Risk-Adjusted Performance of Private Equity Investments

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Abstract:

We investigate the risk-adjusted performance of Private Equity (PE) investments on a sample of 133 transactions completed in the United States between 1984 and 2004. The benchmark for the risk adjustment is a levered mimicking strategy of investments in the S&P 500 Index. To set up the strategy, initial and final equity betas of the sample transactions were calculated, based on information usually not available to academic researchers. In calculating the betas, we specify the risk of debt and determine a method for “unlevering” and “relevering”. We conduct a sensitivity analysis and investigate the role of debt and operating risk on the performance of the mimicking strategy. Our results emphasize the necessity of correctly specifying the risk borne by lenders and in assessing PE investment performance. We find superior performance of the Private Equity investments expressed by significant positive Jensen alphas in some cases of the sensitivity analysis. The alphas are large and significant if Private Equity funds structure deals transferring a substantial part of the risk to the lenders. In general, it is not adequate to measure the performance of Private Equity investments without adjusting for leverage risks, nor it is possible to easily track Private Equity investments with public market securities.

Classification words: Private Equity, Venture Capital, Alternative Asset, Buyout, Performance Measurement

1. Introduction

Interest and investment in the Private Equity (PE)[1] asset class has grown exponentially in recent years. Advocates of the industry argue that it offers superior risk-adjusted returns compared to public market securities. Testing this theory has thus far been difficult, as we are missing both an appropriate theory to accurately describe the asset class, as well as sufficiently comprehensive data regarding PE transactions. In terms of the first constraint, certain characteristics of the segment distinguish it from the public market sector described in the prevailing capital market theory, including its illiquidity, lack of homogeneity and information asymmetry. These characteristics are frequently highlighted as impeding the development of a suitable descriptive model. Indeed, it is the lack of transparency regarding PE transactions that is also responsible for the paucity of data upon which empirical studies could be based. This paper presents an empirical examination of PE performance drawn from a database of 5,553 PE transactions, contributed by PE funds and institutional investors. From this, detailed data regarding 133 later-stage transactions in the US was obtained giving an unprecedented source for examining the performance of individual PE transactions. In exploiting this original source, this paper seeks to make an empirical contribution to the ongoing “PE Performance Puzzle”.

There are several arguments against investing in PE assets. These focus primarily on the sector’s lack of transparency and its illiquidity. Many argue that the market does not compensate for these idiosyncratic risks and that neither the efforts of active private investors, incentives schemes

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[1] For the purpose of this study Private Equity is defined as an asset class based on the relationship between an institutional investor and an intermediary (the PE fund). A PE fund is usually structured as a limited partnership, and is comprised of a management team (the general partner), which manages the investments of the limited partner. The PE fund's investors hold shares of the limited partner. PE funds invest the institutional money in private (target) companies and these investments are typically structured as equity claims respectively similar to equity claims. An investment vehicle is created for each individual transaction, capitalised by the PE fund and other third parties, mainly debt providers and mezzanine investors. This transaction vehicle will later acquire shares in the target company and/or will merge somehow with it, thus creating a unique opportunity to specify its capital structure and to design particular claims and incentive structures. PE fund investments can be syndicated among other PE funds. The contributing PE funds hold a majority of equity voting rights and hence play a role as active investors. Most notably this entails monitoring, managing and restructuring the target companies to create value. In a syndication, one of the funds will be the lead investor, joined by further equity investors such as the target company management teams, its employees or the former owners. Unless the target companies are in a later stage of their lifecycle, we refer to the term "Venture Capital". The transaction date is called the closing date. The PE fund's engagements are terminated at the so-called exit either by being written off or sold.
A comprehensive overview of PE is given by: Lowenstein (1985), Sahlman and Stevenson (1985), Smith (1986), Jensen (1989a), Jensen (1989b), Kaplan (1989a), Kaplan (1989b), Kaplan and Stein (1990), Sahlman (1990), Jensen (1991), Kaplan (1991), Bygrave and Timmons (1992), Kaplan and Stein (1993), Gompers and Lerner (1997), Black and Gilson (1998), Gompers (1998), Wright and Robbie (1998), Gompers and Lerner (1999), Gompers and Lerner (2000), Lerner (2000) and Cotter and Peck (2001).

nor modifications to the capital structure could improve company performance. Equally, they argue that a PE investor's changes to the management team and governance structure have little long-term average impact on market value.[2] Further, they state that the efficiency of capital markets is such that no opportunities for arbitrage between the quoted and unquoted market segments exist, and that it is possible to replicate PE investment strategies using public markets instruments, thereby saving on transaction costs and management time. Also, as private company valuations follow the public market, the public market remains their primary performance driver.

Despite these arguments, the PE sector continues to expand and attract increasingly sophisticated investors, such as university endowments and funds of funds. Though publicly available performance figures for the category have been disappointing – particularly in recent years – institutional investors have increased their PE exposure. Many have also been investing in PE assets for some time, making them aware of the long-term risks and returns. Given this, we can assume that such investors would not maintain high exposure without a compensatory valuable diversification effect or a risk-adjusted PE premium. Commentators have argued, particularly those adopting the free cash flow hypothesis,[3] that this latter could arise from any of the advantages associated with the efforts of active investors in private companies, ranging from incentive schemes to closer governance to free cash flow growth. Alternatively, the premium could be drawn from arbitraging between the public and private capital market segments, or even from information asymmetry.

Rather than entering into the theoretical debate regarding the effects of private equity investments on target companies, the intention of this paper is to examine whether PE exposure yielded an *ex post* premium over public market investments with similar risk. Evidence is provided by the performance of a mimicking portfolio drawn from the S&P 500 Index, allowing for borrowing and lending. Adopting the perspective of a fund of funds investor, the mimicking strategy assumes that the investor is already well diversified and that he will track PE transactions as closely as possible. Thus, non-systematic risks are ignored.

A number of studies of PE investment performance – focusing on either one or several funds – exist. All of these large-scale empirical studies however, measure performance based on cash flow to investors, rather than on the allocation of capital in individual transactions. Financial

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2 See *e.g.* Rappaport (1990) versus Jensen (1989a).

3 See the comprehensive research provided by Jensen (1986), Kaplan (1989a), Kaplan (1989b), Hite and Vetsuypens (1989), Lehn and Poulsen (1989), Marais, Schipper and Smith (1989), Lehn, Netter and Poulsen (1990), Asquith and Wizman (1990), Palepu (1990), Smith (1990), Opler (1992), Holthausen and Larcker (1996), Bae and Simet (1998), Elitzur, Halpern, Kieschnick and Rotenberg (1998), Nohel and Tarhan (1998), Cotter and Peck (2001), Holmstrom and Kaplan (2001) and Bruton, Keels and Scifres (2002).

risk measures are thus attributed to cash flow distributions, rather than to any inherent characteristic of the investment. By providing specific information on particular PE fund transactions, our dataset permits us to analyse transactions on a deal-by-deal basis, thus making it possible to determine the individual transaction risks.

Briefly, we adopt the following methodology: We determine the systematic equity risk of individual transactions by combing business and leverage risk. Business risk is measured by public market comparables and leverage risk is determined by the capital structure of the PE transaction, as well as the possibility of transferring risk to the lenders. The leverage risk usually changes over the holding period: being initially high, but subsequently diminishing due to debt redemption and increasing equity values. With knowledge of the equity betas over time, we can create a mimicking portfolio. An equivalent amount is invested in an index-portfolio, and this is “levered up” to the same beta factor as the PE transaction. If its beta is lower than one, funds can be lent. The risk of the mimicking strategy is then adjusted annually tracking the risk pattern of the PE transaction. On exit, the public market investment is liquidated and the residual equity value (after serving debt) represents its final payoff. Thus, we obtain two cash flows with identical risk that can be compared: that of the PE transaction, and that of the mimicking strategy. This comparison is carried out by regressing the internal rates of return of the PE transactions on those of the mimicking strategies. A Jensen alpha is obtained from the intercept of the regression, giving us a measure of performance. Since the calculation of equity betas for the mimicking strategies incorporates assumptions about the relevant parameters, we provide several scenarios for the beta calculations.

Having thus adjusted for the systematic risks of PE investments, we find positive Jensen alphas in all of our scenarios though not all are statistically significant. Hence, we find empirical evidence that PE investments outperform public market investments, though superior performancedepends largely on the funds’ ability to assign transaction risks to the lenders. On the other hand, without adjusting for systematic risk, PE investments appear to perform on a par with the public market. This underlines the necessity of correctly attributing and adjusting for risk.

This paper is structured as follows: the next section provides a brief overview of the literature dealing with PE performance. Section 3 presents the research sample and data. Section 4 discusses the theoretical framework of the mimicking strategies and Section 5 presents both our results and a sensitivity analysis. Lastly, Section 6 concludes.

2. Affiliated Research on Private Equity Investment Performance

As early as 1968, Rotch pioneers investigations of risk and returns of early stage investments in small businesses with high growth potential by analysing the portfolio of the American Research and Development Corporation (ARDC).[4] He identifies the risk associated with the segment, pointing out its higher standard deviation of returns over the public equity market and its long investment horizon. He also highlights the broad distribution in the segment: while a few investments yield very high returns, 25% - 40% of invested capital is lost.

Seven years later, Poindexter (1975) argues that an efficient relationship exists between the Venture Capital and the public market segments. Using the CAPM, he calculates Jensen alphas to test his hypothesis. However, he is unable to find statistical support for his hypothesis. By basing his analysis on interim accounting data from venture-backed companies (collected between 1960 and 1973), his calculations are probably compromised by accounting behaviour.

The return distribution of 110 investments, made by three Small Business Investment Companies (SBICs) between 1960 and 1968, reported in Huntsman and Hoban (1980), echoes Rotch's results. It is presented in Figure 1 below:

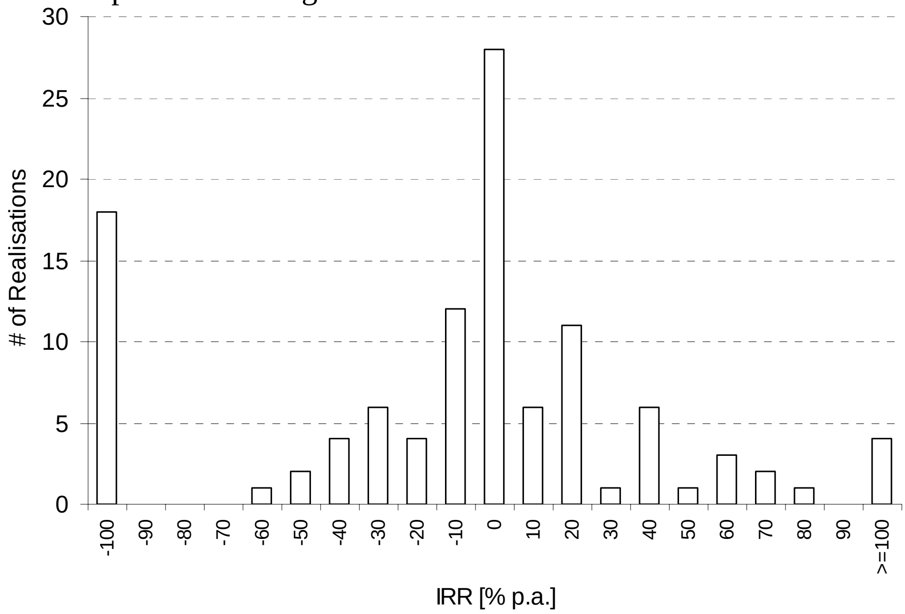

Figure 1: Internal Rate of Return for 110 Venture Capital Investments

Huntsman and Hoban also report that the average yield of 18.9% could only be achieved through the contribution of the upper 9% quantile. Without this, the average yield would have been negative.

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4 See e.g. Bygrave and Timmons (1992), pp. 16 and Lerner (2000), p. ix.

A number of studies attempt to rank PE investments, with conflicting findings. While Patricof (1979) argues that the asset class has superior performance, he is contradicted by Fast (1979). Martin and Petty (1983) rank publicly traded Venture Capital Trusts against other investment funds for the 1974-9 period. According to their Sharpe Ratios, while seven Venture Capital Trusts ranked in the top ten funds, two were in the middle and two were at the bottom, the first place was held by an investment fund. No clear picture emerges from this study, though a satisfactory risk/return ratio is demonstrated for the asset class.

Moskowitz and Vissing-Jorgensen (2002) examine the returns on early stage entrepreneurial investments reporting a high correlation with the public stock market. They conclude that the risk-adjusted returns of the PE class are too low. However, by adopting a very broad definition of PE – literally defining it as investments that are private – their focus is actually on the entrepreneurial activities of individuals. In contrast, this paper adopts a more stringent definition of the PE asset class (see footnote 1).

In compiling returns from a survey of Business Angels (that invest personally or semi-professionally in young ventures), Mason and Harrison (2002) encounter a serious selection bias arising from the response behaviour.[5] Their results, like those of Murray (1999) who investigates the returns of three professional Venture Capital funds and of Bygrave and Timmons (1992),[6] emphasize the kurtosis and skew of the return distribution.

Gompers and Lerner (1997) address the "stale price" problem[7] and propose market tracking as a tool for measuring risk-adjusted returns of PE investments.[8] They build equally weighted indexes of publicly quoted companies with equal three-digit SIC codes to benchmark individual PE transactions. To model the quarterly exposure of one PE fund, they use these indexes as a performance indicator (in the absence of a cash payment or write off). If any payment or write off takes place, then a new company value can be calculated and attributed to the transaction. The authors concede that their approach assumes perfect correlation between the target company valuations and the chosen index. They argue that this could overstate the risk involved. Using this approach, the authors find superior risk-adjusted performance for this PE fund.

Ljungqvist and Richardson's (2003) extensive data from a fund of fund investor reports on cash outflow, inflow and management fees from investments in 73 different PE funds. To determine

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5 See also Wetzel (1986).

6 See Bygrave and Timmons (1992), pp. 149.

7 Also refer to Huntsman and Hoban (1980), pp. 45, Chiampou and Kallett (1989), pp. 5, Reyes (1990), pp. 25 and Emery (2003).

8 Gottschalg, Phalippou and Zollo (2004) chose the same market tracking strategy.

risk-adjusted returns they calculate industry beta factors using the methodology of Fama and French (1997). Lacking data on the leverage of the target companies, they are unable to correct for different leverages and therefore implicitly assume average industry debt/equity ratios.[9] From this, they obtain an average beta factor of all the different PE fund portfolios of 1.08 and an average annual internal rate of return of 21.83%. The annual performance of the S&P 500 Index during the same period was 14.1%. The authors argue that, provided the degrees of leverage were no higher than twice the average industry leverage, this would lead to a risk-adjusted premium for the PE transactions.

Jones and Rhodes-Kropf (2003) investigate the idiosyncratic risks of PE-transactions, arguing that they play an important role in PE transactions that must be priced. They find that, on average, PE investors do not earn positive alphas. Surprisingly, they also find that funds exposed to more idiosyncratic risk earn higher returns than more diversified portfolios.

Quigley and Woodward (2002) and Woodward and Hall (2003) develop a PE price index based on the Repeat Sales Regression Method introduced by Bailey, Muth and Nourse (1963) to benchmark real estate investments. Quigley and Woodward (2002) further correct for sample selection bias with the Heckit Two Step Regression.[10] They calculate Sharpe-ratios and conclude that for diversification purposes, securities portfolios should include 10% to 15% of PE exposure. However, they concentrate on early stage funds lacking data on individual transaction leverages and do not correct for leverage risk.

Cochrane (2005) points out that empirical PE research usually only observes valuations if target companies go public, receive new financing or are acquired by third parties. These events are more likely to occur when good returns have already been experienced. This results in a sample selection bias that the author overcomes via a maximum likelihood estimate.[11] He uses data on 16,613 financing rounds between 1987 and June 2000 for 7,765 target companies from the VentureOne database. This database includes early stage and later stage transactions. With his reweighting procedure Cochrane (2005) calculates an arithmetic mean return of 59% and an arithmetic alpha of 32% using the S&P 500 Index as market proxy.

Most recently, Kaplan and Schoar (forthcoming 2005) similar to this paper, employ a public market comparable approach for benchmarking PE funds. They construct a mimicking strategy of

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[9] Gottschalg, Phalipou and Zollo (2004) adopt a similar approach but lever the initial equity beta calculations by debt/equity ratios of 3. Thus, they refer to Cotter and Peck (2001) who provide detailed information on capital structures within PE transactions. However, they find underperformance of PE investments.

[10] See Heckman (1974 and 1976).

[11] Also refer to the similar approach and the results of Peng (2001a and 2001b).

certain PE funds, investing an equal amount over an equally long period in the S&P 500 Index and comparing the index return. They conclude that PE partnerships earn returns (gross of fees) above the S&P 500 Index, but acknowledge however, that their results are misleading if the beta of the funds does not equal one. They thus recognise that they may understate market risk and that a selection bias may exist in their sample. We adopt Kaplan and Schoar's approach investigating the possibility of risk greater or less than one, and focusing on the levered structures. Their approach forms one of the scenarios in our sensitivity analysis.

Thus far, broad research into PE performance has been based on more or less aggregated fund-level sample data that do not provide information on the investments in specific target companies and have failed to come to a consensus. With precise information on the valuations of individual target companies, their competitors and industry, and on the capital structures of the investment vehicles at the closing date and at exit, it is possible for us to attribute financial risk to individual transactions. Thus, we can establish well-defined mimicking strategies.

3. Sample and data

In order to set up a mimicking strategy, precise data for each transaction, obtained at closing and exit is necessary. First, at closing, the date, company valuation, acquired equity stake, amount paid, target-company industry and a short product and market description, or description of competitors (in order to determine its SIC code) are necessary. Second, at exit, the date, company valuation, equity stake and amount returned to the PE investor must be obtainable. Further, in order to verify that the cash flows have been correctly matched, we need to know the investment's gross internal rate of return.

Our dataset is compiled from information on PE funds made available either directly by the general partners or by large institutional investors. The limited partners collect information on general partners as part of their due diligence processes for their fund allocations. Our research partners are among the world's largest PE investors and collectively allocate more than US$10 billion in the asset class. In their due diligence processes, the investors usually screen a variety of new PE funds. Most of the information has been extracted from offering documents (the so-called private placement memorandum). In these, PE funds describe their previous transactions for the purpose of raising a new fund. They are submitted to potential investors and used by them to assess the quality and strategy of the general partners. Typically these documents contain information about all transactions carried out by the general partner. Given the confidential nature of these documents, they have never before been used in academic research. The origin of all data was disguised in order to render it anonymous.

From our overall dataset of 5,553 early stage and later stage transactions, only 152 later stage transactions provided all of the required information outlined above. The vast majority of these transactions took place in the United States, though others occurred in the United Kingdom, Japan, Canada, Argentina, Switzerland, France, Italy, Germany, the Benelux and some Nordic countries. As the non-US results would lack statistical weight for any individual country while also distorting the US results, we decided to omit all non-US transactions from the sample. We also eliminated outliers with short holding periods and extraordinary high returns. The final sample consists of 133 PE transactions closed after October 1984 and completely divested before July 2004. For each of these transactions we created the financial risk profile from initial leverage and subsequent redemption of debt. In several transactions, additional “add-on investments” and disbursements occurred. This leads finally to a sample of 199 cash flows for which risk can be attributed. The transactions are described in Table 1:

	Min	**Max**	**Average**	**Median**	**Std. Dev.**
Enterprise Value at Closing [$m]	3.50	8,997.50	343.52	88.00	870.17
Enterprise Value at Exit [$m]	0.01	13,500.00	547.90	135.00	1,366.82
Equity Investment [$m]	0.20	1,147.00	46.53	18.00	100.70
Final Payoff [$m]	0.01	1,773.10	145.42	57.80	580.22
IRR (p.a.)	-100.00%	472.00%	51.54%	40.70%	94.86%
Closing Date	Nov 84	Mar 03	Nov 95	Jul 96	
Exit Date	Feb 88	Jun 04	Jul 99	Dec 99	
Holding Period [years]	0.08	15.08	3.67	3.08	2.63
Equity Stake at Closing	8%	100%	76%	86%	25%
Equity Stake at Exit	8%	100%	74%	86%	27%
Initial Debt/Equity	0.00	17.05	2.94	2.49	2.75
Exit Debt/Equity	0.00	14.09	1.28	0.64	1.99

Table 1: Descriptive Statistics of Sample Data

The transactions were carried out by 41 different PE funds. The enterprise values at closing range from $3.5 million to almost $9,000 million. The average (median) was $343.5 million ($88.0 million). Similarly the amount of equity invested at closing ranges from $0.2 million to almost $1,150 million signalling the large exposure of certain transactions. On average (median) the amount of equity invested was $46.5 million ($18 million). The lowest amount invested represented an add-on investment in one transaction. The lowest company value at exit and the lowest final payoff represent failed transactions in which the equity was written off. This leads to internal rates of return of between –100% and an astonishing 472% p.a. However, the mean average internal rate of return and its median are 51.54%, and 40.70%, respectively, which appears high and will be discussed below.

The holding periods range from one month (for some add-on payments) to 15 years plus one month. The average and the median are below four years. The equity stakes range from 8% to 100% ownership. The average (median) is 76% and (86%). This figure reflects the industry strategy of securing majority voting rights in target companies in order to be able to control them effectively. The transactions with minor equity stakes are all syndicated participations. Regarding the degrees of financial leverage, the average (median) was 2.94 (2.49) at closing, and 1.28 (0.64) at exit. In principle, this is in line with the results of Kaplan and Stein (1993) and Cotter and Peck (2001). However, some of the transactions were extremely highly levered.[12]

A comparison with a Thomson Venture Economics dataset clarifies the suspicion that the internal rates of return of our sample are comparatively too high. We compared our sample data with return data from 244 later stage PE funds raised between 1983 and 1996. The time period is chosen to ensure that the funds began operations at approximately the same time as our sample's first transaction and that they were correspondingly divested by the latest exit in our sample.[13] It is important to mention that the Thomson Venture Economics return data is highly aggregated on a fund level, thus probably represents a few thousand individual transactions. As Thomson Venture Economics reports data net of all fees, it is difficult for us to make a direct comparison with our gross returns. Typically, the management fee is structured as an annual percentage of the capital under management (1-4%) plus a performance related share (15%-35% of the returns), which is subject to a hurdle rate.[14] In most cases, there is no correction for risks. The kind of fee structure

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12 When calculating leverage ratios, one has to be aware that PE funds often do not fully own the companies. Thus, their invested equity capital represents only a fraction of the total equity. To determine the degree of financial leverage of the transaction, this fraction has to be corrected by the equity proportions of the other investors.

13 Rotch (1968), pp. 142, already notes a six-year average holding period, Huntsman and Hoban (1980), pp. 45, calculate five years, but emphasize that some very long holding periods also exist. Ljungqvist and Richardson (2003), p. 2, argue that it usually takes six years to invest 90% of the committed capital and that the payments break even after eight years on average. According to our calculations, the average holding period is 3.67 years. We hold from our observations that on average a year passes between fundraising and the first transaction. Further, we believe that funds being raised after 1996 cannot fully be divested by 2004.

14 A comprehensive description and discussion of compensation models can be found in Bygrave, Fast, Khoylian, Vincent and Yue (1985), pp. 96, Jensen (1989a), pp. 68, Jensen (1989b), pp. 37, Sahlman (1990), pp. 491,

should result in a more skewed distribution gross of fees. Funds with good gross performance achieve higher fees and funds with worse or even negative performance that do not reach their hurdle rates, receive fewer fees.

The adequacy and potential biases of this and affiliated databases in general are comprehensively discussed in Gompers and Lerner (2000), Kaplan, Sensoy and Stromberg (2002) and Ljungqvist and Richardson (2003). Despite their shortcomings, a more reliable source regarding return information does not exist. Further, our focus on the later stage market segment and the use of the aggregated fund data precludes some of the selection problems discussed in the literature. In general, the later stage market segment involves fewer players and transactions than the early stage segment. Further, survivorship bias should be less significant in the database, as it is easier to drop a single transaction from the database than a total fund. For these reasons, our sample could represent one fund in the Thomson Venture Economics database, such being interpreted as one draw of that population. The following figure gives the distribution of the gross internal rates of return of our sample transactions related to the total relevant population (net of fees):

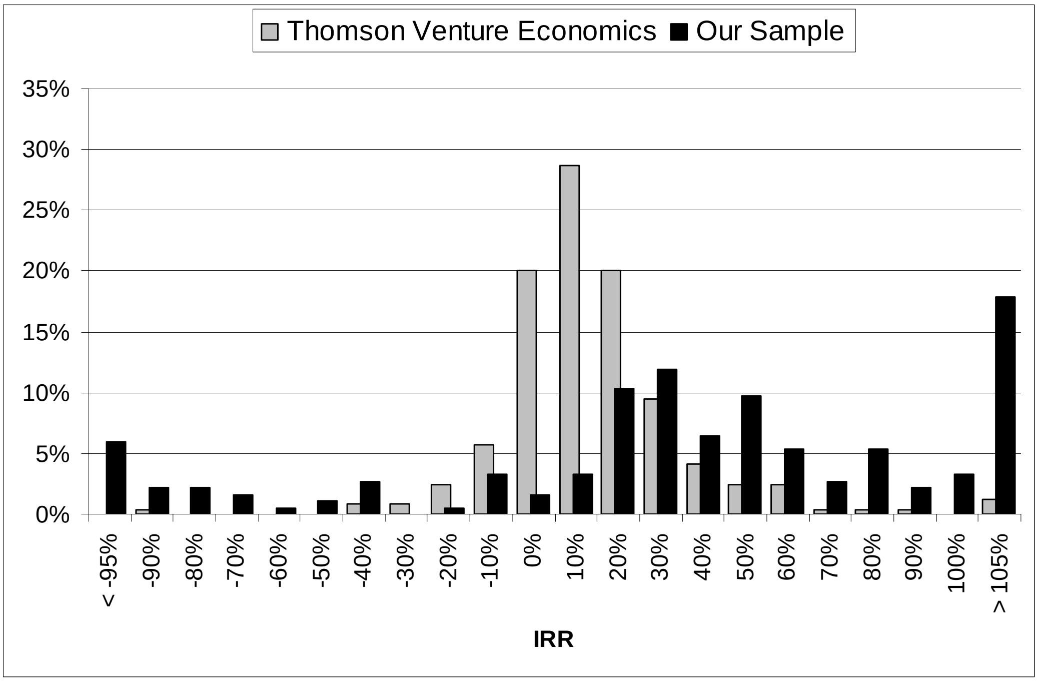

Figure 2: IRRs Net of Fees of 244 Later Stage PE Funds, Provided by Thomson Venture Economics and Our Sample Gross IRRs

The mean of 14.9%, median of 11.9%, and standard deviation of 26.8% of the Thomson Venture Economics distribution and especially the fat tail on the right side of our sample suggest

Murray and Marriott (1998), pp. 966 Gompers and Lerner (1999a), pp. 57, and Gompers and Lerner (1999b), pp. 7.

that we probably have to correct for a selection bias towards more successful transactions. We first correct the Thomson Venture Economics data for management fees, knowing that an annual fee of 2% of committed capital is typically paid to the general partner. Assuming that committed capital is steadily and fully invested over the lifetime of a fund this yields 4% on invested capital. The return on the invested capital is further charged by the carried interest. On average, this is 20% of the internal rate of return subject to a hurdle rate of 8%. Simply correcting the mean average of the Thomson Venture Economics distribution in this way yields a mean average return gross of fees of 20.63%. However, a 30.91% gap between the samples' means remains. This may be because, seeking to incorporate as many observations as were available to us, our sample includes many minor and short-term add-on investments that neither meaningfully affect the overall invested capital, nor the overall internal rate of return. Thus, they increase the equally weighted average return and the standard deviation on single cash flows. Since the precise timing of our sample's cash flows are known, we can calculate the internal rate of return an investor would have gained had he or she invested in a portfolio consisting of all our sample transactions. This results in 33.1% p.a., lower than the mean average, though still possibly too high. We address issues regarding sample selection later.

We specified 116 different peer groups for our 133 target companies. Some transactions were "buy and build strategies", with platform acquisitions and follow-up investments in the same industry. Other transactions were made simply in the same business. A peer group is defined by the four-digit SIC code and by the company headquarters being in the United States. With some transactions, the principal competitors were named in the documents, thus facilitating the peer group analysis. The majority however, had to be defined by the description of the relevant market and the product/service. Generally, good peer group samples were obtained. An advantage of focusing on later stage transactions is that reasonable comparable quoted companies usually exist. The reasonability of the peer group selection was qualitatively verified by comparing the major business units and products. If some companies in the peer group selection did not appear to provide an adequate proxy for the target company's business risk, they were dropped from the selection. We decided that in order for the definition to be meaningful, a peer group had to consist of at least three companies. In a very few cases we found more than 20 peer group members. In these cases, we narrowed the search by including an appropriate company size in terms of market capitalisation. We eliminated those companies from the peer group that were out of the range of 50% to 200% of the equity value of the target. We are aware that this approach excludes non-successful competitors with low market capitalisation and perhaps facing operating difficulties.

However, this approach is in line with our basic assumption of not incorporating non-systematic risk. Finally we identified 1,207 peers to incorporate into our analysis.

4. The Mimicking Strategies

The mimicking strategies replicate the individual PE transactions by transactions of an equal systematic risk level in the public market. The equity betas of the PE transactions and of the portfolio of publicly traded securities must correspond. In order to track the transactions, we adopt an index portfolio representing a parallel investment, allowing for funds to be borrowed or lent. In the first setting, we assume that borrowing and lending is possible in unlimited amounts and at the risk free interest rate. In the course of sensitivity analysis, this assumption is relaxed allowing us to investigate the effect of credit spreads. The selected market index has to be corrected for dividends, which we assume are reinvested. If the indexed portfolio is to accurately reflect the PE transactions, this correction is important, as dividends are not usually paid during PE holding periods. DataStream provides total return calculations for the S&P 500 Index, which we will use as a performance benchmark. To track the equity betas of the PE transactions the following approach is adopted.

a) Theoretical Background

Modigliani and Miller (1958) provide the theoretical foundation for our mimicking strategy. Using perfect market conditions, they assume that every company is exposed to economic risk by its business and that this is both unavoidable and constant. Thus risk classes can be attributed to every company. Also called operating or unlevered risk, this has to be borne by the investors of a company. If a company is fully equity financed, the equity is directly exposed to that risk. If debt financing is used, risk is allocated to the equity investors and the debt providers according to ratios discussed below. For the purpose of our analysis, the constant risk class assumption means that a risk class shall be attributed to every target company defined by the operating risk of its peers. From the closing date of the transaction, the companies remain in their assigned risk classes until the exit date.[15] This assumption merits discussion because, within the PE industry, efforts are often made by management teams to reduce operating risks e.g. by focussing on safer business strategies.[16]

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15 For early discussions of the constant risk class hypothesis refer to Ball and Brown (1967), who argue, that according to some typical ratios, different risk classes can be attributed to enterprises. Gonedes (1969) tests the constant risk class assumption. He finds some support against the hypothesis. Sharpe and Cooper (1972) investigate risk classes at the New York Stock Exchange and find evidence for the existence of constant risk classes.

16 Some evidence that target companies focus less risky businesses after PE transactions is provided by Hite and Vetsuypens (1989), pp. 959, Kaplan (1989a), pp. 224, Lehn and Poulsen (1989), pp. 776, Marais, Schipper and

However, we cannot correct for this kind of risk class transition because: first, we usually do not have sufficient information about the strategic activities of the target companies within the holding period; and second, we would be unable to assess how the activities had influenced the companies' business risk. Our data does not provide accurate figures of the target companies' profit and loss statements that could be used to calculate a measure for basic operating risk. For these reasons, we base our model on the assumption of unchanging risk classes. Any possible risk class migration will be discussed in the sensitivity analysis when we investigate the general influence of changing operating risks on our results. Further, as the PE market segment also lacks several of the perfect market conditions, the risk parameters have to be taken as lower bounds for risk measures. This issue is also addressed in the sensitivity analysis by increasing the transactions' risks.

The constant risk class assumption must be underlined once more. Since it is practically impossible to identify adequate peer group companies and obtain the necessary data for the moment the PE transactions took place, we perform all the calculations for the business class-risks with present data. Weekly stock prices and balance sheet data for the peers between 1999 and 2003 are used. These results are then transferred to the period of the actual transaction. In this way, we assume that typical business class risks remain constant even over a very long time horizon.

The Modigliani and Miller (1963) arbitrage proof is based on the theory of replicating company debt with personal debt, including the tax advantages of debt financing. Kaplan (1989b) emphasizes that tax savings are a major element in overall value creation in PE transactions. For these reasons, tax benefits must also be taken into account in constructing a mimicking strategy. This can be achieved by correctly first "unlevering" the peer group risk to obtain measures for business class risks, then "levering up" the individual transactions. Thereby, an appropriate formula for the value of tax shields has to be incorporated. The unlevering and levering is a two-step procedure.

1. Achieving a Measure of Business Class Risk

The business class risks for all of our 133 transactions shall be best measured by a market-weighted average of the unlevered beta factors of the relevant peer group companies. These are the beta factors the peers would have if they were fully equity financed. To gain these beta factors, we calculate the actual levered beta factors of every single peer-group company using the S&P 500

Smith (1989), pp. 167, Asquith and Wizman (1990), pp. 197, Muscarella and Vetsuypens (1990), pp. 1398, Palepu (1990), pp. 248, Smith (1990), pp. 145, Opler (1992), pp. 28, Holthausen and Larcker (1996), pp. 328. Bae and Simet (1998), pp. 159, Elitzur, Halpern, Kierschnick and Rotenberg (1998), pp. 352, Nohel and Tarhan (1998), pp. 197, Cotter and Peck (2001), pp. 105, Holmstrom and Kaplan (2001), pp. 127, and Bruton, Keels and Scifres (2002), pp. 713. The operating risk is thereby generally expressed by the steadiness of operating earnings or by the ratio between fix costs and variable costs.

Index as a benchmark and weekly returns from January 1999 to December 2003. To unlever these beta factors, we calculate the average leverage ratio of the companies during the same period from balance sheet and market data, obtained from DataStream. Therefore we net total debt for the periods (which includes short and long-term interest bearing debt) by cash positions and divide it by the year-end market capitalisations (of straight and preferred equity). Finally, we determine the arithmetic average. Thus, we assume that the nominal value of balance sheet debt equals the market value of outstanding debt. This implies that the beta factors reflect, but do not anticipate, current leverage ratios. With the arithmetic average of the leverage ratios we then need a beta transformation formula to achieve the beta factor as if the company had no debt. To derive such a formula, one has to consider the role of the tax benefit of debt financing (the tax savings that result from deducting interest from taxable earnings). By deducting a single dollar of interest, a firm reduces its tax liability by τ, the marginal corporate tax rate. The annual tax benefit of interest deduction is therefore the product $\tau r^d D_t$, where r^d is the interest on debt D_t in period t. To capitalise the future tax benefits, an adequate discount rate has to be determined. In the simplest case where: debt is perpetual and risk free, the interest expense can always be fully deducted from the taxable earnings, and the tax rate and the interest rate do not change, the capitalised value of the tax shield simplifies to τD.[17]

While perfect market conditions and the assumption of unchanging risk class may have to be accepted, the assumption for risk-free debt was relaxed by Mandelker and Rhee (1984) to allow for real market conditions, such as credit spreads on corporate bonds. They represent how operating company risk is borne by equity investors and debt providers according to the applied leverage ratio:[18]

$$\beta^u = \frac{\beta^e + \beta^d (1-\tau)\frac{D}{E}}{1 + (1-\tau)\frac{D}{E}} \tag{1}$$

where:

β^d systematic risk borne by debt providers (debt beta)

β^e systematic risk borne by equity investors (levered equity beta)

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17 This was originally derived by Modigliani and Miller (1958 and 1963), first empirically tested by Hamada (1972) and transferred into the CAPM by Rubinstein (1973). Refer to Drees and Eckwert (2000) for a critique of this approach.

18 See Mandelker and Rhee (1984), equation (3) and footnote 2. We define D as the market value of all tax-deductible sources of capital such as senior, subordinated and mezzanine debt and E as market value common and preferred equity.

β^u systematic operating risk (unlevered beta)

τ marginal tax rate

D market value of debt

E market value of equity

After determining the beta factor for debt β^d (which is subsequently discussed) and having fixed the marginal tax rate at 35%,[19] we can calculate the unlevered beta factor for every single peer-group company applying its average debt-to-equity ratio. Finally, we determine the market capitalisation weighted average of the unlevered beta factors of all the companies of a peer group. We refer to this as our measure for the systematic operating risk of the target companies.[20]

2 Levering Up the Individual Transactions

Depending on the degree of financial leverage chosen for the PE transaction, the systematic operating risk is split between the equity sponsors and the debt providers. However, Formula (1) reflects the assumption that uncertainty regarding the company's ability to gain the tax benefits from debt financing is best measured by the rate at which its creditors lend the money. This is the cost of debt r^d. As long as the leverage ratios are moderate, this seems to be the correct relationship between the systematic operating risk and the risk borne by the shareholders and debt financiers. If leverage ratios increase, the company may be unable to realise the tax benefits either fully or partially, simply because it does not generate sufficient income and will be unable to carry losses forward.[21] The risk of not being able to fully profit from debt finance is then as high as the risk of obtaining the income itself (the operating systematic risk). Then, the more appropriate rate for discounting the tax benefits equals the unlevered cost of capital.[22] The operating company risk is then borne by the equity and debt investors according to the following relationship:[23]

$$\beta^u = \frac{\beta^e + \beta^d \frac{D}{E}}{1 + \frac{D}{E}} \qquad (2)$$

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19 See for a similar approach Graham (2000).

20 A comprehensive discussion regarding degrees of operating and financial leverages and the implications on operating and equity beta factors is lead by Hamada (1972), Gonedes (1973), Lev (1974), Beaver and Manegold (1975), Hill and Stone (1980), Gahlon and Gentry (1982), Frecka and Lee (1983), Huffman (1983), Mandelker and Rhee (1984), Lee and Wu (1988), Healy and Palepu (1990) and Darrat and Mukherjee (1995).

21 See Modigliani and Miller (1963), Footnote 5.

22 See the discussions about this topic in Myers (1974), p. 22, Riener (1985), pp. 231, Myers and Ruback (1987), p. 9, Kaplan and Ruback (1995), p. 1062, Arzac (1996), pp. 42 and Graham (2000), pp. 1917.

23 See Ruback (2002), Equation 34.

We assume that for the publicly quoted companies of our peer groups, the degrees of leverage are moderate and therefore, the tax benefits are discounted by the cost of debt. We follow Kaplan and Ruback's (1995) argument regarding PE transactions and capitalise the tax benefits by the operating cost of capital. Hence, we make use of Formula (2). This theory is based principally on two typical features of PE transactions. First, on average, the amount of debt used in initiating a PE transaction leads to leverage ratios far higher than the average debt-to-equity ratios of quoted companies.[24] This results in a higher risk association with tax shields because the companies might not achieve enough income to obtain the interest payments. Second, attempts are usually made to redeem debt levels as quickly as possible. Therefore, it is common to liquidate assets and to use free cash flows for debt service.[25] This results in uncertain and highly negatively correlated future debt levels to free cash flows generated by asset sales and by the operating business. Hence the uncertainty about future interest payments (and therefore the tax benefit) is as high as the uncertainty about the operating business.

As discussed, the resulting equity beta factors are influenced by the assumption regarding the risk of achieving the future tax shields. Since some transactions in our sample have lower debt levels and therefore higher probabilities of benefiting from tax shields, it could be argued that Formula (1) is more appropriate at least for some of the transactions. Further, it could be argued, that in accordance with Kaplan (1989b), the tax benefits of PE transactions are most meaningful to investors. Thus the investors ensure that the risk of receiving the tax benefits is rather low and therefore again, Formula (1) would be the more appropriate to lever up the beta factors for the PE transaction. Since both arguments seem rich, we consider both approaches in the sensitivity analysis.

Again, after having specified the systematic risk of debt β^d, we can calculate the equity beta for every single PE transaction and adjust them annually for the redemption abilities of the target companies. This provides *ex post* equity beta transition patterns between closing and exit for the individual transactions.

b) Deriving Debt Betas

We next need to specify the systematic risk of debt in order to be able to lever and unlever the systematic equity risk according to Formulas (1) and (2). We distinguish between the moderately levered publicly traded companies and the (in general) more highly levered PE

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24 See De Angelo, De Angelo and Rice (1984), pp. 373, Marais, Schipper and Smith (1989), pp. 159, Kaplan and Stein (1993), table 3 and Cotter and Peck (2001), pp. 105 and our table 1.

25 See Shleifer and Vishny (1992), pp. 1362 and Kaplan and Stein (1993), pp. 333

transactions. An adequate measure of the systematic risk of the debt layers of the quoted companies would be provided by the beta factor of investment grade debt. Due to different maturities and decreasing durations and therefore, decreasing volatility over time, it is not clear which bonds would be best suited to measuring systematic debt risk.[26] This problem is exacerbated when calculating a risk proxy for PE transaction debt. Therefore low grade/high yield bonds would be the benchmark. These bonds usually have larger coupon payments, are called, converted or default more frequently than investment grade bonds.[27] This leads to the problem that on average the duration and hence, the volatility, might be even lower than for investment grade bonds.[28]

We follow Cornell and Green (1991) and calculate average debt beta factors from the price data of open-end bond funds. This resolves the issue of lacking price data on low-grade bonds, defaults, calls, and conversions. The cross-sectional difference between the operating risk and the risk of debt is kept constant over time. This disregards the dependence of bond risk on general interest levels or other parameters. Since our analysis does not focus on the risk of debt, this seems to be acceptable provided that different levels of debt risk are addressed in a sensitivity analysis. Further, this approach is consistent with our assumption that operating risks do not fluctuate.

We retrieved weekly gross returns and 2004 year-end market capitalisations for 314 open-end funds investing in investment-grade corporate debt. Again, using fund statutes, we retrieved the same data for 101 open-end bond funds investing in low-grade debt securities.[29] Using the S&P 500 Index as a market proxy over a two-year horizon, we calculated the beta factors for each fund. We then determined the market capitalisation weighted average for the investment grade and for the high yield samples. For the investment grade sample, we determined a debt beta factor of 0.296 and of 0.410 for the high yield sample. Since the risk profile of our sample transactions is highly dependent on the assessment of the debt betas, we will perform a sensitivity analysis and include other research results on debt beta calculations.

Blume, Keim and Patel (1991) directly calculate betas with the S&P 500 for different periods using Scholes and Williams' (1977) and OLS-regressions of returns on government bonds and on low-grade bonds with at least ten years to maturity. They find beta factors for the government bonds ranging between 0.16 and 0.83 and betas for the low-grade bonds of between 0.32 and 0.71 (less than the maximum of the government bonds!). Cornell and Green (1991) calculate debt betas for different bond risk classes and periods using bond fund returns. Their

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26 See Fisher and Weil (1971), Boquist, Racette and Schlarbaum (1975), Lanstein and Sharpe (1978), pp. 657, Livingston (1978) and Cox, Ingersoll and Ross (1979).

27 See Altman (1989), pp. 913, Asquith, Mullins and Wolff (1989), pp. 928, and Blume, Keim and Patel (1991).

28 See Cornell and Green (1991), pp. 47.

29 Data was retrieved from Bloomberg.

investment-grade debt betas range from 0.19 to 0.25 and their high-yield betas range from 0.29 to 0.54.

Kaplan and Stein (1990) determine implied debt betas for a sample of 12 leveraged recapitalisations of publicly quoted companies.[30] They calculate equity beta factors before and after the transactions and provide the implied debt betas under two different assumptions. In this way, they use three different estimation models. With their first assumption, that operating risks do not change, they find that the equity betas rise surprisingly little, between 37% and 57% on average (depending on which method is used to estimate them). This leads to average (median) implied debt beta factors of 0.65 (0.62) for all debt layers of the individual transactions, such as senior and junior debt. Their second assumption is that the operating beta factor is reduced by approximately 25%. This reduction is linked to the market-adjusted premium paid at the recapitalisation, which could represent an anticipation of decreased fixed costs. In this case, the corresponding average (median) implied systematic debt risk is 0.40 (0.35). The method developed by Kaplan and Stein (1990) also offers an alternative way of calculating reduced operating beta factors. If a fixed beta factor for the debt is inserted into their model, a hypothetical reduced operating beta factor can be calculated. They refer to Blume, Keim and Patel (1989) who provide beta factors for low-grade bonds during different time periods, and use 0.25 as the debt providers' systematic risk for the relevant period.[31] This results in an average reduction of operating betas by 41%. Kaplan and Stein (1990) argue that their research should be best considered as yielding ranges of risk, rather than a single estimate. Following their reasoning, information on operating and debt betas will be used in our sensitivity analysis.

c) Treatment of the Individual Transactions

Each transaction must be analysed thoroughly in terms of the timing and the character of the underlying cash flows. Our data provides us with the dates and payments at closing and at exit, in addition to add-on investments and distributions. Likewise, principle claims linked to the equity and debt cash flows are recorded. For our analysis, common and preferred equity are treated as equivalent. Similarly, all debt is treated as straight debt. Unfortunately, lacking information about the structure of claims, we are unable to correct for risk-reducing factors such as call/put options, conversion or arising voting rights. For the same reason, we cannot differentiate rankings or

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30 A leveraged recapitalisation is a transaction whereby a large dividend is paid to the existing shareholders of a quoted company. The dividend is financed with debt so that the company's capital structure is similar to that of typical PE transactions. The main difference from PE transactions is that the ownership does not change and the company continues to be traded after the transaction. See Kaplan and Stein (1990), p. 217.

31 See Blume, Keim and Patel (1989) published (1991), table V.

collateral for particular debt layers. We assume that all PE fund investments are equity investments unless they are explicitly declared as higher ranking properly collateralised debt instruments. If this is the case, this amount is deducted from the PE fund's exposure, in order for us to focus on equity risk and performance. This approach considers the fact that investments by a PE fund can usually be regarded as equity investments in terms of their inherent risk. Even if investments are structured as debt (e.g. shareholder loans), their economic character and risk differs from that of loans. They are usually of a junior rank and are unaccompanied by substantial collateral, thus making all investments resemble equity. All remaining layers other than common or preferred equity provided by third parties is treated as debt.

To build the mimicking strategy we attribute the same systematic risk to the cash flows as to that of the PE transactions. The systematic risk for PE investors consists of the two elements of operating risk and leverage risk. For the operating risks, we use the peer group operating betas as proxies. The leverage risk is determined by the individual transaction structure adopted (and subsequently changed) in the PE transaction. We know all cash flows from and to investors within the PE transactions and we know the capital structures for the entry and the exit dates. With this data, we can calculate the initial leverage ratios and the ratios at exit. Between closing and exit we assume that the leverages change linearly. Kaplan (1989) finds evidence for asset sales and immediate reduction of the degree of leverage following PE transactions. Muscarella and Vetsuypens (1990) and Opler (1992) report decreasing investments after PE transactions close, while Zahra (1995) cites lower R&D expenditure. Their results are compatible with the PE strategy of focusing on core businesses and improving operations and organisation during the holding period. However given this, the typical deleveraging pattern should be hyperbolic rather than linear but given the absence of parameters for estimating a hyperbolic function we retain the linearity assumption.

In order to determine a transaction's risk structure we must differentiate between two general outcomes. First, the investment was exited, providing us with the company valuation and hence the degree of leverage at exit. These transactions will be referred to as "non write-offs". Second, the investment was written off ("write-offs"). We assign different assumptions regarding the leverage linearity to both outcomes. The "non write-offs" are entered and exited at certain leverage ratios. During the holding period the leverage ratio either decreases (as in most cases), it linearly grows or stays constant. The "write-offs" are entered into at a given degree of leverage and by definition, are written off at an infinitely large leverage ratio. This is because the equity value approaches zero while the debt is usually somehow collateralised and therefore retains some value. This leads to problems in terms of the mimicking strategies, because it implies the unrealistic need to leverage investments in public market securities to an infinite exposure. Therefore, we refer to the cause of bankruptcy and assume that the investment was written off because covenants were breached and debt providers claimed their rights. In most cases, this explains the loss of invested capital. With this reasoning, one can argue that the targeted leverage ratios, defined by loan contracts and covenants could not be maintained. The debt providers in PE transactions do not usually allow their risk to be increased. On the contrary, they insist on debt redemption. For us, this leads us to keep leverage risk constant over the total holding period of the "write off" transactions. As the leverage ratios could not be successfully lowered, and banks would not allow them to be increased, this would appear to be the most rational treatment of them. This approach is further supported by accounting guidelines and best practice rules of immediately writing off investments once substantial changes in value such as a breech of covenant takes place.[32]

In the simplest case without add-on investments and disbursements, the cash flows can then be duplicated by a single payment at closing and a single payoff at exit. The initial payment takes place at a certain systematic risk level characterised by the operating risk and the additional leverage risk. The systematic risk level is determined by the initial equity beta of the corresponding PE transaction. The mimicking strategy is set up by investing the same amount in the S&P 500 Index portfolio and levering it up with borrowed funds to achieve an equal systematic risk. If the equity beta of the PE transaction is lower than one, funds are lent. We assume that the PE transactions are settled on the last trading day of the proposed months. The systematic risk of the mimicking strategy is adjusted each year until exit, to secure parity with the PE transactions. Therefore, the mimicking portfolio is liquidated, interest on debt is paid, debt is redeemed and the residual equity is invested in the S&P 500 Index portfolio being levered to the prevailing systematic risk. Again, if the prevailing beta factor is lower than one, funds are lent. In a first setting, we assume risk free borrowing and lending at the one-year US treasury-bill rate. In the sensitivity analysis we introduce a credit spread, but without bid and ask differences. The value change of the mimicking portfolio is measured by a total return index on the S&P 500 portfolio provided by DataStream.

The risk adjustment procedure is repeated until the exit date. The final payoff of the mimicking strategy is compared with the initial equity investment and determines the internal rate of return at an equal systematic risk. If the residual equity of a mimicking investment approaches zero at any time within the holding period, the position is closed, and the internal rate of return is calculated up to that point.

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32 See e.g. EVCA (2003).

d) The Treatment of Add-on Investments and Premature Payoffs

To consider add-on investments by the PE funds and premature payoffs to the funds, we need to know the amounts and the investment dates. For the “non write-offs” we simply extrapolate the equity beta at the time of either the add-on investments or the early disbursements. Provided that the payments are not accompanied by changes in debt, they immediately affect the leverage ratios and then follow the same risk pattern as the initial investments. Since we have details of neither the company valuations, nor the prevailing leverage ratios at the time of the add-on investments or disbursements, we cannot correct for the “leverage-jumps”. We implement add-on investments and disbursements in our linearity approach. The add-on investments are reflected by the degrees of leverage at exit and hence are incorporated into the transactions’ final risk levels. This approach might smooth the overall risk patterns. However, if the equity add-on is accompanied by debt in the same proportion as the prevailing capital structure, this approach should hold true. In the mimicking strategy, add-on payments are treated as the initial investments, but take place at a later stage. From the time they are made, they follow the same risk pattern as the initial transaction. Early disbursements lower the capital at risk and therefore we deduct them at the relevant month from the prevailing equity. We determine the internal rate of return of the mimicking strategy until that date and calculate the present value of the disbursement at the transaction closing. That present value is then subtracted from the initial payment giving us two separate cash flows. The remaining equity following disbursement is retained in the mimicking portfolio until the exit, except should it have become negative. In this case, the position is closed on the disbursement. If the PE fund’s percentage of equity ownership is influenced by an add-on investment or a premature distribution, this is considered at exit. If there is a change, we assume it will have a linear influence between closing and exit.

For the “write offs” the approach is straightforward.[33] Add-on investments in the “write off” cases are usually made to prevent the debt providers from claiming bankruptcy. Debt is recapitalised by equity. The add-on payments would lower the leverage ratio immediately. However, the debt providers would not necessarily have asked for additional equity if the company’s prospects were still good. Debt providers thus demand the payment in order to maintain an acceptable leverage ratio. This leads us to consider that the leverage ratios are unaffected by the add-on investments in “write off” companies. This is supported by the fact that these engagements finally had to be written off, meaning that the debt claims could obviously not be serviced sufficiently and hence the leverage ratios could not be lowered.

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[33] Premature disbursements in “write-off” transactions were not observed in our sample.

e) *Changes in Ownership*

In some transactions the ownership structure changes within the holding period, either due to non-proportional add-on investments or distributions or by any execution of contingent claims such as conversion rights, or call or put options. If the ownership structure changes, it is noted in the transaction description but not in sufficient detail to permit further investigation. We account for these types of changes in the proportion of the equity stake at exit, thus again assuming that all changes in ownership structure develop linearly over the holding period.

f) *Correction for Sample Selection Bias*

Our sample data relies on market participants to provide the data and we are aware that our sample may be biased in two ways. The first is that it may contain a survivorship bias, arising from the fact that the detailed data necessary is only provided by PE funds with ongoing operations. Our data is drawn from documents prepared for marketing new funds. The second source of selection bias results from the insight that the participants tend to provide more accurate data on successful transactions than on unsuccessful ones. Despite the fact that we need less information on unsuccessful transactions (e.g. we do not need to know the final capital structure of a “write-off”), participants were markedly less willing to provide detailed information for the failed transactions. Being obliged to report their overall track record to investors, those market participants raising new funds had to mention failed transactions. We know therefore, that more failed transactions exist. Since transactions with negative outcome are included in our sample, we cannot provide a general truncation point for our selection. Further, it was so far impossible to identify parameters that account for willingness to provide data from which we could build a correction model. These circumstances prevent us, at this stage, for performing either maximum likelihood estimates or “Heckit-Two-Step Regressions” to correct for the bias. This sample selection problem will be discussed at a subsequent stage of our analysis.

We adopt a “hands-on” approach to correcting for sample selection bias. We adjust the intercepts of the regressions by the difference in means of both our sample mean internal rate of return and the mean gross return of Thomson Venture Economics *i.e.*, by 30.91% points.

5. Results and Sensitivity Analysis

Applying Formula (1) and the above-mentioned procedures we calculate unlevered beta factors as proxies for all the transactions in our sample. For this, we use our calculation of 0.296 as the average debt beta and 35% as the constant corporate tax rate. The mean average leverage ratio of all peers over the five years is 1.38, the median is 0.83, and hence less than half of the leverage ratios of our sample. The resulting unlevered beta factors range between 0.108 and 2.033. Their mean average is 0.670 and their median 0.575. With the unlevered beta factors we then determine the equity betas for the closing and exit for the PE transactions using Formula (2), again applying our own calculation for the high yield debt beta of 0.410. In a few cases, this debt beta factor is larger than the unlevered beta factor of the target companies. Since equity claims (as residual claims) must be at least as risky as debt claims, we always truncate the risk of debt at the level of the operating risks. This assumes that in the less risky transactions, debt and equity investors bear the same (low) risk.

We construct the mimicking strategies and calculate their internal rates of return, thus establishing our base scenario. Finally, we regress the internal rates of return of the PE transactions onto the internal rates of return of the mimicking strategies. The intercept of the regression will be comparable to a Jensen alpha and thus provides information about superior or inferior performance of the PE transaction. In order to correct for the selection bias, the intercept is adjusted by the difference in means between our sample and that of the Thomson Venture Economics distribution gross of returns. The regressions and significance tests are performed with Stata 8.1. The slope of the regression can be regarded as a “PE-beta” in relation to the mimicking strategy. Similarly, the correlation coefficient measures the correlation to the levered public market strategy and therefore expresses its tracking power.

The descriptive statistics and the regression results for our base scenario and for the sensitivity analysis are summarised in Table 2. The descriptive statistics for the resulting equity beta factors for each scenario are summarised in Table 3.

Scenario	Desription	Debt Beta	Operating Betas	Mimicking Portfolio Parameters: Mean	Median	Standard Deviation	Intercept	Slope	Correlation	Corrected Alpha	Standard Error Alpha	t Alpha	Alpha Significant at 0.95 tc=1.655	Standard Error Slope	t Slope	Slope Significant at 0.95 tc=1.655
base case	our calculation	0.410	our calculation	12.9%	12.5%	23.3%	43.6%	0.612	0.156	12.7%	0.074	1.728	yes	0.277	2.209	yes
1	our calculation, Kaplan/Stein reduced operating beta	0.410	our calculation -25%	9.8%	9.7%	15.0%	41.9%	0.978	0.155	11.0%	0.083	1.331	no	0.462	2.116	yes
2	Kaplan/Stein implied debt beta	0.65	our calculation	10.1%	10.8%	18.9%	42.9%	0.858	0.171	12.0%	0.078	1.532	no	0.365	2.353	yes
3	Kaplan/Stein implied debt beta and reduced operating beta	0.65	our calculation -25%	7.9%	9.6%	13.4%	40.0%	1.460	0.206	9.1%	0.080	1.147	no	0.514	2.841	yes
4	our calculation, 3% credit sread	0.410	our calculation	11.0%	13.1%	24.1%	43.3%	0.752	0.191	12.3%	0.076	1.635	no	0.286	2.630	yes
5	our calculation, 3% credit sread, Kaplan/Stein reduced operating beta	0.410	our calculation -25%	10.2%	11.6%	16.1%	40.8%	1.055	0.179	9.9%	0.082	1.209	no	0.428	2.465	yes
6	Kaplan/Stein implied debt beta, 3% credit spread	0.65	our calculation	10.2%	12.4%	18.9%	42.3%	0.902	0.180	11.4%	0.078	1.456	no	0.365	2.470	yes
7	Kaplan/Stein implied debt beta and reduced operating beta, 3% credit spread	0.65	our calculation -25%	9.1%	11.5%	13.6%	38.6%	1.425	0.204	7.7%	0.082	0.933	no	0.428	3.328	yes
8	risk free debt	0	our calculation	17.1%	17.8%	36.2%	42.3%	0.541	0.206	11.4%	0.076	1.510	no	0.190	2.851	yes
9	Kaplan/Stein reduced operating beta, risk free debt	0	our calculation -25%	14.5%	14.8%	27.8%	41.5%	0.695	0.204	10.6%	0.077	1.371	no	0.247	2.809	yes
10	equal debt beta for unlevering and relevering	0.296	our calculation	13.2%	13.0%	27.5%	43.0%	0.647	0.188	12.1%	0.076	1.583	no	0.250	2.586	yes
11	equal debt beta for unlevering and relevering, Kaplan/Stein reduced operating beta	0.296	our calculation -41%	8.9%	9.2%	14.5%	41.8%	1.104	0.168	10.8%	0.081	1.340	no	0.478	2.311	yes
12	our calculation, increased operating risk	0.410	our calculation +20%	13.7%	13.7%	31.5%	44.2%	0.536	0.178	13.0%	0.075	1.767	yes	0.219	2.446	yes
13	our calculation, increased operating risk, Kaplan/Stein implied debt beta	0.65	our calculation +20%	11.0%	11.8%	25.9%	44.4%	0.647	0.177	13.5%	0.075	1.805	yes	0.266	2.432	yes
14	our calculation, increased operating risk, 3% credit spread	0.410	our calculation +20%	11.7%	14.4%	30.7%	44.9%	0.567	0.184	14.0%	0.074	1.903	yes	0.224	2.527	yes
15	our calculation, increased operating risk, K./St. implied debt beta, 3% credit spread	0.65	our calculation +20%	10.3%	13.1%	25.7%	44.5%	0.685	0.186	13.6%	0.074	1.831	yes	0.268	2.554	yes
16	no risk-adjustment	1	1	11.7%	15.0%	17.4%	34.7%	1.434	0.262	3.8%	0.082	0.465	no	0.389	3.685	yes

Table 2: Scenarios and Results of our Regressions (Figures are rounded)

Scenario	Mean Equity Beta at Closing	Median Equity Beta at Closing	Minimum Equity Beta at Closing	Maximum Equity Beta at Closing	Mean Equity Beta at Exit	Median Equity Beta at Exit	Minimum Equity Beta at Exit	Maximum Equity Beta at Exit
base case	1387	0.941	0.108	7.965	0.998	0.705	0.108	7.965
1	0.820	0.450	0.081	4.564	0.655	0.448	0.081	4.530
2	0.965	0.564	0.108	5.575	0.810	0.564	0.108	4.584
3	0.600	0.423	0.081	3.378	0.423	0.423	0.081	2.516
4	1.387	0.941	0.108	7.965	0.998	0.705	0.108	7.965
5	0.820	0.450	0.081	4.564	0.655	0.448	0.081	4.530
6	0.965	0.564	0.108	5.575	0.810	0.564	0.108	4.584
7	0.600	0.423	0.081	3.378	0.423	0.423	0.081	2.516
8	2.539	1.984	0.370	13.740	1.492	1.053	0.290	13.740
9	1.904	1.488	0.277	10.305	1.119	0.789	0.217	10.305
10	1.680	1.311	0.108	9.571	1.119	0.812	0.108	9.571
11	0.695	0.422	0.064	3.937	0.538	0.383	0.064	3.937
12	1.869	1.415	0.130	10.713	1.282	0.924	0.130	10.713
13	1.320	0.735	0.130	7.332	1.052	0.732	0.130	7.332
14	1.869	1.415	0.130	10.713	1.282	0.924	0.130	10.713
15	1.320	0.735	0.130	7.332	1.052	0.732	0.130	7.332
16	1	1	1	1	1	1	1	1

Table 3: Descriptive Statistics of the Equity Beta Factors for the Different Scenarios

The base scenario with equity beta factors ranging between 0.108 and 7.965 leads to a mean (median) return of the mimicking investments of 12.9% (12.2%) with a standard deviation of 23.3%. Regressing the internal rates of return of the PE investments on the results yields an intercept of 43.6%, a slope of 0.612 and a correlation of 0.156. Adjusting the intercept for selection bias signals a positive alpha of 12.7%. Calculating a standard error for this parameter and performing a t-test reveals that this alpha is significant on a 95% level.

There are a number of reasons for performing a sensitivity analysis. As mentioned above, different researchers observed a variety of debt beta factors over time. Additionally, we would like to introduce to our investigation the results of earlier research on changing operating risks (caused by some mechanisms within PE transactions). Further, there is a possibility that our assumptions regarding the risk of high-grade debt, receiving tax shields and the adequate tax rate are erroneous, leading to miscalculations of the operating beta factors. Finally we treat our unlevered beta factor risk measure, provided by the theory of an efficient public market, as a lower bound for the measure of PE transaction risk. If we considered additional risk for the illiquidity and information asymmetry of the private market segment, this should result in higher risk factors. To investigate this, we extend our base scenario and examine the influence of the different parameters. We alter both debt and operating risk and analyse the existence of credit spreads in mimicking strategies. Again, for all the different scenarios the risk of debt is truncated at the level of the risk of the operating business.

For the first scenario, we follow Kaplan and Stein (1991) and assume that operating improvements of any kind have lowered operating risk. Thus, we reduce all the operating beta factors by 25%. According to Formula (1) a reduction of operating beta factors could also be justified by an overestimation of the risk of high-grade debt, and an underestimation of the corporate tax rate while initially calculating the operating beta factors. Even if reductions of operating risks are often proposed in PE research, this leads to a lower truncation level for the risk of debt and hence lower levered mimicking investments. Accordingly the mean return of the mimicking strategies shrinks to 9.8%. One would expect the PE transactions to benefit from the lower benchmark returns, but the shape of the regression also changes: The intercept decreases and the slope increases, resulting in a not significant alpha of 11.0%.

In the second scenario we again refer to our calculations of unlevered beta factors, but assume that the debt providers bear more risk of the PE transactions according to the average implied debt beta of 0.65 calculated by Kaplan and Stein (1991). For our calculations we regard a debt beta of 0.65 as the upper limit for the risk of debt. This leads to a larger number of transactions where the debt beta must be truncated at the operating risk level. Consequently the 10.1% mean average return of the mimicking portfolio is lower than for the base scenario, but the regression's intercept is lower and therefore the slope is larger. The result is a not significant alpha of 12.0%. The third scenario combines the higher debt risk with operating improvements. Measured by the equity beta factors as shown in Table 3, this is the least risky scenario for the PE investors. It yields a non-significant alpha of 9.1% and is consistent with the perceptions about the truncations of debt risk.

In the fourth scenario, we step back from the assumption of risk free borrowing and lending. We introduce a constant credit spread of 3%, retaining the systematic risk of debt at 0.410 and our calculations of the business risks. As expected, this transfers wealth from the equity investors to the debt providers and reduces (compared with the base case) the mean average return of the mimicking portfolio to 11.0%. However, the resulting alpha of 12.3% is not significant. The fifth scenario is based on reducing the operating beta factor by 25% once again. It results, surprisingly, that the mean average return of the mimicking investments of 10.2% is larger than in Scenario 1. This is due to the decrease of the operating risks and hence smaller equity betas. Funds can now be lent at a 3% spread, thus increasing the mean average of the mimicking investments. The alpha is 9.9% and not significant.

Scenarios 6 and 7 are equal to Scenarios 2 and 3, but also add a credit spread of 3% on the risk free interest rate. Here, it becomes apparent that with the low equity beta factors, the mimicking investors lend more than borrow funds. If they do so at a higher rate, they eventually gain a higher average return than in Scenarios 2 and 3. This is especially valid for the reduced asset beta scenario. However, the non-significant alphas of 11.4% and 7.7% respectively, are lower than in Scenario 2 and 3.

Scenarios 8 and 9 investigate the hypothetical case that debt providers do not bear any risk, hence the debt betas equal zero. Scenario 9 additionally incorporates lower operating risks. They result in the largest equity beta factors and mean average returns of 17.1% and 14.5% of the mimicking investments. The alphas are 11.4%, and 10.6%, respectively and both not significant.

In Scenarios 10 and 11, the debt risk of PE transactions and the public market is made equal. We use our average debt beta calculation of 0.296 to lever the mimicking strategies. This assumes that debt investors are indifferent to whether they invest in publicly quoted companies or in PE transactions. This constant debt beta case refers to Kaplan and Stein (1991) who calculate an average 41% reduction of the operating beta factor in this scenario. In Scenario 10 we investigate the constant beta case and retain our unlevered beta calculations. In Scenario 11 we lower the operating risk by approximately 41%. This results in non-significant alphas of 12.1% and 10.8%, respectively.

Scenarios 12 to 14 examine whether we systematically underestimated the operating beta factors. It could also be argued that we have thus far calculated with a lower limit of transaction risks. We now consider that investments in private companies must be riskier than investments in quoted companies. Hence, we use our unlevered beta calculations and add 20% operating risk onto every transaction. Scenario 12 incorporates a risk of debt of 0.41 and yields a mean average mimicking portfolio return of 13.7% and a significant alpha of 13.0%. Scenario 13 incorporates a debt risk of 0.65 and results in an average mimicking return of 11.0% and a significant alpha of 13.5%. The highest and significant alphas of 14.0% and 13.6% are observable in Scenarios 14 and 15. Here, we again consider a credit spread of 3% and hence more costly mimicking strategies.

The final scenario investigates the approach proposed by Kaplan and Schoar (2005). We treat all investments as having risk equal to the S&P 500 Index itself. That means we set the equity betas of all transactions equal to one, and follow the assumption that no risk can be transferred to lenders and no risk reduction can be achieved. The mimicking strategy without borrowing or lending is then reduced to the timing of S&P 500 Index investments. This approach yields the lowest non-significant alpha of 3.8%.

6. Interpretation and Conclusion

We provide some evidence for superior performance of PE transactions between 1984 and 2004 in the United States, exclusives of management fees. All of our regression alphas are positive, though not all are significant. This result is, in principle, in line with the latest research by Kaplan and Schoar (2005), Cochrane (2005), and Ljungqvist and Richardson (2003). Inclusive of management fees, returns would be smaller, but would not disapear. Obviously we face a selection bias that we overcome by a simple correction of the regression intercept. This kind of correction could have positively affected the Jensen alphas and will be addressed in ongoing research.

Further, the correlation coefficients calculated in this paper suggest, that PE investments cannot be easily tracked by more liquid publicly traded securities. In all of our scenarios the correlation between the PE returns and the mimicking strategy is never larger than 0.262. This is in line with Kaplan (1989a), and highlights the fact that PE investments are not directly comparable with traded securities. Without question, it should be considered as an individual asset class with its own risk/return profile. From the slopes of the significant regressions, which are at the most 0.685, the PE investments are evidently less risky than the most adequate mimicking strategies.

The different scenarios we investigated in the sensitivity analysis offer interesting interpretations. Our base scenario, calculated by incorporating current market parameters into the leverage/deleverage model, yields significant superior returns. Debt providers play a very important role for the returns of the equity sponsors. Obviously, this arises not from the risk premium they charge, but from the risk they are willing to undertake. The returns of the mimicking strategies do not change meaningfully if we introduce credit spreads, but they will change if we transfer risk from the equity investors to the lenders. A necessary condition to do so, is, that the operating risks exceed the risks the lenders are prepared to bear. The cases with high debt betas in general yield the highest Jensen alphas, though not all of them are significant. If we assume that our measures of operating risks provide lower limits for the operating risks of the PE transactions, we can state that PE investments are successful when a substantial part of the transaction risk can be transferred to the lenders.

Our research also reveals the necessity of accurately specifying the leverage risks and the risks borne by debt providers in order to measure PE performance. If we simplified and set the equity risks equal to the market risk we achieved the lowest non-significant alpha of all our scenarios. This alpha would probably turn negative net of management fees and therefore, would not present a fair treatment of the asset class.

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