

Using past performance to infer investment manager ability

This paper uses observed performance persistence to model a direct link between performance and investment manager ability. Fitting our model to the observed level of performance persistence in private equity funds, we find that 80% confidence in a manager having exceptional ability requires observing superior performance in three or four prior funds. While investments with these select managers are likely to produce superior returns, our model also shows how strict past performance screens create their own challenges.

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Past performance may not be indicative of future results. This disclaimer summarizes much of what makes choosing an investment manager – in a mutual fund, hedge fund, private equity fund, etc. – challenging. Presumably past performance contains information about managerial ability, creating a link between past and future performance. At the same time, luck likely also plays a role in performance, and it not obvious what any given track record implies about manager ability and expected future returns. Further, selecting investment managers based on past performance screens may have unintended, and unrecognized, consequences for an investment program by severely limiting the available pool of managers. A better understanding of the relations between past performance, manager ability, and likely future performance would improve how track records are used to select investment managers.

This paper takes a Bayesian approach to model the link between managerial ability and past performance. There is a top quartile of managers (the right tail of the ability distribution) and a top quartile of fund returns. Potential investors care about ability because it influences future performance, but cannot observe ability directly. Potential investors can observe past performance, but performance depends to some extent on luck so the top quartiles of managers based on 1) ability and 2) past performance are not identical, forcing potential investors to continually update their opinions of manager ability. Our model provides, using a single parameter, the likelihood that a manager with various top quartile track records has the more important characteristic, top quartile ability.

The key insight is that while ability is not observable, the importance of ability to performance can be inferred from performance persistence. At least some performance persistence – better past performers being more likely to earn superior future returns and vice-

versa – has been documented in many asset classes including mutual funds, hedge funds, and private equity funds. Varying manager ability increases return persistence over time (while luck diminishes performance persistence), as better investment managers tend to have better past and future returns. Therefore, the level of performance persistence in a given asset class reveals the role that managerial ability plays in determining investment returns. Observing the level of performance persistence, we are able to quantify the information that past performance provides about ability.

Past performance is a noisy signal of manager ability. Noise lessens over time both because ongoing funds' returns become a better indicator of ability as these funds mature and because investors observe further data as managers raise successive funds. Looking specifically at private equity funds, we fit the model to the observed roughly 40% probability that a top quartile private equity fund will be followed by another top quartile fund, and find that 80% confidence in a manager being in the top ability quartile requires observing top-quartile performance in three or four prior funds. We show that while only investing with these managers – those with a series of top performing past funds – is likely to produce superior returns, using a strict past performance screen creates new challenges that are discussed in the paper's conclusion.

I. Private Equity

While our results apply to investment funds generally, this paper focuses on private equity funds. Private equity – primarily venture capital and buyout funds - captures many of the challenges associated with using past performance to infer managerial ability. Private equity managers, general partners, typically raise their successive funds on a relatively short cycle that provides potential investors, limited partners, with incomplete information about the eventual

performance of the managers' past funds. At the same time, the returns earned by private equity funds vary widely. While much of this variation stems from market conditions, even more is the result of cross-sectional variation across seemingly similar funds, e.g., those within a given vintage (all private equity funds launched in a given calendar year). Top quartile funds are the 25% of funds with the highest returns for that vintage. Second quartile funds are represented by the next 25%, down to the bottom quartile consisting of the 25% of the vintage funds with the lowest returns. One measure of the dispersion among private equity returns is the spread between quartile break points, that is, the 25th percentile, median, and 75th percentile returns within a vintage. Exhibit 1 shows the variation in private equity internal rates of return (IRR), across time and within vintages, using funds in the Private Equity Intelligence database (over 3,400 funds managed by over 1,100 private equity firms). The horizontal lines show the 25th and 75th percentile returns (top and bottom, respectively) while the dot shows the median IRR for each vintage through year-end 2006.

The median fund return varies considerably, ranging from over 20% for 1993 vintage funds to roughly zero for 1999 vintage funds. The gap between the 25th and 75th percentile returns is similarly large, averaging roughly 20 percentage points. While private equity fund investors might benefit from choosing the right years to invest, it is at least as important to choose the right funds to invest with. The 25th percentile IRR (the bottom of the top quartile) consistently reaches levels similar to or better than the long-term stock market yield, never falling below 10% during this period and often exceeding 20% or even 30%. The 75th percentile IRR, on the other hand, rarely exceeds 10% and dips as low as -10% for vintage-1999 private equity funds. Being able to identify the better (e.g., top quartile) private equity managers would substantially enhance an investor's returns.

If relative performance among private equity funds were random, there would be no way for investors to consistently obtain superior returns because returns would revert to the mean over time: investing in funds with high past returns would not, on average, produce superior future returns. Even if performance is not random, luck could play a sufficiently large role to prevent investors from clearly discerning the truly skilled managers. In these cases, investing in funds with high past returns may produce only marginally higher future returns. If, however, luck plays a limited role, higher past returns should be associated with higher future returns.

The empirical evidence is consistent with skilled private equity managers consistently offering superior performance. Kaplan and Schoar [2005] study 764 private equity funds between 1980 and 2001 and document that better past performance is associated with better future performance (and vice-versa). Conner [2005] and Rouvinez [2006] replicate this result, and Private Equity Intelligence recently released a study using their data that finds that funds raised subsequent to a top quartile fund have a 43.3% probability of also being top quartile, while funds raised following a bottom quartile fund have a 35.1% probability of remaining bottom quartile (Performance Spotlight [2007]).

The combination of performance persistence and a consistently large spread between better and worse performing funds leads many private equity limited partners to focus on investing in the subsequent funds of past top quartile performers. There are, however, challenges inherent to implementing this strategy. Substantial time is necessary, typically years, before the results of private equity investments become known. In the interim, funds generally carry their portfolio at cost unless there is a subsequent financing event. Thus, private equity managers often raise their next fund before performance in the previous fund can be accurately measured. Today, for example, we may observe that good vintage-1995 funds tended to be followed by

good vintage-1997 funds. Exploiting that fact for investment purposes requires knowing in 1997 which of the vintage-1995 funds would end up being good.

This is difficult. Analyses by Venture Economics (available in their *Investment Benchmarks* publications) show that the composition of the top return quartile for a given vintage varies considerably over time. While seasoned (e.g., funds eight years into their life) funds that rank in the top quartile have a high probability of remaining top performers, funds that rank top quartile early in their lives have a much lower probability of ending up in the top quartile. Given that new funds are commonly raised every two to four years, the inability of recent interim performance to precisely predict eventual performance limits a prospective limited partner's practical ability to discern top funds using past performance.

Consider two empirical findings: 1) only 47% of the 1991-vintage venture funds that had ranked top quartile in 1994 (three years into the fund's life) remained top quartile in 2000 (Venture Economics); and, 2) 43% of top quartile funds end up being followed by another top quartile (Private Equity Intelligence). Note that the second finding implies that $(1-0.43)/3 = 0.19$, or 19%, of lower quartile funds end up top quartile in their following fund (to replace the 57% of top-quartile funds that fail to repeat in the top quartile). This, along with the first finding, implies that being observed in the top quartile three years into a fund's life implies a 30% $(0.47*0.43+ 0.53*0.19)$ chance of the subsequent fund ending up in the top quartile. Investing with a manager whose track record consists of a three-year old top quartile private equity fund produces odds of future top quartile performance (30%) that are fairly close to chance (25%).

We note a caveat to linking past performance to managerial ability solely based on performance persistence. Managers with similar ability may select portfolios with substantially

different risk levels. Technology investments might, on average, generate higher returns, but with correspondingly higher risk. Some buyout managers may consistently use more leverage. Consistently different risk-taking across managers can create performance persistence that is unrelated to ability. To the extent that the differences are unobservable, differential risk-taking reduces the information that past performance conveys about managerial ability. Throughout this paper we are implicitly assuming that strategy differences play a trivial role in creating performance persistence. To the extent that this is not true, our results overstate the likelihood that a manager with a strong track record has exceptional ability. Similarly, performance rankings being susceptible to manipulation (Winston [2005]) will also reduce the information in past performance.

II. Modeling performance persistence

We define the top 25% of private equity managers as exceptional. These managers represent the true “top quartile” because their funds have higher expected future returns. The assumption that investors pursue the top quartile is not critical; we could, for example, define the top decile of managers as exceptional. Exceptional ability is not directly observable, and we ignore the possibility that exceptional managers might credibly signal their ability to prospective limited partners (in practice, private equity partnership terms do not seem to vary in ways that are consistent with signaling, e.g., Gompers and Lerner [1999]). Thus, limited partners are forced to base their assessment of ability on the past performance of a manager’s prior fund(s). Funds have a ten-year life (e.g., funds liquidate after ten years). Prior to liquidation interim performance is a noisy signal of the fund’s eventual performance. Further, eventual (fully-liquidated) performance may be a noisy signal of ability: exceptional managers are not necessarily guaranteed a spot in the top return quartile. Additionally, we later allow for the

possibility that ability can change over time, with some exceptional managers becoming ordinary and some ordinary managers becoming exceptional.

There are $4N$ private equity funds managed by $4N$ different managers. This leaves N funds in each return quartile and N funds that have an exceptional manager. The two groups of N may only partly overlap. There are $3N$ funds outside of the top quartile and $3N$ ordinary managers. Initially we consider the relation between funds' final (fully-liquidated) quartile rank and managerial ability. Let x represent the probability that a fund with an exceptional manager liquidates in the top return quartile. This probability captures the relative role of "skill" and "luck:" if $x=1$, then all exceptional managers have top quartile funds (skill alone determines performance); if $x=0.25$, then performance depends solely on luck. Multiple funds with the same manager are indexed as F_t , where the second fund, F_2 , follows the first fund, F_1 . We define the follow-on probability, FP , as the probability that F_{t+1} is top quartile conditional on F_t being top quartile. In the model the follow-on probability is the number of current top quartile funds that subsequently repeat their top quartile ranking divided N , the number of current top quartile funds.

The (unobservable) probability of an exceptional manager ending up in the top quartile, x , can be estimated from the (observable) FP because the over-representation of exceptional managers in the top return quartile drives performance persistence. There are an expected xN current top-quartile funds that have exceptional managers, leaving $(1-x)N$ top quartile funds with ordinary, but lucky, managers. This leaves an expected $(1-x)N$ exceptional managers currently outside of the top quartile (the fraction of exceptional managers in the top quartile also equals x) due to bad luck. The probability that an ordinary manager lucks into the top return quartile is $[(1-x)/N]/3N = (1-x)/3$. The follow-on probability will reflect the fraction, x , of the xN

exceptional managers that repeat in the top return quartile and the fraction, $(1-x)/3$, of the $(1-x)N$ ordinary managers that remain in the top quartile:

$$FP = [x^2N + (1-x)^2N/3]/N \quad (1)$$

Equation (1) quantifies how a select group of managers having exceptional ability translates into performance persistence over time. At one extreme, when there are no exceptional managers (that is, the top quartile of managers is not over-represented in the top return quartile), there is no persistence (when $x=0.25$, $FP=0.25$). At the other extreme, when ability alone determines performance (that is, all exceptional managers are in the top return quartile), there is perfect persistence (when $x=1$, $FP=1$). Because we want to infer (unobservable) x from (observable) FP , we solve Equation (1) for x giving

$$x = [1 + (1 - 4(1-3FP))^{1/2}] / 4 \quad (2)$$

Using Equation (2) we compute each unique probability that an exceptional manager attains the top return quartile that is consistent with follow-on probabilities between 25% and 100%. Because follow-on probabilities below 25% do not make sense, this relation, shown in Exhibit 2, encompasses the relevant luck/skill range.

Based on private equity persistence studies (Conner [2005], Kaplan and Schoar [2005], and Rouvinez [2006]), FP appears likely to fall in the range of 35%-45%. That is, if F_t is top quartile, there is a roughly 40% chance that F_{t+1} will be a top quartile fund. At this follow-on probability both luck and skill play meaningful roles in determining performance as roughly 60% of top-quartile funds have exceptional managers (when $FP = 0.4$, $x = 0.585$).

An example is useful to demonstrate the relation. Suppose that there are 1,000 funds and 1,000 managers, 250 with exceptional ability and 750 with ordinary ability. Based on our results above, assume that the top return quartile contains 146 exceptional managers ($x=0.584$). This assumption sets the balance between ability and luck. It leaves 104 slots in the top quartile for lucky ordinary managers, giving ordinary managers a $104/750 = 13.9\%$ chance of making the top quartile (which, of course, equals $(1-x)/3$). Similarly, there are 104 exceptional managers, $104/250 = 41.6\%$ (which, of course, equals $1-x$) of the exceptional group, unlucky enough to miss the top return quartile.

The follow-on probability is the fraction of the 250 funds in the current top return quartile that end up top quartile on their next fund. For exceptional managers, the probability is 58.4%, so 85 of the 146 exceptional managers currently in the top quartile can be expected to attain the top return quartile in their follow-on fund. For ordinary managers, the probability is 13.87%, so 14 of the 104 ordinary managers currently in the top quartile can be expected to attain the top return quartile in their follow-on fund. Together, 99 of the 250 funds in the current top return quartile repeat as top quartile, making the follow-on probability 40%. These steps represent Equation (1) for this 1,000-fund example, providing the performance persistence (FP) that results from the relative importance of managerial ability (x). In practice, the steps are reversed as in Equation (2): we observe the 40% follow-on probability and infer that 58.5% of top quartile funds have exceptional managers.

III. Past performance as a signal of manager ability

a. Single past funds

Because private equity funds are long-lived, follow-on funds are typically raised well before the earlier funds mature. Consequently, although a fully-liquidated top quartile fund may

have a roughly 60% probability that its manager is exceptional (making the follow-on fund attractive), fully-liquidated performance is not available when the follow-on fund is raised and the composition of the top quartile for a given vintage varies considerably over time. While a seasoned fund that ranks in the top quartile has a high probability of finishing as a top performer, a fund that ranks in the top quartile earlier in its life has a much lower probability. Given that new funds are commonly raised every two to four years, the inability of recent interim performance to precisely predict eventual performance limits a prospective limited partner's ability to use past performance to identify exceptional managers.

We assume that a fund's quartile ranking after one year provides no information about the fund's eventual performance (a fund ranked in the top quartile after one year has no better than chance, 25%, of finishing in the top quartile), and that the probability that a fund with an interim top quartile ranking finishes in the top quartile rises linearly through liquidation. This schedule is shown in the first column of Exhibit 3 and plotted in the upper line of Exhibit 4. The second column of Exhibit 3 shows the corresponding probabilities calculated from data in Venture Economics' 2000 Investment Benchmarks Report: Venture Capital (page 215, Figure 5.06). Our probability schedule is consistently somewhat lower than the Venture Economics probabilities. However, we should not put excessive weight on the probabilities calculated by Venture Economics in any given year. Further, using the Venture Economics probabilities in the subsequent calculations has no impact on the paper's conclusions.

Combining the assumed probability schedule in Exhibit 3 with a fully-liquidated follow-on probability of 0.4 provides the likelihood, shown by the lower line of Exhibit 4, that a fund ranked in the top quartile T years into its life has an exceptional manager. Suppose that a manager launches F_1 in 1990 and looks to raise F_2 in 1992. Prospective limited partners in F_2

naturally look at F_1 's performance, which we will assume is top quartile (in 1992). Our analysis demonstrates how much useful information F_1 's interim top quartile ranking – a noisy signal of the eventual quality of F_1 , which itself is a noisy signal of managerial ability – provides limited partners. First, a fund that ranks top quartile after two years has a one-third chance of maintaining its top quartile ranking through year 10. If the fund ends up top quartile, it has a 58.5% chance of having an exceptional manager, while if the fund does not end up top quartile, the probability is only $(1-0.585)/3$ or 13.8%. Therefore, the probability that F_2 is being raised by an exceptional manager is $0.333*0.585 + 0.667*0.138 = 0.287$, or 28.7%. Given that a randomly chosen fund has a 25% chance of having an exceptional manager, little information is provided by F_1 's early top quartile rank.

Additional seasoning provides increasingly better information. A fund that is in the top return quartile after four years has a 50% chance of finishing in the top quartile, raising the probability that the manager is exceptional to 36.2%. A manager with a fund in the top return quartile after eight years has a better than 50% chance of being exceptional. However, as time passes managers launch additional funds whose performance provides further information about manager ability that complements the original fund's increased seasoning.

b. Multiple funds

Suppose a manager continues to launch a new fund every two years, and when the manager raises F_3 in 1994 both F_1 and F_2 are in their respective top return quartiles. F_1 's now has a 50% chance of ending up in the top quartile (Table 1), raising the probability that the manager is exceptional to 36.2% based on F_1 's performance alone. F_1 's performance is augmented by F_2 's early top quartile rank, raising the probability that the manager is exceptional to 40.7%.

To see this, consider the N top-quartile 1990-vintage funds, 36.2% of which have exceptional managers. These exceptional managers have a 28.7% chance of having their 1992-vintage fund in the top quartile, while the ordinary managers who lucked into a top-quartile 1990-vintage fund only have a 23.8% chance of also having a 1992-vintage top quartile fund. The number of exceptional managers with two top-quartile funds is $(0.362 \times 0.287)N = 0.104N$, while the number of ordinary managers with two top-quartile funds is $(0.638 \times 0.238)N = 0.152N$. Exceptional managers make up $0.104 / (0.104 + 0.152) = 0.407$ of this group, or 40.7%.

Three existing funds all ranked top quartile (as F_4 is raised in 1996) increases the probability that the manager is exceptional to 61.4%. The increased probability stems primarily from more mature funds. F_1 being top quartile six years into the fund's life makes the probability 43.6%. F_2 remaining top quartile in 1996 raises the probability to 56.8%, and F_3 's top quartile ranking provides the final boost. F_3 's performance, however, provides relatively marginal information: when F_1 and F_2 are top quartile but F_3 is not, there is a 55.2% probability that the manager is exceptional.

Four top-quartile funds in 1998 raises the probability of an exceptional manager to 83.3%, while five top-quartile funds in 2000 (at this point F_6 in being raised and F_1 is fully liquidated) makes the probability 95.5%. Multiple consecutive top quartile funds provide increasingly unambiguous information about manager ability, even when some of the funds are relatively young. Consequently, a limited partner using consistent past performance as a screen for manager ability will be limited to investing in a manager's later funds.

The number of past funds necessary for a confident assessment of managerial ability depends, in part, on the fundraising cycle. It is plausible that a manager raises a new fund every two years, as we assume above, but this is a relatively short cycle. Exhibit 5 provides the

probabilities that a manager is exceptional depending on both the number of top quartile past/existing funds and the time between successive funds. For a given number of top-quartile funds, the probability that the manager is exceptional is higher the longer the cycle because these funds being more seasoned increases the likelihood that the superior performance will continue through fund liquidation. Two top quartile funds give a manager with a two-year investment cycle has a 41% chance of being exceptional while two top quartile funds give a manager with a four-year cycle a 64% chance.

Given a fixed number of years into a manager's career, however, the increased seasoning associated with a longer investment cycle is more than offset by having fewer funds to evaluate. Consider two managers, one with a two-year investment cycle and one with a four-year cycle, who are both consistently in the top return quartile. Eight years into their careers, a manager with a two-year cycle (four funds) has a much greater probability, 83%, of being exceptional than a manager with a four-year cycle (two funds, 64%).

c. Changing manager ability

A potentially serious shortcoming of the framework presented so far is the implicit assumption that managerial ability is static. While exceptional managers must be likely to stay exceptional for the label to have any meaning, it is plausible that changing conditions can cause an exceptional manager to become ordinary and vice-versa. Significant churn among the exceptional manager population would lower the information value associated with strong past performance.

However, all else equal churn among exceptional managers also lowers FP. Given $FP = 0.4$, churn's impact on the information imbedded in past performance is modest unless the churn rate is very high. Intuitively, performance persistence ($FP > 0.25$) requires that past performance

predict future manager ability. If the population of exceptional managers is very fluid over time (many currently exceptional managers become ordinary in their next fund), then the fraction of (currently) exceptional managers in the current top quartile, x , must be high enough to absorb the churn and still produce performance persistence. When managerial ability varies over time, a follow-on probability of 40% will imply that more than 58.5% of managers in the top return quartile are (currently) exceptional.

Suppose that a fraction p of the N currently exceptional managers become ordinary when they raise their next fund (which, in turn, implies that $p/3$ of the $3N$ ordinary managers become exceptional). Now the follow-on probability will reflect p , the churn rate, in addition to x , the fraction of managers in the top quartile that are exceptional. Consider our earlier 1,000-fund example, with $FP = 0.4$ (100 of the 250 funds that are top return quartile repeat in the top quartile in the next fund). Recall that 146 of the current top quartile funds can be expected to have an exceptional manager because when $FP = 0.4$, $x = 0.585$. Suppose that $p=0.2$, so that 20% of exceptional managers become ordinary (and 6.7% of ordinary managers become exceptional) in their next funds. Looking forward, this reduces the expected number of exceptional managers in the current top return quartile to 124 because 29 ($0.2*146$) of the exceptional managers become ordinary while seven ($0.067*104$) of the ordinary managers become exceptional.

However, exceptional managers making up 49.6% ($124/250$) of the top quartile going forward is inconsistent with a 40% follow-on probability ($x=0.496$ maps to $FP=33\%$). When there is 20% churn, (currently) exceptional managers must make up more than 58.5% of the top return quartile to maintain $FP = 0.4$. Specifically, with a churn rate of p

$$FP = (N*[x^2(1-p)+x(1-x)(p/3)] + N*[x(1-x)(p/3) + (1/3)(1-x)^2(1-p/3)])/N \quad (3)$$

Solving Equation (3) for x gives

$$x = [6-8p + [(8p-6)^2 - 4(12-16p)(3-p-9FP)]^{1/2}] / [2(12-16p)] , \quad (4)$$

which allows us to calculate the probability that a current top quartile fund has, at least for the moment, an exceptional manager given a specific churn rate.

In the 1,000-fund example above, with 20% churn rate and a 40% follow-on probability, $x = 0.642$. That is, there must be 160 (currently) exceptional managers in the top quartile (64.2% of the 250 funds). Looking forward, we expect 20% of the exceptional managers to become ordinary and 6.67% of the ordinary managers to become exceptional, changing the current top-quartile return group breakdown to $160 - 0.2*160 + 0.067*90 = 134$ exceptional managers and 116 ordinary managers. These 134 exceptional managers have a 64.2% chance of attaining the top return quartile in their next fund, while the 116 ordinary managers have an 11.9% chance, creating the follow-on probability of $(134*0.642 + 116*0.119)/250 = 40\%$.

Exhibit 6, which assumes $FP=0.4$ and a three-year investment cycle, shows that churn's impact on the information provided by past performance tends to be relatively modest until a large fraction of exceptional managers become ordinary in each fund cycle. The effect of churn is substantially mitigated by the fact that the model encompasses the observed 40% follow-on probability. As seen before, absent churn, a top quartile fund having a 40% chance of being followed by another top quartile fund requires that exceptional managers make up 58.5% of the top return quartile. If one-half of the currently-exceptional managers become ordinary in their next fund (a 50% churn rate), then 83% of top quartile funds must currently have exceptional managers for the follow-on probability to be 40%. The balance between p and x causes the

information provided by past performance to deteriorate less than one might imagine when managerial ability changes over time.

IV. Conclusion

Highly variable returns across private equity funds and performance persistence over time gives private equity limited partners a strong incentive to invest in the subsequent funds of past top performers. Because past performance is an indicator of ability, which influences future performance, this strategy can be thought of as an attempt to identify exceptional managers. In practice, limited partners may restrict their investments to managers with an extended track record of superior returns. There are, however, two challenges inherent to implementing this strategy. First, the evidence on return persistence suggests that it is not terribly strong. Research in private equity, for example, suggests that a top quartile fund has an approximately 40% chance of being followed by another top quartile fund, a probability that is far closer to random chance (25%) than perfect predictability (100%). While managerial ability matters, luck weakens the link between ability and both past and future performance.

Second, past performance is generally an incomplete and evolving picture. For example, private equity groups often raise subsequent funds before the previous funds' performance can be accurately measured. Today, for example, we may observe that good vintage-1995 funds tended to be followed by good vintage-1997 funds. But exploiting this for investment purposes required knowing in 1997 which of the vintage-1995 funds were good. Interim performance is a noisy signal of eventual performance, which is itself a noisy signal of future performance, compounding the challenge of identifying top private equity managers.

This paper constructs a framework to quantify what past performance can tell investors about managerial ability and likely future performance. Future returns depend in part on

managerial ability, with exceptional managers (the top quartile of ability) having better odds of strong performance (being in the top quartile of fund returns). Past performance becomes an increasingly good indicator of ability as funds mature and additional funds are raised. Good past performers are more likely to be good future performers. The challenge is to understand and quantify the relation.

If managerial ability is the underlying driver of performance persistence, the information that past performance provides about managerial ability must be related to the observed likelihood that top-quartile performance in one fund is followed by top-quartile performance in the next fund (the follow-on probability). This insight leads to a closed-form solution for the relation between the relative importance of managerial ability and performance persistence that can be used to infer the information provided by varying histories of superior performance given an observed follow-on probability.

Because the performance-ability link is concave, managerial ability plays a larger role in determining returns than observed performance persistence might seem to imply. That is, a 40% follow-on probability implies that a significantly higher fraction, almost 60%, of top quartile private equity funds owe their superior performance to ability (rather than to luck). However, the information provided by an early top-quartile ranking (within a few years of fund launch) is minimal. We estimate that two years into a private equity fund's life a top quartile rank reveals a 28.7% probability that the fund has an exceptional manager (compared to 25% in a randomly-selected fund). The probability remains below 40% after five years. Given that successive private equity funds are generally raised on a two- to four-year cycle, this makes inferring manager ability from past performance difficult.

Multiple funds, however, provide additional information about manager ability. A manager with three (interim) top-quartile funds raised in the past six years has a better than 60% chance of being exceptional, higher odds than a manager with a single fully-liquidated top-quartile fund, despite none of the three funds being more than six years old. Multiple top-quartile funds providing an increasingly precise signal of exceptional ability strengthens the case for judging manager ability based on past performance.

Manager ability varying over time (exceptional managers becoming ordinary and vice-versa) has a relatively modest impact on our estimates of the information conveyed by past performance. This stems from the fact that the model is tied to an observed (in private equity, roughly 40%) follow-on probability. While the possibility that an exceptional manager becomes ordinary reduces the link between current ability and future performance, it increases the inferred link between current ability and current performance. This partly offsets the noise introduced by (potentially) changing ability.

From a practical standpoint, this paper suggest that a combination of luck and unseasoned funds creates sufficient noise that at least three consecutive top-quartile private equity funds are necessary for limited partners to confidently (>80%) deem a manager exceptional. A more conservative limited partner might justifiably demand four top-quartile funds before investing, particularly when a fund has a relatively short investment cycle.

While our results suggest that investing with top past performers would produce high returns, this strategy has implementation issues. Because bad luck can prevent an exceptional manager from generating a string of top quartile funds, the strategy produces a relatively small number of qualified funds. Managers with three top-quartile private equity funds in nine years (a three-year investment cycle) have a better than 80% chance of being exceptional. While this

group is a very good bet, is also small, roughly 10% of all funds, and represents a minority, 40%, of all exceptional managers. Presumably other potential limited partners recognize three past top quartile funds as a sign of (likely) exceptional managers and also wish to invest. If so, new investors in the later funds of top-quartile performers may find it difficult to obtain a significant allocation. For allocations to be available to new investors, the size of the fund may need to grow to a level inconsistent with the original strategy that generated the superior past returns. If so, this could create a severe adverse selection problem for investors pursuing strong past performance.

Our model shows that screens based on past performance can be very accurate and avoid virtually all ordinary managers. The cost of this precision is that the number of funds that pass the screen becomes diminishingly small: in our model less than 1% of all funds can be expected to offer past performance consistent with 99% confidence that the manager is exceptional, despite the fact that 25% of funds have exceptional managers. In statistical terms, strict past performance screens minimize the number of type I errors (ordinary managers deemed to be exceptional) at the cost of many type II errors (exceptional managers deemed to be ordinary), exacerbating the difficulty of using these screens to allocate large amounts of capital.

While this paper suggests that superior past performance is a good indicator, on average, of both exceptional managers and a high likelihood of strong future performance, investment strategies that rely on performance persistence may fail to achieve their objectives. Past performance is recognized as an important signal of manager ability, and widely recognized investment strategies rarely provide an edge. Investors may be better served by working to develop more sophisticated measures (see, for example, Surz [2006]) than past quartile rankings to promptly and accurately identify exceptional managers. It seems likely that there are better

opportunities to invest with the 10-24% of exceptional (but unlucky) managers that fail strict past performance screens than the 1-10% that pass.

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Exhibit 1: The dispersion of private equity returns

Private equity internal rates of return (IRR), by vintage 1984-2004, based on Private Equity Intelligence data. The top and bottom of the vertical lines show the 25th and 75th IRR percentiles, respectively, while the dot shows the median annualized return for each vintage through year-end 2006.

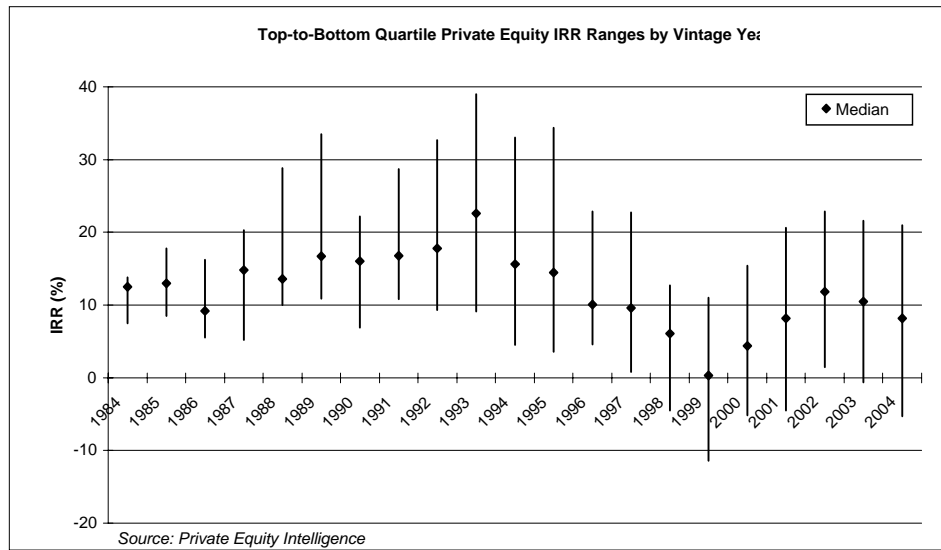


Exhibit 2: Manager ability and top-quartile performance persistence

The follow-on probabilities – the probability that a top return quartile fund is followed by another top quartile fund – associated with different probabilities that an exceptional manager attains the top return quartile.

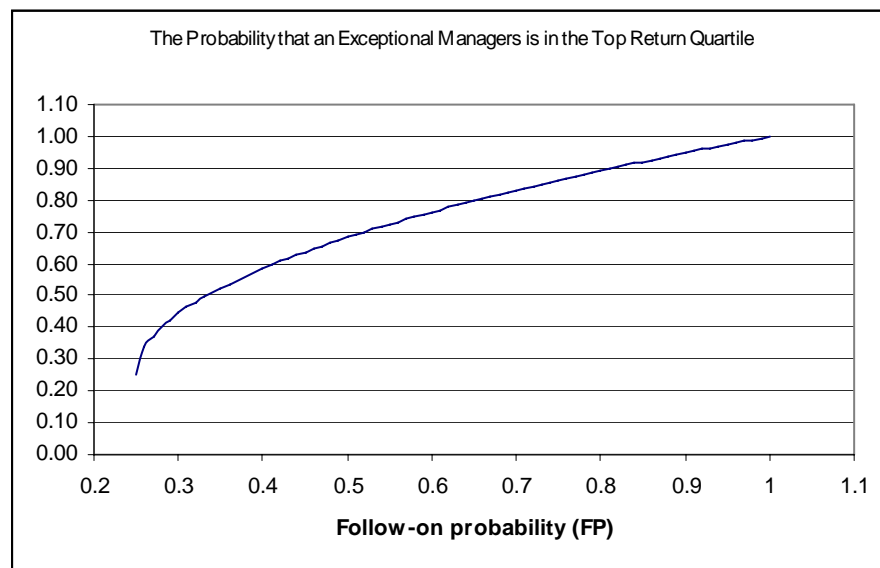


Exhibit 3: The information content of interim top quartile rankings

Years into the vintage	Assumed probability that a top quartile fund (at this point) finishes top quartile	Venture Economics probabilities (Investment Benchmarks 2000)*
1	25%	26%
2	33%	36%
3	42%	47%
4	50%	54%
5	58%	66%
6	67%	74%
7	75%	77%
8	83%	90%
9	92%	93%
10	100%	100%

* Venture Economics' 2000 Investment Benchmarks Report: Venture Capital (page 215, Figure 5.06)

Exhibit 4: The (interim) top return quartile as a vintage matures

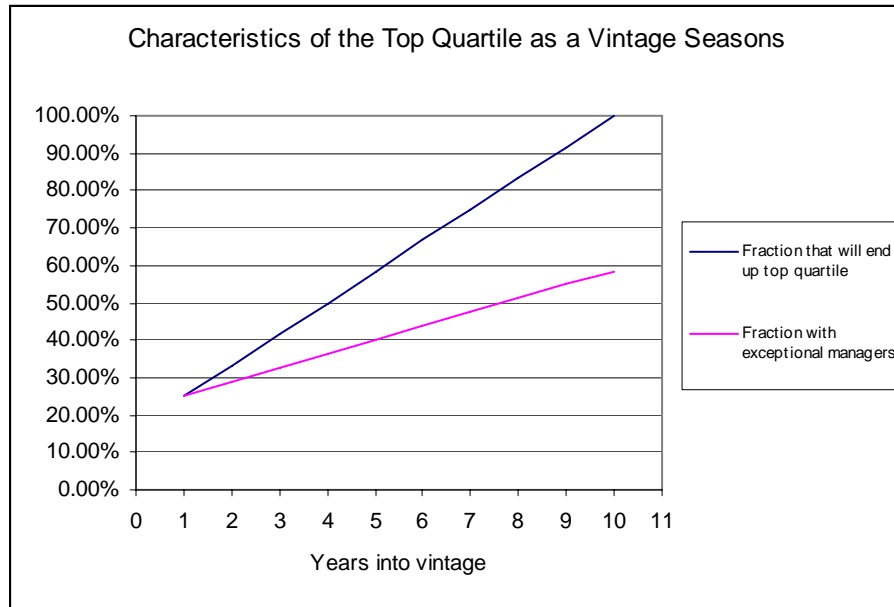


Exhibit 5: Track record and manager ability

The probability that a manager is exceptional given different investment cycles and track records.

Number of past top quartile funds	Probability that a manager is exceptional		
	2-yr cycle	3-yr cycle	4-yr cycle
0	25%	25%	25%
1	29%	33%	36%
2	41%	53%	64%
3	61%	80%	88%
4	83%	95%	97%
5	96%	99%	99%

Exhibit 6: Track record, churn rates, and the probability that a follow-on fund has an exceptional manager.

Churn rates define the fraction of exceptional managers that become ordinary in their next fund.

		Percentage of exceptional managers that become ordinary each fund cycle (churn rate)					
		0%	10%	20%	30%	40%	50%
Past funds observed	In the top quartile	Probability that a manager will be exceptional in their next fund					
1		33%	32%	31%	31%	30%	29%
2		53%	51%	49%	46%	44%	41%
3		80%	78%	74%	71%	66%	60%
4		95%	93%	91%	88%	84%	78%
5		99%	98%	97%	96%	94%	90%