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Venture Capital Funds: Performance Persistence and Flow-Performance Relation

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Abstract

This paper shows that the persistence of performance in venture capital is due to the overlapping of successive funds. The persistence result vanishes if we require a minimal spread between two successive funds or if we use an ex-ante measure of past performance. When we separate funds, we find that funds that are expected to be backed by more skilled investors show no performance persistence but a significant flow-performance relation. In contrast, funds that are expected to be backed by less skilled investors show performance predictability and have a non-significant flow-performance relation. These results suggest that only skilled investors use all available information to adjust their capital allocation and, as a result, eliminate performance predictability as argued theoretically by Berk and Green (2004).

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Non-technical Abstract

Venture capital funds are structured as non-tradable 10 years long partnerships during which investors cannot change their capital allocation. Every two to five years the venture capital firm – which runs the funds – raises a follow up fund.

In a recent literature that investigates venture capital as an investment vehicle, one of the most striking findings is that of performance 'persistence' by Kaplan and Schoar (2005). They find that the performance of fund N_i is positively related to the performance of the previously raised fund N_{i-1} by the same venture capital firm. This result has had a large impact in the field as it raises a puzzle. Why investors do not adjust capital allocations to the point where persistence disappears? Why funds do not adjust fees to the point where persistence disappears?

Kaplan and Schoar (2005) conjecture that this result comes from the fact that top funds voluntarily restrict their size. This argument can be related to the Berk and Green (2004) model of mutual funds. Investors learn about skills of a manager. Following good performance, they want to allocate more up to the point where expected performance of the top fund equals that of other funds. If funds limit their size, then persistence arises.

Hochberg, Ljungqvist and Vissing-Jorgensen (2008) model this argument and argue that incumbent investors have soft information about fund manager abilities based on which they could hold up the fund manager. The idea is that if the incumbent investors do not re-invest in the follow up fund, outside investors will think that the soft information is negative and, as a result, will reduce their allocation to the newly raised fund. The venture capital firm, hence, needs to pay a rent to the incumbent investors and they do so by limiting their size, hence offering high expected returns.

Another recent paper by Glode and Green (2008) argue that it is not soft information about abilities that fund managers can be held-up with but information about their investment strategy. The same reasoning as above follows. Fund managers need to pay a rent to incumbent investors thus creating persistence.

This paper goes back to the original empirical evidence. It starts with the observation that there is no evidence yet on whether investors rationally respond to past performance information or not. The finding that a 1988-1998 fund performance is related to a 1985-1995 fund performance does not say that investors have not correctly reacted to available information in 1988. Nor does it say that the fees for the 1988-1998 fund were not appropriate. The same argument goes with fund size. The relation between fund size in 1988 and performance of the 1985-1995 fund is not informative about how investors have reacted.

This paper is the first to study the organizational structure of the venture capital industry by investigating both performance persistence and the flow-performance relation ex-ante. The distinction between overlapping persistence and ex-ante persistence turns out to be an important one. While data show that the result of Kaplan-Schoar of overlapping persistence is robust and of large magnitude, there is no evidence of ex-ante persistence. We also show that if we require a minimal spread of 6 years between the two successive funds, the persistence result vanishes. This is a first contribution of the paper.

The idea that there should not be any ex-ante persistence in the delegated money management industry stems from Berk and Green (2004) and is based on the assumptions that investors rationally learn about manager abilities. It is then natural to create sub-sets based on investor learning capacities. Unfortunately, this is not directly observable. However, Lerner, Schoar and Wongsunwai (2007) show that some investors do not learn from private and public information about VC abilities and that these investors back poorly performing funds. Therefore, they suggest that fund performance is a good proxy for investor learning capacities. Hence, we create sub-sets based on fund performance.

Looking at sub-sets based on fund performance is also interesting given the conjecture of Kaplan and Schoar (2005) to explain persistence. They argue that better performing funds voluntarily restrict their size for some reasons and that creates persistence. This conjecture, therefore, also suggests that the relation will be different for top and bottom performing funds. The second contribution of the paper is then to

separately investigate ex-ante performance persistence and the flow-performance relation for superior and inferior funds (performance-wise). Such an exercise reveals empirical facts consistent with those of Lerner, Schoar and Wongsunwai (2007).

We find significant and robust ex-ante performance persistence for funds whose performance is *below* median but no performance persistence for funds whose performance is *above* median. Hence, better performing funds do not show any sign of persistence. Inferior funds, in contrast, do.

Next, we find no significant ex-ante flow-performance relation for funds whose performance is *below* median but a very strong and robust flow-performance relation for funds whose performance is *above* median. The flow-performance relation is as much as 10 times larger for better performing funds. Hence, better performing funds have a significant flow-performance relation. Inferior funds, in contrast, do not. We interpret these results as evidence that funds backed by more sophisticated investors show no performance persistence and significant flow-performance relation. In contrast, funds backed by less sophisticated investors show performance persistence and no significant flow-performance relation.

Besides empirically documenting whether ex-ante information on past performance at the time of fund raising carries any predictive value, our analysis provides an ideal test for the theory of Berk and Green (BG, 2004). Venture capital funds have few and sophisticated investors. These investors need to think hard once every 2 to 4 years about the optimal fund size. This is very different from mutual funds where fund size changes every day and is the result of a large number of uncoordinated, likely unsophisticated investors. Therefore, fund size in venture capital is a rather 'pure' variable that we can link to past performance, thereby appropriately testing BG model. In our setting, BG model appears to capture first-order features of the venture capital industry.

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In a recent literature that investigates venture capital as an investment vehicle, one of the most striking findings is that of performance 'persistence' by Kaplan and Schoar (2005).[1] They find that the performance of fund N_i is positively related to the performance of the previously raised fund N_{i-1} by the same venture capital firm. This result has had a large impact in the field as it raises a puzzle. Why investors do not adjust capital allocations to the point where persistence disappears? Why funds do not adjust fees to the point where persistence disappears?

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Hochberg, Ljungqvist and Vissing-Jorgensen (2008) thoroughly model this argument and in particular endogenize the decision to limit fund size. They argue that incumbent investors have soft information about fund manager abilities based on which they could hold up the fund manager. The idea is that if the incumbent investors do not re-invest in the follow up fund, outside investors will think that the soft information is negative and, as a result, will reduce their allocation to the newly raised fund. The venture capital firm, hence, needs to pay a rent to the incumbent investors and they do so by limiting their size, hence offering high expected returns.

Another recent paper by Glode and Green (2008) argue that it is not soft information about abilities that fund managers can be held-up with but information about their investment

[1] To name a few, Gompers and Lerner (1999) and Metrick and Yasuda (2007) study fees, Cochrane (2005), Cumming and Walz (2004), Kaplan and Schoar (2005) and Phalippou and Gottschalg (2007) look at performance, Driessen, Lin and Phalippou (2007) measure risk and Lerner, Schoar and Wongsunwai (2007) analyze the performance achieved by different type of investors. Other important articles in this literature include but do not restrict to that of Axelson, Jenkinson, Stromberg and Weisbach (2007), Hochberg, Lu and Ljungqvist (2007), Jones and Rhodes Kropf (2003), and Ljungqvist, Richardson and Wolfenson (2007).

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This paper is the first to study the organizational structure of the venture capital industry by investigating both performance persistence and the flow-performance relation ex-ante.[2] The distinction between overlapping persistence and ex-ante persistence turns out to be an important one. While data show that the result of Kaplan-Schoar of overlapping persistence is robust and of large magnitude, there is no evidence of ex-ante persistence. We also show that if we require a minimal spread of 6 years between the two successive funds, the persistence result vanishes. This is a first contribution of the paper.

The idea that there should not be any ex-ante persistence in the delegated money management industry stems from Berk and Green (2004) and is based on the assumptions that investors rationally learn about manager abilities. It is then natural to create sub-sets based on investor learning capacities. Unfortunately, this is not directly observable. However, Lerner, Schoar and Wongsunwai (2007) show that some investors do not learn from private and public information about VC abilities and that these investors back poorly performing funds. Therefore, they suggest that fund performance is a good proxy for investor learning capacities. Hence, we create sub-sets based on fund performance.

Looking at sub-sets based on fund performance is also interesting given the conjecture of Kaplan and Schoar (2005) to explain persistence. They argue that better performing funds voluntarily restrict their size for some reasons and that creates persistence. This conjecture, therefore, also suggests that the relation will be different for top and bottom performing funds.

[2] In a recent version of their working paper, Hochberg et al. (2008) also include ex-ante specifications. Their data enable them to work only with IRR and the max of all previous fund performance. In contrast, I will work with a present value based measure of performance (hence free of IRR pitfalls) and will aggregate all previous fund cash flows to get a better picture of firm total past performance.

The second contribution of the paper is then to separately investigate ex-ante performance persistence and the flow-performance relation for superior and inferior funds (performance-wise). Such an exercise reveals empirical facts consistent with those of Lerner, Schoar and Wongsunwai (2007).

We find significant and robust ex-ante performance persistence for funds whose performance is *below* median but no performance persistence for funds whose performance is *above* median. Hence, better performing funds do not show any sign of persistence. Inferior funds, in contrast, do.

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Besides empirically documenting whether ex-ante information on past performance at the time of fund raising carries any predictive value, our analysis provides an ideal test for the theory of Berk and Green (BG, 2004). Venture capital funds have few and sophisticated investors. These investors need to think hard once every 2 to 4 years about the optimal fund size. This is very different from mutual funds where fund size changes every day and is the result of a large number of uncoordinated, likely unsophisticated investors. Therefore, fund size in venture capital is a rather 'pure' variable that we can link to past performance, thereby appropriately testing BG model. In our setting, BG model appears to capture first-order features of the venture capital industry.

The rest of the paper continues as follows. The first section presents the data. The second section shows the empirical analysis. The third section covers robustness and the fourth section concludes.

1. Data and hypotheses

We start by outlining our data source and the institutional details that are particularly important for our empirical tests. Next, we derive three hypotheses. Finally, we describe our empirical design to test our hypotheses (sample selection scheme, measure of performance, control variables) and provide descriptive statistics.

A. Data and institutional background

Data are from a 'cash-flow' dataset maintained by Thomson Venture Economics (TVE). It contains the amount and date of all cash flows to/from investors as well as the quarterly Net Asset Values (NAVs) from 1980 to 2003.[3] The dataset also contains information on fund characteristics: size, stage focus (venture capital or buyout), and geographical focus (US versus non-US). Earlier versions of this dataset have been used by Jones and Rhodes-Kropf (2003), Kaplan and Schoar (2005), and Phalippou and Gottschalg (2007). These data are also the basis of the industry standard performance benchmark published by TVE and by various industry associations. This dataset is considered the most comprehensive source of performance information on private equity funds.

Investors in private equity funds commit a certain amount of capital at fund inception, the year of which is called vintage year. Fund managers "call" money when needed – up to the amount committed. When a divestment occurs, the fund distributes the proceeds to its investors. A fund typically has a life of ten years, which can be extended to thirteen. Stakes in private equity funds were basically non-tradable during our study period. Private equity firms manage a set of funds and raise a new fund every 2 to 5 years.

What is key for our empirical study is that investors cannot increase or decrease their allocation to a fund during its life. They are locked in. Hence, it is only at the time of fund inception that investors look at a track record of a firm to decide on their capital allocation.

[3] NAV measures the value of on-going investments. It is self-reported by funds.

B. Hypotheses

We start with the main theory of delegated portfolio management developed by Berk and Green (BG, 2004). Their model generates an economy in which performance is unpredictable and yet a strong flow-performance relation exists. The idea is that there are decreasing returns to scale for fund managers, fees are sticky, fund managers vary in their skills and investors learn rationally about these skills. When a fund manager has good past performance, investors update their belief, increase their capital allocation up to the point where they eliminate performance predictability (due to decreasing return to scale).

Hypothesis 1 is that the venture capital industry in a pure BG economy. Investors learn rationally about fund manager skills. They thus react optimally to past performance by increasing their capital allocation and by doing so eliminate predictability. Under hypothesis 1, there should be a significant flow-performance relation and no performance persistence.

Hypothesis 2 reflects Kaplan and Schoar (KS, 2005) conclusion. Investors may be rational but better performing funds voluntarily restrict their size for some reasons. Under this hypothesis, i) the flow-performance relation should be weaker for the better performing funds than it is for inferior funds because better funds are those restricting most their size and ii) persistence should be stronger for the better performing funds than it is for inferior funds as a direct consequence of (i) in a BG economy.

Hypothesis 3 is a BG economy in which investors differ in their degree of sophistication. Following BG insight, in equilibrium, funds with more sophisticated investors should exhibit less performance persistence and a stronger flow-performance relation than funds with less sophisticated investors. Sophistication in a BG economy means capacity to learn about manager abilities.

Lerner, Schoar and Wongsunwai (2007) bring evidence that investors differ in their capacities to learn about manager abilities. They report that certain institutional investors "rely on overly rigid decision criteria or lack a sufficient understanding of the asset class." They also stress that the lesser sophistication of some institutional investors "should be most dramatic for those cases for which it is most difficult to assess performance, namely, venture capital." They illustrate their claim empirically by finding that the performance of a fund is highly related to its investor type (worse are banks, best are private Endowments), and its

investor experience (older investors do better). In addition, and importantly for this study, they also show direct evidence that investors differ greatly in their learning capacities. They find that if an Endowment decided to invest in a fund X_n from the same fund family it had invested with in the past (e.g. it invested in fund X_{n-1}), then fund X_n significantly outperform. The opposite holds true when an Endowment decide to stop investing with a fund family. This predicts under-performance. Hence, Endowments display high learning capacities. Other types of investors (e.g. banks) do not demonstrate such capacities.

This evidence suggests that some investors do not have the capacity to interpret the signals to predict future performance and do not follow/imitate rational investors (maybe they do not realize this is what they should do or top funds refuse to grant them access, or both). As a result, venture capital firms with higher performance are expected to be backed by more sophisticated investors.

Bringing Berk and Green (2004) insight to the empirical findings of Lerner et al. (2007), we (non-formally) derive hypothesis 3: i) better performing funds have a stronger flow-performance relation than inferior funds because their investors are more responsive to information on past performance (they learn) and ii) better performing funds exhibit less performance persistence than inferior funds as a direct consequence of (i) in a BG economy. These implications are the opposite as those of hypothesis 2.[4]

To summarize:

Hypothesis 1: Fund size (at inception) *is an increasing function* of past performance. Fund performance *is not* predictable (at inception).

Hypothesis 2: Funds with low performance have their size (at inception) that is *more positively related* to past performance than funds with high performance. Funds with low

[4] The formal derivation of such a model is beyond the scope of this paper. Formally, one needs further assumptions and analysis to obtain separation of investors in terms of learning capacities. We take it as given here following Lerner, Schoar and Wongsunwai (2007) evidence. The intuition developed above is simply to guide empirical analysis. Also, the conjecture of Kaplan and Schoar (2005) also suggests that persistence and flow-performance relation may be investigated separately for superior and inferior funds. For a rigorous theoretical modeling of performance persistence in private equity, the reader may refer to Hochberg, Ljungqvist and Vissing-Jorgensen (2008) and Glode and Green (2008).

performance have their performance *less related* to past performance than funds with high performance (at inception).

Hypothesis 3: Funds with low performance have their size (at inception) that is *less positively related* to past performance than funds with high performance. Funds with low performance have their performance *more related* to past performance than funds with high performance (at inception).

C. Empirical design and descriptive statistics

We consider venture capital funds raised between 1980 and 1995 with a size greater than $5 million (1990 US dollars).[5]

Below, we study how two characteristics (final performance and fund size) of a set of funds (called focal funds) relate to their firm track record in year *t*, year in which these focal fund partnerships are formed (called fund raising/inception time). To ensure that the track record is known to investors at the time of fund raising, we measure it at the end of year *t*-1. Funds considered for the track record needs to be sufficiently old for their intermediary performance measure to be economically valuable. The threshold is set to the median spread between two successive funds, i.e. 3 years. Hence, if the focal fund vintage year is 1995, then only funds raised in 1992 or before are considered. Also, only funds raised after 1983 can be considered as focal funds.

As in the literature, performance is measured by Profitability Index (PI), which is the present value of all dividend distributions (to investors) divided by the present value of all capital contributions (of investors). As Kaplan and Schoar (2005), we use the S&P 500 index as a discount rate.

An important element to compute the track record and final performance is the self reported NAVs. In the literature, there have been three approaches. First, Kaplan and Schoar (2005) and Jones and Rhodes-Kropf (2003) always treat them as unbiased estimates of market values. Second, Phalippou and Gottschalg (2007) argue that writing them off is most appropriate for funds that are both more than 10 years old (typical liquidation age) and have

[5] There are too few buyout funds to conduct the analysis below. In the main tables, regressions would have less than 50 observations.

been inactive for more than 18 months (no NAV update, no cash flows).[6] Third, Driessen, Lin and Phalippou (DLP, 2007) offer a statistical model to estimate jointly fund risk and market value of final NAVs. They show that key determinant of the market values of NAVs is the duration of inactivity (last time NAV is updated, last time a dividend has been paid). Funds that have been inactive for a longer period have most inflated NAVs.

DLP model has satisfactory predictive power for mature funds (year 8 and above). We thus use it to convert all the final NAVs of the focal funds. For the track records, however, funds may be as young as 3 years old. At such a young age, it is natural to treat the NAVs as market values. Hence NAVs are treated as correct when computing the performance track record.

To measure past performance at the time of fund raising, we pool the cash flows of all preceding funds and add the sum of the last NAVs reported. This way we obtain the venture capital firm aggregated cash flows at a given date and can compute the Profitability Index.

< Table 1 >

In Table 1, we compare our sample (focal funds) with the universe of funds according to TVE. Our sample is half of the universe in terms of number of funds and more than half in terms of size. Focal funds are slightly biased towards U.S.-focus. This reflects the fact that private equity has a longer history in the U.S. Focal funds also have superior performance as first time funds are not included by definition and are known to underperform (Kaplan and Schoar, 2005). The average performance across vintage years is 1.00 (i.e. performance is at par with that of the S&P 500) for focal funds and only 0.89 for the universe of funds (underperformance of the S&P 500).

< Table 2 >

Table 2 provides the correlation matrix of all the variables of interest and their distribution percentiles. We note that all measures of past performance are highly correlated. Hence results are likely to be robust to changes in past performance measures. Size and performance are positively and strongly correlated. However, they are likely to be jointly determined, hence we do not know how the causality works without good instruments. We note a relatively small dispersion in the level of past performance but a large dispersion in

[6] Ljungqvist and Richardson (2003) also write off NAVs for funds beyond their 10th anniversary.

performance. The inter-quartile range is only of a third of value invested (in present value terms) for past performance but almost one hundred percent of value invested for final performance. We also note a fat tail for performance as the 95th percentile is about 3 times the average and four times the median. This is why we work with the log-transform of performance.

2. Main Empirical Results

We first study performance persistence. We start by replicating the persistence finding of Kaplan and Schoar (2005) on our sample and then study whether past performance can predict future performance 'ex-ante'. We next turn to the flow-performance relation and proceed in the same way. We first replicate the flow-performance finding of Kaplan and Schoar (2005) on our sample and then study flow-performance on an ex-ante basis. These empirical results enable us to test the three hypotheses we derived in section 1.B above.

A. Persistence with Overlapping Measurement Period

Kaplan and Schoar (KS, 2005) regress the performance of a fund on the performance of its preceding fund. Both performances are measured at the end of their sample time period (December 2001 or at fund liquidation date). We run a similar regression on our sample of funds. Results are shown in Table 3. As in KS, we find a very strong relation between the final performance of two successive funds (*t*-stats are above 4).

< Table 3 >

The performance of two successive funds is thus correlated showing a fixed effect in fund-family performance. From an investment perspective, it is however important to know the time spread between two successive funds. A longer spread means that the investor is more likely to know the final performance of the preceding fund and can thus predict the performance of the focal fund. Data reveal that, in fact, the spread is often small. The median is 3 years, 15% of the spreads are only of 1 year and 22% are of only 2 years (non-tabulated). Hence, for investors to act on this correlation, they would often need to know what the final performance of a fund is after only a few years of operation.

We have therefore replicated the KS results of a fund-family fixed effect in performance.

To tackle the overlapping issue, Kaplan and Schoar (KS, 2005) show that their result still holds when they use the fund raised before the previous fund (one to last). But even then the spread may be low. We propose here a more direct test. We consider all preceding funds of the focal fund and record the spread between the vintage years of each preceding fund and of the focal fund. Next, we form groups (terciles) based on these spreads. The first group contains every pair focal-preceding fund that has a spread of one or two years, the intermediate group has a spread between three and five years and the top group has a spread of six years or more. We then re-run the regression for our four specifications in each of these samples separately.

< Table 4 >

Results are reported in Table 4. In the specification with all control variables, the relationship between preceding fund performance and focal fund performance is very strong (coefficient is 0.44 and t-stat is 4.74) when the overlap between funds is high (i.e. small spread between vintage years). The coefficient then decreases by more than one third (from 0.44 to 0.28) and the t-stat is halved (2.77) when the overlap is at the intermediate level (3 to 5 years spread). Finally, the 'performance persistence' result is gone when the overlap is lowest (6 years spread or more). Given that fund life is 10 years, even the low overlap sample has still quite some overlap. Yet, the persistence result is gone.

This is a first strong indication that the persistence result documented in the literature is largely driven by the overlapping of the successive funds. Additional evidence is presented in the next section. We look at whether investors can forecast the focal fund performance based on ex-ante performance information on the preceding funds.

B. Ex-ante persistence

As mentioned in the data section, investors cannot change their capital allocation to a fund continuously. Their allocation to a fund is a one-time decision, which happens at the time of fund raising. It is thus interesting per se to study whether information on past performance at the time of fund raising (i.e. ex-ante) carries any predictive value. In addition, such an

analysis sheds light on the venture capital industrial organization by testing the three hypotheses derived above.

For ease of comparison, we keep the same setup as in the last regression reported in the previous sub-section. The only difference is that we do not measure past performance at the end of the life of the preceding fund. Instead, we measure past performance at the time investors had to take their investment decision. We consider two measures of past performance. One is the fund family full track record (denoted *PI_tr*). And the other one is as in KS, the performance of the previously raised fund (denoted PI_{i-1}).[7]

< Table 5 >

Results are reported in Table 5 – Panel A. We still find a positive relation between past and future performance but it is much weaker and not significant when all control variables are included. Hence, we conclude that there is no evidence of a significant relation between past performance and future performance ex-ante. This confirms that the performance persistence result of KS is due to the overlap between funds.

In section 1.B, we propose three hypotheses to test. Hypothesis 1 is consistent with the above result. Then, to distinguish between hypothesis 2 and 3, we need to condition on focal fund performance. We thus separate funds in two equal sets, those with high (focal fund) performance and those with low (focal fund) performance. The same six specifications as above are then run separately for each sub-sample.

Consistent with hypothesis 3, we find in Table 5 – Panel B that funds with poor performance have a significant and positive relation between past and future performance ex-ante. That is, in the sample of inferior funds, those with worse past performance have worse future performance. The relation is always significant at a 5% level test and very stable in economic terms across specifications. For better performing funds, however, there is no such relation in any of the specifications (Table 5 – Panel C).

We also find that both sequence and lagged size have some predictive power for the performance of inferior funds (significant at a 5% level test). But neither of them are related to future performance of top funds. This is also consistent with hypothesis 3. Investors

[7] We require a minimum spread between the vintage year of the preceding fund and that of the focal fund of 3 years. This is because the NAVs, hence performance, is not very informative in the first three years. At the end of year three, only one fifth of the funds have their NAV set at cost (down from about half at the end of the first year).

backing top funds appear to incorporate all available information be it about past performance or firm characteristics. In contrast, investors backing inferior funds do not. As a result the performance of the funds they invest in is partly predictable.

At this stage, hypotheses 1 and 2 are rejected while strong support is found for hypothesis 3.

C. Flow-performance with Overlapping Measurement Period

To further test hypothesis 3, we now study the flow-performance relation. As above, we start by replicating the finding of Kaplan and Schoar (2005).

As Kaplan and Schoar (KS, 2005), we regress fund size at date *d1* on the performance of the fund previously raised (at date *d0<d1*) measured about 10 years later. For example, the size of a fund raised in 1990 will be regressed on the performance achieved by a fund between 1987 and 1997.

< Table 6 >

We show results in Table 6. Whether we require 3 years spread between the two successive funds or not, we always find a strong relation. Size of fund *i*, *S(i)*, is always positively related to the final performance of the previously raised fund (*i*-1) at a 1% level test.

As for the performance persistence test conducted in sub-section 2.A, there is an overlapping issue. This issue makes results particularly difficult to interpret in the context on the flow-performance relation. For example, let's assume that large funds outperform and performance of subsequent funds is positively correlated (both claims are made by KS). This implies that size of fund *i*, *S(i)*, will be positively related to the performance of the previous fund *even if* investors do not allocate capital as a function of past performance. Hence from the above finding of a positive flow-performance relation, we do not know how investors react to past performance. To know this, we need to study this relation ex-ante. It avoids this endogeneity related issue and sheds light on investor behavior. In addition, studying how investors react to the current track record when allocating capital answers the question of performance chasing attitude and relates to the three hypotheses above.

D. Ex-ante Flow-performance relation

We now study the flow-performance relation from an ex-ante perspective. As shown in Table 7 – Panel A, past performance is significantly and positively related to fund size in 3 specifications out of 6 at a 5% level test and in all specifications except one at a 10% level test. Hence, investors react to past performance for capital allocation but it is not as strong ex-ante as it is ex-post.

< Table 7 >

As noted above, the endogeneity issue that arises when measuring this relation ex-post makes it difficult to interpret results. One could interpret the above finding as investors being able to predict ex-post performance better than the econometrician and this is why the flow-performance relation is stronger with ex-post performance. This is certainly true to a certain extent. The measure of past performance used here is plain and quite naïve; an issue we further discuss in the conclusion. Another explanation could be that larger venture capital funds perform better as argued by KS. The reason could be that they save on substantial fixed costs. As a result when a fund family raises a larger fund the performance of the existing funds improve. That would also be consistent with the above finding.

We also note that the size of the preceding fund is by far the best predictor of focal fund size. The fact that current size depends on previous size also fits well the BG model of delegated management. As investors learn about fund abilities, they update the optimal fund size. Hence a direct implication of learning is that size of fund (i) relates significantly to size of fund (i-1).

The importance of the size of the preceding fund for current fund size also means that two funds with an equally good track record will not typically raise a fund of the same size. A fund that has raised $1 billion before is expected to raise more capital than a fund that has raised $100 million before even if both funds have the same track record.

Next, we study the flow-performance relation separately for superior and inferior funds as in section 2.B above. Results in Table 7 – Panel B show that for inferior funds, the flow-performance relation is perfectly flat. For these funds, there is no significant link between a fund track record and fund size. These funds were those above that displayed

significant predictability in performance. In Table 7 – Panel C, we find that for superior funds, the flow-performance relation is very strong. It is always significant at a 5% level test.

It is also interesting to note that the coefficient on previous fund size is similar for superior and inferior funds (specifications 3 and 6). It means that superior funds grow at a similar pace as inferior funds. There are two possible explanations. First, superior funds constrain their growth and not inferior funds. Second, superior funds may go to their optimal size but small funds are too aggressive. Given the finding that ex-ante persistence is concentrated in inferior funds and that these funds have a weak flow-performance relation, the latter seems to hold.

All these results are in contradiction with hypothesis 2 but are consistent with hypothesis 3.

3. Robustness checks

In this section, we undertake a number of robustness checks. First is the econometric method used. To obtain some of the central results in this study (section 2.B), we truncate our sample based on the dependent variable. This case is called a truncated regression model (see Greene, section 22.2.3, 2003). Both least square estimators and inference can be biased and a maximum likelihood estimator taking into account the truncation may be used instead. Similarly, in section 2.D, we truncate our sample based on performance and the dependent variable is size. The two being correlated, we have a similar problem called "incidental truncation". Again, an appropriate maximum likelihood method described in Greene (2003) may be used. We report the results in Table 8 – Panel A. Both the coefficient estimates and inference are similar to what we report with robust least square estimators.

< Table 8 >

Second, we consider different sub-samples. Following the discussion in section 1.D, we studied persistence and flow-performance relation conditional of fund future performance. Berk and Green (2004) theory states that it is the sophistication of the investors of the focal fund (the one being raised) that matters. Hence, we should separate funds based on this measure. Conditioning on other variables should not produce similar results. In Table 8 – Panel B, we show results for sub-samples based on either size or past performance. In both

cases, results are different from those obtained when conditioning on performance. Small funds, unlike inferior funds, do not exhibit any performance persistence.

When conditioning on past performance, results are also different from those obtained when conditioning on performance. Loser funds (low past performance) exhibit performance persistence at a 10% level test while winner funds exhibits none. The flow-performance relation is significant for neither although slightly stronger for loser funds.

A natural question is whether one could find an ex-ante conditioning variable that would enable investors to pick better than average funds. The above results show that ex-ante variables I have do not work (size, sequence and past performance). We have tried other variables such as NAV increase before fund raising, recent dividend distributions but they did not work either.

< Table 9 >

The top firms may show a fixed effect in the performance of their various investments ex-post but investors cannot take advantage of it based on past performance information. Fund size appears to be the equilibrium clearing mechanism as described in Berk and Green (2004). Some firms may restrict their fund size to consistently be top performers but they appear to be an exception rather than the rule. KS argue that persistence is concentrated in top firms and not in inferior firms. They base this judgment on a transition matrix that shows conditional probabilities of a fund being in a given performance tercile. In Table 9 – Panel A, we replicate their finding. We also find that it is more frequent for a firm with top ex-post performance on a previous fund to raise a top fund than for a firm with inferior ex-post performance on a previous fund to raise an inferior fund. However, in Table 9 – Panel B, we show that if we conduct the same exercise on an ex-ante basis instead of ex-post, the effect disappears.

In non-tabulated results, we also look at the concavity of the flow-performance relation. We find that the correlation between past performance and its square is 97%. This extreme multi-colinearity makes it impossible statistically to test for concavity. Using piece-wise regression also leads to inconclusive evidence. We also look at the KS regression (section 2.A) for persistence separately for top and inferior funds. We find similar results as ex-ante. For top funds, the performance persistence relation is weak. It loses statistical

significance in several specifications. In contrast, for inferior funds, the relation is positive and statistically significant.

4. Discussion and conclusion

In this paper, we show that venture capital fund performance exhibits a strong fund-family fixed effect but no ex-ante performance persistence. That is, when a fund is being raised, its performance is only weakly related to that of the previously raised funds. We conjecture, based on previous research, that funds with higher performance are backed by more sophisticated investors. We then separate funds based on performance and find that better performing funds (those expected to be backed by more skilled investors) show no performance persistence and have a significant flow-performance relation. In contrast, inferior funds (those expected to be backed by less skilled investors) show performance predictability and have a flat flow-performance relation. These results suggest that only skilled investors use all available information to adjust their capital allocation to funds and, as a result, eliminate performance predictability as predicted by Berk and Green (2004).

Our findings show that previous research on VC performance persistence is inconclusive. The fact that we obtain non significance means that using the aggregate performance figure at the moment of fund raising does not help predicting performance. However, investors may use other variables that enable them to predict future performance. For example, they may look only at mature investments and not at recent investments valued at cost (data which I do not have).

More broadly, our results indicate that private equity firms may not be as different from other financial intermediaries as previously conjectured. The model of Berk and Green (2004) seems to apply to a sizeable part of the private equity industry in a similar way as it does in the hedge fund industry (Fung, Hsieh, Naik and Ramadorai, 2007) for example. What appears different in the venture capital industry is the potential segmentation between sophisticated and non-sophisticated investors. This apparent segmentation warrants further research: Why ill-suited investors stay in the venture capital industry despite poor performance? Why don't they imitate more sophisticated investors?

References

Axelson, U., Jenkinson, T., Stromberg, P., and M., Weisbach, 2007, Leverage and pricing in buyouts: An empirical analysis, Mimeo.

Berk, J. and R.C. Green, 2004, Mutual fund flows and performance in rational markets, *Journal of Political Economy* 112, 1269-1295.

Cochrane, J., 2005, The risk and return of venture capital, *Journal of Financial Economics* 75, 3-52.

Driessen, J., T.C. Lin, and L. Phalippou, 2007, Estimating the Performance and Risk Exposure of Private Equity Funds: A New Methodology, Working Paper, University of Amsterdam.

Fung, W., D.A., Hsieh, N.Y., Naik and T. Ramadorai, 2007, Hedge funds: Performance, risk and capital formation, *Journal of Finance* forthcoming.

Glode, V., and R.C. Green, 2008, Information Spill-Overs and Performance Persistence in Private Equity Partnerships, Working Paper, Carnegie Mellon University.

Gompers, P., and J. Lerner, 1999, An analysis of compensation in the U.S. venture capital partnership, *Journal of Financial Economics* 51, 3-44.

Greene, W.H., 2003, Econometric Analysis, 5th edition, Prentice Hall.

Hochberg, Y., Ljungqvist, A., and Y. Lu, 2007, Venture Capital Networks and Investment Performance, *Journal of Finance* forthcoming

Hochberg, Y., A., Ljungqvist, and A. Vissing-Jorgensen, 2008, On the Interaction of Private Equity Funds and their Investors, working paper, Northwestern University.

Jones, C. and M. Rhodes-Kropf, 2003, The price of diversifiable risk in venture capital and private equity, Working paper, Columbia University.

Kaplan, S.N. and A. Schoar, 2005, Private equity performance: Returns, persistence, and capital flows, *Journal of Finance* 60, 1791-1823.

Lerner, J. and A. Schoar, 2004, The illiquidity puzzle: Theory and evidence from private equity, *Journal of Financial Economics* 72, 3-40.

Lerner, J., A., Schoar, and W., Wong, 2007, Smart Institutions, Foolish Choices?: The Limited Partner Performance Puzzle, *Journal of Finance* forthcoming.

Ljungqvist, A., Richardson, M., and D., Wolfenzon, 2007, The investment behavior of buyout funds: Theory and evidence, Working Paper NYU.

Metrick, A. and A. Yasuda, 2007, Economics of Private Equity Funds, Working Paper, Wharton Business School.

Phalippou, L., 2008, Beware when venturing in private equity, *Journal of Economic Perspectives*, forthcoming.

Phalippou, L., and O. Gottschalg, 2007, The Performance of Private Equity Funds, *Review of Financial Studies*, forthcoming.

Table 1: Descriptive statistics

This table gives descriptive statistics for both our working sample and the universe (TVE cash-flow dataset). Only funds with size greater than $5 million (1990 U.S. dollars) are considered. Focal funds are funds with at least one predecessor fund. Predecessor funds are raised by the same firm at least 3 years before the focal fund. Table shows the number of funds (N), their total capital committed (Size; in billion of U.S. dollars), fund average Profitability Index (PI), average number of preceding funds (N_tr), average Profitability Index of all preceding funds (PI_tr), average Profitability Index of the predecessor fund (PI_{i-1}), and fraction of funds with a U.S. focus.

	Our working sample							Universe			
	Focal funds				Track record						
Year	N	Size	PI	%US	N_tr	PI_tr	PI_{i-1}	N	Size	PI	%US
1983	7	1.40	0.62	1.00	2	0.82	0.82	59	4.57	0.56	0.93
1984	18	2.04	0.47	0.89	2.11	0.98	0.97	66	4.69	0.51	0.92
1985	10	0.62	0.63	0.90	2.20	0.78	0.77	60	4.08	0.65	0.73
1986	21	3.67	0.63	0.86	2.38	0.72	0.72	50	5.45	0.68	0.82
1987	36	2.92	0.89	0.92	2.28	0.71	0.72	74	7.05	0.75	0.80
1988	38	4.41	0.92	0.79	2.82	0.78	0.76	58	5.60	0.78	0.76
1989	50	5.95	0.85	0.78	2.64	0.75	0.77	71	7.52	0.91	0.72
1990	22	2.15	1.16	0.68	3.09	0.72	0.73	37	2.85	0.97	0.57
1991	19	1.09	0.68	0.74	2.53	0.81	0.83	34	4.01	0.75	0.53
1992	25	2.77	1.33	0.88	3.00	0.87	0.93	33	3.38	1.18	0.79
1993	34	3.67	1.36	0.91	3.76	0.86	0.90	52	4.99	1.13	0.73
1994	34	5.30	1.38	0.82	3.62	0.82	0.94	53	7.92	1.12	0.74
1995	34	4.35	2.12	0.74	3.32	0.89	1.13	61	6.41	1.61	0.70
Mean			1.00	0.84	2.75	0.81	0.85			0.89	0.75
Total	348	40.33						708	68.52		

Table 2: Correlation matrix and distribution

This table gives the correlation matrix and distribution percentiles for the variables of interest. All variables are log-transformed before computing correlations. Percentiles are given for the original variable (before log-transformation). Size is capital committed to the focal fund in million of U.S. dollars, Previous size is the predecessor fund size, Sequence is the sequence number of a fund. Past performance measures are the Profitability Index of the preceding fund (PI_{i-1}), and the (aggregated) Profitability Index of all preceding funds (PI_tr).

	PI	Size	Previous size	Sequence	PI_{i-1}	PI_tr
PI	1.00					
Size	0.35	1.00				
Previous size	0.32	0.63	1.00			
Sequence	0.28	0.22	0.32	1.00		
PI_{i-1}	0.17	0.19	0.09	0.11	1.00	
PI_tr	0.03	0.16	0.03	-0.11	0.77	1.00
Mean	1.09	115.90	104.70	2.87	0.85	0.80
25th prctile	0.42	38.23	36.36	2.00	0.68	0.66
50th prctile	0.72	69.67	63.71	2.00	0.81	0.78
75th prctile	1.22	130.63	118.66	3.00	0.93	0.89
95th prctile	3.02	277.52	251.99	5.00	1.35	1.24

Table 3: Persistence with Overlapping Measurement Period

This table shows results from least-squares regressions with the focal fund performance (log of one plus the Profitability Index) as dependent variable. Past performance (PI_{i-1}) is the final performance of the preceding fund. Preceding funds need to be raised at least 3 years before the focal fund. Independent variables include sequence (log of the sequence number of a fund) and the log of the size of the preceding fund. *t*-statistics based on firm-level clustered standard errors are reported below each coefficient in italics. Vintage year fixed effects and geographical focus fixed effects may be included.

	Dependent variable: Log Profitability Index (PI)			
	Spec 1	Spec 2	Spec 3	Spec 4
PI_{i-1}	0.50	0.48	0.45	0.42
	5.86	*5.70*	*5.19*	*4.84*
Sequence		0.20	0.14	0.14
		3.56	*2.75*	*2.60*
Size (lagged)			0.06	0.06
			3.59	*3.42*
Focus F.E.	no	no	no	yes
Year F.E.	yes	yes	yes	yes
Adj. R-squared	0.18	0.22	0.22	0.23
N-obs	414	414	414	414

Table 4: Persistence and Time Overlap

This table shows results from least-squares regressions with the focal fund performance (log of one plus the Profitability Index) as dependent variable. Past performance (PI_{i-1}) is the final performance of a preceding fund. Each preceding fund corresponds to one observation. The sample is separated in preceding funds that are raised less than three years before the focal fund, between 3 and 6 years before and more than 6 years before. Independent variables include sequence (log of the sequence number of a fund) and the log of the size of the preceding fund. *t*-statistics based on firm-level clustered standard errors are reported below each coefficient in italics. Vintage year fixed effects and geographical focus fixed effects may be included.

	High overlap (overlap < 3 years)				Intermediate overlap				Low overlap (overlap > 5 years)			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
PI_{i-1}	0.48	0.47	0.45	0.44	0.41	0.41	0.31	0.28	0.20	0.20	0.11	0.09
	5.30	*4.81*	*4.96*	*4.74*	*3.93*	*3.93*	*3.18*	*2.77*	*1.37*	*1.38*	*0.80*	*0.68*
Sequence		0.01	0.01	0.02		0.01	0.02	0.03		0.03	0.05	0.05
		0.76	*0.45*	*0.75*		*0.39*	*1.08*	*2.10*		*1.92*	*2.77*	*3.06*
Size (lagged)			0.03	0.04			0.10	0.10			0.10	0.10
			1.29	*1.38*			*5.45*	*5.50*			*3.68*	*3.41*
Focus F.E.	no	no	no	yes	no	no	no	yes	no	no	no	yes
Year F.E.	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Adj. R-squared	0.35	0.35	0.36	0.36	0.25	0.25	0.29	0.30	0.12	0.12	0.16	0.16
N-obs	157	157	157	157	347	347	347	347	299	299	299	299

Table 5: Ex-ante Persistence

This table shows results from least-squares regressions with the focal fund performance (log of one plus the Profitability Index) as dependent variable. Past performance is either that of the preceding fund (PI_{i-1}) or that of all preceding funds (PI_tr). Past performance is measured at the end of the year preceding focal fund inception. Preceding funds need to be raised at least 3 years before the focal fund. Independent variables include sequence (log of the sequence number of a fund) and the log of the size of the preceding fund. *t*-statistics based on firm-level clustered standard errors are reported below each coefficient in italics. Vintage year fixed effects and geographical focus fixed effects may be included. In Panel A, the regressions are run on the full sample. In Panel B, the sample includes top focal funds (with performance above median). In Panel C, the sample includes inferior focal funds (with performance below median).

Panel A: All funds

	Dependent variable: Log Profitability Index (PI)							
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5	Spec 6	Spec 7	Spec 8
PI_{i-1}	0.31	0.29	0.34	0.23				
	2.20	*2.12*	*2.02*	*1.29*				
PI_tr					0.10	0.22	0.17	0.04
					0.88	*1.45*	*0.84*	*0.18*
Sequence		0.26	0.14	0.14		0.28	0.16	0.14
		4.24	*1.86*	*1.77*		*4.00*	*2.04*	*1.80*
Size (lagged)			0.12	0.11			0.12	0.11
			4.96	*4.75*			*4.91*	*4.74*
Focus F.E.	no	no	no	yes	no	no	no	yes
Year F.E.	yes	yes	yes	yes	yes	yes	yes	yes
Adj. R-squared	0.09	0.12	0.17	0.19	0.07	0.11	0.16	0.18
N-obs	348	348	348	348	348	348	348	348

Panel B: Low performance funds

	Dependent variable: Log Profitability Index (PI)							
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5	Spec 6	Spec 7	Spec 8
PI_{i-1}	0.17	0.17	0.17	0.19				
	2.28	*2.23*	*2.14*	*2.20*				
PI_tr					0.15	0.17	0.19	0.22
					1.98	*2.38*	*2.26*	*2.35*
Sequence		0.08	0.05	0.06		0.10	0.07	0.08
		1.76	*1.20*	*1.29*		*2.27*	*1.64*	*1.78*
Size (lagged)			0.02	0.02			0.02	0.02
			1.69	*1.76*			*1.67*	*1.74*
Focus F.E.	no	no	no	yes	no	no	no	yes
Year F.E.	yes	yes	yes	yes	yes	yes	yes	yes
Adj. R-squared	0.05	0.06	0.06	0.06	0.04	0.06	0.06	0.06
N-obs	174	174	174	174	174	174	174	174

Panel C: High performance funds

	Dependent variable: Log Profitability Index (PI)							
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5	Spec 6	Spec 7	Spec 8
PI_{i-1}	-0.01	-0.01	-0.01	-0.09				
	-0.00	*-0.01*	*-0.05*	*-0.42*				
PI_tr					-0.01	0.00	-0.23	-0.31
					-0.04	*-0.01*	*-0.90*	*-1.16*
Sequence		0.01	-0.05	-0.04		0.01	-0.07	-0.07
		0.30	*-0.57*	*-0.46*		*0.21*	*-0.76*	*-0.71*
Size (lagged)			0.02	0.02			0.03	0.03
			0.69	*0.62*			*0.84*	*0.80*
Focus F.E.	no	no	no	yes	no	no	no	yes
Year F.E.	yes	yes	yes	yes	yes	yes	yes	yes
Adj. R-squared	0.12	0.11	0.11	0.11	0.12	0.11	0.11	0.11
N-obs	174	174	174	174	174	174	174	174

Table 6: Capital flows and previous fund final performance

This table shows results from least-squares regressions with the (log of) focal fund size as dependent variable. Past performance (PI_{i-1}) is the final performance of the preceding fund. Preceding funds need to be raised at least *y* years before the focal fund, with the spread *y* being set to either 0 or 3. Independent variables include sequence (log of the sequence number of a fund) and the log of the size of the preceding fund. *t*-statistics based on firm-level clustered standard errors are reported below each coefficient in italics. Vintage year fixed effects and geographical focus fixed effects may be included.

	Dependent variable: Log Size					
	No minimum spread			3 years spread minimum		
	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3
PI_{i-1}	1.08	1.02	0.83	1.44	1.37	1.20
	4.68	*4.45*	*4.08*	*5.31*	*5.31*	*5.11*
Sequence		0.52	0.34		0.60	0.31
		3.25	*2.49*		*3.21*	*2.14*
Size (lagged)			0.00			0.00
			6.24			*5.64*
Focus F.E.	yes	yes	yes	yes	yes	yes
Year F.E.	yes	yes	yes	yes	yes	yes
Adj. R-squared	0.12	0.15	0.29	0.18	0.22	0.37
N-obs	414	414	414	348	348	348

Table 7: Capital flows and past performance ex-ante

This table shows results from least-squares regressions with the (log of) focal fund size as dependent variable. Past performance is either that of the preceding fund (PI_{i-1}) or that of all preceding funds (PI_tr). Past performance is measured at the end of the year preceding focal fund inception. Preceding funds need to be raised at least 3 years before the focal fund. Independent variables include sequence (log of the sequence number of a fund) and the log of the size of the preceding fund. *t*-statistics based on firm-level clustered standard errors are reported below each coefficient in italics. Vintage year fixed effects and geographical focus fixed effects may be included. In Panel A, the regressions are run on the full sample. In Panel B, the sample includes top focal funds (with performance above median). In Panel C, the sample includes inferior focal funds (with performance below median).

Panel A: All funds

	Dependent variable: Log Size					
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5	Spec 6
PI_tr	0.78	0.78	0.61			
	2.90	*3.21*	*2.49*			
PI_{i-1}				0.66	1.02	0.80
				2.35	*3.36*	*2.72*
Sequence		0.69	0.06		0.77	0.13
		3.50	*0.37*		*4.04*	*0.92*
Size (lagged)			0.58			0.58
			7.45			*7.65*
Year F.E.	yes	yes	yes	yes	yes	yes
Focus F.E.	yes	yes	yes	yes	yes	yes
Adj. R-squared	0.08	0.13	0.44	0.08	0.14	0.44
N-obs	348	348	348	348	348	348

Panel B: Low performance funds

	Dependent variable: Log Size					
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5	Spec 6
PI_tr	0.09	0.09	0.31			
	1.04	*1.09*	*1.03*			
PI $_{i-1}$				0.03	0.21	0.46
				1.05	*1.55*	*1.43*
Sequence		0.54	0.16		0.56	0.20
		2.55	*0.96*		*2.85*	*1.21*
Previous Size			0.45			0.45
			5.44			*5.57*
Year F.E.	yes	yes	yes	yes	yes	yes
Focus F.E.	yes	yes	yes	yes	yes	yes
Adj. R-squared	0.08	0.11	0.32	0.08	0.11	0.32
N-obs	174	174	174	174	174	174

Panel C: High performance funds

	Dependent variable: Log Size					
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5	Spec 6
PI_tr	1.28	1.27	0.75			
	2.68	*2.73*	*2.26*			
PI $_{i-1}$				1.74	2.08	1.19
				2.65	*3.11*	*2.56*
Sequence		0.49	-0.12		0.63	-0.03
		1.49	*-1.55*		*1.94*	*-0.72*
Previous Size			0.61			0.59
			5.70			*5.78*
Year F.E.	yes	yes	yes	yes	yes	yes
Focus F.E.	yes	yes	yes	yes	yes	yes
Adj. R-squared	0.05	0.07	0.40	0.06	0.11	0.41
N-obs	174	174	174	174	174	174

Table 8: Robustness

In Panel A, coefficients are obtained by maximum likelihood, taking into account the truncation on the dependent variable. In Panel B, the conditioning variable (performance) is replaced by either size or past performance. All the variables are as defined in Table 4 and 6. Robust *t*-statistics are reported below each coefficient in italics.

Panel A: Truncated regression estimation

Dependent var	Profitability Index				Size			
Sample	Low PI	Low PI	High PI	High PI	Low PI	Low PI	High PI	High PI
PI_tr	0.19	0.19	-0.07	-0.13	0.02	0.48	2.31	1.39
	2.22	*2.18*	*-0.50*	*-0.89*	*0.03*	*1.03*	*3.80*	*3.09*
Sequence	0.05	0.05	-0.02	-0.02	0.36	0.21	0.44	0.04
	1.70	*1.68*	*-0.60*	*-0.60*	*2.27*	*1.43*	*2.56*	*0.32*
Previous Size						0.43		0.52
						5.44		*5.97*
Focus F.E.	no	yes	no	yes	yes	yes	yes	yes
Year F.E.	yes	yes	yes	yes	yes	yes	yes	yes
N-obs	174	174	174	174	174	174	174	174

Panel B: Different sub-samples

Dependent var	PI		Size		PI		Size	
Sample	Small	Large	Small	Large	Loser	Winner	Loser	Winner
PI_tr	0.11	-0.11	-0.25	0.74	0.71	0.03	1.57	0.62
	0.67	*-0.44*	*-0.74*	*3.27*	*1.85*	*0.11*	*1.56*	*1.31*
Sequence	0.20	0.13	-0.09	0.23	0.29	0.18	0.27	-0.17
	2.36	*1.50*	*-0.59*	*1.57*	*3.49*	*1.93*	*1.30*	*-0.86*
Previous Size			0.21	0.47			0.49	0.69
			3.86	*5.02*			*5.56*	*11.37*
Year F.E.	yes	yes	yes	yes	yes	yes	yes	yes
Focus F.E.	yes	yes	yes	yes	yes	yes	yes	yes
Adj. R-squared	0.02	0.15	0.12	0.42	0.15	0.05	0.34	0.54
N-obs	174	174	174	174	174	174	174	174

Table 9: Transition probabilities

We sort firms into terciles based on the firm performance track records and calculate the conditional probability that the focal fund stay in the same tercile or move into one of the other two terciles. The results in Panel A are with past performance set to the final performance of the preceding fund (as in Table 3). The results in Panel B are with past performance set to the performance of all funds previously raised measured at the date of the focal fund inception (as in Table 4).

Panel A: Past performance is overlapping – All funds

Performance / Past performance	Lower tercile (%)	Medium tercile (%)	Upper tercile (%)
Lower tercile (%)	0.38	0.38	0.23
Medium tercile (%)	0.34	0.36	0.30
Upper tercile (%)	0.27	0.26	0.48

Panel B: Ex-ante Past performance – All funds

Performance / Past performance	Lower tercile (%)	Medium tercile (%)	Upper tercile (%)
Lower tercile (%)	0.33	0.34	0.33
Medium tercile (%)	0.33	0.31	0.36
Upper tercile (%)	0.33	0.34	0.33