What Drives Private Equity Fund Performance?

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Abstract

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Abstract

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The activities of private equity funds have recently received considerable attention due, primarily, to two factors. First, the amount of capital committed to US private equity funds has grown from $5 billion in 1980 to $300 billion in 2004, totaling over $1 trillion over the last 25 years (Lerner et al., 2004). Second, it has been extensively argued that fund managers play an important strategic role in the companies they finance (e.g. Lerner, 1995, Hellmann, 1998, and Hellmann and Puri, 2002).

Given the importance of private equity both as an investment vehicle and as a catalyst for economic growth, the need for a comprehensive assessment of the risk profile of this industry is apparent. In a review paper, Gompers and Lerner (2001) classify the understanding of risk and return as "what we don't know about venture capital," a statement that is also true for buyout investments.[1]

Getting insight into the risk profile of private equity funds as well as the other drivers of their performance is the objective of this paper. We believe that this endeavor is not only interesting per se (e.g. for portfolio allocation) but also interesting in light of recent research that reports that private equity funds have a relatively low performance. For example, Kaplan and Schoar (2005) show that, in their sample, private equity funds have a performance that is close to the performance of the S&P 500. This is puzzling as the bulk of the money of private equity funds is invested in leveraged buyouts, which are typically significantly more levered than the S&P 500. This should result in a sizeable premium for buyout investments. The rest of the money is invested mainly in venture capital, which might also command a premium over the S&P 500 due to betas likely higher than one. Furthermore, Phalippou and Zollo (2005) show that the sample selected by Kaplan and Schoar (2005) includes superior funds and that the realized aggregated performance of private equity funds is actually significantly below that of the S&P 500. Such results prompt the following questions: what are the characteristics of the funds that under-perform? Do funds exhibit risk and hedging characteristics that would make the above performance estimate fair?

Using a unique and comprehensive dataset containing information on cash flows to/from investors and the investments made by about 700 private equity funds, this paper addresses these two related questions by investigating what are the drivers of private equity fund performance.

To evaluate the influence of business cycles and stock-market cycles on performance, we first construct a proxy for the CAPM-beta of funds. We use the information on the

industry in which funds invest and the type of investment they make (venture capital versus buyout) to compute a beta for each investment based on the matching industry betas and making appropriate leverage assumptions. The investment betas are then aggregated at the fund level to obtain a beta for each fund. These fund betas are found to be about 1.6 and we do not find a statistically significant relation between fund beta and fund performance.

Second, we assess how macroeconomic conditions at the time of investments, during the life of investments, and at the exit of investments relate to fund performance. Irrespective of the proxies we use, we find that private equity fund performance is significantly pro-cyclical. Performance significantly increases with the average GDP growth rate and decreases with the average level of interest rates – in particular corporate bond yields – that prevailed during the life of the investments. Moreover, macroeconomic conditions are found particularly important at the time investments are made. When either credit spreads or corporate bond yields are low at the time investments are made, fund performance is higher.

Third, returns on public stock-markets strongly influence fund performance. We find that performance significantly increases with both the average return on the stock-market (CRSP-VW index) and the average return on the call options written on the S&P composite index that occurred during the life of the investments. This shows that like hedge funds, private equity funds exhibit tail risk, i.e. non-linear systematic risk (see Agarwal and Naik, 2004).

When the effects of the stock-market and macroeconomic variables are compared to one another, we find that the two dominant variables are the level of corporate bond yields at the time investments are made and the level of the stock-market returns that prevail during the life of investments. These findings show that private equity fund performance is pro-cyclical and, therefore, makes the "performance puzzle" even greater.

Our dataset also enables us to study the other drivers of fund performance. First, we further test the hypothesis of Jones and Rhodes-Kropf (2003) according to which idiosyncratic risk should be priced for private equity funds. We do not find strong support for this hypothesis. The only exception is when we measure idiosyncratic risk by the Herfindahl index for industry concentration (of investments). However, we note that the effect is driven by the amount invested in high-tech industries. Second, consistent with widespread belief, small and inexperienced funds have significantly lower performance. Funds that invest more outside the US and in venture capital also witness a lower performance but it is not

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[1] Note that real estate and entrepreneurial investments in non-public companies are also sometimes called

statistically significant. The question is then why certain investors buy small and inexperienced funds and the answer could be that these funds are the only ones accessible to less sophisticated investors or that they are those with highest potential side-benefits for investors (e.g. to establish a commercial relationship) or both.

The paper continues as follows: section 1 reviews the literature, section 2 describes the data, section 3 is dedicated to systematic risk, section 4 focuses on exposure to macroeconomic conditions, section 5 investigates the pricing of idiosyncratic risk, section 6 reports the relation between fund characteristics and performance and section 7 briefly concludes.

I. Risk and Return of Private Equity Investments

A. The private equity industry (see Appendix A.I for details)

Private equity investors are principally institutional investors such as endowments and pension funds. These investors, called Limited Partners (LPs), commit a certain amount of capital to private equity funds, which are run by General Partners (GPs). GPs search out investments and tend to specialize in either venture capital (VC) investments or buyout (BO) investments. In general, when a GP identifies an investment opportunity, it "calls" money from its LPs. When the investment is liquidated, the GP distributes the proceeds to its LPs. The timing of these cash flows is typically unknown *ex ante*.

B. Literature review

We can divide the literature on risk-return of private equity investments into two sets of studies. The first, and most extensive set, documents the (gross-of-fees) performance of individual venture capital investments of GPs. The second set focuses on the cash-flow stream from (*to*) the private equity funds to (*from*) LPs, which includes fee payments and, importantly, contains both buyout investments and venture capital investments. They thus measure the net performance obtained by LPs who invest in private equity funds.

B.1. Performance of individual venture capital investments of GPs

Peng (2001), Quigley and Woodward (2003), and Woodward and Hall (2003) compute a VC index and derive the correlation between this index and a public stockmarket index. The index is built from discretely observed valuations (new financing round, IPOs, acquisitions,

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private equity. In this paper, we consider only buyout funds and venture capital funds.

or liquidation).[2] With similar observations, Cochrane (2005) assumes that the change in the log of the company's valuation follows a log-CAPM and models selection bias explicitly by assuming that the probability of observing a new round follows a logistic function of firm value. Using a maximum likelihood approach, the alpha and beta of the log-CAPM that are most consistent with these observations are then derived.[3]

The results of these studies vary substantially. Quigley and Woodward (2003) finds gross real returns of about 5% per quarter, which is less than the S&P 500 and the Nasdaq over the same period, but find a beta close to 0. Woodward and Hall (2003) estimate that average performance is 20% per year, abnormal performance is 8.5% per year, and beta is 0.86. Peng (2001) finds an average return of 55% per annum (1987-1999) and estimated beta ranges from 0.8 to 4.7. Finally, Cochrane (2005) reports a 59% annual average (arithmetic) gross return, a corresponding alpha of 32% and a beta below 1.

B.2. Net performance of private equity funds (LP perspective)

Four fund-level studies have been conducted to our knowledge, beginning with Gompers and Lerner's (1997) pioneering work. This study examines the risk-adjusted performance of a single fund group (Warburg Pincus) by marking-to-market each investment, in order to obtain the fund's quarterly market value. The resulting time series of portfolio value is regressed on asset pricing factors, giving a performance "alpha" and "beta" for that fund. Second, Kaplan and Schoar (2005) find that the main drivers of performance are past fund performance (i.e. there is persistence) and fund size. The third study, by Jones and Rhodes-Kropf (2003), argues that idiosyncratic risk should be (and is empirically) related to fund returns. The last of the four studies, by Ljungqvist and Richardson (2003), focuses on the determinants of the speed of the draw-downs and capital distributions. They estimate betas of 73 funds by employing a four-step procedure similar to what we use in this paper. First, they identify each portfolio company held by a fund. Second, given this identification, they assign portfolio companies to one industry group. Third, assuming that the leverage of the private company coincides with that of the industry, they assign the industry beta to the portfolio company. Fourth, they compute the average equity beta of the fund using the capital disbursements as weights.

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[2] The main challenge faced by these studies is that in the majority of cases, they observe performance only when the investment was successful. Accounting for such selection bias is difficult as successful investments account for a mere quarter of the total number of observations.
[3] Cummings and Walz (2004) also offers an estimate of investment-level returns, focusing on how the legal environment influences performance.

Our study falls in this second set of studies and uses the most comprehensive dataset to date in that we have both the link between fund cash flows and fund investments like Ljungqvist and Richardson (2003) and a large cross-section of funds like Kaplan and Schoar (2005). We can thus apply the four-step estimation of fund betas described above to a large number of funds (700 funds). In addition, this paper is the first to our knowledge to focus on how macroeconomic conditions influence performance and whether there is evidence of non-linear risk factors (e.g. right tail risk).

II. Data

In this section, we detail our data sources, our sample selection scheme, and our performance estimate. We also offer descriptive statistics about the characteristics of private equity funds and their investments.

A. Data sources

In this study, we use several sources of data. Data on both Treasury bill rates and stock performance are from CRSP (via WRDS). Data on corporate bond yields are from the Federal Reserve Bank of Saint Louis. Data on private equity funds have been obtained from two datasets maintained by Thomson Venture Economics. These datasets cover funds raised from 1980 to 2003. Venture Economics records the amount and date of all cash flows as well as the aggregate quarterly book value of all unrealized investments for each fund until December 2003 (residual values). Cash flows are net of fees as they include all fee payments to the General Partners (GPs, or fund managers), and distributions are reduced by the carried interest and other charges. Throughout the text we refer to this dataset as the "cash-flow" dataset. Venture Economics also collects information on fund investments through its Vxpert database. The unique feature of our dataset is that Venture Economics have provided us with identifiers that link the two datasets. This way, we know the investments and the cash flows for a large cross section of funds. Details about these databases as well as certain corrections that we undertake are provided in the appendix A.

B. Sample selection and treatment of residual values

Until a fund is entirely liquidated, the existence of non-exited investments prevents a precise estimation of fund performance as neither the fund nor its underlying investments are publicly traded. The unique assessment of the value of non-exited investments is the accounting value that is reported quarterly by funds. However, these accounting valuations

are unreliable.[4] A solution proposed by Kaplan and Schoar (2005) is to focus on a sample of quasi-liquidated funds. In such a sample, the treatment of accounting values has a reduced impact but the sample might not be representative. As our dataset allows us to correct partially for sample selection biases (see below), we follow Kaplan and Schoar (2005) in that we select a sample of quasi-liquidated funds (i.e. raised between 1980 and 1996 and is either officially liquidated or have not reported any cash-flow over the last two years.)

In addition, certain funds in this sample have implausibly high residual values (so-called 'living-deads'). Hence, we write-off the residual values of officially liquidated funds and funds that do not have any cash flow reported over the last four years (and are raised before 1993). For the other funds, we assume that their residual values (reported at the end of December 2003) equal the present value of their future cash-flow streams.

Finally, we use the profitability index (PI) as a performance measure. PI equals the present value of cash inflows divided by the present value of cash outflows. As we use the return of the S&P 500 to discount both cash flows, a PI above 1 indicates a better performance than the S&P 500 index.

Table 1

An additional selection requirement for funds to be included in our study is that they have information about at least four investments. We count 705 funds that satisfy these criteria out of the 2844 funds raised between 1980 and 1996. Table 1 reports our sample characteristics. Generally, the descriptive statistics are similar to those reported in the literature (see Kaplan and Schoar, 2005). Venture funds are significantly smaller than buyout funds, with an average invested capital of $48 million for venture funds compared to $225 million for buyout funds. Moreover, reflecting the fact that the private equity industry is young and rather inexperienced, over one third of the funds in our database are first-time funds (i.e. they are the first fund raised by the parent firm). Our sample appears to over-represent both large funds and venture capital funds and to under-represent first-time funds.

Performance data are also similar to what is reported in the literature. If we do *not* correct for sample selection bias, value-weight by deflated capital committed and eliminate 'living-deads', private equity funds in our sample have an average PI of 1.02 for buyout

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[4] The US National Venture Capital Association proposed certain mark-to-market guidelines for the valuation of PE fund investment in 1989 which have become a quasi-standard for the industry since then. Nevertheless, the discussion in the PE industry about appropriate rules for the valuation of unrealized investments is ongoing and accounting practices vary to the point that LPs sometimes receive significantly different valuations from different GPs who jointly invest in the same company. In general, however, the accounting value of a deal stays equal to the amount invested in that deal. Interested readers may refer to Blaydon and Horvath (2002, 2003) for a detailed discussion of accounting practices.

funds and 1.07 for venture capital funds, indicating a slight outperformance with respect to the S&P 500.[5]

<center>Table 2</center>

The fact that our sample is not representative of the universe is confirmed by a Probit regression (Table 2). The dependant variable is a dummy variable that takes the value one if the fund is included in the sample and zero otherwise. From this regression, we deduce the lambda of each fund, which reflects the likelihood of a fund to be selected in the sample. This vector of lambda is added to all the regressions in this paper to control for the fact that our sample of analysis is not representative of the universe but rather is biased toward a certain type of funds (see Greene, 2003, for details on Heckit regression and Cumming and Walz, 2004, for an application in a private equity context).

<center>Table 3</center>

We now turn to the description of investments, which is reported in Table 3. We find that venture funds have almost twice as many investments as buyout funds. Venture funds invest in 28 (22) companies on average (median) and buyout funds in 17 (11) companies for an average period of almost five years for venture capital deals and four years for buyout deals. These figures are consistent with the findings of Gompers and Lerner (1999) for a different sample: they note that venture funds typically invest in two dozen firms over about three years.

Several important elements are worth mentioning. First, we find that venture funds have 9% of their investments on average in buyouts and that as much as 18% of the investments of buyout funds are on average in venture deals. This indicates that a few funds in each category (and more so among buyout funds) are diversified across deal types. Consequently, care should be taken when interpreting differences in the behavior of funds according to their objectives (buyout versus venture capital). Second, the industry focus is very similar for both venture funds and buyout funds as they both concentrate 40% of their portfolio in one industry (out of 48 industry categories). Funds thus appear to be fairly specialized. Third, and finally, more than half of the deals undertaken by venture funds are in high-technology industries (in terms of value).

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[5] If we correct for sample selection bias, this average performance estimate is dramatically reduced and both venture capital funds and buyout funds underperform significantly.

III. Systematic Risk

A first driver of performance should be, in theory, the amount of systematic risk carried by funds. In this section, we propose a methodology to assess the CAPM-beta of private equity funds along the lines of Kaplan and Ruback (1995) and Ljungqvist and Richardson (2003).

Were private equity investments continuously traded, it is likely they would have relatively high betas; the reason being that buyout investments have a high level of debt and venture investments are made in small firms that typically belong to high-beta industries. To obtain an order of magnitude, we compute, for each fund, the average beta of its investments. Importantly, this average investment beta is not the same as the fund beta, but rather is a proxy for fund beta.

We assume that the CAPM holds and that the betas on asset are the same inside a given industry.[6] By making further assumptions regarding the leverage of the deals we can assess the beta of each investment made by GPs. The methodology that we follow is basically what is proposed by Kaplan and Ruback (1995) and Ljungqvist and Richardson (2003); construction details are presented in the appendix B. The fundamental idea is to compute the beta on asset that prevails in each industry, assign it to each private equity investment made in this industry, and lever it up as a function of the deal type (venture capital or buyout). The betas are then averaged for each fund. Given our assumptions, note that variations in betas reflect a combination of the riskyness of the industry in which funds invest, the type of investments made and the time duration of each investment. To compute betas, we assume that the leverage of buyouts decreases linearly over time from a debt-to-equity ratio of 3 (at entry) down to the leverage that prevails in the industry (at exit). The beta on debt is assumed to be 0.25 and the beta for venture deals is assumed to be the same as the beta of the 20%-smallest stocks in the corresponding industry. Importantly, stock betas are computed using Dimson's correction. The choice of the beta on debt is based on Cornell and Green (1991), who evaluate the beta for high-grade debt (from 1977 to 1989). The choice of equity-to-debt ratio is based on Cotter and Peck (2001) and on Lerner et al. (2004), who argue that a 3:1 debt-to-equity ratio for buyouts is rather typical (though slightly conservative).[7]

Table 4

The average estimated betas are reported in Table 4. We document how betas differ between venture funds and buyout funds and between large funds and small funds. The

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[6] Note that here, and throughout this paper, we do not separate US and EU funds. We use US only benchmarks: market portfolio and industry. Such a convention has little impact on our results.

average beta of buyout funds is 1.7 and is similar to the average beta of venture funds, which is 1.6. Similarly, small funds have an average beta of 1.65 and large funds have an average beta of 1.56. We also report how these estimates change as we modify our assumptions about buyout leverage. We observe little overall effect. The beta of buyout funds, however, doubles when we use (for the entire length of the investment) a debt-to-equity ratio of 3 instead of the industry average, which are the two most extreme assumptions one can make about leverage.

When we relate beta to performance, we find a positive but not statistically significant relation [unreported results]. This result holds irrespective of both the control variables that we use and our leverage assumptions. This result might not appear very surprising given that the relation between stock-beta and stock performance has also been found weak.

To summarize, in a CAPM framework, the beta of private equity funds is expected to be substantially higher than 1. Hence the existing estimates of fund performance (e.g. Kaplan and Schoar, 2005) are optimistic as they assume that fund beta is 1. Moreover, systematic risk does not appear to be a driver of fund performance.

IV. Fund exposure to macroeconomic conditions

In this section, we attempt to investigate how business cycles and stock-market cycles influence fund performance. Using available data about the underlying investments of funds, we can compute the exposure of each fund to several factors. Construction details are given in the appendix B, but the idea is straightforward. Assume that we want to know the influence on performance of the level of credit spreads that prevails during the life of the investments. As we know when a given investment starts and finishes, we can compute the (time-series) average level of credit spreads that prevails during the life of this investment. Let us denote it TSAcs(i) for each investment *i*. Then, we compute the (cross-sectional) average of TSAcs(i) across all the investments *i* of a given fund *f*, resulting in Acs(f). Acs(f) is labeled 'fund loading on credit spreads'. Indeed, if a fund invests mainly during times when credit spreads are high then its 'loading on credit spreads' will be high. Finally, by running a cross-sectional regression of fund performance on the vector of Acs(f), we assess the exposure/sensitivity of fund performance to the level of credit spreads.

We compute the exposure to variables that are related to both business cycles and public stock-markets: real GDP growth rate, BAA-bond yields, credit spreads, market portfolio performance, and option-based risk factors. All these variables are taken at a

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[7] Leverage in buyouts has decreased over time. From 95% debt - 5% equity in the 80s down to 70% debt – 30%

quarterly frequency. Yields of Corporate-BAA bonds as reported by Moody's reflect the cost of debt for buyout investments. Credit spread is the difference between the yield on the corporate-BAA bonds and the 10-year treasury bonds. This variable captures both the probability of default and the expected recovery in case of default in the economy, which is important for the cost of financing buyouts. Importantly, both credit spreads and bond yields also capture certain dimensions of business cycles that are relevant for both venture and buyout investments. Times of high credit spread and high bond yields typically correspond to down economic times (i.e. times with low free cash-flows), especially for small and innovative firms. The market portfolio loading aims at assessing the impact of investing in periods of high stock-market performance. Finally, the option-based risk factors consist of out-of-the-money European call and put options on the S&P 500 composite index traded on the Chicago Mercantile Exchange. These option-based factors are proposed by Agarwal and Naik (2004), who argue that it is important to take into account option-like features to evaluate the risk of hedge funds.[8] In the context of private equity, both venture and buyout investments are likely to have an option-like payoff: buyout investments as they are highly levered and venture investments as they are carried up by stages with, each time, a target market value beyond which there is a new round of financing. This point is emphasized by Cochrane (2005) who states that "venture capital investments are like options; they have a small chance of a huge payoff." This type of payoff is expected to resemble the payoff of a call option.

Finally, we compute both the average earning-to-price ratio (price multiples) and the state of the IPO market that prevails (amount of equity issued) in the year when investments are *exited*. Similarly, we compute both the average yields of Corporate-BAA bonds and the average credit spread that prevail when investments are made (i.e. *at entry*). These indicators being related to the valuation of firms at entry and exit, they may play an important role for performance.

Table 5

In Table 5, we report how these loadings relate to performance. In order to compare the economic importance of each loading, variables are standardized by subtracting their sample mean and dividing by their sample standard deviation (i.e. each variable is expressed in terms of z-score). Each regression includes a correction variable (vector of lambdas, see

Greene 2003 for details about Heckit regressions) to account for a potential sample selection bias.

As these loadings have a high correlation among one another, we first report their statistical and economic significance one at a time. The signs of each proxy always indicate that private equity funds offer pro-cyclical performance. Private equity funds that entered investments at time when interest rates and credit spreads were high underperform. Performance increases substantially when investments take place during times of high GDP growth, high public market performance, high return for call options, and low returns on put options. The exit variables are not statistically significant unlike entry variables. Among entry variables, the yield on risky corporate bonds (rated BAA) is the most important variable. In Panel C, we show that this variable remains significant irrespective of the other variables we add in the regression. It appears that the two most significant variables are the yield on risky corporate bonds at the time of investment and the average stock-market return during the life of the investment.

The significance of the public stock-market return is slightly superior to the significance of the call option return. The two variables are however highly positively correlated and both are highly significant when we control for corporate bond yields at entry. The result of the call option return is particularly interesting because this factor has also been found significantly related to hedge fund performance by Agarwal and Naik (2004). It shows that, like hedge funds, private equity funds bear significant right-tail risk. That is, the performance is mainly realized when the public stock-market has high returns. If the public stock-market return is below a certain threshold then private equity performance is very low irrespective of how low public stock-market returns are.

V. The pricing of Idiosyncratic risk

Jones and Rhodes-Kropf (2003) point out that GPs are forced to hold considerable idiosyncratic risk and that idiosyncratic risk should be an important determinant of performance. Consequently, it is important to include measures of idiosyncratic risk among explanatory variables for fund performance. In addition, a unique feature of our dataset allows us to shed further light on the results uncovered by Jones and Rhodes-Kropf (2003).

Jones and Rhodes-Kropf (2003) propose a model whereby more idiosyncratic risk should be associated with higher returns, in equilibrium. The idea is that investors want GPs

to specialize so that they have higher performance.[9] In equilibrium, GPs obtain a compensation that increases with the amount of idiosyncratic risk and "all else equal, the return received by the investors is increasing in the amount of realized idiosyncratic risk, even though they face competitive market conditions" (their theorem 4). To test this implication they argue that a reasonable proxy for idiosyncratic risk is the number of investments that a fund makes. In the absence of this information they use the number of take-downs. Our dataset, in contrast, enables us to use directly the number of investments and, in addition, to construct several proxies that capture more closely the spirit of their model. In addition to the number of take-downs and of investments, we then construct the proportion invested in the dominant industry and use Herfindahl indices for type and industry concentration based on the number of investments across deal type (venture deals vs buyout deals) and across 48 industries.[10]

Table 6

Results are reported in Table 6. Unlike Jones and Rhodes-Kropf, we find a positive relation between take-downs and performance as well as between the number of investments and performance. Nonetheless, the industry Herfindahl is significantly positively related to performance. The Herfindahl based on the type of deals is also positively related to performance but not significantly so.[11] However, we note that when we control for the fraction invested in high-tech industries, this effect vanishes.[12] We therefore do not find evidence that idiosyncratic risk is priced in our sample.

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[9] Being focused enables GPs to work with smaller and more specialized teams that may learn faster via a high number of similar deals. An additional benefit is that GPs build tight links with the industry which may improve performance. It may also happen that unskilled managers diversify because they have failed in a certain type of deal and thus try something different or are forced to change (e.g. a manager that ends up with a couple of BO in bankruptcy may not have access to the debt market anymore). Finally, there is casual evidence (Lerner et al., 2004) that several funds have invested in a country, industry, or private equity type that is different to their stated objective in order to have a track record in that investment category and then raise a new fund in that category. In other words, GPs have an incentive to build their reputations at the expense of LPs. Interestingly, we note that, nowadays, most contracts explicitly limit this type of behavior.

[10] The 48 industries are as defined in Fama and French (1997).

[11] Note that a similar result is reported by Gompers and Lerner (2002, chap. 5). They find that companies that are funded by corporate investors that have a well-defined strategic focus enjoy greater success.

[12] Industry groups are defined as follows. Health comprises three Fama French (1997) industries: healthcare, medical equipment, and pharmaceutical products. High-tech comprises four Fama French (1997) industries: electrical equipment, telecommunications, computers, and electronic equipment.

VI. Fund characteristics and fund performance

We now focus on the characteristics that are related to performance. The main goal here is to characterize the type of funds that underperform in order to better understand the source of the documented low fund performance (Kaplan and Schoar, 2005, and Phalippou and Zollo, 2005).

To begin with, we include fund size and fund size squared. Size is an important characteristic that captures several performance-related dimensions such as reputation, economies of scale, and learning. Indeed, a larger fund may learn faster as it makes more deals than a smaller fund. An often-invoked downside of running a large fund is, however, that it increases the difficulty of finding enough good deals.

We also include as explanatory variable the proportion invested outside the US as Kaplan *et al.* (2003) and Hege *et al.* (2003) document that certain European private equity investments have lead to very poor performance. They advance various reasons for this, such as a wrong type of contract used and institutional differences. In addition, the private equity industry outside the US is younger and thus at a lower point in the learning curve.

Gompers and Lerner (1999) and Kaplan and Schoar (2005) find that performance depends on the fund sequence number.[13] We thus include this variable as well. We also include the proportion invested in venture capital and the average length of the investments. As Lerner *et al.* (2004) report that certain private equity funds rush young firms to the public market place to demonstrate a successful track record, we expect the loading on investment length to be negative. On the other hand, long duration for investments might signal living-deads and thus predicts lower performance. Finally, we include the amount of capital committed in a given year as Gompers and Lerner (2000) find that, in their sample, this proxy for the amount of "money chasing deals" negatively impact fund performance. Importantly, each estimation, unlike in the previous literature, is executed using a sample selection correction factor.[14]

Table 7

Results are reported in Table 7. Unlike previous literature, we do not find evidence of a concave relationship between performance and fund size but do find a positive relation between size and performance as in Kaplan and Schoar (2005). Neither do we find evidence

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[13] Fund families raise one fund at a time. The first fund ever raised by a given fund family is assigned a sequence number of 1, the second fund is assigned a sequence number of 2 etc.

[14] This so-called lambda is derived from the Probit estimation reported in Table 3 (see Greene, 2003, for details)

of a "money chasing deals" effect.[15] This finding is not only driven by sample correction but also by the choice of control variables and the treatment of residual values in our performance measure.

We confirm the importance of family experience for fund performance as measured by fund sequence. This effect is of considerable magnitude and in line with what Gompers and Lerner (1999) and Kaplan and Schoar (2005) report for different samples. Fund sequence appears as the best determinant of fund performance. The next best explanatory variable is the fraction invested in high-technology industries. Likely, funds raised before 1996 (our sample) that have invested in high-tech industries have benefited from the buoyant IPO market of the late 90s. Finally, we note that funds that keep their investments longer tend to have lower performance.

Overall, we find six key determinants of fund performance: the level of corporate bond yield at the time of investments, the return of the public stock-market during the life of investments, the length of investments (between start and exit), the size of the fund and the experience of the fund family. These six variables explain 11% of the cross-sectional variation in fund performance.

VII. Conclusion

Many institutional investors invest heavily in private equity funds based on the belief that returns are largely uncorrelated with market returns. For example, Lerner et al. (2004) report that Yale endowment fund, one of the largest investor in private equity funds, believe that private equity funds can "generate incremental returns independent of how the broader markets were performing." This paper shows that, in reality, the performance of private equity funds is pro-cyclical as it positively co-varies with both the business cycles and public stock-markets. In addition, this paper points toward small and inexperienced funds as the main drivers of the documented low performance of private equity funds.

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[15] We note, however, that capital committed in a given year is not a precise measure of the money chasing deals as the capital committed in the previous years that is not invested yet is also chasing deals.

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Appendix A: Industry description and datasets

A.I. Industry description

A brief description of the industry is offered in this appendix. For a more detailed description, we advise interested readers to refer to Lerner *et al.* (2004) and Gompers and Lerner (2002).

Private Equity funds are typically structured as limited liability partnerships in which a specialized Private Equity firm serves as the general partner (GP) and institutional investors or high-net-worth individuals provide the majority of capital as limited partners (LP). Most Private Equity funds are closed-end funds with a finite life of 10 or 12 years, which may be extended with the consent of the majority of the shareholders (Gompers and Lerner, 1999). During this period, the GP undertakes investments of various types (e.g. venture capital, bridge financing, expansion capital, leveraged buyouts), with the obligation to liquidate all investments and return the proceeds to the investors by the end of the fund's life. A minority of funds, so-called "evergreen" funds have an infinite life and no obligation to liquidate their positions.

At the time of the fund's inception, LPs commit to a percentage of total fund size. In the first years of the fund life (typically the six first years), the GP makes capital calls (or take-downs) to LPs whenever it finds an investment opportunity. Typically, within two weeks, LPs have to provide the corresponding cash. The total amount of such "capital calls" can exceed the capital committed at the fund's birth, but this is relatively rare. In fact, it is more common for a fund to liquidate without having invested all the capital committed.

Whenever a fund receives returns on its investments, proceeds are proportionally distributed to LPs, net of fees and so-called "carried interest". These distributions can be in form of cash or shares (common, preferred, or convertibles). GP receives compensation in varying forms. A fixed component, a yearly management fee (between 1% and 3%) of the total committed capital is charged to LPs. In addition, GPs can receive fees for each transaction performed (fixed or as a percentage of deal value) and participates in the fund returns through "carried interest" which often specifies that 20% of all net gains (or gains beyond a certain "hurdle rate") accrue to the GP whilst the rest is distributed among LPs.

PE firms often manage several funds, raising a new fund three to five years after the closing of the fundraising process for the previous fund. Note also that some PE funds are structured as non-partnership captive or semi-captive vehicles with one dominant (or exclusive) LP. This is mainly the case with funds that are managed by subsidiaries of large insurance companies or banks that invest the parent company's money.

A.II. VentureXpert content and corrections

Venture Economics' Private Equity Performance Database (also called cash-flow dataset in the text) is the most comprehensive source of financial performance of both US and European Private Equity funds and has been used in previous studies (e.g., Kaplan and Schoar, 2005). It covers about 88% of venture funds and 50% of buyout funds in terms of capital committed. In terms of number of funds, it offers cash-flow series for about 40% of both Europe funds and US funds. Venture Economics builds and maintains this dataset based on voluntarily reported information about cash flows between GPs and LPs in Private Equity funds. Venture Economics obtains and crosschecks information from both GPs and LPs, which increases the reliability of this dataset. Finally, the aggregate residual values of unrealized investments (*i.e.*, non-exited investments) are obtained from audited financial reports of the partnership.

Venture Economics makes certain simplifying assumptions about cash flows. First, cash flows are assumed to take place at the end of the month. Second, stock distributions are valued based on the closing market price the day of distribution to LPs. In the case of an IPO, GPs have to hold on to the stock until the end of the lockup period. After this date, however,

they have some flexibility regarding when to distribute the stock to the LPs. In addition, the valuation at the time of stock distribution to LPs differ from the value of actual realizations by LPs, as LPs may hold the shares for a while and may face substantial transaction costs (mainly via the price impact of their trade).

For each fund, Venture Economics collects information on underlying investments through its VentureXpert database, starting from 1980 (Vxpert in the text). This database contains information on Private Equity investments in 29 739 companies. Several of these investments have received funding at different points in time (e.g. subsequent rounds in VC investments) and by different private equity funds, so that the total number of investments amounts to 134 641. Data on investments include information about the target company (location, industry description, age), the investment (time of investment, stage, group of co-investors, equity amount provided by each fund, exit date and exit mode for liquidated investments), and the fund (investment focus, vintage year). Note that the industry description of the target company is codified by Vxpert. We have converted each of these industry codes into one of the 48 industries as defined by Fama and French (1997) ourselves.

Due to the confidential character of Private Equity investments, the composition of this dataset is based on information Venture Economics obtained through its relationships with the GP and LP community over the past decades. However, despite all these efforts, a complete coverage of all investments by all funds remains difficult to achieve. Consequently, missing information about certain investments is accommodated in the following way.

Vxpert includes a number of investments with a 0 value. These correspond to confidential investments with an undisclosed equity amount. We assign an equity value to these deals according to the following logic. If we have information about at least three other investments of the same fund at the same stage (four stages are defined: early, intermediate, late VC, and buyout), we assigned the average amount of these investments to the focal investment (71% of the missing cases). Whenever there are too few investments of the same category by the same fund, we turned to the firm level (*i.e.*, consider all investments made by the same GP) and apply the same procedure. Whenever there are too few investments made even by the firm, we rely on the average per stage across the entire sample. Similarly, Vxpert provides information on many investments but relatively few divestments. This can be explained by the confidential character of many divestitures. We then have to correct for certain missing holding periods. First, certain investments are still in the database as "active investments" with a holding period of more than seven years (*i.e.*, that started before 1996). Second, some investments are reported as terminated but lack an exit date. The same logic as above is then applied. We estimate the average length for each type of deal and deduce the exit date. For 82% of the cases there were enough investments in the same stage operated by the same fund to use the stage-fund average length. It is important to note that these simple interpolations aim at neutralizing these anonymous deals in our weighting exit success scheme.

Recently, Kaplan, Sensoy and Stromberg (2002) studied the accuracy of Vxpert and point out that discrepancies arise from the treatment of milestone rounds; many are missing in the dataset. However, we do not use this information in our analysis. Note that Gompers and Lerner (2002, chap. 16) also describe and discuss the quality of the databases collected by Venture Economics. They report a coverage of deals of about 90% in terms of value and note that the number of rounds is overstated. Their analysis shows that VE data do not suffer from any significant biases that would impair our analysis. Regarding buyout investments, we do not know any study that discusses the accuracy of Vxpert. It is nonetheless known that buyouts have not been the focus of Venture Economics until recently and thus several deals are missing. Casual checking of Vxpert reveals that at least the largest deals are present (e.g. Nabisco).

Appendix B: Systematic risk of private equity fund portfolios

We evaluate the systematic risk of private equity fund portfolios in three steps. We first estimate industry-wide unlevered beta. Second, we assign each company (deal) to an industry and assume that the unlevered beta of the company is the same as the corresponding industry-aggregate. We lever it up for BOs and VCs in a different fashion. Finally, we aggregate each deal beta at the fund level.

1. Estimation of industry-wide unlevered betas

First, we assume that the CAPM holds, hence the risk-return trade-off for the equity of firm h is:

(1) $R_h^e = R_f + \beta_h^e (R_m - R_f)$

Where R_f is the risk-free rate (proxied by T-bill 30 days), β_h^e is the stock's systematic risk, and R_m is the market portfolio (proxied by the CRSP value-weighted index). Estimating (1) at a monthly frequency, using the Dimson's correction and rolling over the past 60 months, we obtain a time series of $\beta_{h,t}^e$ for each stock. These betas are then unlevered using the following relationship:

(2) $\beta_{h,t}^u = \dfrac{\beta_{h,t}^e E_{h,t} + \beta_{h,t}^d (1 - \tau) D_{h,t}}{E_{h,t} + (1 - \tau) D_{h,t}}$

Where $E_{h,t}$ is the capitalization of firm h at the beginning of the month, $D_{h,t}$ is the book value (from Compustat) of the long-term debt, updated yearly. We further assume that the corporate tax rate τ is constant across both firms and time, and equals 35%. Finally, we denote $\beta_{h,t}^u$ the systematic risk of the unlevered firm and we denote $\beta_{h,t}^d$ the systematic risk of debt. Following Cornell and Green (1991), who estimate the systematic risk of high-grade debt, we assume that $\beta_{h,t}^d$ equals 0.25.

Relation (2) makes some simplifying assumptions. In particular, it values interest tax shields at the full corporate tax rate and assumes that the value of tax shields has the same systematic risk as the unlevered firm. More details and comments on these issues can be found in Kaplan and Ruback(1995) and Fernandez (2004).

Next, each stock is assigned to one of the 48 industries defined in Fama and French (1997). Then, individual betas are aggregated in each industry to obtain a time-series of industry (unlevered) betas:

(3) $\beta_{i,t}^u = \sum\limits_{h=1}^{N_i} w_{h,t} \beta_{h,t}^u$, with $w_{h,t} = \dfrac{E_{h,t}}{\sum\limits_{h=1}^{N_i} E_{h,t}}$, $i = 1,\dots,48$

Finally, we construct the (equally-weighted) average equity betas for the 20%-smallest stocks in each industry and denote it as $\beta_{i,t}^{se}$.

2. Estimation of equity betas for venture capital and buyout deals

Each investment j, carried out by a given fund, has a VEIC number assigned by VentureXpert. Using their industry description, we assign each VEIC number to one of the 48 industries (manually, by eye match).

Each venture capital investment is assigned an equity beta for each month between the date of entry (*dentry*) and the date of exit (*dexit*) of the deal. The equity beta is $\beta_{i,t}^{se}$ described above. That is, each venture capital investment operating in industry i is assigned a time-series of equity betas: ($\beta_{i,dentry}^{se}, ..., \beta_{i,dexit}^{se}$).

For buyout investments, we need to lever-up the unlevered beta. To begin with, we need to make an assumption about debt levels. We investigate three scenarios:

S1: A buyout starts with a debt-to-equity ratio of 3, i.e. a debt-to-asset ratio of 75%. This ratio then linearly decreases down to the industry average debt-to-equity ratio.
S2: A buyout has a debt-to-equity ratio of 3 throughout investment's life.
S3: A buyout has a debt-to-equity ratio equals to the industry average debt-to-equity ratio.

S1 is the most realistic scenario while S2 and S3 serve as a sensitivity check of our assumption about the decrease in leverage. A debt-to-asset ratio of 75% is common in practice, as document by Cotter and Peck (2002).

Using equation (2) and assuming that the systematic risk of the unlevered investment (in industry i at time t) is $\beta_{i,t}^{u}$, we deduce the systematic risk of the given buyout investment for each month of its life.

3. Aggregation at the fund level

If funds invested all capital committed at inception and exited all the investments at liquidation, then the aggregation would be trivial. We would simply value-weight each investment characteristic and compute the average at the fund level. Since it is not the case, we process with a close analog that is adopted for all the characteristics of the deals (e.g. the above estimate of systematic risk, loadings on credit spread, GDP, etc.). The characteristic X of each deal, each month, is multiplied by the amount invested in this deal (I*j*). These amounts are then summed over investments and time, and then divided by the sum of the length of each investment times their amount. In other words, we value-weight the characteristics of each investment at the fund level, where the weights are both investment length and amount dependent.

The characteristic $X_{j,f}$ of each investment j of fund f is then summarized by X_f at the fund level as follows:

(4) $X_f = \dfrac{1}{\sum_{j=1}^{N_f} L_j I_{j,f}} \sum_{j=1}^{N_f} L_j I_{j,f} X_{j,f}$, where $I_{j,t}=I_j$ if the deal j is active at time t, and $I_{j,t}=0$

otherwise.

Example 1: Assume credit spreads are 2% from 1980 to 1990 and 4% from 1991 to 2003. A fund invests in two deals: 1000 in deal 1 that starts in Jan 1988 and ends in Dec 1992, and 100 in deal 2 that starts in Jan 1991 and ends in Dec 2001. The loading of this fund to credit spreads is (1000+1000+100+120,4%)/72000=2.5%

Example 2: Assume that earning-to-price ratios are 10 from 1980 to 1994 and 20 from 1995 to 2003. Consider the fund in example 1. The loading of this fund to the ratio at exit is (1000 60 10+100 120 20)/72000=11.7

Table 1: Descriptive statistics – Sample characteristics

This table displays descriptive statistics of two samples as of December 2003. The "universe" consists of all funds raised between 1980 and 1996 that are mentioned in either the cash-flow database of Venture Economics or in Vxpert. "Our sample" consists of quasi-liquidated funds raised between 1980 and 1996 for which more than four investments are reported in Vxpert. A quasi-liquidated fund is a fund that is either officially liquidated or has not shown any sign of activities over the last two years (2002 and 2003).Statistics for venture and buyout funds within each sample are reported separately. We report, respectively and for each sample, (i) the average (equal weights) of the capital invested by funds in $million (Size), the proportion of (ii) first-time funds, (iii) second-time and third-time funds, (iv) experienced funds (the GP group has already raised more than 3 funds at fund inception) and (v) the average (value-weighted by deflated size) of the profitability index of each fund (present value of money distributed divided by present value of money taken). Finally, we report the number of observations for each sub-sample.

	Universe		Our sample	
	VC	**BO**	**VC**	**BO**
Size (million)	16.4	91.4	48.6	225
First time (%)	0.38	0.52	0.31	0.34
Second&Third time (%)	0.33	0.28	0.40	0.45
Experienced (%)	0.29	0.20	0.29	0.21
Average Performance (PI) (value weighted by deflated size, Uncorrected)	n.a.	n.a.	1.07	1.02
Standard deviation of PI	n.a.	n.a.	1.17	1.25
t-stat (H0: PI=1)	n.a.	n.a.	*1.39*	*0.21*
Nber of obs.	2034	810	539	166

Table 2: Estimation of selection bias

This table reports the results of a Probit regression to model the fund selection process. The dependant variable is a dummy variable that takes the value 1 if the fund is in our sample and zero otherwise. The independent variables are fund characteristics: the natural logarithm of the total amount invested, and the natural logarithm of the sequence number of the fund in its private equity firm family (sequence), fraction of non-US investments, fraction of venture-capital investments. A constant is included but not reported.

	Dependent variable: $1_{(if\ in\ sample)}$
Size (ln)	0.11 (13.74)
Sequence number (ln)	-0.05 (1.44)
% non-US	-0.82 (-8.14)
% Venture capital	0.68 (8.33)
Nber obs.	2844

Table 3: Descriptive statistics – Investment behavior

This table displays descriptive statistics about the investment characteristics of the 705 funds in our sample. We report, for all funds as well as for venture funds and buyout funds separately, the average (equal weights) and median (in italics) of (i) the number of investments, (ii) the length (in months) of investments, (iii) the Herfindahl index based on the number of industries in which the fund invested, the proportion (in terms of amount invested) invested in (iv) venture capital deals, (v) the health industry (healthcare, medical equipment, and pharmaceutical products), (vi) the high-technology industry (electrical equipment, tele-communications, and computers), (vii) Europe and (viii) the dominant industry (i.e. the industry in which the fund has invested the most).

	All	Venture	Buyout
Nber investments	26.02	27.53	16.66
	21.00	*22.00*	*11.00*
Deal length (months)	56.16	57.27	49.27
	54.61	*56.47*	*45.86*
Herfindahl industry	0.26	0.27	0.20
	0.22	*0.23*	*0.19*
% Venture capital	0.81	0.91	0.18
	0.95	*0.97*	*0.14*
% Health	0.20	0.23	0.07
	0.15	*0.18*	*0.00*
% Hi-tech	0.47	0.51	0.17
	0.47	*0.53*	*0.12*
% European	0.12	0.07	0.38
	0.00	*0.00*	*0.02*
% Dominant industry	0.42	0.42	0.41
	0.38	*0.39*	*0.35*

Table 4: Systematic risk

This table displays the estimated fund CAPM-Beta. The methodology is detailed in the text and in the appendix. We display results obtained under three different assumptions. For Beta1, we assume, for buyout deals, a beta on debt of 0.25 and a debt-to-equity ratio that decreases linearly from 3 (at entry) to the industry average (at exit); and, for venture deals, we assume that Beta equals the average of the betas of the smallest (25%) public firms in the same industry. Beta3 (*Beta2*) is like Beta1 but assumes that the debt-to-equity ratio for buyout deals is always 3 (*the industry average*).

	Beta1 (D/E from 3 to average)	Beta2 (D/E = ind. average)	Beta3 (D/E = 3)
All	1.60	1.48	1.73
VCs	1.58	1.53	1.63
BOs	1.73	1.14	2.32
Largest 25%	1.56	1.52	1.60
Smallest 25%	1.65	1.39	1.91

Table 5: Performance and business cycles

This table presents the results of multiple regressions, in which the dependent variable is ln(1+PI); where PI is the profitability index (see text for definition). Explanatory variables include: 1) average corporate bond yield (BAA) and credit spread (BAA bond yield minus 10 years Treasury-Bill); during the quarter when the investment was made, 2) average real GDP growth, corporate bond yield, public stock-market portfolio return (CRSP-VW), return of the out-of-the-money *call* option on the S&P composite index and return of the out-of-the-money *put* option on the S&P composite index; during the life of the investments, 3) average earning-to-price ratio (for all stocks listed on the NYSE/AMEX/NASDAQ) and the amount of money raised through an IPO during the year when investment was exited. There are 705 observations. The *t*-statistics are reported between parentheses. All the variables are expressed as a z-score. A constant and a vector of lambdas (which controls for the fact that the fund was selected in our sample; Heckit methodology, see Greene, 2003) are included in all regressions but are not reported.

Panel A: Regression of performance on macroeconomic variables during investments

	1	2	3	4	5
Market	0.08 (1.89)				
GDP		0.18 (4.42)			
BAA-yield			-0.16 (-3.90)		
OTM Call Option				0.06 (1.24)	
OTM Put Option					-0.06 (-1.32)

Panel B: Regression of performance on macroeconomic variables at entry and exit of investments

	1	2	3	4	5
At entry:					
Credit spread	-0.12 (-2.93)				-0.06 (-1.20)
BAA-yield		-0.16 (-3.98)			-0.13 (-2.83)
At exit:					
IPO			0.06 (1.55)		
E/P				0.05 (1.20)	

Panel C: Regression of performance on macroeconomic variables

	1	2	3	4
BAA-yield entry	-0.19 (-4.56)	-0.08 (-1.76)	-0.20 (-4.64)	-0.17 (-4.18)
Market during	0.13 (3.01)			
GDP during		0.13 (2.72)		
OTM Call Option during			0.12 (2.78)	
OTM Put Option during				-0.08 (-1.98)

Table 6: Pricing of idiosyncratic risk

This table is like Table 5 except for the set of explanatory variables that is used, which include here i) the average corporate bond yield (BAA) during the quarter when the investment was made, ii) the average public stock-market portfolio return, iii) the natural logarithm of the number of capital calls (i.e. take-downs), iv) the natural logarithm of the number of investments, v) the Herfindahl index for industry concentration of investments, v) the Herfindahl index for the concentration of investment types (venture capital versus buyout), and the proportion (in terms of amount invested) invested in vi) the dominant industry (i.e. the industry in which the fund has invested the most), (vii) the health industry (healthcare, medical equipment, and pharmaceutical products), (vii) the high-technology industry (electrical equipment, tele-communications, and computers). A constant and a vector of lambdas (which controls for the fact that the fund was selected in our sample; Heckit methodology, see Greene, 2003) are included in all regressions but are not reported. There 705 observations.

	1	2	3	4	5	6
BAA-yield entry	-0.13 (-2.91)	-0.22 (-5.01)	-0.19 (-4.49)	-0.20 (-4.75)	-0.19 (-4.50)	-0.24 (-5.46)
Market during	0.11 (2.48)	0.13 (2.88)	0.13 (2.90)	0.13 (3.02)	0.13 (3.07)	0.13 (3.12)
Nber takes	0.13 (3.00)					
Nber investment		0.09 (2.07)				
Herfindahl indus			0.07 (1.85)			0.03 (0.70)
Herfindahl type				0.06 (1.51)		
%dominant indus					0.06 (1.57)	
% in Health						-0.08 (-1.86)
% in High-tech						0.13 (2.72)

Table 7: Drivers of fund performance

This table is like Table 5 except for the set of explanatory variables that is used, which include here i) the average corporate bond yield (BAA) during the quarter when the investment was made, ii) the average public stock-market portfolio return, the proportion invested in iii) the high-technology industry (electrical equipment, tele-communications, and computers), iv) the average length of the investments, v) the natural logarithm of the amount invested by the fund, the proportion invested in vi) venture capital and vii) non-US companies, vii) size squared, viii) the amount committed to all private equity funds during the year of fund creation and the natural logarithm of the sequence number of the fund in its private equity firm family (sequence). A constant and a vector of lambdas (which controls for the fact that the fund was selected in our sample; Heckit methodology, see Greene, 2003) are included in all regressions but are not reported. There 705 observations. R-square ranges from 9% to 11% (specification 5).

	1	2	3	4	5
BAA-yield entry	-0.17 (-2.70)	-0.17 (-2.68)	-0.13 (-1.87)	-0.16 (-2.51)	-0.14 (-2.33)
Market during	0.10 (2.14)	0.10 (2.17)	0.10 (2.14)	0.10 (2.14)	0.11 (2.68)
% in High-tech	0.20 (4.31)	0.04 (0.25)	0.20 (4.39)	0.19 (4.12)	0.17 (3.96)
Length investment	-0.10 (-1.74)	-0.10 (-1.74)	-0.09 (-1.58)	-0.10 (-1.81)	-0.11 (-1.98)
Size (log)	0.08 (1.93)	0.08 (1.95)	0.09 (1.98)	0.08 (1.77)	0.09 (2.39)
% venture capital	-0.07 (-1.37)	-0.06 (-1.37)	-0.07 (-1.38)	-0.07 (-1.49)	
% non-US	-0.08 (-1.69)	-0.08 (-1.17)	-0.08 (-1.59)	-0.06 (-1.35)	
Size (log) - squared		0.16 (1.16)			
Total committed			0.06 (1.13)		
Sequence nber				0.17 (4.24)	0.17 (4.32)