash inflows and cash outflows where

contemporaneous S&P 500 returns are used for discounting. They also report the result using the internal rate of return reported by private equity partnerships. They report that PME and IRR have a correlation of 0.88. I also construct the PME measure for funds with cash flows data available (83 buyout funds and 156 venture capital funds) and find that the correlation between PME and IRR is 0.94 (0.68 for buyout funds and 0.95 for venture capital funds). Therefore, using a different measure of performance does not seem to be the source of the discrepancy.

Lastly, Kaplan and Schoar study funds with vintage year before 1996, whereas I examine funds whose vintage year is before 2006. To see whether the different sample window leads to the discrepancy, I replicate Table 3 using only funds which are raised before 1996, i.e. preceding as well as follow-on funds are raised before 1996. In this case, current fund performance and the second previous fund performance are not strongly correlated, a result similar to that in Table 3 (unreported). But this lack of statistical significance may be due to small sample: there are only 50 buyout funds and 95 venture capital funds which enter into the regression. To circumvent this problem I select funds raised before 2000: there are 183 buyout funds and 246 venture capital funds which report at least two successive funds' performance. When I restrict the sample for funds raised before 2000 (see Appendix C for the results), I find stronger performance persistence for buyout funds. But venture capital funds still do not exhibit performance persistence other than between two neighboring funds. For buyout funds, the point estimates of the coefficients on the first and second previous fund performances are respectively 0.385 and 0.326. The coefficient estimate on the third previous fund performance is not statistically significant. When two preceding funds are included together in column (4) and (9), the coefficients on both performances are positive and significant.

On balance, it appears that the difference in the findings between this study and Kaplan and Schoar come from using different sample periods: my sample includes more recently raised funds from the late 1990s to the early 2000s. As discussed in Section 2, there is a large negative time-series correlation between average IRRs and total committed capital in the private equity industry (about -50%). Given the explosive growth of private equity especially since the late 1990s which coincides with the end

of sample period of Kaplan and Schoar, the weaker performance persistence among recently raised funds suggests that recent private equity funds may find it harder to sustain their performance due to heightened competition for assets in the private equity industry.[10]

To examine the effect of competition on performance persistence, I use the total amount of committed capital in the private equity industry as a proxy for competition and compute how much total committed capital changes (in absolute term) from the year when a preceding fund is raised to the year when the follow-on fund is raised. Then I interact this change with the preceding fund's IRR and include this interaction term as an independent variable in equation (1) (unreported). The negative coefficient estimate on this interaction term will suggest that when fund raising environments are different (i.e. when the interaction term is large) persistence will decline. The coefficient estimates are -0.131 and -0.119 for buyout and venture capital funds, respectively. However, the estimate for venture capital funds is not statistically significant. Though weak in magnitude, fund raising environment affect not only performance but also persistence. A considerable growth in committed capital (as clearly evident in Figure 1) since the late 1990s, therefore, appears to explain the weakening performance persistence in the industry.

3.4.2. Survivorship and sample selection bias

Can the finding be a mechanical result due to some unobservable industry characteristics? Can the results hitherto be driven by the biases in the database? I explore alternative explanations for the findings and discuss how potential biases in the database would affect the results.

It may be that among funds in portfolio 4 (the worst performing fund portfolio), only those which investors believe would perform better in the future are able to raise follow-on funds. If investors in private equity have the ability to distinguish funds which were simply unlucky from those which lack skills, then an improvement in performance may be observed among those funds in portfolio 4 which succeed in raising subsequent funds which is, in fact, what I document. However, the same survivorship bias cannot explain performance deterioration in the top performing portfolios.

[10] See also for example, "Fittest to survive in 'crowded' private equity market', Private Equity News, Mar. 11, 2011.

Alternatively, it is possible that GPs of successful private equity partnerships – those with skills – tend to leave their original firm to start their own private equity partnerships. This may explain why better performing funds cannot sustain their performance in the long run.[11] In addition, unsuccessful private equity partnerships may hire GPs with talents, leading to an increase in performance. These are plausible explanations. However, the data on individual GPs is not available, making it difficult to test these alternative explanations.

Another concern with the data is a potential sample selection bias. Alleviating this concern is that Preqin collects performance data (85% of them) from the Freedom of Information Act and, occasionally, from fund managers.[12] However, it is still possible that funds in Preqin are systematically different from those which are not covered by Preqin. In particular, if funds with strong performance persistence tend not to enter into the database, my analysis would underestimate the true performance persistence in the private equity fund industry. One plausible reason that this may be the case is that funds and LPs of those funds which continue to outperform may not have incentive to disclose their performance to Preqin or others. Those funds do not need to disclose and market their next funds since they may already have an investor base from which they could raise enough amount of capital. LPs of those funds may not want to disclose performance data either because they may not want to increase competition among investors and increase fund size to the detriment of performance. Even though well-known best performing private equity firms such as KKR, Carlyle, TPG are included in the analysis, I cannot validate this hypothesis and the results in this study should be interpreted with this caveat in mind.

Therefore, this study together with other works in the private equity literature shares common problems arising from poor data. Again, one should be cautious in generalizing the results.

[11] One GP, in a private conversation, said partners of successful private equity partnerships sometimes split into two or more groups and establish independent partnerships. One primary reason is to circumvent the limit on fund size imposed by an implicit or explicit agreement between GPs and LPs.

[12] Preqin claims "the performance data is available for over 4,900 private equity funds for all types and geographic focus, which represents about 70% of all capital every raised" (http://www.preqin.com/item/private-equity-performance-analyst/1/11)

4. Determinants of Performance Persistence

This section aims to understand why performance persists in the short-run and why it disappears in the long-run. I first investigate whether and how economic commonality influences performance persistence in private equity funds. Then I examine the interaction between fund performance and capital flows to see whether fund flows affect performance persistence.

4.1. The effect of the time gap on performance persistence

Can common economic conditions explain performance persistence? Typically, private equity partnerships raise follow-on funds three to five years after the preceding fundraising. Since a private equity partnership usually lasts ten to thirteen years, two neighboring funds have five to ten years of overlap in their investment periods. These features of private equity industry imply that successive funds are likely to be exposed to common market conditions, and the performance of successive funds may therefore be highly correlated due to this underlying economic commonality.

One prediction is that the longer an investment period is shared by successive funds, the greater the performance correlation will be. If two funds are further apart in time, they are also more likely to be dissimilar in terms of performance. To test this prediction, I estimate the following ordinary least square equation:

$$(IRR)_{i,t} = \alpha + \beta\,(IRR)_{i,t-1} + \gamma\,(\text{Time Gap})_{i,t-1} + \delta\,(\text{Time Gap})_{i,t-1}\,(IRR)_{i,t-1} + \mathbf{Z}_t\,\boldsymbol{\Delta} + \varepsilon_{i,t}$$

$$= \alpha + [\beta + \delta\,(\text{Time Gap})_{i,t-1}](IRR)_{i,t-1} + \gamma\,(\text{Time Gap})_{i,t-1} + \mathbf{Z}_t\,\boldsymbol{\Delta} + \varepsilon_{i,t}, \qquad (2)$$

where $(\text{Time Gap})_{i,t-1}$ is the log of the number of years between two successive fundraisings. $\mathbf{Z}_t$ includes a list of control variables as in model (1). If the estimate of δ is negative, this would suggest that performance persistence decreases as the time gap grows, conditional on the previous fund's

performance. The IRR and time gap variables are standardized with a mean of zero and a standard deviation of one to reduce the possible multi-collinearity problem and to ease the interpretation of the interaction term (McClelland and Judd (1993)). Column (1) of Table 5 reports the estimation results. Appendix E reports the estimation results using the benchmark-adjusted IRRs.

The coefficient estimate on the interaction term is negative, but only for buyout funds. The estimate of the coefficient, δ, is -0.133 in column (1). Therefore a one standard deviation increase in the log of time gap results in a decrease in persistence by 39.7% (=0.133/0.335). Performance persistence will disappear if the log of the time gap increases by a 2.5 standard deviation from its mean.

I interact the buyout dummy variable with the interaction of IRR and the time gap variable to see whether the effect of the time gap variable on persistence is statistically different between buyout and venture capital funds (unreported). The coefficient on this triple interaction term is negative and statistically significant, suggesting that the performance persistence of buyout funds is more affected by the length of overlapping investment period than that of venture capital funds. This result is consistent with what Figure 1 alludes to – a strong co-movement of buyout funds' performance compared to that of venture capital funds. This implies that buyout funds tend to be more simultaneously affected by some common factors than venture capital funds are.

On the other hand, the coefficient estimate on the interaction of IRR and time gap is positive and insignificant for venture capital funds (the point estimate is 0.043). This suggests that venture capital fund performance persistence tends to be stronger when successive fund raisings are further apart in time. In other words, if a venture capital partnership raises and invests funds fast, it is difficult to sustain its performance. But due to the lack of statistical power, this result should be interpreted with caution.

4.2. Common market conditions

In the previous section, I find suggestive evidence that common economic conditions underlying the successive funds with overlapping investment periods affects performance persistence. What are the relevant economic factors influencing private equity fund's performance and its persistence? I first briefly

describe the investment cycles of private equity funds to gain insight into what macro economic conditions may matter to private equity performance.

Fundraising usually takes from six months to two years depending on market conditions and various factors such as past performance and a private equity's reputation. Only accredited investors can invest in private equity funds, and institutions such as pension funds, university endowments, insurance companies, foundations, and family offices and trusts are major investors in this market. Fund of funds which invest in other private equity funds also play an increasingly important role in the private equity industry. These investors "commit" a certain amount of capital to a partnership, which means that they do not invest the committed capital up front but over the course of a fund's life capital is "drawn down" when needed, up to a committed amount.

As noted above, a typical private equity fund is managed for ten years with two to three year extensions conditional on an agreement between the GPs and LPs. During first several years GPs focus on investments (the acquisition of target firms by buyout funds and the provision of financing to portfolio companies by venture capital funds); during the later part of a fund's life, GPs focus on divesting their investments before the partnership contract expires. Figure 3 plots investors' typical cash contribution and the cash distribution to investors from a private equity partnership over a fund's life. The pattern is usually called "J-curve" (Graph C) in that lots of draw-downs and investments are made early in the fund's life while cash inflows start kicking in as a fund liquidates (divests) its early investments through trade sales and IPOs. The duration of the investment period in a portfolio company varies substantially. But on average buyout funds are known to hold a portfolio company shorter than venture capital funds: 3 years, on average, versus 5 years.

Buyout funds almost always leverage each investment (acquisition) with large amount of debt, whereas venture capital funds do not usually do so. How much and at what price they borrow debt are important determinants of performance in buyouts. Targets of buyout funds have stable cash flows, a long track record, a high level of cash, and low leverage, whereas targets of venture capital funds are young

without much of a track record or profits; they also face substantial risks associated with product development and marketing.

Private equity funds can improve returns by increasing (or reducing) multiples at exit (multiples at acquisitions), improving performance (earnings or cash flows) or by using an appropriate level of leverage at a cheaper price. Therefore, various market conditions at the inception of funds, the time of investments, and the time of divestments directly affect funds' performance. For example, pricing and liquidity of capital are important determinants of private equity performance, especially for buyout funds. Exit market conditions such as the IPO market and mergers and acquisitions market directly affect a fund's performance. In addition, the market-wide price (multiples) at which business are purchased and sold as well as public stock market multiples are also important.

Ultimately, I seek to examine the extent to which the correlation of economic conditions explains the correlation of the performances of two consecutive funds. To test this, I begin by constructing a simple market similarity measure ("MSM") as follows:

$$MSM_{i,t} = abs[\ (Market\ Condition)_{i,t+1} / (Market\ Condition)_{i,t} - 1\ ], \quad (3)$$

which is the absolute value of the ratio of market condition during a follow-on fund's life to what it is during a current fund's life. A larger MSM value implies that the market conditions of the current and subsequent funds' lives are more dissimilar.

Based on the preceding discussion, I examine the following non-exhaustive market condition variables which could affect funds' performance as well as performance persistence of successive funds: 1) the IPO volume from the fifth to tenth year of a fund's lifetime as a measure of exit market condition for portfolio companies,[13] 2) the GDP growth during a fund's life as a measure of general economic condition, 3) the S&P 500 stock returns over the fund lifetime also as a measure of economic condition, 4) the three month Treasury bill yield during first five years of a fund's life as a measure of liquidity of

[13] The IPO volume data is obtained from Jay Ritter's website.

credit in the market, and 5) the ratio of average S&P 500 price earnings ratio during first five years to that during subsequent five years as a proxy for the change in acquisition multiples (i.e. at what price companies are being sold and bought)[14]. These variables are designed to proxy the general condition of the economy and the exit market conditions. After constructing MSM in Equation (3), I estimate the following regression equation similar to Equation (2):

$$(IRR)_{i,t} = \alpha + \beta\,(IRR)_{i,t-1} + \gamma\,(MSM)_{i,t-1} + \delta\,(MSM)_{i,t-1}\,(IRR)_{i,t-1} + \mathbf{Z}_t\,\mathbf{\Delta} + \varepsilon_{i,t}$$

$$= \alpha + [\beta + \delta\,(MSM)_{i,t-1}](IRR)_{i,t-1} + \gamma\,(MSM)_{i,t-1} + \mathbf{Z}_t\,\mathbf{\Delta} + \varepsilon_{i,t}. \quad (4)$$

Z_t is the same set of control variables as in model (2). Standard errors are clustered at the private equity firm level. The negative coefficient, δ, on the interaction term of MSM and IRR will imply that as the market conditions under which two funds are managed become dissimilar, the correlation (persistence) between the current and previous fund performance becomes smaller. IRR and MSM variables are standardized to a mean of zero and a standard deviation of one. Column (2) through (6) and (8) through (12) in Table 5 report the estimation results.

Most coefficients estimates of δ are negative. The exceptions are column (2) and (6) where the MSM based on IPO volume is used. In column (3), for example, the negative coefficient suggests that as the general conditions of the economy (measured by GDP growth over the following ten years since the inception of a fund) of the current and follow-on funds become more dissimilar, performance persistence weakens. The coefficient estimate on the interaction term between IRR and MSM, –0.126, suggests that a one standard deviation increase in the dissimilarity measure, MSM, leads to a 32% (=0.126/0.388) decrease in performance persistence. The effect of stock market condition on persistence is more pronounced for venture capital funds: the estimates on the interaction term is -0.11 for buyout and -0.386 for venture capital funds. The impact of credit market condition and market wide price-earnings ratio is similar in magnitude for both buyout and venture capital funds.

[14] The S&P500 price earnings ratio is obtained from Robert Shiller's website.

The overall evidence suggests that as the common economic conditions under which the successive funds are managed become more similar, there is more performance persistence in private equity funds.

The fact that performance persists only for a short period of time and that even this persistence can be largely explained by the commonality of market conditions is not consistent with the view that private equity partnerships have differential and proprietary skills. Since whether individual fund managers continue to stay with a private equity partnership cannot be observed, the findings do not necessarily imply that individual fund managers do not have heterogeneous skills. However, it is clear that private equity partnerships cannot sustain their performance consistently in the long run.

4.3. Fund flows and fund performance

Previous studies find that capital tends to chase past returns in the mutual fund industry (e.g. Sirri and Tufano, 1997) as well as in the hedge fund industry (Fung, Hsieh, Naik, and Ramadorai, 2008), and there are decreasing returns to scale in mutual funds (Chen, Hong, Huang, and Kubik, 2004) and hedge funds (Fung et al. 2008). Similarly, Chung, Sensoy, Stern, and Weisbach (2010) also document that superior performance leads to greater fund inflows in the private equity partnership. And Lopez de-Silane, Phalippou, and Gottschalg (2009) find a negative relation between fund scale and performance among buyout funds. Based on these recent findings and on Berk and Green's (2004) argument in the context of the mutual fund industry, it seems natural to suspect that return-chasing capital and decreasing returns to capital flows will erode the persistence of private equity fund performance. Seen in this light, the finding that performance does not persist does not necessarily imply an absence of differential ability across PEs. In other words, if a private equity fund performs well, then it is likely that the private equity partnership is able to raise a larger follow-on fund. However, if there are diminishing returns to scale, the private equity who now manages a larger fund will not be able to perform as well as before. Therefore, performance persistence is seen to be declining over time.

Before studying whether this argument holds, I first consider the relationship between fund flows and fund performance. In Table 6, Panel A, I examine how current fund performance affects future fundraising. Panel B investigates how current fund inflows influence future fund performance. Specifically, the table reports the estimates of the following equations:

$$\text{Panel A: } (\text{Fund Growth})_{i,t} = \alpha + \beta\,(\text{IRR})_{i,t-1} + \gamma\,(\text{Fund Size})_{i,t-1} + \mathbf{Z}_t\,\boldsymbol{\Delta} + \varepsilon_{i,t,} \quad (5)$$

$$\text{Panel B: } (\text{IRR})_{i,t} = \alpha + \beta\,(\text{Fund growth})_{i,\,t-1} + \gamma\,(\text{IRR})_{i,\,t-1} + \delta\,(\text{Fund Size})_{i,\,t} + \mathbf{Z}_t\,\boldsymbol{\Delta} + \varepsilon_{i,t,} \quad (6)$$

where fund growth, IRRs, and fund size are all logarithmized. The subscripts t and t-1 represent the current and preceding fund, respectively. Control variables, $\mathbf{Z}_t$ includes a list of control variables as in model (1). Standard errors are clustered at the private equity firm level.

The last two columns, (5) and (6), also include the interaction term between the buyout dummy variable (1 if a fund is a buyout fund and 0 if it is a venture capital fund) and $(\text{IRR})_{t-1}$ in Panel A and between the buyout dummy variable and $(\text{Fund growth})_{t-1}$ in Panel B to see whether the effect of past performance or past fund growth on the corresponding dependent variable is different between buyout and venture capital funds.

Consistent with Chung et al. (2010), I find positive and statistically significant coefficients on preceding funds' IRRs in Panel A. Past fund performance has a strong impact on follow-on fundraisings. This effect is stronger for buyout funds: when I estimate a regression that includes the interaction of the buyout fund dummy variable and the preceding fund IRR, the coefficient estimate on the interaction term is positive and statistically significant. This difference suggests that buyout funds are more scalable than venture capital funds, conditional on past performance. The results are similar when using benchmark adjusted IRRs.

Panel B reports the relationship between fund flows and follow-on fund performance using unadjusted as well as benchmark adjusted IRRs. Here I include the fund growth from the preceding fund to the current fund as an independent variable. It turns out capital flows are negatively related to follow-

on fund performance. However, the negative relationship is statistically significant only for venture capital funds (columns (3) and (4)). None of the coefficients estimates on past fund growth are statistically significant for buyout funds (columns (1) and (2)). When I estimate the regression including the interaction term between the buyout fund dummy variable and the preceding fund growth, the coefficient on the interaction term is positive (columns (5) through (6)). Therefore, a venture capital firm performance tends to deteriorate more when capital inflows are greater, compared to a buyout firm. This result is consistent with the evidence in Panel A: one reason that buyout funds are more scalable than venture capital funds is because buyout funds suffer less from diminishing returns to capital inflows.

Taken together, capital tends to chase returns in both buyout and venture capital funds, but the effect seems to be slightly greater for buyout funds. In addition, venture capital fund performance decreases in capital inflows, but buyout fund performance does not. These findings suggest that, conditional on fund growth, venture capital funds will show stronger performance persistence. I investigate this point in the next section.

4.4. The effect of fund flows on performance persistence

I examine whether fund growth affects performance persistence. Specifically I estimate the following ordinary least square equation and report the estimation results in Table 7:

$$(IRR)_{i,t} = \alpha + \beta\,(IRR)_{i,t-1} + \gamma\,(\text{Fund Growth})_{i,t-1} + \delta\,(\text{Fund Growth})_{i,t-1}\,(IRR)_{i,t-1} + \mathbf{Z}_t\,\boldsymbol{\Delta} + \varepsilon_{i,t}$$

$$= \alpha + [\beta + \delta\,(\text{Fund Growth})_{i,t-1}](IRR)_{i,t-1} + \gamma\,(\text{Fund Growth})_{i,t-1} + \mathbf{Z}_t\,\boldsymbol{\Delta} + \varepsilon_{i,t,} \qquad (7)$$

where $(IRR)_{i,t-1}$ and $(IRR)_{i,t}$ are current and follow-on fund performance and $(\text{Fund Growth})_{i,t-1}$ is fund growth from the current to the next fund. IRR and fund growth variables are standardized with a mean zero and a standard deviation one. The same set of control variables, $\mathbf{Z}_t$, are included as before.

The estimate of δ will tell us how much excessive capital inflows conditional on past performance will affect future fund performance. If the estimate of δ is negative, it will suggest that performance persistence decreases as a fund grows greater.

While the coefficient estimates on the interaction term is not statistically significant for buyout funds (columns (1) and (2)), they are negative and statistically significant for venture capital funds (columns (3) and (4)). This seems consistent with the results in Table 6 where I find that only venture capital funds' performance deteriorates as a fund grows greater. The coefficient estimate on the interaction term of unadjusted IRR and fund growth is -0.393 for venture capital funds. Therefore, a one standard deviation increase in fund growth will almost completely eliminate performance persistence.

It is worth noting that the coefficient estimate on the preceding fund performance substantially increases from 0.256 (in Panel B, Table 3) to 0.409 for venture capital funds while it is not for buyout funds. When the equation (7) is estimated using the second previous fund performance as an independent variable (reported in Appendix F), again the coefficient estimate on the second preceding fund performance increases from 0.09 to 0.268. Therefore, after accounting for the effect of fund flows on persistence, venture capital funds exhibit very strong persistence.

In column (5), I interact the buyout dummy variable with the interaction of IRR and fund growth to see whether the effect of fund growth on persistence is different for buyout and venture capital funds. The coefficient estimate is positive and statistically significant, suggesting that the negative effect of fund growth on persistence is indeed stronger for venture capital funds. In sum, one potential reason that private equity fund performance persists only in the short run is because investors move capital in response to past performance and because fund managers' performance is negatively associated with capital inflows, especially for venture capital funds.

The results are consistent with the hypothesis that decreasing returns to capital flows reduce performance persistence. In addition, there are some subtle differences between buyout funds and venture capital funds. This difference implies that management skills and technology for managing venture capital funds are not readily scalable, while they seem to be more so for buyout funds. In other words, the results

are consistent with the view that the venture capital industry is more labor- (that is, management-) intensive while the buyout industry is more capital intensive.

5. Conclusion

This study examines performance persistence in private equity funds and uncovers several novel findings. First, I show that even though performance persists consistent with several previous studies, this persistence is short lived. In the long run, performance tends to converge across funds. Comparing buyout and venture capital funds, it appears that buyout funds show stronger persistence, particularly for funds raised before 2000. Second, common market conditions facing successive funds increase performance persistence. Third, capital inflows into a fund after controlling for past performance reduce performance persistence. Venture capital funds suffer more from this growth effect and, after accounting for this effect, show similar magnitude of persistence as buyout funds.

The evidence presented in this paper is skeptical about whether private equity partnerships have differential and proprietary skills and whether they can sustain performance for the long run. However, the short-living persistence does not necessarily imply that fund managers do not have differential skills, if one accepts the implication of the Berk and Green (2004) model. Since the effect of capital flows on persistence is significant only for venture capital funds, the findings can be consistent with the view that venture capital partnerships have differential and unique skills whereas it is less clear for buyout partnerships. Also, this finding manifests the different natures of the two types of funds: venture capital is more labor-intensive while buyout is more capital-intensive.

Notwithstanding, the evidence in this paper has important implications for investors in the private equity industry. Investors need to actively monitor and rebalance their portfolios. The second or prior fund performance can be a misleading indicator of future performance. Particularly, investors should be careful in investing in better performed funds in the past since it is likely that their performance will decline. Worse performed funds, conditional on their survival, tend to improve over time.

As mentioned, however, the results in this paper should be interpreted with caution. Among others, because of the private nature of the industry, the database on which this study is based does not have complete performance data for all buyout and venture capital funds in the market as other previous studies. It is possible that funds that do not report performance may exhibit stronger performance persistence. Second, we do not observe individual GPs and cannot test whether these GPs' performance persist on not. My finding only suggests that private equity partnerships find it difficult to persistently maintain their performance.

References

Acharya V., J. Franks, and H. Servaes, (2009) "Private Equity: Boom and Bust?" *Journal of Applied Corporate Finance* 19, Fall

Axelson U., T. Jenkinson, P. Stromberg, and M. Weisbach, (2010) "Borrow Cheap, Buy High? The Determinants of Leverage and Pricing in Buyouts," NBER working paper.

Berk, J. and R. Green, (2004), "Mutual Fund Flows and Performance in Rational Markets," *Journal of Political Economy* 112, pp. 1269-1295.

Chen J, H. Hong, M. Huang, and J. Kubik, (2004) "Does Fund Size Erode Mutual Fund Performance? The Role of Liquidity and Organization," *American Economic Review* 94, pp. 1276-1302.

Chung J., B. Sensoy, L. Stern, and M. Weisbach, (2010) "Incentives of Private Equity General Partners from Future Fundraising," Ohio State University working paper.

Daniel K., M. Grinblatt, S. Titman, and R. Wermers, (1997) "Measuring Mutual Fund Performance with Characteristic-Based Benchmarks" *Journal of Finance*, 52, pp. 1035-1058.

Fung W., D. Hsieh, N. Niak, and T. Ramadorai, (2008) "Hedge Funds: Performance, Risk, and Capital Formation," *Journal of Finance* 62, pp. 1777-1803.

Glode V. and R. Green, (2008) "Information Spill-Overs and Performance Persistence in PE partnerships," Working paper.

Hochberg Y., A. Ljungqvist, and A. Vissing-Jorgensen, (2009) "Informational Hold-up and Performance Persistence in Venture Capital," Working paper.

Kaplan S. and A. Schoar, (2005) "Private Equity Performance: Returns, Persistence, and Capital Flows," *Journal of Finance* 60, pp. 1791-1823.

Kaplan S. and J. Stein (1993) "The Evolution of Buyout Pricing and Financial Structure in the 1980s," *Quarterly Journal of Economics* 108, pp. 313-357.

Lerner J., A. Schoar, and W. Wongsunwai (2007) "Smart Institutions, Foolish Choices? The Limited Partner Performance Puzzle," *Journal of Finance*, 62, pp. 731-764

Lopez de-Silane F., L. Phalippou, and O. Gottschalg, (2010) "Giants at the Gate: Diseconomies of Scale in Private Equity," Working paper.

Lynch A. and D.Musto, (2003) "How Investors Interpret Past Fund Returns," *Journal of Finance* 58, pp. 2033-2058.

Marquez R., V. Nanda, and M. Yavuz (2010) "Private Equity Fund Returns: Do Managers Actually Leave Money on the Table?" Working pper.

McClelland G. and C. Judd, (1993) "Statistical Difficulties of Detecting Interactions and Moderator Effects," *Psychological Bulletin* 114, pp. 376-390.

Metrick A. and A. Yasuda (2010) "The Economics of Private Equity Funds," *Review of Financial Studies* 23, pp. 2303-2341.

Phalippou L., (2009) "Venture Capital Funds: Performance Persistence and Flow-Performance relation," *Journal of Banking and Finance* 34, pp. 568-577.

Phalippou L., and O. Gottschalg, (2010) "The Performance of Private Equity Funds," *Review of Financial Studies* 22, pp. 1747-1776.

Preqin Private Equity Spotlight (2010), http://www.preqin.com/docs/newsletters/PE/Preqin_Private_Equity_Spotlight_February_2010.pdf

Sirri E. and P. Tufano (1998), "Costly Search and Mutual Fund Flows," *Journal of Finance* 53, pp. 1589-1622.

Figure 1. Private equity fund performance and fund raising by vintage year

The figures plot the distribution (1st and 3rd quartiles, mean, and median) of fund performance and committed capital by vintage year for buyout funds (Graphs A and C) and venture capital funds (Graphs B and D). I use as a performance measure the internal rate of returns (IRR) reported by limited partners or PE partnerships and collected by Preqin.

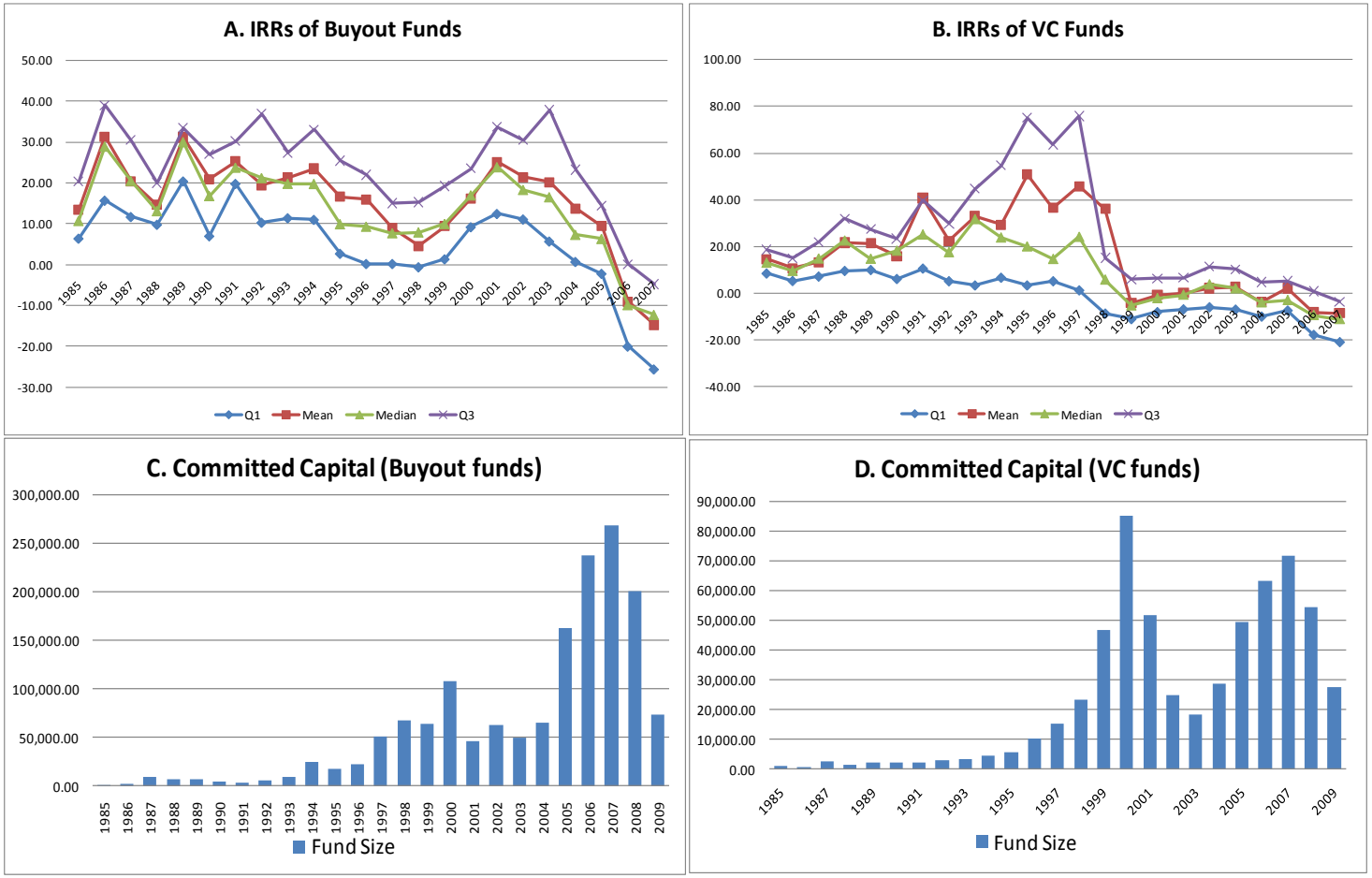
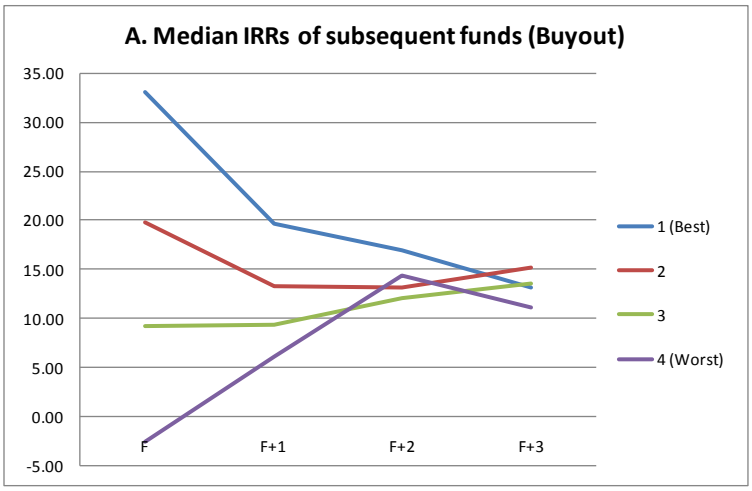


Figure 2. Performance of quartile portfolios ranked on current fund performance

Funds are sorted into four portfolios based on current funds' IRR. Next, median IRRs are computed for follow-on funds in each quartile and are plotted. F is the current funds used to rank funds and form portfolios. F+t, where t takes 1, 2, or 3, represents t-th follow-on fund. Graph A is a plot for buyout funds and Graph B for venture capital funds.



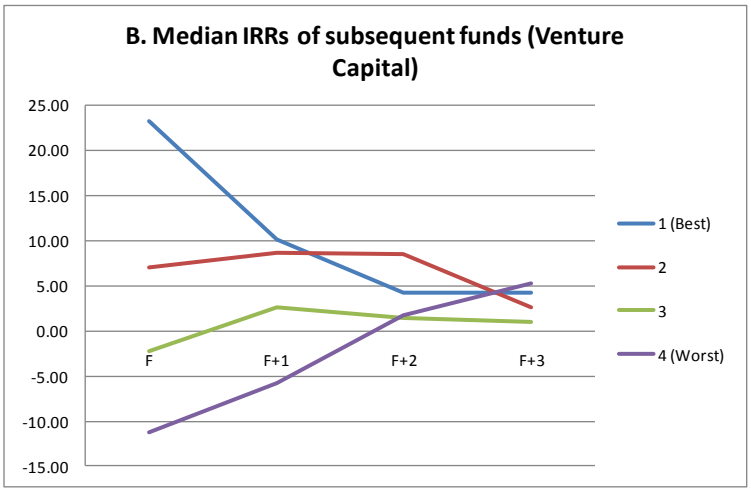


Figure 3. Cash flows of a private equity fund over its lifetime

This graph plots the cumulative contribution (Graph A), cumulative distribution (Graph B), and net cash flows (Graph C) of a private equity fund (randomly chosen from the Preqin cash flow dataset) over its fund's lifetime. The fund was raised in 1993; its size is $473M. Cumulative contribution is the sum of all drawn down capital to that date; cumulative distribution is the sum of all profits returned to investors. Net cash flow is cumulative distribution minus cumulative contribution at a given date.

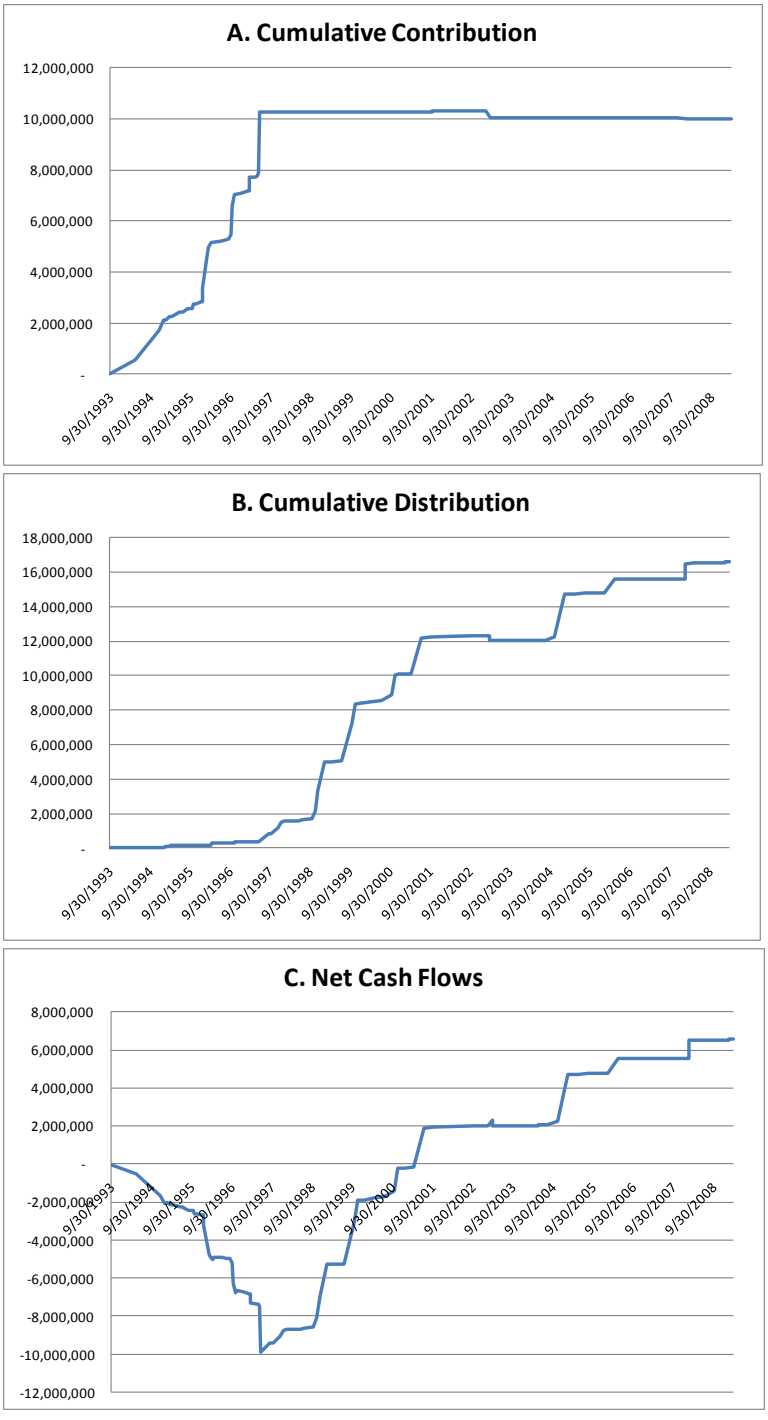


Table 1. Private equity fund performance and fund raising

The table reports the distribution of performance (in percentage) and fund size (in millions) of buyout (Panel A) and venture capital funds (Panel B) by three vintage year groups: funds raised before 1989, between 1990 and 1999, and between 2000 and 2005. N denotes the number of funds raised and Q1 and Q3 denote first and third quartiles.

		Buyout						Venture					
	Vintage	N	Q1	Mean	Median	Q3	StdDev	N	Q1	Mean	Median	Q3	StdDev
IRR	~1989	59	12.40	24.34	20.00	31.10	17.42	182	7.60	16.53	12.95	21.00	19.63
	~1999	334	2.70	13.60	11.15	22.40	20.57	413	-3.50	27.86	10.30	31.90	76.89
	~2005	329	4.20	16.41	13.80	26.70	21.32	424	-7.35	0.43	-1.20	7.50	16.58
	Total	722	4.80	15.76	13.20	25.00	20.85	1019	-4.70	14.42	6.10	18.20	52.26
Multiple	~1989	66	1.77	3.51	2.51	3.71	3.19	206	1.48	2.47	1.99	3.07	1.80
	~1999	364	1.15	1.77	1.57	2.19	1.04	465	0.74	2.44	1.40	2.42	3.91
	~2005	368	1.06	1.56	1.43	1.89	0.87	523	0.74	1.07	0.94	1.22	0.71
	Total	798	1.13	1.82	1.54	2.12	1.40	1194	0.79	1.85	1.18	1.94	2.68
Fund Size (Nominal)	~1989	75	50.00	353.55	125.00	325.00	788.62	205	16.21	55.79	36.00	72.50	58.31
	~1999	556	100.00	481.85	225.00	507.50	736.76	1017	30.00	115.47	65.93	135.00	156.42
	~2005	795	100.00	621.99	250.00	558.00	1137.07	1738	27.30	148.53	70.74	180.00	215.64
	Total	1426	100.00	553.23	228.00	521.00	985.32	2960	27.03	130.75	65.00	150.00	191.28

Table 2. Transition probabilities from current funds' performance quartiles to follow-on funds' performance quartiles

I sort all funds for which I have follow-on funds into performance quartiles and calculate the conditional probability that a partnership's 1st through 3rd follow-on funds will either stay in the same performance quartile as its current funds, or that it will move into one of the other three quartiles. The first, second, and third sub-panels of each panel report transition probabilities from current fund to the 1st, 2nd, and 3rd follow-on funds, respectively. Panels A reports the probabilities for buyout and Panel B for venture capital funds. The first rows of each sub-panel (the raw headings with *Obs*) report the number of follow-on funds in each quartile portfolio. The column heading with *Total* shows the number of funds in each of the initial portfolio. χ^2 reports Chi-square test statistics testing the null hypothesis of no association between current and follow-on funds performance. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, *, respectively.

Panel A. Buyout Funds

		1	2	3	4	Total	χ^2	
Current	Obs	68	81	81	73	303	50.99	***
to 1st	1	42.03	34.78	13.04	10.14	69		
follow-on	2	22.22	27.16	33.33	17.28	81		
	3	14.29	26.19	35.71	23.81	84		
	4	13.04	18.84	21.74	46.38	69		
Current	Obs	40	45	46	42	173	7.74	
to 2nd	1	28.21	20.51	30.77	20.51	39		
follow-on	2	26.09	32.61	19.57	21.74	46		
	3	23.91	17.39	28.26	30.43	46		
	4	14.29	33.33	28.57	23.81	42		
Current	Obs	17	28	32	21	98	12.37	
to 3rd	1	15.79	26.32	47.37	10.53	19		
follow-on	2	17.24	34.48	24.14	24.14	29		
	3	11.11	25.93	48.15	14.81	27		
	4	26.09	26.09	13.04	34.78	23		

Panel B. Venture Capital Funds

		1	2	3	4		χ^2	
Current	Obs	89	97	99	93	378	52.31	***
to 1st	1	36.26	25.27	24.18	14.29	91		
follow-on	2	31.52	29.35	23.91	15.22	92		
	3	20.20	23.23	35.35	21.21	99		
	4	7.29	25.00	20.83	46.88	96		
Current	Obs	51	58	62	54	225	13.29	
to 2nd	1	33.33	25.93	24.07	16.67	54		
follow-on	2	26.32	17.54	24.56	31.58	57		
	3	16.13	29.03	35.48	19.35	62		
	4	15.38	30.77	25.00	28.85	52		
Current	Obs	30	39	42	32	143	7.29	
to 3rd	1	26.67	33.33	26.67	13.33	30		
follow-on	2	26.83	24.39	29.27	19.51	41		
	3	14.63	29.27	24.39	31.71	41		
	4	16.13	22.58	38.71	22.58	31		

Table 3. Cross sectional regression of current performance on past performance

The table reports the estimates of the following regression: $(IRR)_t = \alpha + \beta (IRR)_{t-\tau} + \mathbf{Z}_t \Delta + \varepsilon_t$, where τ is 1, 2, or 3 and $t-\tau$ represents τ-th previous funds. The IRRs are logarithmized. $\mathbf{Z}_t$ includes a list of control variables: the current fund size (*Size*), sequence number of the current fund (*Sequence*), and dummy variables for vintage year (*Year F.E.*). Funds raised after 2005 are excluded from the estimations. The numbers in the parentheses are t-statistics. Heteroskedasticity-robust standard errors are clustered at the private equity firm level. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, *, respectively.

Panel A. Buyout Funds

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
IRR(t-1)	0.393***			0.365**	0.844***	0.390***			0.350**	0.777***
	(5.286)			(2.138)	(4.691)	(5.224)			(2.078)	(4.779)
IRR(t-2)		0.215**		0.111	-0.075		0.226**		0.127	-0.035
		(2.246)		(0.943)	(-0.556)		(2.294)		(1.115)	(-0.306)
IRR(t-3)			0.133		0.077			0.173		0.154
			(1.058)		(0.661)			(1.441)		(1.366)
log(Size (t))						-0.010*	-0.019**	-0.017	-0.018**	-0.022
						(-1.772)	(-2.168)	(-1.252)	(-2.063)	(-1.628)
log(Sequence (t))						0.011	0.038	0.064	0.029	0.059
						(0.712)	(1.492)	(1.315)	(1.040)	(1.184)
Constant	0.476***	0.635***	0.714***	0.423***	0.087	0.517***	0.680***	0.696***	0.483***	0.105
	(7.475)	(7.001)	(6.620)	(3.569)	(0.801)	(7.127)	(5.602)	(5.096)	(3.753)	(0.832)
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	303	173	98	153	74	303	173	98	153	74
Adjusted R2	0.211	0.139	0.114	0.185	0.293	0.216	0.175	0.136	0.214	0.326

Table 3 (Continued)

Panel B. Venture Captal Funds

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IRR(t-1)	0.256***			0.221***	0.178***	0.251***			0.218***	0.164***
	(4.385)			(3.848)	(3.312)	(4.293)			(3.665)	(3.178)
IRR(t-2)		0.090		0.061	-0.081		0.098		0.070	-0.058
		(0.824)		(0.571)	(-0.494)		(0.932)		(0.680)	(-0.376)
IRR(t-3)			0.028		0.066			0.050		0.145
			(0.483)		(1.293)			(0.843)		(1.577)
log(Size (t))						-0.007	-0.008	-0.021	-0.010	-0.047
						(-0.567)	(-0.458)	(-0.883)	(-0.465)	(-1.379)
log(Sequence (t))						0.043*	0.053	-0.006	0.029	-0.042
						(1.780)	(1.284)	(-0.074)	(0.587)	(-0.388)
Constant	0.554***	0.688***	0.797***	0.518***	0.845***	0.533***	0.630***	0.863***	0.510***	1.096***
	(12.030)	(7.190)	(18.209)	(4.679)	(5.880)	(7.203)	(5.680)	(5.643)	(3.155)	(3.431)
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	378	225	143	188	103	378	225	143	188	103
Adjusted R2	0.284	0.246	0.246	0.293	0.307	0.286	0.244	0.243	0.287	0.328

Table 4. Subsequent fund performance (unadjusted IRRs) by quartile portfolios based on current fund performance

Each fund is sorted into four portfolios based on the current fund's IRR. Then, mean and median IRRs are computed for follow-on funds in each quartile portfolio. *F* is current funds used to rank the quartile portfolios. *F+t* where *t* takes 1, 2, or 3 represent the t-th follow-on fund. Panel A is for buyout funds and Panel B for venture capital funds. Sub-panel A.1 and B.1 includes all available funds. Sub-panels A.2 through A.4 and B.2 through B.4 require that a fund have IRR data for its 1st, 2nd, and 3rd following funds. The last four columns report the number of funds included in the computation of the mean and median values. The last two rows of each sub-panel reports the difference in IRR between quartile 1 and 4 and its corresponding p-value based on t-test (for the difference in mean values) or Wilcoxon rank sum test (for median IRRs). Quartile 1 contains the best-performing funds, and quartile 4 contains the worst-performing funds.

Panel A. Buyout

	Mean				Median				N			
Quartile	F	F+1	F+2	F+3	F	F+1	F+2	F+3	F	F+1	F+2	F+3
A.1. All funds												
All	16.36	15.59	16.05	15.08	14.20	13.10	14.40	13.50	636	303	173	98
1	39.70	24.65	19.13	13.68	33.10	19.70	17.00	13.10	153	87	55	35
2	19.54	16.01	12.65	16.78	19.80	13.30	13.20	15.20	164	85	53	31
3	10.46	10.65	16.27	16.29	9.20	9.40	12.10	13.50	167	81	43	20
4	-4.08	7.10	16.17	12.78	-2.60	6.10	14.40	11.15	152	50	22	12
1-4	43.78	17.55	2.96	0.90	35.70	13.60	2.60	1.95				
p-value	**0.00**	**0.00**	0.63	0.90	**0.00**	**0.00**	0.55	0.67				
A.2. Funds with 1st follow-on funds' IRR available												
All	20.04	15.59			18.00	13.10			303	303		
1	38.70	24.65			33.00	19.70			87	87		
2	20.59	16.01			20.80	13.30			85	85		
3	12.26	10.65			12.10	9.40			81	81		
4	-0.75	7.10			-0.70	6.10			50	50		
1-4	39.46	17.55			33.70	13.60						
p-value	**0.00**	**0.00**			**0.00**	**0.00**						
A.3. Funds with 1st and 2nd follow-on funds' IRR available												
All	24.18	19.38	15.04		21.20	17.00	13.70		153	153	153	
1	40.98	25.45	18.24		37.05	21.60	16.95		50	50	50	
2	23.75	19.10	11.11		22.60	20.75	13.15		42	42	42	
3	13.49	15.35	15.42		14.20	13.10	11.90		41	41	41	
4	5.04	13.09	14.52		8.05	7.90	13.05		20	20	20	
1-4	35.94	12.36	3.72		29.00	13.70	3.90					
p-value	**0.00**	**0.01**	0.57		**0.00**	**0.01**	0.35					
A.4. Funds with 1st, 2nd, and 3rd follow-on funds' IRR available												
All	29.43	22.00	17.97	15.09	24.45	19.95	16.95	15.00	80	80	80	80
1	45.71	28.35	21.69	15.18	47.45	24.20	19.40	15.00	30	30	30	30
2	25.19	21.80	16.15	13.93	23.60	20.70	15.20	15.20	23	23	23	23
3	17.70	16.71	12.94	15.73	18.00	14.20	12.90	13.70	19	19	19	19
4	8.40	11.35	21.18	16.54	10.45	11.05	18.75	15.50	8	8	8	8
1-4	37.31	17.00	0.52	-1.35	37.00	13.15	0.65	-0.50				
p-value	**0.00**	**0.00**	0.96	0.91	**0.00**	**0.01**	0.96	0.99				

Table 4. (Continued)

Panel B. Venture Capital

	Mean				Median				N			
Quartile	F	F+1	F+2	F+3	F	F+1	F+2	F+3	F	F+1	F+2	F+3
B.1. All funds												
All	13.29	18.43	23.00	28.96	5.00	4.85	3.70	2.90	807	378	225	143
1	51.58	30.92	30.78	25.95	23.25	10.20	4.20	4.30	194	101	65	46
2	13.73	30.33	21.60	25.99	7.00	8.60	8.50	2.60	204	102	72	48
3	2.10	10.50	26.11	41.57	-2.20	2.60	1.45	1.00	201	90	46	27
4	-11.95	-2.17	7.65	20.26	-11.30	-5.80	1.70	5.30	208	85	42	22
1-4	63.53	33.09	23.13	5.69	34.55	16.00	2.50	-1.00				
p-value	**0.00**	**0.00**	**0.06**	0.67	**0.00**	**0.00**	0.28	0.84				
B.2. Funds with 1st follow-on funds' IRR available												
All	22.30	18.43			10.20	4.85			378	378		
1	66.48	30.92			39.30	10.20			101	101		
2	19.42	30.33			15.30	8.60			102	102		
3	4.58	10.50			5.20	2.60			90	90		
4	-8.06	-2.17			-9.00	-5.80			85	85		
1-4	74.53	33.09			48.30	16.00						
p-value	**0.00**	**0.00**			**0.00**	**0.00**						
B.3. Funds with 1st and 2nd follow-on funds' IRR available												
All	28.10	27.49	24.27		16.85	10.10	3.80		188	188	188	
1	66.69	39.97	29.64		57.10	15.00	4.20		55	55	55	
2	25.94	42.53	24.31		24.00	13.50	8.60		61	61	61	
3	7.14	9.26	28.32		8.40	3.40	0.90		40	40	40	
4	-3.08	4.90	8.40		-2.55	4.25	3.85		32	32	32	
1-4	69.77	35.07	21.24		59.65	10.75	0.35					
p-value	**0.00**	**0.01**	0.13		**0.00**	**0.01**	0.46					
B.4. Funds with 1st, 2nd, and 3rd follow-on funds' IRR available												
All	35.76	31.89	35.48	34.08	27.10	19.90	10.60	2.80	109	109	109	109
1	68.60	42.42	33.43	29.77	61.50	24.80	7.00	3.30	39	39	39	39
2	27.87	34.73	26.60	28.87	26.20	22.10	11.20	2.90	39	39	39	39
3	10.50	16.18	60.01	59.32	10.45	16.80	10.50	1.60	19	19	19	19
4	3.74	17.85	24.79	16.55	4.50	8.10	10.60	-0.40	12	12	12	12
1-4	64.87	24.57	8.64	13.22	57.00	16.70	-3.60	3.70				
p-value	**0.00**	**0.04**	0.67	0.39	**0.00**	0.15	0.95	0.94				

Table 5. The effects of similar market condition on performance persistence

The table reports ordinary least square regression estimates for the following specifications: $(IRR)_{i,t} = \alpha + \beta\,(IRR)_{i,t-1} + \gamma\,(MSM)_{i,t-1} + \delta\,(MSM)_{i,t-1}\,(IRR)_{i,t-1} + \mathbf{Z}_t\,\mathbf{\Delta} + \varepsilon_{i,t}$. MSM is the market similarity measure defined as the absolute value of ((Market Condition)$_{i,t+1}$ / (Market Condition)$_{i,t}$ -1). The market condition variables are the 1) IPO volume from the fifth to tenth year of a fund's life (the column heading with 'IPO volume'), 2) GDP growth during a fund's life ('GDP growth'), 3) S&P 500 stock returns over a fund's lifetime ('S&P500 returns'), 4) three month Treasury bill yield during first five years of a fund's life ('T-bill'), and 5) the ratio of average S&P 500 price earnings ratio during first five years to that during subsequent five years. MSM also includes *Time Gap* which is the difference between the current funds' vintage year and the preceding funds' vintage year. $\mathbf{Z}_t$ includes a list of control variables (see Table 3). IRRs and MSM are logarithmized and normalized with a mean of zero and a standard deviation of one. Funds raised after 2005 are excluded from the estimations. The numbers in the parentheses are t-statistics. Heteroskedasticity-robust standard errors are clustered at the private equity firm level. Standard errors are clustered at the private equity firm level. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

	Buyout Funds						Venture Capital Funds					
MSM:	Time Gap	IPO volume	GDP growth	S&P500 returns	T-bill	P/E	Time Gap	IPO volume	GDP growth	S&P500 returns	T-bill	P/E
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
IRR (t-1)	0.335***	0.372***	0.388***	0.385***	0.351***	0.339***	0.239***	0.337***	0.369***	0.396***	0.309***	0.246***
	(5.093)	(4.628)	(4.871)	(4.782)	(4.339)	(5.202)	(4.848)	(4.215)	(5.101)	(4.924)	(4.085)	(5.054)
MSM (t)	0.022	0.133	0.358	0.054	0.122	0.035	-0.041	0.009	0.105	0.097	-0.057	-0.016
	(0.326)	(1.208)	(1.618)	(0.439)	(1.225)	(0.437)	(-0.560)	(0.124)	(0.677)	(0.801)	(-0.495)	(-0.194)
IRR*MSM (t)	-0.133**	0.056	-0.126**	-0.110	-0.124*	-0.163**	0.043	0.174	-0.273***	-0.386***	-0.157*	-0.133
	(-2.051)	(0.702)	(-1.984)	(-1.383)	(-1.716)	(-2.106)	(0.640)	(1.483)	(-4.344)	(-2.936)	(-1.834)	(-1.418)
log(Size (t))	-0.101*	-0.008	-0.009	-0.003	-0.015	-0.101*	-0.048	-0.123	-0.143*	-0.132*	-0.123	-0.047
	(-1.908)	(-0.117)	(-0.132)	(-0.050)	(-0.211)	(-1.922)	(-0.949)	(-1.589)	(-1.882)	(-1.687)	(-1.496)	(-0.931)
log(Sequence (t))	0.096	0.202	0.178	0.140	0.211	0.077	0.243	0.503**	0.430**	0.500**	0.388	0.239
	(0.528)	(0.834)	(0.748)	(0.583)	(0.829)	(0.445)	(1.529)	(2.307)	(2.030)	(2.322)	(1.613)	(1.542)
Constant	0.535	-0.024	-0.223	-0.030	0.020	0.627	-0.120	-0.187	-0.041	-0.243	0.239	-0.058
	(1.160)	(-0.046)	(-0.409)	(-0.057)	(0.019)	(1.337)	(-0.353)	(-0.406)	(-0.090)	(-0.541)	(0.277)	(-0.161)
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	303	183	183	183	178	303	378	246	246	246	233	378
Adjusted R2	0.222	0.223	0.238	0.221	0.224	0.224	0.283	0.272	0.322	0.292	0.276	0.287

Table 6. The relationship between fund performance and fund growth

The table presents ordinary least square regression estimates of the following specifications: $(\text{Fund Growth})_{i,t} = \alpha + \beta\,(\text{IRR})_{i,t-1} + \gamma\,(\text{Fund Size})_{i,t-1} + \mathbf{Z}_t\,\boldsymbol{\Delta} + \varepsilon_{i,t,}$(in Panel A) and $(\text{IRR})_{i,t} = \alpha + \beta\,(\text{Fund growth})_{i,\,t-1} + \gamma\,(\text{IRR})_{i,\,t-1} + \delta\,(\text{Fund Size})_{i,\,t} + \mathbf{Z}_t\,\boldsymbol{\Delta} + \varepsilon_{i,t,}$ (in Panel B). Fund growth (from the 1st preceding fund to the current fund), IRRs, and fund size are logarithmized. In models (5) and (6), I also include the buyout fund dummy variable (taking a value of 1 if a fund is a buyout fund, 0 otherwise) and the interaction term between the buyout dummy variable and IRRs. Models (1), (3), and (5) use unadjusted IRRs including vintage year fixed effect, and models (2), (4), and (6) use benchmark adjusted IRRs. Benchmark IRRs are the median IRRs of the portfolio of funds with same vintage year, geographic focus, and investment type (early stage, venture capital, and buyout). $\mathbf{Z}_t$ is the list of the same control variables as in Table 3. Funds raised after 2005 are excluded. The numbers in the parentheses are t-statistics. Heteroskedasticity-robust standard errors are clustered at the private equity firm level. Standard errors are clustered at the private equity firm level. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Panel A. The effect of performance on fund growth

	Buyout Funds		Venture Capital Funds		All Funds	
	IRR	Adjusted IRR	IRR	Adjusted IRR	IRR	Adjusted IRR
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
IRR(t-1)	0.894***	0.670**	0.203*	0.233**	0.147	0.203**
	(2.737)	(2.336)	(1.944)	(2.521)	(1.532)	(2.191)
Buyout=1					-0.396	-0.083
					(-1.464)	(-0.382)
Buyout*IRR					0.914***	0.560*
					(2.617)	(1.847)
log(Size (t-1))	-0.187***	-0.192***	-0.154***	-0.123***	-0.174***	-0.156***
	(-6.418)	(-5.700)	(-6.275)	(-4.553)	(-8.102)	(-7.016)
log(Sequence (t))	0.178*	0.219**	0.050	0.029	0.103*	0.111*
	(1.807)	(2.266)	(0.821)	(0.407)	(1.868)	(1.892)
Constant	1.085***	1.365***	1.307***	1.258***	1.357***	1.319***
	(2.919)	(4.997)	(8.568)	(8.965)	(10.147)	(11.417)
Year F.E.	Yes	No	Yes	No	Yes	No
Obs	303	303	378	378	681	681
Adjusted R2	0.282	0.233	0.250	0.122	0.256	0.193

Table 6. (Continued)

Panel B. The effect of fund growth on performance

	Buyout Funds		Venture Capital Funds		All Funds	
	IRR	Adjusted IRR	IRR	Adjusted IRR	IRR	Adjusted IRR
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Fund Growth (t-1) to (t)	-0.002	-0.007	-0.072***	-0.070***	-0.065***	-0.072***
	(-0.119)	(-0.426)	(-3.090)	(-3.960)	(-2.909)	(-3.603)
IRR (t-1)	0.393***	0.417***	0.272***	0.301***	0.333***	0.322***
	(4.643)	(5.444)	(5.425)	(4.658)	(6.288)	(5.639)
Buyout*Fund Growth					0.047*	0.070***
					(1.706)	(2.713)
Buyout=1					-0.025	-0.073***
					(-0.891)	(-2.657)
log(Size (t))	-0.010	-0.011*	0.002	-0.013	-0.006	-0.012**
	(-1.609)	(-1.917)	(0.147)	(-1.221)	(-0.953)	(-1.971)
log(Sequence (t))	0.011	0.012	0.023	0.038	0.032**	0.028*
	(0.623)	(0.686)	(0.989)	(1.518)	(2.063)	(1.664)
Constant	0.517***	0.461***	0.579***	0.583***	0.550***	0.584***
	(7.100)	(7.378)	(7.056)	(7.439)	(7.541)	(8.639)
Year F.E.	Yes	No	Yes	No	Yes	No
Obs	303	303	378	378	681	681
Adjusted R2	0.213	0.128	0.302	0.107	0.212	0.121

Table 7. The effects of fund growth on performance persistence

The table reports the ordinary least square regression estimates for the following specifications: $(IRR)_{i,t} = \alpha + \beta (IRR)_{i,t-1} + \gamma (\text{Fund Growth})_{i,t-1} + \delta (\text{Fund Growth})_{i,t-1} (IRR)_{i,t-1} + \mathbf{Z}_t \mathbf{\Delta} + \varepsilon_{i,t}$. The triple interactions of IRR, Time Gap, and the Buyout dummy variable is included in Models (5) and (6). Fund growth is the growth rate from the preceding fund to the current fund. IRRs and Fund growth are logarithmized and normalized with a mean zero and standard deviation one. Buyout is a dummy variable taking 1 if the fund is a buyout fund, 0 otherwise. $\mathbf{Z}_t$ includes a list of control variables (see Table 3). Models (1) and (2) are for buyout funds, and (4) and (5) are for venture capital funds. In all regression estimations, vintage fixed year effects are included. The numbers in the parentheses are t-statistics. Heteroskedasticity-robust standard errors are clustered at the private equity firm level. Standard errors are clustered at the vintage year level. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

	Buyout Funds		Venture Capital Funds		All Funds	
	IRR	Adjusted	IRR	Adjusted	IRR	Adjusted
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
IRR (t-1)	0.381***	0.419***	0.409***	0.443***	0.510***	0.444***
	(5.844)	(6.474)	(7.629)	(8.111)	(9.708)	(8.326)
Fund Growth (t-1) to (t)	0.022	0.009	-0.230***	-0.266***	-0.207***	-0.260***
	(0.289)	(0.123)	(-3.175)	(-3.532)	(-2.936)	(-3.635)
IRR*Fund Growth	-0.058	-0.087	-0.393***	-0.455***	-0.499***	-0.455***
	(-0.860)	(-1.215)	(-5.556)	(-5.840)	(-7.048)	(-5.976)
Buyout					0.055	0.036
					(0.596)	(0.387)
IRR*Buyout					-0.171**	-0.023
					(-2.102)	(-0.273)
Fund Growth*Buyout					0.177*	0.267***
					(1.789)	(2.641)
IRR*Fund Growth*Buyout					0.454***	0.368***
					(4.676)	(3.478)
log(Size (t))	-0.105*	-0.114**	0.000	-0.077	-0.069*	-0.095***
	(-1.909)	(-2.195)	(0.009)	(-1.550)	(-1.849)	(-2.644)
log(Sequence (t))	0.131	0.153	0.109	0.222	0.196*	0.191
	(0.741)	(0.835)	(0.735)	(1.367)	(1.697)	(1.576)
Constant	0.522	0.450	-0.128	0.098	0.076	0.234
	(1.124)	(1.425)	(-0.398)	(0.359)	(0.289)	(1.180)
Year F.E.	Yes	No	Yes	No	Yes	No
Obs	303	303	378	378	681	681
Adjusted R2	0.213	0.129	0.356	0.180	0.252	0.161

Appendix A. Transition probabilities from current fund performance quartiles to follow-on funds' performance quartiles (using benchmark adjusted IRRs)

Using benchmark adjusted IRRs, I sort all funds for which I have follow-on funds into performance quartiles and calculate the conditional probability that a partnership's 1st through 3rd follow-on funds will either stay in the same performance quartile as its current funds, or that it will move into one of the other three quartiles. The first, second, and third sub-panels of each panel report transition probabilities from current fund to the 1st, 2nd, and 3rd follow-on funds, respectively. Panels A reports the probabilities for buyout and Panel B for venture capital funds. The first rows of each sub-panel (the raw headings with *Obs*) report the number of follow-on funds in each quartile portfolio. The column heading with *Total* shows the number of funds in each of the initial portfolio. χ^2 reports Chi-square test statistics testing the null hypothesis of no association between current and follow-on funds performance. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, *, respectively.

Panel A. Buyout Funds

		1	2	3	4	Total	χ^2	
Current	Obs	70	79	83	71	303	35.05	***
to 1st	1	43.48	20.29	26.09	10.14	69		
follow-on	2	22.22	30.86	27.16	19.75	81		
	3	15.48	29.76	30.95	23.81	84		
	4	13.04	21.74	24.64	40.58	69		
Current	Obs	40	46	44	43	173	11.45	
to 2nd	1	25.64	28.21	33.33	12.82	39		
follow-on	2	21.28	38.30	21.28	19.15	47		
	3	22.22	20.00	26.67	31.11	45		
	4	23.81	19.05	21.43	35.71	42		
						.		
Current	Obs	20	28	30	20	98	6.04	
to 3rd	1	26.32	26.32	36.84	10.53	19		
follow-on	2	20.69	27.59	27.59	24.14	29		
	3	14.81	29.63	40.74	14.81	27		
	4	21.74	30.43	17.39	30.43	23		

Panel B. Venture Capital Funds

		1	2	3	4	Total	χ^2	
Current	Obs	89	97	101	91	378	49.04	***
to 1st	1	38.20	26.97	22.47	12.36	89		
follow-on	2	29.29	30.30	26.26	14.14	99		
	3	15.46	26.80	32.99	24.74	97		
	4	11.83	18.28	24.73	45.16	93		
Current	Obs	52	56	63	54	225	16.58	*
to 2nd	1	33.96	26.42	24.53	15.09	53		
follow-on	2	32.79	19.67	24.59	22.95	61		
	3	11.67	23.33	33.33	31.67	60		
	4	13.73	31.37	29.41	25.49	51		
Current	Obs	30	40	41	32	143	18.37	**
to 3rd	1	23.33	50.00	20.00	6.67	30		
follow-on	2	29.27	19.51	24.39	26.83	41		
	3	12.50	17.50	40.00	30.00	40		
	4	18.75	31.25	28.13	21.88	32		

Appendix B. Cross sectional regression of current performance on past performance (using benchmark adjusted IRRs)

The table reports the estimates of the following regression: $(IRR)_t = \alpha + \beta\,(IRR)_{t-\tau} + \mathbf{Z}_t\,\Delta + \varepsilon_t$, where τ is 1, 2, or 3 and t- τ represents τ-th previous funds. The IRRs are benchmark adjusted and logarithmized. $\mathbf{Z}_t$ includes a list of control variables: the current fund size (*Size*), sequence number of the current fund (*Sequence*), and dummy variables for vintage year (*Year F.E.*). Funds raised after 2005 are excluded from the estimations. The numbers in the parentheses are t-statistics. Heteroskedasticity-robust standard errors are clustered at the private equity firm level. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, *, respectively.

Panel A. Buyout Funds

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Adjusted IRR(t-1)	0.419***			0.385***	0.659***	0.409***			0.369***	0.622***
	(6.130)			(2.675)	(6.791)	(6.013)			(2.634)	(6.158)
Adjusted IRR(t-2)		0.157		0.047	0.008		0.170*		0.069	0.032
		(1.596)		(0.446)	(0.067)		(1.758)		(0.690)	(0.259)
Adjusted IRR(t-3)			0.138		0.087			0.158		0.136
			(1.222)		(0.973)			(1.477)		(1.437)
log(Size (t))						-0.011**	-0.021***	-0.013	-0.018**	-0.016
						(-2.167)	(-2.794)	(-1.266)	(-2.462)	(-1.370)
log(Sequence (t))						0.014	0.046	0.038	0.039	0.043
						(0.806)	(1.637)	(0.764)	(1.374)	(0.924)
Constant	0.402***	0.590***	0.599***	0.389***	0.160	0.461***	0.643***	0.606***	0.441***	0.165
	(8.037)	(7.816)	(6.890)	(4.227)	(1.627)	(7.364)	(6.459)	(4.447)	(4.418)	(1.150)
Year F.E.	No	No	No	No	No	No	No	No	No	No
Obs.	303	173	98	153	74	303	173	98	153	74
Adjusted R2	0.121	0.011	0.004	0.117	0.244	0.130	0.067	0.010	0.149	0.254

Appendix B (Continued)

Panel B. Venture Captal Funds

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Adjusted IRR(t-1)	0.284***			0.314***	0.279**	0.279***			0.306***	0.249**
	(4.217)			(3.212)	(2.560)	(4.069)			(3.029)	(2.193)
Adjusted IRR(t-2)		0.060		-0.054	-0.060		0.103		-0.015	0.038
		(0.804)		(-0.552)	(-0.677)		(1.346)		(-0.155)	(0.347)
Adjusted IRR(t-3)			-0.107		-0.159			-0.033		-0.067
			(-1.508)		(-1.207)			(-0.478)		(-0.535)
log(Size (t))						-0.021*	-0.032*	-0.040*	-0.032	-0.056*
						(-1.801)	(-1.735)	(-1.739)	(-1.528)	(-1.918)
log(Sequence (t))						0.058**	0.078*	0.002	0.058	0.001
						(2.161)	(1.670)	(0.020)	(1.109)	(0.014)
Constant	0.524***	0.703***	0.851***	0.555***	0.739***	0.545***	0.704***	1.002***	0.601***	0.914***
	(10.281)	(11.796)	(11.877)	(5.407)	(3.834)	(7.449)	(7.243)	(5.597)	(4.058)	(2.918)
Year F.E.	No	No	No	No	No	No	No	No	No	No
Obs.	378	225	143	188	103	378	225	143	188	103
Adjusted R2	0.071	-0.002	-0.001	0.068	0.045	0.088	0.021	0.029	0.085	0.091

Appendix C. Cross sectional regression of current performance on past performance (with funds raised before 2000)

The table reports the estimates of the following regression for funds raised before 2000: $(IRR)_t = \alpha + \beta\,(IRR)_{t-\tau} + \mathbf{Z}_t\,\Delta + \varepsilon_t$, where τ is 1, 2, or 3 and t- τ represents τ-th previous funds. The IRRs are benchmark adjusted and logarithmized. $\mathbf{Z}_t$ includes a list of control variables: the current fund size (*Size*) and sequence number of the current fund (*Sequence*). Funds raised after 2005 are excluded from the estimations. The numbers in the parentheses are t-statistics. Heteroskedasticity-robust standard errors are clustered at the private equity firm level. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, *, respectively.

Panel A. Buyout Funds

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
IRR(t-1)	0.385***			0.139*	0.586***	0.385***			0.140*	0.601***
	(4.614)			(1.806)	(2.972)	(4.528)			(1.726)	(2.944)
IRR(t-2)		0.326***		0.269**	0.089		0.326***		0.281**	0.096
		(3.021)		(2.062)	(0.382)		(2.921)		(2.118)	(0.451)
IRR(t-3)			0.132		0.023			0.148		0.051
			(0.931)		(0.145)			(1.080)		(0.326)
log(Size (t))						-0.000	-0.009	-0.024*	-0.001	0.007
						(-0.008)	(-1.209)	(-1.678)	(-0.136)	(0.613)
log(Sequence (t))						0.015	0.044	0.097	0.028	0.052
						(0.767)	(1.603)	(1.409)	(0.875)	(0.932)
Constant	0.482***	0.544***	0.715***	0.477***	0.225	0.464***	0.534***	0.710***	0.432***	0.052
	(6.853)	(5.573)	(5.868)	(4.331)	(1.342)	(4.848)	(4.450)	(3.771)	(3.132)	(0.288)
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	183	98	51	87	38	183	98	51	87	38
Adjusted R2	0.228	0.315	0.153	0.305	0.339	0.220	0.317	0.207	0.291	0.356

Appendix C (Continued)

Panel B. Venture Captal Funds

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IRR(t-1)	0.313***			0.343***	0.279***	0.298***			0.335***	0.220**
	(5.692)			(4.317)	(2.661)	(5.995)			(4.128)	(2.295)
IRR(t-2)		0.033		-0.094	-0.175		0.047		-0.080	-0.113
		(0.247)		(-0.522)	(-0.538)		(0.375)		(-0.469)	(-0.404)
IRR(t-3)			-0.023		0.038			0.008		0.111
			(-0.296)		(0.245)			(0.123)		(0.596)
log(Size (t))						-0.020	-0.025	-0.044	-0.036	-0.107
						(-1.070)	(-0.886)	(-0.833)	(-1.129)	(-1.546)
log(Sequence (t))						0.084**	0.095	-0.049	0.077	-0.080
						(2.539)	(1.406)	(-0.351)	(1.105)	(-0.459)
Constant	0.508***	0.737***	0.836***	0.559***	0.864***	0.493***	0.669***	1.044***	0.579***	1.503**
	(12.354)	(6.437)	(13.825)	(4.300)	(3.652)	(7.188)	(4.904)	(3.649)	(2.956)	(2.561)
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	246	145	91	121	63	246	145	91	121	63
Adjusted R2	0.258	0.187	0.152	0.232	0.173	0.271	0.188	0.152	0.236	0.241

Appendix D. Subsequent fund performance (benchmark adjusted IRRs) by quartile portfolios based on current fund performance

Each fund is sorted into four portfolios based on the current fund's benchmark adjusted IRR. Then, mean and median IRRs are computed for follow-on funds in each quartile portfolio. *F* is current funds used to rank the quartile portfolios. *F+t* where *t* takes 1, 2, or 3 represent the t-th follow-on fund. Panel A is for buyout funds and Panel B for venture capital funds. Sub-panel A.1 and B.1 includes all available funds. Sub-panels A.2 through A.4 and B.2 through B.4 require that a fund have benchmark adjusted IRR data for its 1st, 2nd, and 3rd following funds. The last four columns report the number of funds included in the computation of the mean and median values. The last two rows of each sub-panel reports the difference in IRR between quartile 1 and 4 and its corresponding p-value based on t-test (for the difference in mean values) or Wilcoxon rank sum test (for median IRRs). Quartile 1 contains the best-performing funds, and quartile 4 contains the worst-performing funds.

Panel A. Buyout

	Mean				Median				N			
Quartile	F	F+1	F+2	F+3	F	F+1	F+2	F+3	F	F+1	F+2	F+3
A.1. All funds												
All	2.88	2.96	3.16	2.62	0.80	0.55	1.75	0.88	636	303	173	98
1	26.44	11.50	5.19	1.50	20.45	6.05	2.10	1.10	153	87	55	35
2	6.01	3.18	0.29	4.02	5.30	1.10	2.20	1.30	164	85	53	31
3	-3.16	-1.24	4.68	3.22	-3.15	-2.15	0.55	-1.48	167	81	43	20
4	-17.61	-5.48	2.03	1.24	-14.73	-5.03	2.75	-5.55	152	50	22	12
1-4	44.05	16.98	3.15	0.26	35.18	11.08	-0.65	6.65				
p-value	**0.00**	**0.00**	0.60	0.97	**0.00**	**0.00**	0.37	0.62				
A.2. Funds with 1st follow-on funds' IRR available												
All	5.63	2.96			2.80	0.55			303	303		
1	24.67	11.50			17.85	6.05			87	87		
2	6.17	3.18			5.20	1.10			85	85		
3	-2.66	-1.24			-2.70	-2.15			81	81		
4	-15.01	-5.48			-12.20	-5.03			50	50		
1-4	39.67	16.98			30.05	11.08						
p-value	**0.00**	**0.00**			**0.00**	**0.00**						
A.3. Funds with 1st and 2nd follow-on funds' IRR available												
All	8.69	5.84	2.33		6.05	2.35	1.10		153	153	153	
1	26.44	12.15	4.33		20.80	7.80	1.98		50	50	50	
2	7.70	5.08	-1.22		6.40	2.93	-0.40		42	42	42	
3	-1.99	1.95	4.16		-2.25	0.50	0.55		41	41	41	
4	-11.69	-0.36	1.04		-11.08	-4.70	-1.63		20	20	20	
1-4	38.13	12.50	3.29		31.88	12.50	3.60					
p-value	**0.00**	**0.01**	0.62		**0.00**	**0.00**	0.27					
A.4. Funds with 1st, 2nd, and 3rd follow-on funds' IRR available												
All	12.50	8.05	3.75	2.21	7.40	6.10	2.28	0.88	80	80	80	80
1	29.59	15.07	7.14	2.62	29.63	11.00	4.28	2.03	30	30	30	30
2	7.95	7.68	2.09	0.77	6.15	3.65	2.20	-1.90	23	23	23	23
3	0.08	3.21	-0.57	2.45	-1.05	2.50	1.10	-0.85	19	19	19	19
4	-9.04	-5.67	6.12	4.22	-7.75	-5.53	4.23	1.33	8	8	8	8
1-4	38.63	20.74	1.02	-1.60	37.38	16.53	0.05	0.70				
p-value	**0.00**	**0.00**	0.92	0.89	**0.00**	**0.00**	0.76	0.90				

Appendix D (Continued)

Panel B. Venture Capital

	Mean				Median				N			
Quartile	F	F+1	F+2	F+3	F	F+1	F+2	F+3	F	F+1	F+2	F+3
B.1. All funds												
All	7.36	12.89	18.45	24.61	0.00	1.38	0.85	0.85	807	378	225	143
1	45.09	25.11	27.63	34.30	20.28	5.30	3.70	4.43	194	101	65	46
2	7.37	22.56	14.34	9.38	4.15	4.00	-0.35	-2.25	204	102	72	48
3	-3.56	2.13	25.70	4.24	-3.60	-0.33	-0.30	-2.00	201	90	46	27
4	-17.30	-1.83	3.34	62.59	-14.10	-3.30	0.53	5.95	208	85	42	22
1-4	62.39	26.94	24.29	-28.29	34.38	8.60	3.18	-1.53				
p-value	**0.00**	**0.00**	**0.03**	0.56	**0.00**	**0.00**	0.16	0.79				
B.2. Funds with 1st follow-on funds' IRR available												
All	13.76	12.89			1.88	1.38			378	378		
1	56.93	25.11			27.90	5.30			101	101		
2	10.01	22.56			6.35	4.00			102	102		
3	-3.72	2.13			-4.03	-0.33			90	90		
4	-14.51	-1.83			-13.70	-3.30			85	85		
1-4	71.44	26.94			41.60	8.60						
p-value	**0.00**	**0.00**			**0.00**	**0.00**						
B.3. Funds with 1st and 2nd follow-on funds' IRR available												
All	15.77	19.70	19.73		4.78	2.65	0.30		188	188	188	
1	50.80	30.30	26.50		39.30	9.20	2.40		55	55	55	
2	12.37	31.86	16.15		8.90	4.45	-0.30		61	61	61	
3	-3.73	2.19	27.84		-4.13	-0.60	-0.73		40	40	40	
4	-13.59	0.18	4.79		-12.90	-3.25	1.13		32	32	32	
1-4	64.39	30.12	21.71		52.20	12.45	1.28					
p-value	**0.00**	**0.01**	**0.10**		**0.00**	**0.00**	**0.50**					
B.4. Funds with 1st, 2nd, and 3rd follow-on funds' IRR available												
All	21.11	19.98	28.82	29.88	11.50	9.00	2.40	0.00	109	109	109	109
1	49.77	29.32	30.62	39.26	40.80	12.70	3.70	3.70	39	39	39	39
2	13.14	23.04	16.48	11.27	10.05	9.00	8.05	-2.20	39	39	39	39
3	-1.61	2.19	57.29	4.47	-1.90	-0.35	0.00	-4.75	19	19	19	19
4	-10.17	7.85	17.97	100.08	-7.43	7.55	5.70	5.65	12	12	12	12
1-4	59.93	21.47	12.66	-60.81	48.23	5.15	-2.00	-1.95				
p-value	**0.00**	**0.02**	0.50	0.49	**0.00**	**0.16**	0.72	0.85				

Appendix E. The effects of similar market conditions on performance persistence (using benchmark adjusted IRRs)

The table reports ordinary least square regression estimates for the following specifications: $(IRR)_{i,t} = \alpha + \beta\,(IRR)_{i,t-1} + \gamma\,(MSM)_{i,t-1} + \delta\,(MSM)_{i,t-1}\,(IRR)_{i,t-1} + \mathbf{Z}_t\,\mathbf{\Delta} + \varepsilon_{i,t}$. IRRs are benchmark adjusted. MSM is the market similarity measure defined as the absolute value of ((Market Condition) $_{i,t+1}$ / (Market Condition) $_{i,t}$ -1). The market condition variables are the 1) IPO volume from the fifth to tenth year of a fund's life (the column heading with 'IPO volume'), 2) GDP growth during a fund's life ('GDP growth'), 3) S&P 500 stock returns over a fund's lifetime ('S&P500 returns'), 4) three month Treasury bill yield during first five years of a fund's life ('T-bill'), and 5) the ratio of average S&P 500 price earnings ratio during first five years to that during subsequent five years. MSM also includes *Time Gap* which is the difference between the current funds' vintage year and the preceding funds' vintage year. $\mathbf{Z}_t$ includes a list of control variables (see Appendix C). IRRs and MSM are logarithmized and normalized with a mean of zero and a standard deviation of one. Funds raised after 2005 are excluded from the estimations. The numbers in the parentheses are t-statistics. Heteroskedasticity-robust standard errors are clustered at the private equity firm level. Standard errors are clustered at the private equity firm level. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

	Buyout Funds						Venture Capital Funds					
MSM:	Time Gap	IPO volume	GDP growth	S&P500 returns	T-bill	P/E	Time Gap	IPO volume	GDP growth	S&P500 returns	T-bill	P/E
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Adjusted IRR (t-1)	0.348***	0.380***	0.415***	0.394***	0.377***	0.372***	0.268***	0.368***	0.362***	0.439***	0.339***	0.281***
	(5.354)	(4.790)	(5.288)	(4.965)	(4.807)	(5.797)	(5.272)	(4.749)	(4.964)	(5.582)	(4.404)	(5.610)
MSM (t)	0.077	0.129*	0.155**	-0.014	0.213***	0.024	0.076	0.049	-0.134	-0.087	-0.041	-0.039
	(1.253)	(1.653)	(2.035)	(-0.183)	(2.847)	(0.376)	(1.138)	(0.690)	(-1.516)	(-0.777)	(-0.387)	(-0.628)
IRR*MSM (t)	-0.162**	0.038	-0.145**	-0.126	-0.124*	-0.135*	0.017	0.219**	-0.268***	-0.457***	-0.140*	-0.226**
	(-2.399)	(0.460)	(-2.247)	(-1.596)	(-1.738)	(-1.823)	(0.239)	(1.971)	(-4.266)	(-3.397)	(-1.707)	(-2.481)
log(Size (t))	-0.123**	-0.063	-0.082	-0.066	-0.089	-0.117**	-0.125**	-0.199***	-0.200***	-0.210***	-0.229***	-0.139***
	(-2.408)	(-0.973)	(-1.264)	(-1.000)	(-1.346)	(-2.303)	(-2.503)	(-2.788)	(-2.929)	(-3.142)	(-3.124)	(-2.799)
log(Sequence (t))	0.172	0.267	0.126	0.189	0.272	0.110	0.412**	0.679***	0.507**	0.604***	0.545**	0.330**
	(0.921)	(1.056)	(0.508)	(0.755)	(1.088)	(0.615)	(2.411)	(2.864)	(2.186)	(2.599)	(2.067)	(1.981)
Constant	0.474	-0.118	0.183	-0.007	0.040	0.525*	0.047	0.083	0.296	0.234	0.439	0.248
	(1.508)	(-0.291)	(0.459)	(-0.017)	(0.098)	(1.645)	(0.158)	(0.195)	(0.744)	(0.581)	(0.972)	(0.836)
Year F.E.	No	No	No	No	No	No	No	No	No	No	No	No
Obs	303	183	183	183	178	303	378	246	246	246	233	378
Adjusted R2	0.143	0.122	0.141	0.118	0.151	0.134	0.087	0.123	0.189	0.168	0.125	0.100

Appendix F. The effects of fund growth (from the second preceding fund to the current fund)on performance persistence

The table reports the ordinary least square regression estimates for the following specifications: $(IRR)_{i,t} = \alpha + \beta\,(IRR)_{i,t-2} + \gamma\,(\text{Fund Growth})_{i,t-2} + \delta\,(\text{Fund Growth})_{i,t-2}\,(IRR)_{i,t-2} + \mathbf{Z}_t\,\mathbf{\Delta} + \varepsilon_{i,t}$. The triple interactions of IRR, Time Gap, and the Buyout dummy variable is included in Models (5) and (6). Fund growth is the growth rate from the second preceding fund to the current fund. IRRs and Fund growth are logarithmized and normalized with a mean zero and standard deviation one. Buyout is a dummy variable taking 1 if the fund is a buyout fund, 0 otherwise. $\mathbf{Z}_t$ includes a list of control variables (see Table 3). Models (1) and (2) are for buyout funds, and (4) and (5) are for venture capital funds. In all regression estimations, vintage fixed year effects are included. The numbers in the parentheses are t-statistics. Heteroskedasticity-robust standard errors are clustered at the private equity firm level. Standard errors are clustered at the vintage year level. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

	Buyout Funds		Venture Capital Funds		All Funds	
	IRR	Adjusted	IRR	Adjusted	IRR	Adjusted
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
IRR (t-2)	0.286***	0.221**	0.268***	0.251***	0.306***	0.254***
	(2.826)	(2.253)	(3.238)	(2.938)	(3.808)	(3.198)
Fund Growth (t-2) to (t)	-0.243**	-0.179*	-0.124	-0.183*	-0.117	-0.161*
	(-2.110)	(-1.722)	(-1.267)	(-1.730)	(-1.255)	(-1.697)
IRR*Fund Growth	0.104	0.067	-0.186***	-0.155***	-0.181***	-0.156***
	(1.071)	(0.656)	(-3.618)	(-2.722)	(-3.502)	(-2.923)
Buyout					0.096	0.091
					(0.641)	(0.616)
IRR*Buyout					-0.112	-0.033
					(-0.872)	(-0.244)
Fund Growth*Buyout					-0.204	-0.038
					(-1.442)	(-0.271)
IRR*Fund Growth*Buyout					0.347***	0.235*
					(3.034)	(1.902)
log(Size (t))	-0.159**	-0.202***	0.017	-0.120	-0.084	-0.157***
	(-2.116)	(-2.859)	(0.224)	(-1.581)	(-1.569)	(-3.004)
log(Sequence (t))	0.231	0.357	0.031	0.174	0.173	0.245
	(0.766)	(1.149)	(0.116)	(0.591)	(0.851)	(1.142)
Constant	0.992	0.687	-0.233	0.413	0.162	0.482
	(1.440)	(1.386)	(-0.399)	(0.843)	(0.350)	(1.390)
Year F.E.	Yes	No	Yes	No	Yes	No
Obs	173	173	225	225	398	398
Adjusted R2	0.189	0.073	0.299	0.065	0.175	0.069