The Risk Profile of

Private Equity Fund-of-Funds

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ABSTRACT

Private equity fund-of-funds (FoF) investments are now contributing more than 10% of the capital to private equity, i.e. venture capital and buyout. However, their risk profile is not well understood due to the opaque and illiquid market, and the limited access to performance figures. FoFs need to understand their risk profile, if they are to convince potential investors of their lower risk. Research on direct and funds investment exists. Directs show significant variability of returns with a significant probability of a total loss and extreme profits. Funds are less risky, because they invest in up to twenty direct investments. We show that FoFs even further significantly reduce the risk due to diversification. To this aim, we present a framework to construct the risk profile of FoFs using funds performance data. We also discuss the choosen data source, and the results of the simulations.

INTRODUCTION

A fund-of-funds (FoF) collects capital from investors to invest in about 20 or more funds on their behalf. FoF investors are typically pension funds, banks, insurance companies, corporate investors, and other FoFs. The first private equity FoF was raised in 1978. FoFs have increased their share considerably over the last years, and now provide around 10% of the capital of funds. In 2002, 67 FoF managers existed in the US, and 49 FoF managers in Europe. They manage about $130 billion. FoFs allow investors to easily invest and diversify on a global basis. They typically charge a management fee of around 0.5% per year, and participate in the profits with 5% to 10%. Internal cost savings for the FoF investor and the FoF manager's added value partially or more than fully compensate these fees, which are often wrongly perceived as fees on fees.

A FoF, which has a portfolio of funds, should have a reduced risk in comparison to a single funds investment due to a non-perfect correlation between funds. A fund has about 20 direct investments in its portfolio, and a FoF, e.g. with 20 funds, has 400 direct investments. Thus, FoF investors should have clear diversification benefits through a second level of diversification, and can also consist of small and medium-sized investors. The aim of this paper is to clarify the diversification benefits. It is difficult to find historical FoFs return data. Therefore, historical FoFs need to be modeled. Historical FoF are constructed by creating portfolios of historical funds that are randomly selected from the VE database while respecting the timeline. Fifty thousand such portfolios are created, and the historical distribution of a FoF is obtained. For example, to create a set of historical FoF with two funds invested over two years, two funds would repeatedly be randomly selected from the historical funds for each of two consecutive vintage years. Both years are sample in the sample portfolio to give each vintage year the same weight. Our data source is the Venture Economics database, with 282 (195) European and 745 (401) US VC funds (buyout funds). The results show the advantages of an investment in a FoF comparable to a single fund. Therefore, FoFs have higher returns and lower distributions of returns than direct investments. The diversification effect by increasing the number of investments is larger than the effect by increasing the investment period. Contrary to individual funds, European FoFs seem to provide better investment opportunities to an investor than the US counterpart. American buyout funds have a lower level of risk than VC funds. This relationship does not apply for the European market.

FRAMEWORK

It is needed to construct historical FoFs, because performance data on historical FoFs does not exist, and standard portfolio theory cannot be used for model FoFs using funds. Firstly, continuous transaction-based pricing does not exist for funds. Fluctuations of VC funds values do therefore not necessarily reflect any intrinsic variability of returns and hence an underlying risk. Secondly, returns of VC are not normally distributed, which violates a major assumption of standard portfolio theory. And finally there is no reliable data on correlations available, especially at the level of funds.[1] As standard concepts of financial theory are not applicable for the construction of VC portfolios, other techniques to analyse the risk profile of this asset class have to be applied. For that reason Monte Carlo simulation is used to compute the performance of FoFs.

To construct a historical fund, a hypothetical FoF is situated in a chosen year, and funds are assigned, in which it could have invested during its investment period, to its portfolio. Every fund is drawn only once. The performance of the FoF is the average performance of the underlying funds. Ideally, all possible combinations of the portfolio of a FoF should be constructed. However, this is not feasible. For example, a FoF with only two funds in its portfolio and with a dataset of 100 funds has 100! (i.e. 100*99*98…) combinations, which is much higher than one million. Therefore, a simple Monte Carlo simulation is used, which results in randomly choosing the year, and the funds within a year. The more portfolios are constructed randomly, the closer the sample comes to the population of all possible combinations. The simulation with 50,000 historically possible FoFs delivers a very good approximation to the population of all possible combinations. FoFs are simulated of up to 50 funds invested within a five year investment period. The sample of the performance of the constructed FoFs contains all information needed for the risk

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[1] Several authors tried to calculate correlations between VC and public markets. Terhaar et al. [2003] for example use a factor approach to build a set of return and risk characteristics for conventional and alternative assets.

profile, e.g. average performance and standard deviation. Additionally, the probability of losing capital and the average loss in case a loss of capital is being recorded.

A historical analysis of FoFs would imply that we keep the historical proportion of FoFs for each vintage year. In the past, the number of FoFs has significantly increased, and all historical funds would be considerably biased towards the past few years. Therefore, we will treat every vintage year equal, and assume a constant number of FoFs for each year.

An important issue remains: Is the risk profile of a fund influenced by factors like stage, market, size, and vintage year? If this is the case, we need to distinguish between different FoF types. For example, if the difference between the US sample and the European sample is statistically significant, we consider this in the construction of FoFs. Thus, US FoFs and European FoFs have to be treated differently. A statistical analysis needs to be done on the data source to determine performance influencing factors. The link between performance and vintage year is more difficult. Due to the insistence on a historically feasible selection of funds, the vintage year is automatically taken into account. If no correlation between vintage years and performance is found, it will be possible to relax this constraint and randomly select the funds from all vintage years.

The performance of a fund is only a summarising snapshot of the many cashflows of the fund, and the timing and amount of the cash flows is not reflected in this framework. Unfortunately, the VE database does not deliver any specific information on the cash flow.

DATA SOURCE

Database

Possible data sources are VentureXpert from Venture Economics, CEPRES from VCM and the database from Cambridge Associates. The following analysis uses the VentureXpert database. Venture Economics is probably the largest provider of VC data. Observation period stretches from 1983 to 2003. The dataset for the last 20 years will be assumed representative for the future long-term performance of private equity. The number of all venture capital funds observed in this sample amounts to 1,969 for the US and 702 for Europe, of whom 745 US and 282 European funds disclosed performances. For the buyout funds 1,187 for the US and 286 for Europe were observed, of whom 401 US and 195 European funds disclosed performances.

The sample consists of all funds older than five years from 1983 onwards. Thus, the youngest funds are of vintage year 1998. A fund should be at least five years old, because its interim performance expressed in interim internal rate for return (IRR[2]) is on average an underestimation of the final performance. The interim IRR is the IRR of a fund´s past cashflows and its net asset value as the last cash flow. This underestimation is due to set-up costs, management fees, and at cost valuation. The net asset value (NAV) of the fund is kept at cost first, but setup costs and management fees are deducted. The effect is shown in exhibit 1. The averaged-over-all-funds interim IRR follows the J-curve and returns on investment are negative in the first years. Thus, a meaningful prediction regarding the performance of funds is only possible after five years. And the error of judgment is greatest the first five years. While the IRR continuously increases within the first four years in Europe, it seems to remain relatively constant in the US. This might partially stem from different fee and accounting structures in both markets.

Bias

As successful and unsuccessful direct investments are linked together to the performance of a fund, both are included and a selection bias does not arise (Chen, Baierl and Kaplan, 2002). As Venture Economics' dataset is based on voluntary reporting and performance is published only anonymously, reporting funds should have no incentive to bias their performance data. Other potential sources of bias are funds that stop reporting if their returns decrease and funds that do not report their performance at all if the management expect to perform poorly. Kaplan and Schoar [2003] suggest that these biases do not occur in the VE database.

The number of funds in the Venture Economics dataset varies for different vintage years. Concerning our simulation, a low number of data for a vintage year may lead to two different sources of error. Firstly, statistical error, i.e. the fluctuation margin of a result, increases. Secondly, a systematic bias becomes

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[2] The IRR is the implied discount rate that makes the net present value (NAV) of all cash flows zero: $0 = \sum_{i=1}^{T} \frac{CF_i}{(1+IRR)^i}$
CF = net cash flow = distributions – drawdowns in all periods except for the last period in which net cash flow = NAV + distributions – drawdowns, i = cash flow sequence

increasingly likely with lower coverage in a vintage year. In contrast to the European dataset (minimum number of funds in a year: 4 in 1993), the US data show a relative high coverage (minimum number of funds: 18 in 1991).

Measures

Private equity associations (EVCA, BVCA) recommend the IRR as the most appropriate performance measure for funds. Interim IRRs are rather estimates than realized rates of returns. As funds mature, the degree of confidence in the IRR calculation improves. Definitive IRRs can only be calculated once a fund is liquidated. Furthermore, FoF IRRs can only be calculated by averaging the funds IRRs, because the underlying cash flows of the funds are not known. The methodology does therefore not reflect the true IRR of the portfolio, because it does not take into account the scale and timing of the underlying cash flows. However, even the average IRR does not reveal the actual value. Assumingly the results should not be biased to a large extent.[3] To figure out whether the bias indeed exists, the TVPI[4] performance measure is used as a control variable for the IRR. The TVPI is a cumulative realisation ratio, also called multiple. It is a measure of gross returns to invested capital. Unfortunately, it does not consider the time value of money and thus it does not incorporate the opportunity costs of capital. If the TVPI is larger than one, the investor turned the investment to a profit. The used performance measures are net amounts deducted by fees, expenses and carry.[5]

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3 This is supported by the fact that simulations using the TVPI performance measure show the same outcomes in general.

4 TVPI = DPI + RVPI with

$$DPI = \frac{Cumulative\ distributions}{Cumulative\ Paid-in\ Capital} \qquad RVPI = \frac{Residual\ value}{Cumulative\ Paid-in\ Capital}$$

5 Carry = carried interest = percentage of profits (generally 20-25%) that general partners receive out of the profits of the investments made by the fund.

STATISTICAL TESTS ON FUNDS FOR SIMULATION

Test of Normality

The Kolmogorov-Smirnov test checks for the normality of the funds performance. With a probability of 0.00, the funds performances are not normally distributed.[6] Therefore standard concepts of financial theory which imply normally distributed returns are not applicable for the construction of private equity portfolios.

Performance versus Size

The relation between performance and funds size was tested by correlation analysis and the Kruskal-Wallis test. The correlation analysis returned no correlation between performance and funds size for European funds and a small but statistically significant correlation for US funds. Larger funds seem to perform slightly better than smaller funds in the US. This finding is in accordance with Kaplan and Schoar [2003]. A possible explanation therefore is that successful fund managers are able to raise larger funds. It is not chosen to distinguish between funds of different size categories as the correlation of performance and funds size is only signifcant for the US market and the impact is relatively small.

Performance versus Stage

In compliance with the findings of Kaplan and Schoar [2003] no significant statistic difference in the performance between the early and the late stage funds for the European and the US market can be found.[7] This conclusion is contradictory to the general assumption that later stage deals are less risky than early stage deals. Significant differences between VC and buyout funds are found. Therefore the analysis of FoFs is done separately for VC and buyout funds and VC funds are examined as a whole.

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[6] The Kolmogorov-Smirnov Test is used to decide if a sample comes from a population with a specific distribution. The distribution of the Kolmogorov-Smirnov test statistic itself does not depend on the underlying cumulative distribution function being tested. As funds performance is not normally distributed non-parametric tests like the Mann-Whitney test and the Kruskal-Wallis test have to be used.

[7] In this case the Mann-Whitney test statistic was conducted.

Performance versus Vintage Year

It can be assumed that the performance of a VC funds depends on the year in which the fund was launched.[8] The funds performances show a cyclical pattern, especially for the US. In fact, this connection between vintage year and performance is actually proven to exist for both performance measures. Several authors claim that funds performance is linked to public equity market performance. This linkage seems reasonable as market conditions impact strongly the performance of venture backed IPOs, which is the most profitable exit strategy. Trade sales are also affected by public market conditions as company valuations are often based on multiples of comparable publicly traded companies. But on the other hand, a fund could also benefit from low purchase prices in a recession. Due to the strong linkage between performance and vintage year it was decided to implement a simulation scenario that considers that investments are done in following vintage years within a certain time period.

Performance versus Market (USA versus Europe)

US funds outperform European funds on average, but also show higher variation. The results of a Mann-Whitney test show that these differences between both markets are statistically significant. The performance gap could be explained by differences in contractual relationships in both markets. In general the US VC market is much more developed than the relatively young market in Europe. Furthermore, the US market has advantages in terms of experience, network effects and sophistication. Gilson and Black [1999] and Jeng and Wells [2000] argue that well developed stock markets are decisive for the existence of vibrant VC markets. Both papers claim that IPOs are the most important determinant of VC investing. While the US posses a stock-market centred system with an active IPO market, most European countries lack in a comparable industry. These varieties are supported by the different exit strategies seen in both markets. IPOs are the predominant exit strategy in the US whereas trade sales are the most common form of exit in the European market. These differences might also explain the outperformance of US funds as IPOs are the most profitable exit strategy (Bygrave and Timmons, 1992, and Jeng and Wells, 2000). While the European VC market in general has seen a substantial upswing since the mid 1990s large differences

[8] Bygrave and Timmons [1992] have shown that funds performance can vary clearly in consecutive vintage years

remain between the various European nations.[9] As different funds performances are found for both markets it was decided to analyze the risk structure of private equity FoFs separately for Europe and the US.

RESULTS

Distribution of Returns

Exhibit 2 and 3 visibly demonstrate the diversification benefits of FoFs. It can be seen that the distribution of FoF returns has much smaller tails and is less skewed than the distribution of individual fund returns. Thus, FoF investments bear less risk than individual fund investments. Despite the different underlying distributions of venture capital and buyout returns the simulaion of FoFs show similar pattern. The returns of the simulated portfolios with 20 funds seem to be nearly normally distributed. Exhibit 2 and 3 show that FoFs clearly limit the downside risk of VC investments. The probability of a negative FoF performance tends to zero.

Funds versus Fund-of-Funds

Exhibit 4 shows the IRRs of individual funds and simulated FoFs with a portfolio of 20 funds and an investment period of five years. The table confirms the results of the probability distribution shown in Exhibit 2 and 3. Comparing the returns of individual funds and FoFs it can be seen that the mean IRR is relatively similar for both, while the median IRR is much higher for FoFs. This is because the FoF distribution is much less skewed than the distribution of individual funds. The mean and the median IRR of FoFs are very close to each other, which imply a relatively symmetric distribution.

The risk as the standard deviation of IRRs is much smaller for FoFs compared to the individual funds. Exhibit 4 shows that the standard deviation for VC funds is decreasing from 27.47 to 5.53 in Europe and from 54.57 to 16.62 in the US for the FoF investments. The degree of the reduction of standard deviation is similar for buyout funds.

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[9] The largest and most developed VC market in Europe is the United Kingdom. Nearly 40% of the European funds of the used dataset are domiciled there.

USA versus Europe

The mean or median and the standard deviation offer different types of information used in evaluating performance, but they can lead to conflicting conclusions if considered independently. Therefore, a return-risk ratio comparable to the Sharpe ratio is calculated. This ratio, defined as the mean return divided by standard deviation, is an appropriate measure to compare assets with different standard deviations. The return-risk ratio measures the performance per unit of risk. The higher the ratio the more performance is gained per unit of risk. Exhibit 4 shows that the risk-return ratio is much higher for FoFs compared to individual funds in both markets. With a ratio of 1.65 for the European market and 1.37 for the US market, European FoFs seem to provide a better risk-return structure to an investor. With a value of 0.32 for Europe and 0.39 for the US, the ratio for individual VC funds is slightly higher in the US. Thus, the higher ratio for European FoFs might be explained by better diversification coming from a lower correlation across European VC funds.

Venture Capital versus Buyout

Buyout funds typically acquire certain classes of securities in strategically attractive companies in mature industries. As buyout funds invest in more developed companies, they should have a lower level of risk than VC funds. This relation seems to be valid for the US market where historical buyout funds have lower rates of returns and lower risk compared to VC funds. Exhibit 4 shows that in the US market the mean IRR and the standard deviation of VC funds and FoFs are approximately twice that of its buyouts counterparts. Interestingly, this relationship does not apply for the European market. In Europe buyouts have higher rates of returns and lower risk compared to their VC analogue. This abnormality is due for both, funds and FoF investments. One possible explanation is that VC is a relatively new business area in Europe and goes trough a learning curve effect, whereas buyout funds are well established. This assumption is supported by the fact that the risk/return profile of buyout funds is relatively similar in Europe and the US, whereas VC performances and levels of risk are very different in both markets. If the hypothesis of a learning curve effect in the European VC market is true, it should be expected that the abnormality between VC and buyout funds should be corrected within the next couple of years.

Diversification by Number

FoFs can clearly limit the default probability of VC investments. Exhibit 5 discloses the diversification benefits by enhancing the number of investments. The default probability as a measure of risk of a FoF portfolio decreases with the rising number of funds in its portfolio. This kind of risk is also called shortfall risk or downside risk. A large part of diversification benefits appear to derive from the first five funds. The more the number of funds in the portfolio increases, the more idiosyncratic risk is diversified. Thus the probability of loss for a FoF consisting of 20 VC (Buyout) funds lies at 0.01% (0.4%) for US funds and at 1.7% (0.001%) for European funds.

Exhibit 6 plots the average variance of FoFs returns for increasing portfolio sizes. As the number of funds in the portfolio increase the average variance converge against a non zero value. The reason for that is an idiosyncratic risk converging to zero. The observation period reveals that the average variance converges against 160 (29) for US and 12 (11) for European VC (Buyout) funds.

Diversification by Time

Exhibit 7 shows the cumulated probability distribution of portfolio IRRs for different investment periods. The probability of loss is decreasing by the length of the investment period. This diversification benefits are clearly smaller than those by number. The diversification effect by time is much stronger in the US than in Europe. This effect should be explained by the clear dependence on vintage years for the US sample.

Adjustment to Fees

All individual funds performances used for the simulation are net of fees. But investors who invest into a portfolio of funds have to pay an additional fee to the FoF manager over and above the fees paid to the partnerships. Typically, FoF fee ranges between one and two percent. The simulation process does not consider any FoF fees. However, it can be roughly considered a fee by simply shifting the probability distribution to the left. Looking at the results of Exhibit 2 and 3 it can be seen that FoFs still provide diversification benefits even if the probability distribution of portfolio returns is shifted about two percent to the left.[10]

Additionally, some FoFs gain a so-called carry, which will be charged if the performance exceeds a certain level. The carry is typically around five percent of the profits and cannot be implemented in the model as easy as the fees. The carry will slightly decrease the mean and standard deviation of the generated risk profile. However, it will not change the downside risk of VC fund-of-funds as it is only charged on the profits.

CONCLUSION

We show how to construct historically possible FoFs from fund performance data. This allows us to derive a probability distribution of historically possible FoF performances, and conclude on the risk profile of a FoF. The risk associated to a FoF investment is significantly smaller than the one for a fund investment.

[10] Alternatively, it can be also calculated an upper bound of fees for a FoF having the same risk-return ratio as individual funds. But using the risk-return ratio stated above, a linear relationship between risk and return is assumed. The result of this calculation shows that the risk-return ratios of VC funds and FoF would be equal if the fees are about 7% in Europe and about 14% in the US. These outcomes clearly demonstrate that FoF still have diversification benefits even if fees are considered.

EXHIBITS

EXHIBIT 1

J-Curve Effect

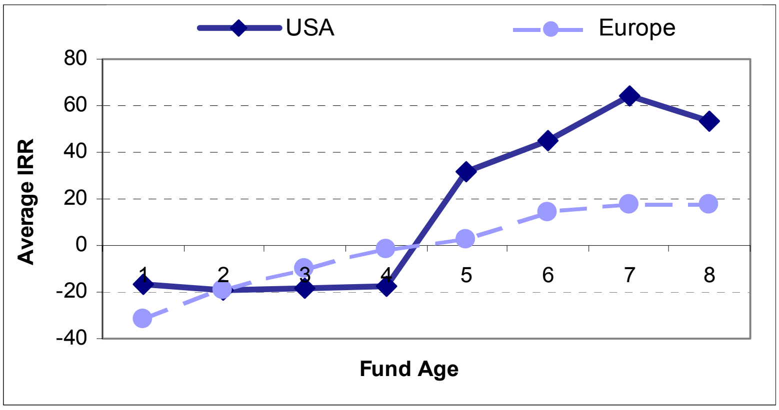


EXHIBIT 2

The Risk Profile of US VC Funds and Fund-of-Funds

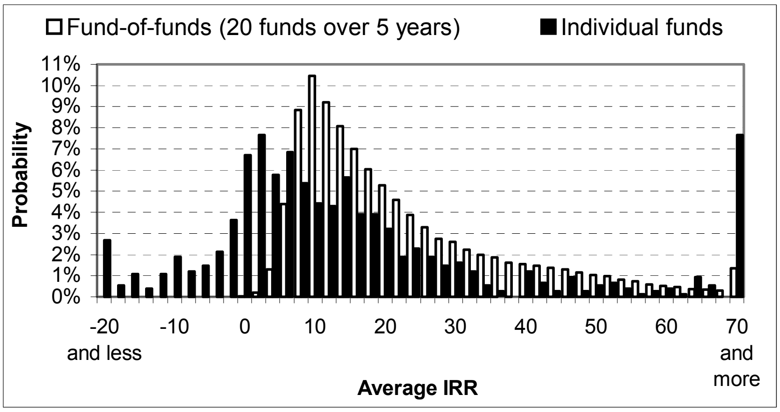


EXHIBIT 3

The Risk Profile of US Buyout Funds and Fund-of-Funds

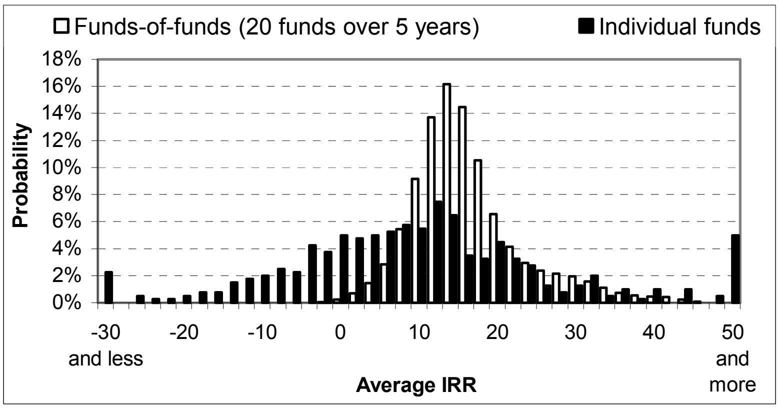


EXHIBIT 4

Performance of Funds and Fund-of-Funds

		Venture Capital		Buyout	
		Individual Funds	Fund-of-Funds	Individual Funds	Fund-of-Funds
USA	Mean IRR	21.32	21.40	10.83	15.29
	Median IRR	8.73	16.14	8.54	14.03
	Standard Deviation	54.57	15.62	26.19	7.72
	Ratio	0.39	1.37	0.41	1.98
Europe	Mean IRR	8.82	9.12	13.71	15.82
	Median IRR	4.35	8.15	10.27	14.91
	Standard Deviation	27.47	5.53	20.97	5.27
	Ratio	0.32	1.65	0.65	3.00

EXHIBIT 5

Diversification by Number: Cumulative Probability Curve

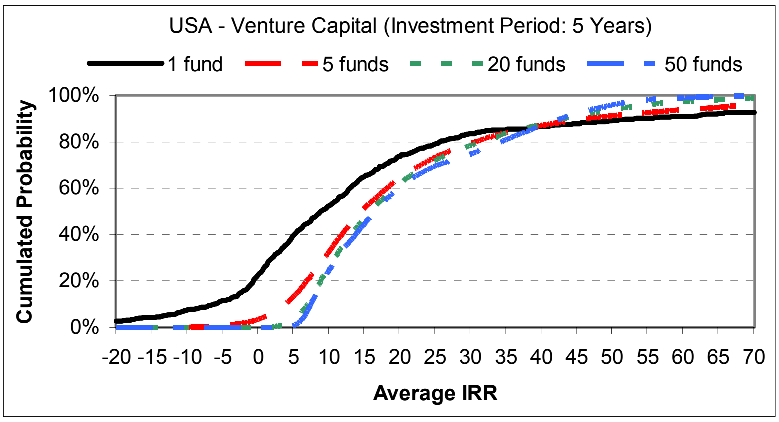


EXHIBIT 6

Diversification by Number: Convergence of Portfolio Variance

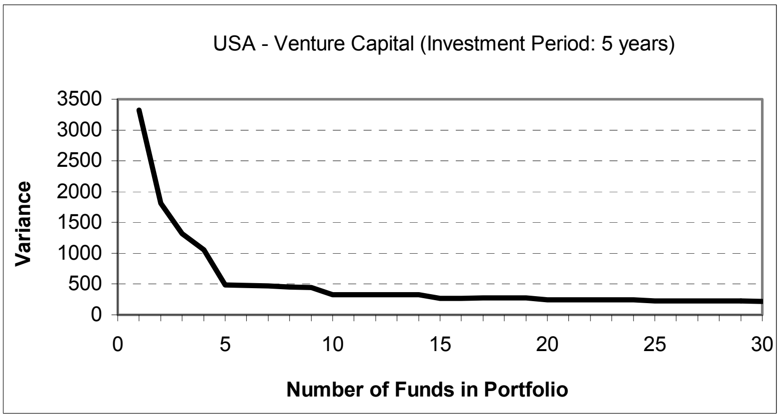
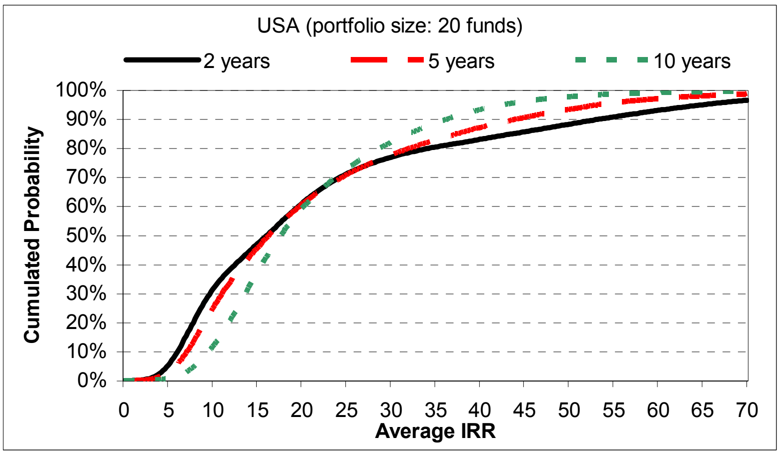


EXHIBIT 7

Diversification by Time: Cumulative Probability Curves



REFERENCES

Bygrave, D., and Timmons, J. (1992). Venture Capital at the Crossroads. Boston: Harvard Business School Press.

Chen, P., Baierl, G., and Kaplan, P. (2002). Venture Capital and its Role in Strategic Asset Allocation. The Journal of Portfolio Management, 28, No. 2, 83-89.

Gilson R., and Black, B.(Winter 1999). Does Venture Capital Require an Active Stock Market? Journal of Applied Corporate Finance, 36-48.

Jeng L., and Wells P. (2000). The Determinants of Venture Capital Funding: Evidence across Countries. Journal of Corporate Finance, 6, 241-289.

Kaplan S., and Schoar, A. (2003). Private Equity Performance: Returns, Persistence and Capital. NBER working paper, No. 9807.

Terhaar, K., Staub, R. and Singer, B. (Spring 2003). Appropriate Policy Allocation for Alternative Investments. The Journal of Portfolio Management, 29, No. 3, 101-110.