The Performance of Private Equity Funds

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When *The Economist* dubbed private equity funds as "Capitalism's new kings",[1] it was in part commenting on the astonishing growth in the amount of money managed by these funds.[2] Indeed, the capital committed to US private equity (PE) funds increased from $5 billion in 1980 to $300 billion in 2004, and in the course of the past 25 years, over $1 trillion has passed through the hands of private equity funds (Lerner *et al*., 2004). Moreover, as most investments are highly levered, the economic impact is even greater than the amounts invested suggest.[3]

Despite being a major class of financial assets, estimates of the net performance of private equity funds are scarce and are the subject of this paper. Two recent exceptions — studies by Ljungqvist and Richardson (2003) and Kaplan and Schoar (2005) — both report that private equity funds outperform the S&P 500. Importantly, the focus of these two studies is not on measuring performance but rather on certain aspects of investing in private equity funds (e.g. the flow-performance relationship, performance persistence, or determinants of the speed at which capital is invested). One reason why these studies do not center on the expected performance of private equity investors is the lack of a comprehensive dataset. Indeed, in a universe of at least 3 400 funds, Ljungqvist and Richardson (2003) base their analysis on 73 funds while Kaplan and Schoar (KS, 2005) examine 746 funds.

Our study draws on an updated version of KS's dataset, comprising 983 funds. In addition, this dataset is enriched by information on the performance-related characteristics of 1 391 additional funds, which enables us to correct for sample selection bias when estimating performance. Furthermore, as our focus is on performance, we make two methodological contributions that consist of a more economically appealing fund aggregation device and treatment of residual values (deletion of so-called 'living-deads').[4] We find that these three corrections dramatically decrease performance estimates.

The first correction adjusts the original KS dataset for a potential sample-selection bias (that was acknowledged by KS). Using the traditional Heckit methodology, and information about both the investment success and characteristics of the additional funds in our sample, we find that the expected performance of these additional funds is about 2% lower than the expected

[1] 27 November 2004, *The Economist*.
[2] Note that real estate and entrepreneurial investments in non-public companies are sometimes called private equity. In this paper, we consider so-called private equity funds. Such funds primarily invest in buyout and venture capital.
[3] For example, the largest historical buyout, of NRJ Nabisco, used only $1 billion of equity for an acquisition worth $25 billion. More recent leveraged buyouts (LBOs), however, use less extreme leverage.
[4] Residual value is the value of non-exited investments reported by funds on a quarterly basis.

performance of selected funds in terms of Internal Rate of Return (IRR) and 9% lower in terms of Profitability Index (PI).[5] After correcting for this sample selection bias, the value-weighted average performance of private equity funds is found to be below that of the S&P 500 (PI is reduced from 1.05 to 0.95). The second correction consists in computing performance based on the aggregated cash flows across all funds, thereby giving an estimate of the return of the overall private equity portfolio. In our sample, this estimate of overall performance differs significantly from the value-weighted average performance (with capital committed as weights) used in the literature. This change reduces PI from 1.05 (over-performance) to 0.94 (under-performance) and IRR from 16.24% to 15.08%. Finally, we argue that the residual value reported by several funds likely reflects 'living-dead' investments and should thus be written off. Indeed, we count 296 funds (out of 983) whose age is above the typical age limit of funds (i.e. 10 years) and that have not shown any sign of activity (i.e. cash-flow distribution or cash-flow call) over the last four years. The $13 billion residual value reported by these 296 funds for non-exited investments is written-off. This change alone also reduces the average value-weighted PI from 1.05 to 0.94. Of particular interest, an underperformance of 0.94 is found to be statistically significant.

When we correct for the sample-selection bias, write off certain residual values (approximately half) and aggregate cash flows across funds, we obtain an IRR of 12.44% and a PI of 0.73 for the overall private equity fund portfolio. That is, private equity funds raised between 1980 and 1996 have returned only 73% (and not 105% as documented in the literature) of the invested capital in present value terms. This corresponds to an underperformance of 3.3% per annum with respect to the S&P 500 and the three corrections above decrease the original performance estimate by a very similar amount.

It is important to note that the relatively low performance estimate reported above is voluntarily optimistic. First, funds raised between 1997 and 2001 invested three times more capital as funds in our sample and display very low preliminary performance. These funds are not included in our estimate as their performance is not definitive yet. Second, additional costs incurred by investors are not deducted from our estimated performance as we do not have access to this data. Indeed, certain investors hire funds-of-funds when investing in private equity and thus pay supplementary fees. Also, investors face transaction costs when "cashing" stock

[5] Profitability Index (PI) is the present value of the distributed cash flows divided by the present value of the invested cash flows.

distributions made by funds. Third, we do not account for the illiquidity of the funds' stakes for the investors. Fourth, we have implicitly assumed conservative risk properties of private equity investments as we assign a beta of 1 to both cash inflows and cash outflows (in a CAPM framework, with the S&P 500 as a proxy for the market portfolio.) Ljungqvist and Richardson (2003), however, argue that the beta of cash outflows is close to zero and the beta of cash inflows is higher than 1. If we use the risk-free rate to discount cash outflows and an estimated beta of 1.3 for cash inflows, the estimated performance is drastically reduced as it reaches a staggering 0.3. That is, without correcting for either sample bias, aggregation bias or living-dead, but simply assuming some fairly reasonable betas (1.3 for inflows and zero for outflows), we obtain that private equity funds have destroyed more than two thirds of the capital allocated to them.

We also show that the underperformance of private equity funds is robust to our choice of the sample bias correction estimation, treatment of residual values and benchmark. The exact extent of the underperformance cannot be determined yet as we do not have all the necessary data and the challenging task of measuring the risk of investing in private equity funds is left to future research. In this paper, we propose a lower bound for this underperformance, which we estimate to be 3.3% per year. Such a finding is puzzling and prompts us to question why private equity funds have such low performance. Hypotheses range from mispricing to the existence of side-benefits of investing in private equity funds. Another important issue is to assess to which extent this low performance reflects a learning cost. Interestingly, we find that the performance persistence effect documented by Kaplan and Schoar (2005) is present in our extended sample. This means that future performance might differ from that observed in our dataset and that our findings could be partly explained by learning. Nonetheless, even if young funds are removed from the sample, we still find that private equity funds underperform. In addition, there is no significant trend in performance and if anything, the trend is negative due to the poor preliminary performance of recently raised funds.

The rest of the paper is structured as follows: Section 1 reviews the literature, Section 2 describes the data, Section 3 gives performance estimations, Section 4 shows some robustness checks, Section 5 discusses why our performance estimate is optimistic, Section 6 offers three explanations for the observed underperformance of private equity funds, and Section 7 concludes.

1. Risk and Return in 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.

The performance of individual venture capital investments made by GPs has been studied by Peng (2001), Quigley and Woodward (2003), Woodward and Hall (2003) and Cochrane (2005). 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.

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, or liquidation). With similar observations, Cochrane (2005) proposes another approach. It assumes that the change in the log of the company's valuation follows a log-CAPM and models selection bias explicitly, as it is assumed 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.[6]

[6] Cummings and Walz (2004) also offers an estimate of investment-level returns, focusing on how the legal environment influences performance.

The results of these studies vary substantially. Quigley and Woodward (2003) finds gross real returns on VC investments 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 and a corresponding alpha of 32%.

The second set of studies focuses on funds rather than on investments. An attractive feature of fund-level studies is that they include buyout investments. This is important as private equity funds have invested more in buyouts than in venture capital. Moreover, at the fund level, the selection bias mentioned above is substantially reduced as cash flows are more likely to reflect both successful and unsuccessful investments. Nonetheless, fund-level studies encounter two related sample selection problems. First, certain funds have not liquidated all their investments. As the performance of these funds cannot be reliably computed, they cannot be included in the analysis. Second, certain funds do not release cash-flow information necessary for evaluating performance. Both situations imply that the selected sample is not representative.

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".

Kaplan and Schoar focuses mainly on performance persistence and performance-flow relationship. In doing this, they also report that their 746 funds have a value-weighted profitability index of 1.05 and a value-weighted IRR of 18%. Their study is discussed at length in the next section.

The third study, by Jones and Rhodes-Kropf (2003), proposes and tests a model in which principal-agent problems result in competitive fund returns that increase with the amount of idiosyncratic risk. It also finds a positive but not statistically significant performance alpha. Though these findings on the pricing of idiosyncratic risk are important, the estimated alphas are noisy because they are calculated on quarterly residual values. These residual values are both

artificially sticky in that they typically equal the total amount invested, and subjective in that they are set at the GP's discretion (e.g. Blaydon and Horvath, 2002).

The last of the four studies, by Ljungqvist and Richardson (2003), analyzes GP investment behavior, focusing on the determinants of draw-downs and capital distributions. The results are crucial to improving our understanding of the risk of private equity investments. Its reporting of high average performance, however, should be treated with caution as their sample is relatively small and, in addition, under-represents first-time funds and venture funds, both of which have lower than average performance according to Kaplan and Schoar (2005).

All of the above studies provide insight into specific issues related to private equity funds. They do not, however, focus on overall performance and when they provide performance measures, it is as a descriptive statistic. Our study thus provides the first comprehensive assessment of the overall performance of the private equity portfolio.

2. Data

Our data sources and sample selection scheme are detailed below. Some descriptive statistics of private equity funds are offered and the estimates of fund performance reported in the literature are replicated.

A. Data sources

This study draws on several data sources. 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 between 1980 and 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 GPs and carried interest. Throughout the text this dataset is referred to as the "cash-flow" dataset. Venture Economics also collects information on fund investments through its Vxpert database. Details about these databases as well as certain corrections that we carry out are provided in Appendix A.II.

B. Sample selection and treatment of residual values

Until a fund is entirely liquidated, non-exited investments prevent 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 reported quarterly by funds. However, these accounting valuations are unreliable.[7] Kaplan and Schoar (2005) propose to focus on a sample of liquidated and nearly liquidated funds. In such a sample, the treatment of accounting values has a reduced impact but the sample might be biased toward "winners". Indeed, non-liquidated funds (hence excluded from the sample) may be finding it difficult to sell their current investments or may simply be waiting before realizing, and officially acknowledging, poor performance. In addition, poorly performing funds have an incentive to postpone liquidation to artificially increase their IRR (which is the commonly used performance measure). The liquidation decision, therefore, may be endogenous and partly influenced by the success of investments. Consequently, a sample of liquidated funds is not representative.

As our dataset allows us to correct partially for sample selection biases, we privilege the accuracy of the performance measure and thus follow Kaplan and Schoar (2005) in that we select a sample of 'quasi-liquidated' funds. A fund is thus included in our database if it is raised between 1980 and 1996 and was either officially liquidated as of December 2003 or if it has not reported any cash flow during the last two years of our sample (2002 and 2003). We count 983 funds that satisfy these criteria out of the 1 317 funds with cash-flow data raised between 1980 and 1996.[8] Combining the Vxpert dataset and the cash-flow dataset, we count 2 844 funds raised between 1980 and 1996. Table 1 reports the characteristics of each sample. 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 $58 million for VC funds, compared to $225 million for BO funds. Moreover, reflecting the fact that the PE 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).

Table 1

[7] The US National Venture Capital Association proposed certain mark-to-market guidelines for the valuation of PE fund investments in 1989 which have become a quasi-standard for the industry. Nevertheless, the discussion in the PE industry about appropriate rules for valuing unrealized investments is ongoing, and accounting practices vary to the point that GPs jointly investing in the same company have been known to issue substantially varying valuations. In general, however, the accounting value of a deal remains 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.

C. Average performance of funds

We first replicate Kaplan and Schoar's (2005) results in our sample. We compute fund performance using two measures: the internal rate of return (IRR) and the profitability index (PI) (the present value of cash inflows divided by the present value of cash outflows).[9] As returns on the S&P 500 are used to discount both cash flows, a PI above 1 indicates a better performance than the S&P 500 Index. Finally, we treat the residual value as a cash equivalent inflow. That is, we implicitly assume that the residual value is an accurate estimate of the expected present value of future cash distributions, which is a standard assumption (e.g. Kaplan and Schoar, 2005, and Venture Economics when reporting aggregate performance measures).

Table 2

Table 2 shows the performance of the selected group of quasi-liquidated funds. For venture funds (VC), buyout funds (BO) and all funds, we report the 25th, 50th and 75th percentile, as well as the average performance using both IRR and PI. The average is either equally weighted or value weighted using capital committed (as in KS). Unsurprisingly, given that we have closely followed their methodology and adopted the same assumptions, our results are similar to those reported by KS. The average value-weighted IRR is about 16% and the average value-weighted PI is 1.05, which indicates an outperformance of private equity funds. However, equally-weighted performance is significantly lower, which indicates that the weighting convention plays an important role and confirm that large funds significantly outperform small funds in this sample (Kaplan and Schoar, 2005). We also find wide heterogeneity and large skewness in that there are a few funds with very high performance in the sample. About 25% of the funds in our sample have a negative IRR and less than 25% of the funds have an IRR above 16%.

[8] Note that the KS dataset consists of 746 funds, due to its termination date of December 2001.

[9] For example, if one invests $1 and receives $2 after a period and the opportunity cost of capital is 10% (over the period) then PI is 182%. In this simple case, PI is gross return over the gross opportunity cost of capital; in other words, it is the (gross) return on investment, when both total investments and total payoffs are expressed in present value terms.

3. Correcting Performance Estimates for Potential Biases

Having replicated the performance estimate reported in the literature, we now argue that this estimate is optimistic. We correct for sample selection biases and provide a more realistic fund aggregation device and treatment of residual values.

A. Correction for sample selection bias

Our sample very closely resembles that of Kaplan and Schoar (2005) in that we select funds raised between 1980 and 1996 that were either not active over the last two years (2002-2003) or were officially liquidated. These 983 'quasi-liquidated' funds invested a total of $83 billion (or $102 billion in 2003 US dollars) over the period and their committed capital (size) was $87 billion (or $127 billion in 2003 US dollars). The universe of funds from which this sample is drawn includes 2 844 funds raised between 1980 and 1996 (funds mentioned in either Vxpert or the cash-flow dataset; see Appendix) that collectively invested $284 billion. Thus, our estimate of overall performance of private equity funds (similar to the KS estimation) is based on about one-third of the private equity funds raised between 1980 and 1996 (29% in terms of capital committed and 35% in terms of numbers).

As our performance estimates are based on a minority sample of funds, it is important to assess the extent to which these estimates might be biased due to the sample selection procedure. The unique feature of our dataset is that it includes investment information from additional funds that are not quasi-liquidated. In particular, we know how investments made by these funds were exited (e.g. IPOs, bankruptcy). This information enables us to infer fairly well the expected performance of these additional funds.

To obtain a reliable estimate of the investment characteristics, we select funds that are excluded from the quasi-liquidated group of funds and have at least made four investments and one exit. The 1391 funds that satisfy these criteria (out of 1861 funds excluded from the quasi-liquidated group) have collectively invested $148 billion.

Our goal is then to determine the expected performance of these 1 391 additional funds, which we label "out-of-sample" and thereby correcting for a potential sample selection bias. To do so, we apply the widely used two-step Heckit methodology (see Carhart *et al*., 2002, for an application to mutual funds). The first step consists in estimating a Probit model. The dependent variable is a dummy variable that has a value of 1 if a fund is in the selected sample and 0

otherwise. The explanatory variables consist of the proportion of investment exits (weighted by capital invested) that took place through an IPO, the proportion of investment exits that ended up in bankruptcy, the proportion of investments still reported as active, the proportion of investments made outside the US, the proportion of investments in venture capital, the natural logarithm of fund size, and the natural logarithm of fund sequence. These variables reflect the success of the exits (e.g. IPOs, bankruptcy) and some well-documented determinants of fund performance (e.g. size and experience) that can also be related to the likelihood of reporting performance to Venture Economics.

The second step consists of computing a "lambda" for each fund. This lambda is an index that increases with the probability of a fund being selected in the sample and it is derived from the results of the Probit estimation, it is also called the inverse of Mill's ratio (see Greene, 2003, for details). Fund performance is then regressed on a constant term and the vector of fund lambdas. The loading on the vector of lambdas indicates the degree of the sample selection bias. If the loading is not statistically significant, the average performance found in the selected sample does not statistically differ from the average performance in the entire universe of funds.

Table 3

Results are reported in Table 3. Funds are more likely to be included in the sample if they have been more successful with their investments (more exits via IPOs and less via bankruptcy), if they are larger, if they have fewer investments still active and if they have invested more both in venture capital and in the US. Interestingly, the median (average) fund in our sample has exited 30% (33%) of its investments via an IPO whereas the median (average) fund that is not in our sample has exited 22% (29%) of its investments via an IPO. Similarly, the average fund in our sample had 21% (both in terms of value and number) of its investments ending by an IPO and the average fund excluded from our sample had 16% of its investments ending by an IPO (untabulated figure). As the fraction of IPOs is often used as a measure of performance in the private equity literature, this is a first indication that the funds that have been selected in our sample (and in the KS sample) have abnormally high performance.[10] In addition, Kaplan and

[10] For instance, Ochberg *et al*. (2005) reports that: "The economic magnitude of this effect [network quality of GPs] is meaningful…a one-standard-deviation increase in network centrality increases exit rates by around two percentage points from the 34.2% sample average. Using limited data on fund IRRs disclosed following recent Freedom of Information Act lawsuits, we estimate that this is roughly equivalent to a two percentage point increase in fund IRR from the 15% average IRR." The exit rate in this study uses both M&As and IPOs. If we compute the exit rate in the

Schoar (2005) find that both larger funds and venture funds perform better, which will also make our selected sample more likely to overstate average performance.

Both the Probit and OLS estimation confirms these univariate statistics. The most significant variables are the natural logarithm of the amount invested, the proportion of active investments and the proportion of venture funds.

Results of the second step estimation show that the sample bias is statistically significant (Panel A of Table 3). The expected PI of in-sample funds is 0.92 (equally-weighted) and the expected PI of out-of-sample funds is 0.83. If the analysis is conducted with IRRs, in-sample expected performance is 12.49% and the out-of-sample expected performance is 10.14% (non-tabulated results).

For these figures to be comparable to the performance reported in the previous section, we need to value-weight individual fund performance. We then use the lambda of each out-of-sample fund and the estimated performance-lambda relationship to estimate individual fund performance and then value-weight all the estimated individual performances by capital invested. Doing so leads to a value-weighted performance of 0.88 for out-of-sample funds. Consequently, the drop in average fund performance due to sample bias correction is substantial: from 1.05 for the 983 quasi-liquidated funds down to 0.95 for the universe of 2 374 (983+1 391) funds. In terms of IRR, the value-weighted performance decreases from 16.24% to 13.54%.

We note that the magnitude of the sample selection bias depends on how we weight funds. This is because the relationship between fund size and performance is weak out of sample. Interestingly, we also note that the sample selection bias is comparable to the survivorship bias found for both mutual fund studies and hedge fund studies. Indeed, Malkiel (1995) estimates the survivorship bias in mutual funds to be 123 basis points and Malkiel and Saha (2005) estimates the survivorship bias in hedge funds to be 374 basis points.

B. Aggregation issues

In Section 2, we followed the literature in that we value-weighted performance across funds by their committed capital ('literature estimate'). As our objective is to measure the performance of the overall private equity fund portfolio, we argue that it is more reasonable to aggregate the

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same way for in-sample and out-of-sample funds, then we find a 5% spread between the two groups of funds. Hence, according to Ochberg *et al.* (2005), this would correspond to a very large 5% difference in IRR.

cash-flow streams across all funds and then compute both PI and IRR from this single cash-flow stream ('aggregated estimate').

This 'aggregated estimate' diverges from the 'literature estimate' for two reasons. First, the average PI (IRR) of N cash-flow streams is rarely equal to the PI (IRR) of the sum of the N cash-flow streams. In some sense, these performance estimates are 'non-linear.' Hence, averaging them is not a good indicator of the overall performance, even if we take a value-weighted average. Second, the two methodologies implicitly assign different weights to the performance of individual funds. When we compute the 'aggregated estimate', we assign weights close to the present value of the capital invested by each fund, which is economically appealing. With the 'literature estimate' the weights are the amount of capital committed to each fund, which is close to the total capital invested (not discounted and not corrected for inflation) by each fund. Weighting by capital committed is not only less economically appealing but it also arbitrarily overweighs recently-raised funds because the difference between their total capital invested and present value of capital committed is the largest.

Table 4

Consequently, we consider an investor who has bought all the private equity funds and compute the NPV of this investment choice. To do so, we aggregate the cash-flow streams across all quasi-liquidated funds and use the return of the S&P 500 as the discount rate. We find that the NPV is $-39 billion as of December 2003. The negative sign of the NPV enables us to conclude that an investor who has invested a % (a >0) of her wealth in the private equity market portfolio and (1-a)% of her wealth in the S&P 500 has been worse-off (*ex post*) than an investor who has invested all of her wealth in the S&P 500.[11] An illustrative example is reported in Table 4. On 1 January 1980, an investor has a portfolio of $10 billion that she allocates between the S&P 500 Index portfolio and the portfolio of private equity funds. We calculate her wealth level at the end of each month as a function of the proportion of the private equity portfolio bought, denoted a. We find that the final wealth (as of December 2003) decreases from $224 billion to $185 billion when a varies from 0 (no investment in private equity) to 1 (bought the entire private equity portfolio). More generally, final wealth (in billion) $W_t = 224 - 39*a$, where -39 is precisely the NPV of investing in the private equity portfolio. We also note that as the total residual value is

[11] Assuming that the cash-flow stream is as risky as the S&P 500. We also implicitly assume that this investor could have predicted *ex ante* which funds will be in our dataset. As we have shown in the previous section that these funds are better than average, the so-calculated NPV will be higher than the true NPV.

$27 billion, accounting for it on a one-to-one basis (as in Section 2) would still lead to an overall negative NPV.

From this aggregated cash-flow stream, we can also compute the IRR and PI of the private equity market portfolio. We assume as in Section 2 (and in the literature) that residual values are a correct proxy for the present value of the future cash flows from non-exited investments, and find an IRR of 15.08% and a PI of 0.94. That is, the performance computed from the aggregated cash flows is 1.16% lower than the value-weighted average of individual performances ('literature estimate') in terms of IRR and 11% lower in terms of PI. The discrepancy is thus substantial.

To understand why over-weighting recent funds has such a significant effect on results, Table 5 shows the performance obtained for the funds in each vintage year. Panel A displays the average IRR and PI of the funds grouped per vintage year. As in section 2, the average is either equally weighted or value weighted by capital committed. We note that performance tends to be indeed higher in recent years, particularly if capital committed is equally weighted. In Panel B, we aggregate the cash-flows across all the funds in a given year and compute the PI and IRR of aggregated cash-flow streams. The estimated performance of a given vintage year varies substantially between Panel A and Panel B. This is due to the fact that neither IRR nor PI are linear measures as mentioned above. That is, if: (i) fund A has an IRR of 10% and fund B has an IRR of 20% and (ii) fund A and fund B are the same size, then the IRR of the aggregated cash-flow of fund A and fund B will typically be different from 15%. The same holds if performance is measured by PI. Funds raised in 1996 have an aggregated IRR of 28%, differing substantially from the equally weighted average IRR of 43% and value-weighted IRR of 18%.

Table 5

Irrespective of the aggregation convention (Panel A versus Panel B), we observe that funds raised in the mid-90s perform better. It is primarily for this reason that the average PI indicates that quasi-liquidated funds outperform the S&P 500 ('literature estimate') whereas the NPV computed over the aggregated cash-flow stream indicates underperformance.[12] Note, however, that the better performance of funds raised in the mid-90s is driven by the treatment of

[12] To further illustrate this point, in Panel B of Table 4, we repeat the same exercise as in Panel A of the same table, but from the perspective of an investor entering private equity funds in January 1988 rather than in January 1980. The NPV is also negative for this period but the total residual value is now sufficiently large to change the conclusion as a function of what we assume this residual value is worth.

residual values (see Panel B). If we write them off, these funds perform worse and not better than more mature funds. We discuss in details the treatment of residual values below. For now, it is important to keep in mind that a more economically appealing aggregation device leads to the conclusion that private equity funds underperform even if we do not make any additional correction.

C. Combining sample selection bias correction and aggregation of cash flows

In order to obtain an accurate performance estimator, we need to account for sample selection bias on the aggregated cash flows. The Heckit framework above provides an expected PI for out-of-sample funds but does not give the expected cash-flow stream of out-of-sample funds. We then need to make an additional assumption. We match each out-of-sample fund with a quasi-liquidated fund raised in the same year belonging to the same size quartile, with the closest PI (in that order). Once the match is made, we assume that the out-of-sample fund had the same cash-flow stream as the matched quasi-liquidated fund.

Our procedure results in a sample of 2 374 funds whose cash-flow streams are added to obtain a time-series of cash flows, which represents the cash-flow stream of the private equity market portfolio after adjusting for sample selection bias. We then compute the IRR and PI of this cash-flow stream and find that the private equity market portfolio has an IRR of 13.42% and a PI of 0.82, which is respectively 2.8% and 0.23 less than our uncorrected estimates (Section 2). These figures are not surprising as the sample selection bias correction alone decreases IRR (PI) by 2.7% (0.10) and the aggregation correction alone decreases IRR (PI) by 1.16% (0.11).

D. Accounting for residual values

Though we have selected a sample of quasi-liquidated funds, residual values are not always negligible. We first note that 459 funds are officially liquidated and have a negligible residual value ($2 billion in total). The remaining 524 funds have invested $45 billion and report $25 billion of residual values. The total residual value is thus more than 50% of the total amount invested by these funds. Of these 524 funds, more than 398 are more than 10 years old and have not, by definition, shown any sign of activity over the last two years. In particular, they have made no distributions for two years. To this point, when we have computed performance, we

have assumed that these funds would deliver $17 billion worth of cash-inflows from non-exited investments. This assumption seems therefore highly optimistic.

An alternative approach to treating residual values is to follow Ljungqvist and Richardson (2003) who propose writing off residual values on the grounds that they are highly unreliable. Such an approach provides a lower bound to performance and appears to be closer to the true state given the above remarks.[13]

When we write off residual values, we find that funds raised in recent years witness a significant drop in performance. In Panel B of Table 5, we see that the PI of funds raised in 1996 drops from a very high 1.60 to a relatively low 0.93; a similar decline applies for funds raised between 1993 and 1996. Once residual values are written off, all vintage years display a clear underperformance of private equity funds with the exception of 1980, 1985, 1990 and 1995.

Figure 2

Writing off all residual values is probably an aggressive assumption, however. To temper this, we choose to write off residual values of a subset of funds: those officially liquidated and those that both are raised before 1993 (hence are more than 10 years old) and have not shown any sign of activity over the last four years (*i.e.*, did not collect fees, make distributions etc. since January 2000). We believe that since these funds are pasted the typical liquidation date and did not show any signs of activities for a long time, the investments they have are likely so-called 'living-deads', that is investments that appears with positive values in accounting reports but are close to worthless. This leads to the deletion of half of the total residual values, i.e. $13 billion.

The distribution of fund performance after such a correction is shown in figure 2. The average PI is 0.86, and the standard deviation of the mean is 0.03. Hence, the underperformance of funds is statistically significant. However, the distribution appears log-normal and we transform the original PI into Ln(0.05+PI), which is close to normally distributed with mean -0.48 and a standard deviation of 0.03, again showing a statistically significant underperformance even without correction for sample selection bias or aggregation device. When funds are value-weighted, similar results are obtained as we find an average PI of 0.94.

[13] There are additional reasons for believing that residual values overvalue unexited investments. First, residual values are typically equal to the amount invested. Given the downturn in 2000-2001, most firm values are now lower than the amount investors paid in the late 1990s when most investments occurred. Second, funds have an incentive to list "poor" investments as "still active" in order to post a fund-IRR high enough to raise new funds. Acknowledging poor performance would reduce the fund IRR because the cash distribution would be lower than the corresponding residual value.

The question of how to treat residual values can also be solved by working with the sample of 459 fully liquidated funds. The cost is a reduction in sample size and a greater sample selection bias (as they are those who reported their performance and exited all their investments as of now; see section 3.A). In unreported results, we compute the performance of these funds and find that they have a value-weighted average IRR of 16% and a value-weighted average PI of 1.02. When their cash flows are aggregated, IRR drops to 15.6% and PI to 0.97. That is, even the funds that are likely to be the very best funds raised over our 17-year period underperform the S&P 500.

Table 6

In Table 6, we summarize the drop in performance estimates resulting from the various corrections. We note that aggregation alone makes the private equity portfolio underperform the S&P 500. The same holds for the sample selection bias correction. When these corrections are combined and residual values are halved, performance drops further to a low PI of 0.73 and an IRR of 12.44. To obtain a more economically intuitive order of magnitude for the underperformance of private equity funds, we calculate the value of a constant *c* that should be subtracted each month to the return of the S&P 500 in order to obtain a PI equals to 1.00 (instead of 0.73). The answer is 27 basis points, *i.e*. a PI of 0.73 means that the private equity fund portfolio has underperformed the S&P 500 Index by 3.3% per annum.

4. Robustness

A. Other benchmarks

The S&P 500 is used has the benchmark asset in the analysis above. This choice is mainly made to facilitate the comparison with existing literature. If instead of the S&P 500, we use the Nasdaq index as a benchmark, we obtain surprisingly similar results. The average value-weighted profitability index (with the Nasdaq as a discount rate) is 1.0383 (deflated size as a weight; compared to 1.0378 with S&P 500) and 1.0447 (size as a weight; compared to 1.0536 with S&P 500). If a broader stock-market index is used (CRSP value weighted index) then the average performance improves slightly (1.0755 versus 1.04 with S&P 500). The same holds when an industry matched portfolio is used (1.0871 versus 1.04 with S&P 500). To construct the industry matched portfolio, we compute the frequency with which private equity funds invest in each

industry, compute the value-weighted return for each industry, and combining both we derive a time-series of returns corresponding to an industry matched portfolio.

It is important to note that the differences in performance obtained with other discount rates is trivial compared to the underperformance that we document above after correcting for sample selection biases, living deads and aggregation bias.

B. Other selection equation for the Heckit adjustment

Our sample bias correction is not dependent on the choice of variables that we include in the selection equation and in the performance equation. For example, when move the exit success variables (fraction of IPOs and fraction of bankruptcy) from the selection equation to the performance equation, we obtain a coefficient for lambda of 1.21 (instead of 1.33) and a correction for the sample bias of exactly the same magnitude as above.

As pointed out above, we have still left out some funds because they do not have sufficient data about exits for us to compute the fraction of exits that are IPOs, bankrupt etc. Hence, as a robustness check, we have relaxed this requirement (we consider all funds in Vxpert with at least two investments) and accordingly changed the selection equation that now includes only: fraction of active investments, fraction of European investments, fraction of buyout investments, sequence number and size. There are now 1719 out-of-sample funds under consideration (instead of 1391 in section 3.A). In the first step (Probit), fraction of active investments, fraction of buyout investments, and size are highly significant (t-stats of -6, 5 and 8 respectively). In the second step, we obtain that the selection bias is significant (t-stat is 3.05) and the expected profitability index for out of sample funds is now 0.86 (compared to 0.88 obtained in section 3.A). These (untabulated) results also show that our above approach is both conservative and robust to specification changes.

C. Other adjustment for residual values

To adjust the subjective residual values reported by funds, we can use the experience of liquidated funds to estimate a statistical model that relates reported residual values and subsequent cash flows. In Table 7, we first report the total residual value reported by liquidated funds at each age (from their 7^{th} year onward) and what has been the present value of the net cash flows (distributed minus taken) thereafter. We observe that residual values are always optimistic

and increasingly so with age. Second (Panel B), we show that the relation between residual value and subsequent cash flows strongly depends on fund characteristics.[14] The most important characteristics are size (large funds tend to be conservative with their accounting in that for a given reported residual value, the expected net cash flows are higher), venture capital focused (more conservative) and the time elapsed since the last distribution (if funds have not distributed cash for a long time then their residual values are likely aggressive). If we use this model to predict the present value of the future net cash flows for the funds that are in our sample of quasi-liquidated funds but are not fully liquidated and raised between 1991 and 1996, we find that the $18 billion that they report as residual values is worth $7 billion. For funds raised before 1991, we do not have enough observations to make a prediction but from Panel A, we see that for such old funds, their residual values can be reasonably written off. To summarize, our model predicts that the $27 billion of residual values are worth about $7 billion. Our above assumption of writing off $13 billion is, therefore, extremely conservative.

Table 7

5. Additional dimensions

This section highlights additional aspects of private equity investment that suggest that the above estimate is still optimistic. Even after correction for sample selection bias, aggregation bias, and the bias in residual value reports, the performance figures that we have given can be reasonably further downward corrected.

A. Performance of recently raised funds

In our computations, we included funds raised up to 1996 and thus ignored the performance of recently raised funds. These recent funds represent considerable capital and are hence economically important. They are excluded from this study simply because a sufficient number of their investments have not yet been exited and thus no track record of cash distributions exists to calculate reliable IRRs or PIs.

Nonetheless, to obtain a sense of the degree of optimism of our initial performance estimate, we report early performance indicators of funds raised between 1997 and 2001. The

[14] The regression is done in two steps to take into account the fact that we are working with a selected sample (heckit).

idea is to match recently raised funds with a group of funds that are now quasi-liquidated on a same-age basis. For example, funds raised in 1997 are matched to a group of mature funds in their sixth year. Results are reported in Table 8.

Table 8

The first striking observation from Table 8 is that the overall capital raised by private equity funds during these five years (1997 to 2001) is immense, about four times that of our selected sample of quasi-liquidated funds (in deflated dollar terms). When comparing funds raised recently with their mature peers, we can see clear differences in terms of divestments but less in terms of investments. Young funds have thus invested at a similar pace as their mature peers with the partial exception of funds raised in 2000 and 2001, which have not invested as much. In terms of distributions, younger funds are significantly lagging in the 'historical' schedule. For all vintage years, they have distributed significantly less than their mature peers at the same age. For example, mature funds had returned half (one-third) of the cash called after four (three) years while funds raised in 1999 (2000) that are now four (three) years old have returned only 22% (13%).

We also match each young fund to a group of 10 mature funds that are closest to their distribution-to-investment ratio at the same age: five with a higher ratio and five with a lower ratio.[15] We average the final performance (value-weight) within each matched group of mature funds and assign this performance to their matching young fund. We then average this expected performance across all young funds of a given vintage year. We find that funds raised in 1997 and 2001 have reasonably high expected performance. These two years are also those during which the *lowest* amount of capital was raised. The expected average IRR is above 15% for both vintage years. Funds raised in 1998, 1999 and 2000 are, in contrast, expected to have an IRR of about 11% and a PI of about 0.85. When we aggregate across all vintage years, the expected IRR is 12.3%: 4% lower than the average IRR of the quasi-liquidated funds. The expected Profitability Index is between 0.78 and 0.91 depending on the treatment of residual values.

To summarize, our findings suggest that the most recent funds are likely to have difficulty generating the same returns as those achieved by our sample of quasi-liquidated funds. In addition, these funds that appear to have the lowest prospects — those raised in 1998, 1999 and

[15] There are two exceptions. First, when a fund has a ratio equal to 0. In this case, we match it to all the funds of the same age that had a ratio of 0. Second, when a fund has a ratio in the top 10. In this case, we match it to the group of the 10 highest ratios (at the same age).

2000 — raised and invested very large amounts of capital by any historical standards. Overall, we expect those funds to post returns 4% below the return of funds raised between 1980 and 1996. The performance of recently raised funds is not included in the after-correction performance estimate given in the previous subsection. If we were to conjecture a final estimate, we could say that young funds are expected to have an IRR that is 4% less than quasi-liquidated funds and given that they have raised three times as much capital as the mature funds, we could roughly estimate overall IRR to be about 9.5% after correction, which is close to the yield of AAA-corporate bonds over the same period (1980-2003).

B. Risk corrections

Both cash inflows and cash outflows are treated as flows that have the same risk as the S&P 500, an assumption that seems unwarranted. In practice, the takedown schedule is unknown and when a call is made, cash has to be delivered in days (see Appendix A.I.). In addition, results in Ljungqvist and Richardson (2003) show that cash calls are not related to the movement of the public stock market. That is, cash outflows (from the investor's perspective) have a beta close to 0 and thus should be discounted at the risk-free rate.[16] Doing so reduces performance substantially. The value-weighted PI (without any of the above corrections) goes from 1.05 (a slight underperformance) to a low 0.46. That is, private equity funds have returned less than half of the invested capital (in present value terms) even if we both treat residual values as an accurate estimate of the value of non-exited investments, do not correct for sample selection bias and aggregate performance with an upward bias.

In addition, the cash inflows (to investors) have been treated as cash flows with a beta of 1. This also seems a particularly optimistic assumption. Buyouts being highly levered (at least more than the S&P 500), they are expected to command a beta over 1. Similarly, venture capital investments are typically found to have a beta above 1 (Section 1). If we use the most conservative fund beta described in Phalippou and Zollo (2005), we obtain an average beta across funds of 1.3. This beta is constructed by assuming that buyouts have the same beta as the average beta of the publicly-traded stocks in the same industry and that venture capital investments have the same beta as the average beta of the smallest publicly-traded stocks in the same industry

[16] This assumes that the CAPM holds. If additional sources of systematic risk are present in the economy, then cash outflows might have a non-negligible exposure to them and appropriate modification of the discount rate should be made.

(bottom quintile). Hence, this beta does not take into account the high leverage of buyouts, which would automatically increase it. Using these estimated betas to discount inflows, the average PI goes from 1.05 to 0.72. Note that this risk adjustment is tentative as, in fact, the cash inflows should be seen as the payoff from a basket of options, making these adjustments very conservative and rendering the above documented low performance even more puzzling.

When we combine a beta of 0 for outflows and a beta of (on average) 1.3 for inflows, the estimated value-weighted average performance is drastically reduced as it reaches a staggering 0.3. That is, without correcting for either sample bias, aggregation bias or living-dead, but simply assuming some fairly reasonable betas, we obtain that private equity funds have destroyed more than two thirds of the capital allocated to them.

In addition, as described in Appendix A.I., investors commit a certain amount of money to private equity funds and part of this money will be called at an unknown time. This arrangement resembles a credit line granted to private equity funds. Such credit line has a cost that is not taken into account in the above analysis. For example, let us consider two investment vehicles that give the same distribution in Year 10. The first vehicle asked investors (in Year 0) to give 100 in Year 1 and 100 in Year 2. The second vehicle – as in a private equity fund – asked investors in Year 0 to commit 220 and, ex-post, called 100 in Year 1 and 100 in Year 2. If we compute performance as we did above, the two funds have the same performance. However, the first fund is obviously a better investment vehicle. The fact that private equity funds may not call all the committed capital creates an uncertainty that necessitates an extra premium.[17]

Finally, stakes in private equity funds cannot be readily sold to another investor. They are said to be illiquid, in contrast to stakes in the S&P 500 that are highly liquid.[18] This illiquidity should require an additional premium for private equity investors, similar to what Aragon (2005) finds for hedge funds.

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[17] Even when funds call all the capital, it is not guaranteed *ex ante* and, importantly, the timing of the capital calls is (mostly) unknown, making the present value of the capital called unknown *ex ante*.

[18] A secondary market might not exist because the information asymmetry between incumbent LPs and outside investors is very large. Nonetheless, in practice, GPs prevent the transferability of partnership stakes. A potential explanation is that GPs want to avoid a kind of information-based bank runs described by Jacklin and Bhattacharya (1988). Another explanation put forth by Lerner and Schoar (2004) is that when a GP raises a new fund, outside investors tend to suspect that incumbent investors do not reinvest either because of a liquidity shock or because the fund is a 'lemon'. This implies a higher cost of capital for follow-on funds. GPs thus want the first fund to be as illiquid as possible so that only LPs with a low probability of facing a liquidity shock invest. Such a model suggests that LPs have the lowest probability of a liquidity shock, which implies a relatively low compensation for illiquidity. On the other hand, Pratt (2000) reports evidence based on surveys, which suggests that discounts for illiquidity fall in a narrow interval between 25% to 30%. The required liquidity premium is thus unclear, but obviously positive.

C. Additional fees

There are additional expenses that LPs face when investing in private equity funds. Indeed, about 20% of LPs (see Lerner *et al*., 2004) hire gatekeepers. These intermediaries recommend attractive funds and charge about 1% of fund size and sometimes participate in the profits (typically with 5% to 10% carried interest). Moreover, if LPs need to liquidate their position before the closure of the fund, a penalty is charged. Finally, distributions are often made with shares rather than cash. These shares have a lockup period and LPs typically incur a severe price impact when selling these shares in addition to the direct cost of selling them (see Lerner *et al*., 2004: 358, Lerner, 1999, and Appendix A.II). None of these costs being reported in our dataset, we cannot compute their exact impact but can conclude that net performance to LPs is, in reality, lower than that reported in this paper.

6. Potential Explanations

The above evidence is perplexing. We find that investing in private equity funds was a negative NPV project under conservative assumptions. In this section, we speculate about potential explanations for this puzzle.

A. Learning hypothesis

Managing private equity investments requires skill, as GPs are active board members and make many strategic decisions. We thus expect learning to play an important role in performance. Consistent with this assertion, Kaplan and Schoar (2005) and Phalippou and Zollo (2005) find that experienced funds and US funds offer significantly higher performance. Kaplan and Schoar (2005) also find a puzzling performance persistence phenomenon in their dataset. We apply their methodology to our extended dataset and find very similar results. This finding is interesting because it shows that their result is robust to a correction for sample selection and holds in an extended dataset (over four times bigger than the KS dataset for this empirical test). We report the magnitude of fund persistence in Table 9.

Table 9

It is thus possible that by participating in inexperienced and hence poorly-performing funds, LPs tacitly obtain the right to participate in future more profitable funds. It is then possible

that the performance that we observe is not a good estimate of expected performance because it fails to account for this value of investing in future funds.

Investing in private equity equally requires skill. Limited Partners need to screen funds based on indicators of expected performance (e.g. past performance, quality of the management team). Results in Lerner, Schoar and Wong (2005) argue that there exists large differences in skills across institutional investors and that this significantly impacts performance. As the private equity industry is relatively young, it is then possible that the performance that we observe is low because it includes the learning costs for LPs. These costs might be recouped in the future.

These learning-based explanations should, however, be tempered by our finding that recently raised funds currently have very low performance (and raised very large amounts of capital by historical standards), there is generally no upward trend in the time-series of fund performance (Table 5) and removing first-time and second-time funds do not modify the finding of a strong underperformance of private equity funds [unreported result]. Nonetheless, performance disclosure has been rare in the past and might get more frequent in the future, it is thus possible that learning will be much faster and future performance better than what has been observed over the last 25 years.

B. Side benefits of investing in private equity funds

A potential explanation for the low performance of private equity funds is that LPs' objective may not be to maximize returns. Ljungqvist and Richardson (2003) recount that the LP who provided them with data invests in private equity funds in order to establish a commercial relationship with GPs: "…the Limited Partner's twin investment objectives (are) not only to obtain the highest risk-adjusted return, but also to increase the likelihood that the funds will purchase the services our Limited Partner's corporate parent has to offer." These side benefits include consulting work (e.g. for M&As) and underwriting securities for debt or equity issues. A recent study by Hellmann *et al*. (2005) corroborates this view. It argues that banks are strategic investors in the venture capital market as they use their venture capital investments to build relationships for their lending activities.

In addition, certain LPs invest in private equity to stimulate the local economy. This behavior is witnessed among pension fund managers in both the US and Europe.[19] Moreover,

[19] This is also reported by Lerner *et al*. (2005).

agencies such as the International Finance Corporation and the European Bank for Reconstruction and Development have spent many billions of dollars on private equity funds (Brenner, 1999). Similarly, the European Union has invested substantial amounts in as many as 190 private equity funds via the European Investment Fund (EIF), which is, "committed to the development of a knowledge-based society, centered on innovation, growth and employment, the promotion of entrepreneurial spirit, regional development and the cohesion of the Union."

We cannot estimate whether LPs are satisfied *ex post* with the total outcome (investment performance and additional benefits). Neither do we know how much these side benefits explain the current puzzle. It is, nonetheless, important to bear in mind that there are positive externalities of investing in private equity for certain investors.

C. Mispricing

The documented performance is so low that we naturally think that certain investors might have mispriced this asset class. Interestingly, Lerner, Schoar and Wong (2005) investigate whether LPs obtain different average performance when investing in private equity. They find wide heterogeneity that they mainly attribute to differences in skill. Therefore, one explanation for our findings is that certain institutional investors have misvalued this asset class due to lack of skill. Results in Lerner, Schoar and Wong (2005) directly spot banks as the most biased investors.

We also note that this asset class is relatively new and payoffs are highly skewed (see figure 2). Investors might then attribute too much weight to the performance of a few successful investments such as Microsoft. Along these lines, we note that both hedge funds and entrepreneurial investment in non-public companies, whose performance distribution resembles that of private equity funds, are also found to have relatively low performance (Malkiel and Saha, 2005, Hamilton, 2000, and Moskowitz and Vissing-Jorgensen, 2002).

Another possibility is that investors might not realize the full impact of the fee structure on performance given that: performance gross of fees is relatively high (see Section 1); fees are typically ignored in prospectuses used to raise funds (memorandum);[20] and, fees are not salient.[21] Moreover, fees may initially appear to have a minor impact as they typically consist of a quasi-

[20] GPs typically report past performances independently for each investment and gross of fees.

[21] Barber *et al*. (2003) argue that investors do not pay attention to non-salient fees, such as those charged by private equity funds. Indeed, LPs do not pay fees directly, as they are typically deducted from the cash distributions. Note,

fixed component of 2% per year (first six years) and of a variable component of 20% of the profits (carried interest). Such fees can, however, have a large impact on performance. For example, a GP that generates a 100% return over five years for each investment provides a net IRR of only 7% per year.[22]

The above proposed sources of errors are, however, highly speculative and should be treated as such. We nonetheless have casual evidence that such mistakes are not rare in practice.

7. Conclusion

This paper sheds light on the return distribution offered by the private equity industry over the 25 years of its existence. We show that the performance of private equity funds is lower than the performance of the S&P 500 by more than 3% per year. This result has important implications for asset allocation as private equity is now a major class of financial assets. The important role played by the principal PE investors (e.g. pension funds, endowment funds) in the economy also adds to its significance. The potential misevaluation of private equity investments can have significant real consequences. Governments, which also often encourage and sometimes directly finance private equity investments, should also take note of our findings. Finally, a debate as to whether private equity funds should be regulated is currently underway. In the US, because the industry caters exclusively to "sophisticated" investors, it has avoided regulation. If, however, these "sophisticated" investors are mislead by current reporting practices then regulation from authorities such as the SEC may be warranted.

An interesting area for further research is to understand why investors allocate large amounts to this asset class given such a low performance. Particularly interesting questions appear to be: to what extent have apparently sophisticated institutional investors mispriced this asset class? And what is the size of externalities of private equity investments?

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however, that the investors in Barber *et al*. (2003) are individuals and are thus less sophisticated than private equity investors.

[22] A fund is created in January 1980 with *6.X* committed. In January 1981, 1982, 1983, 1984, and 1985, it invests *X*. Each deal is held for 5 years and results in a cash inflow of *2.X* in January 1986, 1987...1990. In January 1990, the fund is liquidated. The fund's IRR is 14.9%. If we assume that for the first 5 years, fees are 2% of fund size (*6.X*) payable at the end of the year and that the carried interest is 20% per deal. This typical fee structure halves the IRR (7.4%).

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Appendices

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 in existence 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 by Venture Economics 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 Private Equity investments through its VentureXpert database, starting from 1980. 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. This dataset is denoted by Vxpert in the text. Data on investments obtained from Vxpert 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), the fund (fund size, investment focus, year of inception or "vintage") and the GP (age, size, location).

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 and its market research activities in the Private Equity industry over the past decades. However, despite all these efforts, a complete coverage of all investments by all funds remains difficult to achieve. Unfortunately, we cannot complete this dataset with other data sources at our disposal without violating our confidentiality agreements. 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) highlighted the inaccuracy of the Vxpert dataset for a sub-sample of VC investments. Their study points out that for this sub-sample, discrepancies arise from the treatment of milestone rounds; many are missing in the dataset (15% in terms of amount invested) but 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 using a sample of biotechnology firms. 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).

Table 1: Descriptive Statistics – Sample Characteristics

This table gives descriptive statistics of two samples as of December 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) and median of the amount invested by funds in millions of dollars (Invested); (ii) the proportion of first-time funds; (iii) the proportion of non-US investments (in number); and, (iv) the average sequence number of a fund within its family. Finally, we report the number of observations for each sub-sample. The two samples consist of: the universe of funds in Venture Economics raised between 1980 and 1996 (Sample 0) and the quasi-liquidated funds raised between 1980 and 1996 (Sample 1). A fund is considered quasi-liquidated if it has cash-flow information and is either officially liquidated or has no cash-flow from January 2002 to December 2003.

	Sample 0 Universe			Sample 1 Quasi-liquidated funds		
	VC	**BO**	**VC+BO**	**VC**	**BO**	**VC+BO**
Mean Invested	71	208	100	58	224	104
Median Invested	22	46	25	38	83	40
First time (%)	39	52	42	39	33	37
Non-US (%)	12	27	15	17	46	24
Mean sequence n°	3.08	2.60	3.05	2.85	2.83	2.84
N° of obs.	2214	630	2844	709	274	983

Table 2: Fund Performance

This table reports performance statistics of quasi-liquidated PE funds raised between 1980 and 1996. We report performance for the group of quasi-liquidated funds. The performance measure used is the profitability index (PI) based on actual cash flows and residual values as of December 2003. These residual values are treated as a cash distribution of the same amount in December 2003. Cash flows are discounted with the S&P 500 Index when computing profitability indices (present value of cash distributed by the fund divided by the present value of cash called by the fund). We report performance percentiles (25th, 50th, and 75th) as well as the value-weighted (VW) and equally-weighted (EW) performance measures. When value-weighting, we use the capital committed to the fund as weight.

	PI			IRR		
	All	Venture	Buyout	All	Venture	Buyout
25th-Percentile	0.42	0.37	0.51	0.47	0.21	1.29
50th-Percentile	0.68	0.64	0.81	7.07	6.34	9.60
75th-Percentile	1.02	0.99	1.09	15.92	14.95	18.31
EW-Average	0.90	0.88	0.95	12.19	11.31	14.46
VW-Average	1.05	1.15	0.99	16.24	16.62	15.98

Table 3: Estimation of Selection Bias

This table reports the results of a Heckit estimation. The first step consists in estimating via Probit the selection equation. The dependant variable is a dummy variable that takes the value 1 if the fund is in the sample and 0 otherwise. The independent variables are fund characteristics: proportion of investment exits through IPO (% IPOs) and bankruptcy (% Bankrupt), proportion of investments still active, proportion of non-US investments, proportion of venture-capital investments, the natural logarithm of the total amount invested, and the natural logarithm of the sequence number of the fund in his private equity firm family (sequence). Results when the estimation is done by OLS are also reported. A constant is included but not reported in both regressions. From the first step, "lambda" (i.e. the inverse of Mill's ratio) is computed for each fund and an OLS regression of fund profitability indices on fund lambda is operated for the in-sample funds. From this estimation, the expected performance for in-sample and out-of-sample funds can be deducted and is reported at the foot of Panel A. In Panel B, we report the median and mean of each fund characteristic for both in-sample and out-of-sample funds.

Panel A: Model for Inclusion in the Quasi-liquidated Sample

	Dependent variable: $\mathbf{1}_{\text{(if in sample)}}$	
	OLS	Probit
% IPOs	0.06	0.20
	1.53	*1.63*
% Bankrupt	-0.09	-0.36
	-1.80	*-2.03*
% Active	-0.22	-0.70
	-5.32	*-5.31*
% non-US	-0.06	-0.22
	-1.50	*-1.52*
% Venture	0.16	0.53
	4.23	*4.31*
Invested (ln)	0.04	0.12
	4.86	*4.92*
Experience (ln)	0.01	0.02
	0.57	*0.58*
N° obs.	1 933	1 933

Performance model: $PI_i = 0.24 + 1.33\ lambda_i + u_i$ (1.15) (3.46)

Expected $PI_{in\text{-}sample} = 0.92$

Expected $PI_{out\text{-}sample} = 0.88$

Panel B: Characteristics of the Two Samples

	Median		Mean			
	Out sample	In sample	Out sample	In sample	Mean difference	*t*-stat
% IPOs	0.22	0.30	0.29	0.33	0.04	*3.02*
% Bankrupt	0.06	0.10	0.15	0.13	-0.02	*-2.40*
% Active	0.42	0.31	0.44	0.35	-0.09	*-7.36*
% non-US	0	0	0.10	0.07	-0.03	*-3.38*
% Venture	0.94	0.95	0.76	0.83	0.07	*5.56*
Invested (ln)	3.32	3.57	3.36	3.51	0.15	*2.21*
Experience	0.69	0.69	0.77	0.85	0.12	*1.92*
N° obs.	1 391	542	1 391	542		

Table 4: Present Value of the Private Equity Portfolio and Final Wealth

This table gives the monthly cash-flow stream of an investor having bought part of the private equity portfolio (either 0, 25%, 50%, 75% or 100%) and having invested the rest of her wealth in the S&P 500. The right-hand side figures show the value of the portfolio invested in the S&P 500 at the end of each month. We assume that each cash flow given by Venture Economics for a given month occurred at the end of that month. The private equity portfolio consists of either the 983 quasi-liquidated funds raised between 1980 and 1996 (Panel A) or the 513 quasi-liquidated funds raised between 1988 and 1996 (Panel B). The initial wealth is $10 billion and all figures are in million of US dollars. The total residual value of these funds as of December 2003 is also reported. The starting date is 1 January 1980 in Panel A and 1 January 1988 in Panel B.

Panel A: Funds Raised between 1980 and 1996

Initial wealth:		**10 000**	Wealth at date *t* as a function of the proportion of the private equity portfolio held				
Date *t*	Cash-flow	Ret. S&P	0	0.25	0.5	0.75	1
Jan-80	-7.5	0.0614	10 614.1	10 612.23	10 610.35	10 608.48	10 606.6
…	…	…	…	…	…	…	…
Sept-03	41.7	-0.0107	199 521.7	190 837.5	182 153.2	173 469.0	164 784.8
…	…	…	…	…	…	…	…
Dec-03	**29.3**	**0.0518**	**223 578.5**	**213 854.6**	**204 130.6**	**194 406.6**	**184 682.6**
Res. value	27 227		223 578.5-184 682.6 = 38 895.9				

Panel B: Funds Raised between 1988 and 1996

Initial wealth:		**10 000**	Wealth at date *t* as a function of the proportion of the private equity portfolio held				
Date *t*	Cash-flow	Ret. S&P	0	0.25	0.5	0.75	1
Jan-88	-168.8	0.0427	10 427.1	10 384.9	10 342.7	10 300.5	10 258.3
…	…	…	…	…	…	…	…
Sept-03	41.7	-0.0107	60 461.32	55 599.29	50 737.25	45 875.22	41 013.19
…	…	…	…	…	…	…	…
Dec-03	**29.3**	**0.0518**	67 751.29	62 310.36	56 869.42	51 428.49	45 987.55
Res. value	27 227		67 751.29 – 45 987.55 = 21 763.7				

Table 5: Aggregation of Performance

This table reports performance per vintage year and shows various overall performance estimates. In Panel A, we report for each vintage year: the number of funds in our sample (quasi-liquidated funds); the total capital committed to these funds (K Com., in million); and the average performance of the funds raised in that vintage year. Performance is either value-weighted or equally-weighted and is either measured by IRR or PI. At the foot of the Panel, we also report the average performance across vintage years if we equally-weight each vintage year. In Panel B, we aggregate the cash flows of all the funds raised in a given year and report the PI and IRR of this aggregated cash-flow under two assumptions: residual values are equivalent to cash in-flows of the same amount in December 2003 and residual values are worthless (*i.e.* they are written-off). We also report the present value (in $ million, as of December 2003) of the total amount invested (*i.e.* taken) and distributed by all the quasi-liquidated funds of a given vintage year. At the foot of Panel B, we report average performance across vintage years if we equally-weight or value-weight (by K Com.) each vintage year.

Panel A: Average Performance of Funds per Vintage Year

Year	N° funds	K Com.	EW-IRR	VW-IRR	EW-PI	VW-PI
1980	22	1 901	15.3	22.5	0.98	1.22
1981	27	892	8.6	10.7	0.66	0.74
1982	33	1 219	3.2	5.0	0.44	0.49
1983	64	3 522	9.9	14.3	0.69	0.85
1984	81	4 250	7.1	14.3	0.59	0.97
1985	73	3 349	11.0	22.9	0.91	1.35
1986	65	4 253	8.1	10.3	0.80	0.89
1987	105	8 265	7.2	11.8	0.77	0.89
1988	81	11 099	8.0	12.0	0.75	0.92
1989	99	7 152	8.7	15.4	0.90	1.11
1990	54	7 124	12.9	18.4	0.94	1.06
1991	50	5 281	11.2	13.6	0.84	0.96
1992	33	4 298	14.7	14.8	1.01	1.00
1993	52	4 859	13.5	13.2	1.08	1.03
1994	51	7 508	15.4	19.3	1.01	0.96
1995	43	5 317	25.9	34.6	1.38	1.54
1996	50	6 618	43.2	18.2	1.93	1.47
Total	983	86 909				
EW-Mean			13.2	16.0	0.90	1.00

Panel B: Performance of Funds Aggregated at the Vintage Level

Year	RV	Taken	Dist.	Agg PI with RV	Agg IRR with RV	Agg PI no RV	Agg IRR no RV
1980	45	22 084	26 678	1.30	21.2	1.30	21.2
1981	62	12 823	9 351	0.72	11.7	0.71	11.6
1982	105	14 395	6 515	0.44	5.4	0.43	4.9
1983	204	33 890	27 481	0.79	12.3	0.78	12.1
1984	586	38 494	36 429	0.96	15.3	0.94	15.1
1985	227	25 871	33 961	1.39	23.6	1.38	23.5
1986	595	25 284	21 443	0.85	12.3	0.82	11.9
1987	1 015	39 271	33 131	0.81	10.7	0.78	10.0
1988	1 199	45 138	40 703	0.91	13.3	0.87	12.7
1989	1 653	32 778	29 578	0.94	13.6	0.88	12.6
1990	1 732	24 727	24 516	1.09	18.0	0.99	16.8
1991	2 756	14 999	12 368	1.01	16.7	0.75	12.9
1992	1 303	11 197	9 799	0.99	18.5	0.85	16.2
1993	3 356	11 380	8 271	**1.03**	**17.0**	**0.63**	**10.2**
1994	4 388	15 221	8 447	**0.82**	**12.2**	**0.48**	**-02.0**
1995	3 214	6 583	7 062	**1.81**	**36.5**	**1.10**	**29.6**
1996	4 786	8 293	7 810	**1.60**	**28.3**	**0.93**	**19.7**
Total	27 227	382 428	343 542				
EW-Mean				1.03	16.9	0.86	14.0
VW-Mean				1.05	17.0	0.85	13.6

Table 6: Performance after Corrections

This table reports the performance of the 983 quasi-liquidated funds raised between 1980 and 1996 after various corrections are operated. Profitability indices are computed using the return on the S&P 500 portfolio for both inflows and outflows. Size-weighted averages use capital committed as weight, deflated size-weighted use capital committed in 2003 US dollars as weights.

Performance as of December 2003	IRR	PI
Size - weighted	16.24	1.05
Deflated size - weighted	15.90	1.04
Present value of investments - weighted	14.35	0.97
Aggregation	14.08	0.88
Correcting for sample selection bias	13.54	0.94
Halve subjective residual values (+ Aggregation)	14.47	0.86
Correcting for sample selection bias (+ Aggregation)	13.42	0.82
Correcting for sample selection biases (+ Aggregation + Halve residual values)	12.44	0.73
Average yearly performance (1980-2003) of:		
S&P 500	15.25	
US stock-market portfolio	14.48	
AAA – Corporate bonds	9.06	

Table 7: Treatment of Residual Values

This table shows how residual values of funds have been converted into cash flows for a sample of fully liquidated funds. At each age (starting at age 7), we look at the amount reported as residual value is given by our sample of liquidated funds and compare it to the present value of the future net cash flows from that age onward. In Panel A, we show at each age what is the total residual value reported by funds, the present value of the subsequent net cash-flow stream (distribution minus take) and the non-discounted sum subsequent net cash-flow stream; all the figures are in billion. In Panel B, results from independent OLS regressions are presented (one for each age). The dependent variable is the present value of the subsequent net cash-flow stream and independent variables include the residual value reported by the fund, its size, its sequence number, a dummy variable that is one if the fund is European focused, a dummy variable that is one if the fund is Venture focused, the number of months since the last cash call (take), the number of months since the last distribution and the ratio of residual value to total capital invested. A constant and the inverse of Mill's ratio (lambda) are included in all regressions but are not reported.

Panel A: Summary statistics

Total residual value	PV (distribution – take)	Sum (distribution – take)	Age
23.95	22.45	33.99	7
19.06	16.70	25.28	8
14.97	13.82	19.75	9
13.01	10.75	14.59	10
9.49	7.79	9.87	11
5.34	4.02	4.98	12
4.04	2.71	3.08	*13*
1.66	0.85	1.00	*14*
1.23	0.44	0.48	*15*
0.95	0.30	0.29	*16*
0.58	0.23	0.21	*17*
0.36	0.03	0.04	18
0.14	0.04	0.04	19
0.10	0.00	0.00	20
0.04	0.00	0.00	21
0.01	0.00	0.00	22

Panel B: Independent OLS regressions – Corrected for sample correction
Dependant variable: Present value (future distribution – future take)

	At age 7		...	At age 10	
	Coef.	t-stat		Coef.	t-stat
Residual value (ln)	0.712	9.04		0.919	15.19
Size (ln)	0.381	4.14		0.078	0.92
Sequence (ln)	0.048	0.48		0.128	1.08
European	-0.077	-0.56		0.162	1.01
Venture c.	0.347	2.46		0.068	0.40
Last take	-0.002	-0.72		0.000	0.16
Last dist.	-0.008	-2.68		-0.011	-3.30
RV/CI	0.026	0.17		-0.142	-0.81
N° obs.	384			282	
R-square	68%			72%	

Table 8: Performance of Young Funds

This table compares the young funds, *i.e.* those with vintage years from 1997 to 2001, to mature funds (vintage years before 1996) at the same age. For example, the situation of funds raised in 1997 (six years old as of December 2003) is compared to the situation of mature funds in December of their sixth year. The number of funds and the sum of the committed capital for each vintage year for young funds are reported in billions of 2003 dollars. The following ratios are displayed for both young and mature funds: total capital called (Called) to total capital committed (Com), and total cash distributed (Dist) to Called. Each young fund is matched to a group of mature funds (typically 10) that had the closest Dist-to-Called ratio at the same age. Each young fund's expected performance is equal to the (value-weighted) average final performance of the group of mature funds. Performance of mature funds is measured either with the residual value treatment as a cash flow of the same amount as of December 2003, or with the residual value written off. IRR and PI are used as performance measures.

	Mature funds at this age		Young funds of these vintage years				Expected performance (value-weighted average based on matched mature funds)		
Vintage year (age)	Called to com.	Dist. to called	Nber	Capital com. (billion)	Called to Com.	Dist. to Called	IRR (RV)	PI (RV)	PI (no RV)
1997 (6 y)	0.92	0.89	170	64	0.80	0.72	16.32	0.97	0.78
1998 (5 y)	0.90	0.71	201	104	0.85	0.39	11.64	0.80	0.70
1999 (4 y)	0.85	0.52	232	97	0.73	0.22	9.64	0.86	0.76
2000 (3 y)	0.76	0.32	271	142	0.50	0.13	10.94	0.88	0.76
2001 (2 y)	0.64	0.19	151	80	0.39	0.13	15.45	1.12	0.98
Overall			1 025	487			12.28	0.91	0.78

Table 9: Performance Persistence

This table reports the probability that a fund will fall into a given performance tercile conditional on the performance terciles into which the fund previously raised by the same family fell. The performance measure is the PI taken with respect to the S&P 500 and assuming that residual values are an accurate estimate of the value of non-exited investments. The sample includes 1 770 funds (family that raised only one fund are eliminated), of which 933 are quasi-liquidated and 837 are additional funds for which we infer performance using the Heckit procedure (Table 3).

Performance terciles (Transition matrix)		Next fund		
		Lower tercile	Medium tercile	Upper terciles
Current fund	Lower tercile	43%	29%	28%
	Medium tercile	30%	41%	29%
	Upper tercile	26%	32%	42%

Figure 1

Capital Raised by US and European Private Equity Funds: 25 Year Perspective

In 2002 millions of US dollars, Total raised: $783 billion

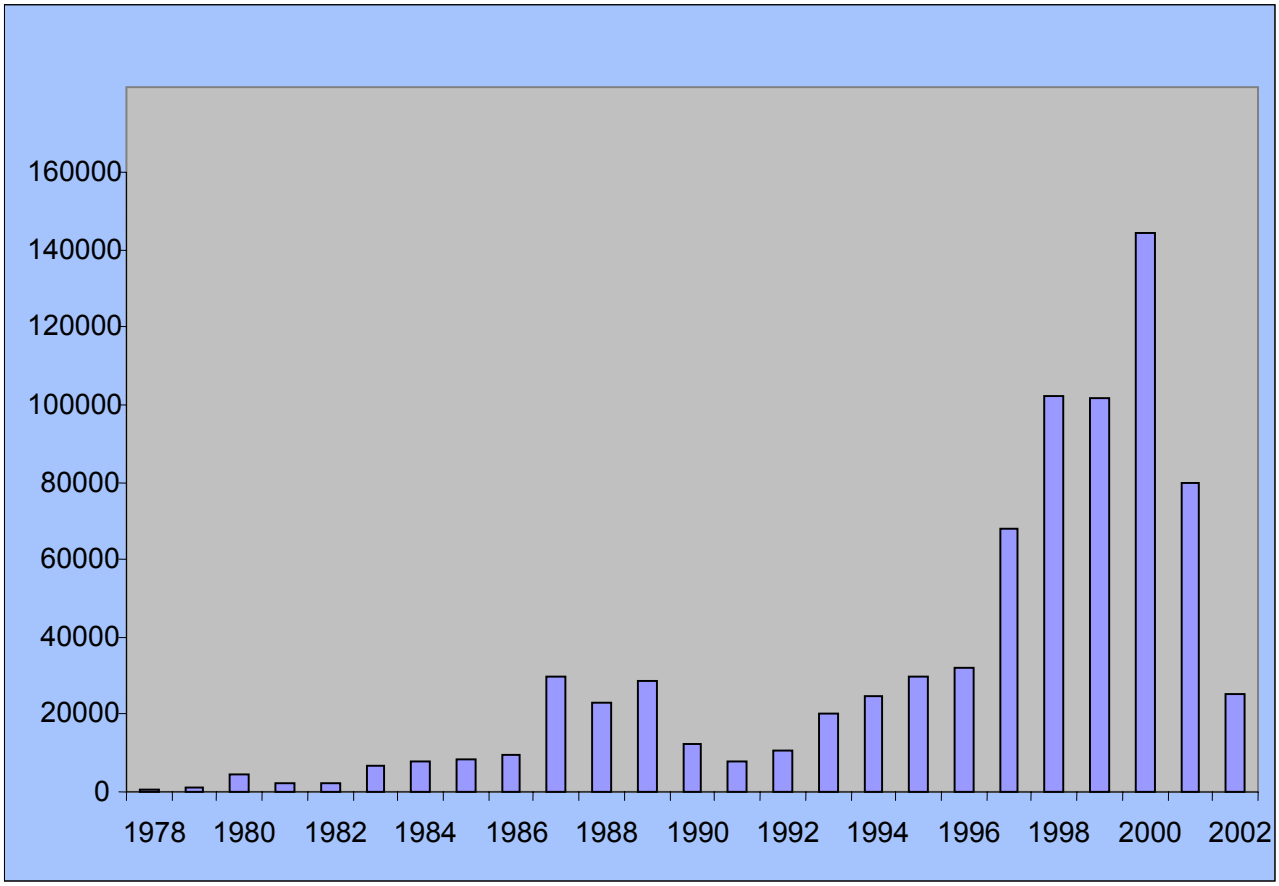

Figure 2

Frequency at which Profitability Indices fall in a given range

'Living-dead' residual values are eliminated; the other residual values are taken as accurate market value of non-exited investments. There are 983 observations (fund profitability index), mean is 0.86, standard deviation of the mean is 0.03. Ln(0.05+PI) is close to normally distributed with mean -0.48 and a standard deviation of the mean of 0.03.