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Performance Drivers of Nordic Private Equity Funds

Abstract

In his paper we investigate the performance determinants of Nordic private equity funds. In this study we look at the industry at the fund level as opposed to the portfolio company level. To proxy for performance, we use both the Internal Rate of Return (IRR) and Total Value to Paid-In capital ratio (TVPI) as the dependent variable in our model, both of which are the standard metrics of performance in the private equity industry. Having reviewed the relevant literature, we define three groups of factors, or independent variables: the Fund characteristics (*size, vesting period, stage, geographical and industrial specialization*), General Partner characteristics (*sequence of the fund*), and Principal-Agent Relationship characteristics (*managerial fee, carry profit, simultaneous management*). Using the proprietary data provided by an investment firm specializing in the Nordic secondary private equity market, we have examined 52 private equity funds with operations in the Nordic region. Factors such as *size, vesting period, geographical specialization, sequence, managerial fee* and *simultaneous management* are found to have a significant impact on the fund performance. According to our results, the Nordic funds that are likely to deliver high returns, exhibit the following characteristics: size less than excessively large, vesting period shorter than average, relatively broad geographical focus, being among the funds first raised by a given private equity firm, low managerial fee, and, finally, being managed simultaneously with other funds. The robustness tests performed indicate stability of the signs of the coefficients. Furthermore, these tests uncover an interesting interaction between the *sequence of the fund* and the *simultaneous management* variables, possibly as a result of the private equity fund manager skill accumulation process. The findings set the ground for further studies, such as closer examination of the causality between the fund performance and fund characteristics, interaction between the independent variables, or comparison of Nordic private equity fund performance versus those of other regions.

Acknowledgments

We would like to express our sincerest gratitude and appreciation to our supervisor, Øyvind Bøhren, for his generous support, guidance, patience and input throughout the last year, particularly in light of his demanding schedule.

We would also like to thank Halvor Øgreid of Cubera Private Equity AS for lending his time and expertise to help us with all the practical matters in the data collection process as well as sharing his wealth of knowledge about private equity.

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1. Objective and Motivation

Our research topic is the private equity industry[1] with focus on Nordic funds. Despite private equity gaining importance as an asset class worldwide[2] and in Nordics in particular[3], the in-depth analyses of the main factors driving the performance of Nordic private equity funds are scarce.

We have focused on the secondary private equity market, which includes transactions of pre-existing investments in private equity funds. Inherently, private equity is an illiquid asset class and is aimed to be a buy-and-hold long term investment. However, the desire of many investors to increase and diversify exposure to private equity, as well as liquidity needs, have led to a significant growth of the secondary market during the past two decades. It has been estimated to have increased from about USD 4.4 bill in 1997, to about USD 63 bill in 2007 (Peterman and Lai 2009). 2011 was named "the busiest year on record in the private equity secondary market" by Cogent Partners, a private equity-focused investment bank providing advisory services to the secondary private equity market.

One of the reasons why secondary private equity market is so hot even during the global financial downturn is that sellers view it as a source of liquidity and exit. For the buyers, on the other hand, it is an opportunity to hand-pick funds, and buy interests at possibly discounted prices. Portfolio diversification and optimization is also an important driver in the rise of the secondary private equity market.

Secondary PE transactions can be generally divided into two categories: sales of limited partnership interests (to a fund of funds typically) and sales of direct interests in portfolio companies (a buyer typically being another private equity fund) (Dodge and Leibler 2010). The incentives driving these two kinds of transactions can be slightly different: limited partners might be motivated to sell their interest due to a change in strategic positioning, regulatory change or cash

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[1] We consider so-called private equity funds, which primarily invest in buyout and venture capital.
[2] Capital raised globally by PE funds has increased from USD 33 bill in 1995 to USD 666 bill in 2008 (Global Private Equity Report 2011 by Bain & Company)
[3] An outstanding example is NBIM considering investments in private equity according to the strategy plan for 2011-2013 http://www.nbim.no/en/About-us/nbim-organisation/nbim-governance/strategy-plan-2011-2013-/

flow needs, while general partners would seek to sell the assets in case of the lack of management capacity (partner talent is limited), insufficient capital for follow-on funding or unavailability of other exit opportunities, as well as to realize greater IRR. The buyers are attracted by the opportunity to enter the fund at the later stage of its life, which promises a faster return on their investment, and also possibility to track the performance of the fund. Understanding the factors driving private equity funds performance is crucial for secondary investors during the selection process. Thus identifying these factors constitutes the main aspiration of our research.

The Nordic secondary private equity market has experienced similar dynamics to the global. According to Thomson Reuters, the number of Nordic trade sales and secondary buyouts has increased over the last decade as did the number of all private equity deals. In fact, the percentage of secondary deals among all the deals has grown from 31% in 2000 (28 deals) to 42% in 2010 (84 deals). Preqin, the leading provider of data and intelligence on alternative assets industry, reports that there are currently 61 investors located in the Nordic region that are considering the possibility of purchasing private equity or real estate fund stakes on the secondary market within the next 24 months. On the seller side, there are currently 26 investors based in the Nordic region that are potentially looking to sell private equity or real estate fund interests.

Given such developments in the global and Nordic private equity market, we see the secondary PE market as an exciting area of research, and therefore concentrate our efforts in studying the private equity industry on the fund level, i.e. we aggregate the data on portfolio companies belonging to the same fund.

1.1 Contribution

In our research, we use a comprehensive dataset (described below), obtained from a private source, and not analyzed before. The main research problem of this thesis is to identify and explore the factors driving Nordic private equity funds' performance and estimate their effect on the funds' excess returns.

2. Introductory Review of Previous PE Studies

The literature on private equity investments can be divided into two sets: the one focusing on performance of individual venture capital investments and the other focusing on funds rather than the separate investment projects and including buyout investments. We are interested in the latter category since we concentrate our attention on various funds' performance.

2.1 Performance Measurement

In our research, we face the problem of adequate measurement of the fund performance. This question was addressed in a number of papers; Gompers and Lerner (1997) is a pioneering work, describing the calculation of risk-adjusted fund returns (i.e. performance alpha). This issue is also addressed in Ljungqvist and Richardson (2003) and Kaplan and Schoar (2005). Phalippou and Zollo (2006) take a different approach to fund performance estimation by making several adjustments (like corrections for sample selection bias and "living dead" investments) to the previously used value-weighted average performance approach. Further discussion of the relevant measurements of the fund performance follows in Section 4.1 Independent Variable.

2.2 Determinants of Fund Performances

The results of previous works are used to identify the probable drivers of the fund performance. In Ljungqvist and Richardson (2003), the *fund size*, *a dummy variable for first-time funds*, *the portfolio beta*, *measures of portfolio diversification*, *vintage year*, *amount of committed capital*, *fund life*, *cost of funds*, *availability of investment opportunities* and *competition among private equity funds* are explored as the determining factors of the PE funds performance. Jones and Rhodes-Kropf (2003) examine how the *principal-agent problem* impacts the fund returns. Lopez de Silanes, Phalippou and Gottschalg (2010) include several other variables pertaining to PE firm's scale and scope (controls for firm-specific structure, firm's age etc.). We elaborate more on the factors of fund performance that might be of interest for our research in Section 4.2 Dependent Variables.

2.3 Agency Problem in Private Equity setting

One characteristic that crucially differentiates private equity investors from public market investors is the *active ownership* of the former. Therefore, we wish to draw particular attention to this issue. The concept of active ownership, or a

hands-on management style, means a high degree of involvement in portfolio companies. In its core, the phenomenon of active ownership in private equity industry is closely tied to the *principal-agent interaction*. Evidently, primary problems arising in the principal-agent relationship are information asymmetry (hidden information) and moral hazard (hidden action) (Pratt and Zeckhauser, 1985).

To elaborate, private equity funds are managed by General Partners (GP), while investors in the funds are Limited Partners (LP). Thus active ownership is a governance mechanism used to mitigate agency problem between GP and target firm management. This agency level has been covered widely in research and was identified as a genuine value driver in private equity (Heel and Kehoe 2005). In this study, the details of 60 PE deals from 11 PE companies (defined by authors as leading) are investigated. Company outperformance relative to industry peers is said to be the primary source of value creation (accounting for 63% of it). Hence, it is concluded that PE firms create value through improving the companies they invest in. Authors name five common features that characterize the top performers. First, the top deal partners seek out expertise before making investments. Second, the substantial and focused performance incentives are employed (we elaborate more on this issue below). Third, they craft a more elaborate value creation plans, together with a rigid set of key performance indicators. Fourth, they devote more hours to managing their investments. Fifth, the management is replaced early in the life of a deal by the more successful deal partners.

However, we are concerned with performance determinants of the fund on aggregate. On this level GP are subject to a different kind of principal-agent problem, with LP's as principal and GP as an agent. To assure sufficient effort from GP at maximizing fund's value, limited partnership contracts are designed to combat principal-agent problem in PE setting. Thus, in the framework of our research, we are interested in contractual compensation structure and peculiar covenants of limited partnership agreement. More in detail, we examine the impact of principal-agent problem between LP and GP on PE funds performance. To be more precise, we want to relate the performance to incentives provided within limited partnership contracts, which are the dominant organizational form

worldwide in PE industry (Gompers and Lerner, 1997) (and in case of our dataset too).

Further data assessment is needed to distil variables that signal contractual incentives. There could be a different contractual balance between fixed fund-size proportional fee and performance-based fee, charged by GP. We would be interested to compare performance results of funds with different contractual compensation structures. For the sake of example, some contracts in our dataset include carry fee by GP, which implies that manager has a claim to certain share of profits should they exceed predetermined level (hurdle rate).

3. Model and Variables

In short, our aim is to create a multivariate model which can describe relations between fund performance and defined factors in conceptual form of:

$$Fund\ Performance = \Sigma[\ Factor_i \times \beta_i\ ]$$

Now, we proceed with defining dependant variable and independent factors expected to determine it.

3.1 Dependent Variable

The dependent variable in our model is the private equity fund performance. However, there is an ambiguity of how it can be measured.

The basic measures of the private equity performance at the fund level are the internal rate of return (IRR), profitability index (PI) and the public market equivalent (PME) and return multiples (cash on cash ratios, e.g. total value to paid-in capital − TVPI). Each of these measures has some advantages and drawbacks, and previous studies have indicated that regression results are sensitive to the performance measure used. At the same time, it was shown that different private equity funds performance measures are highly correlated empirically (Kaplan and Schoar, 2005).

The internal rate of return (IRR) is the prevalent measure in the industry. The IRR of an investment is defined as any rate which equates the present value of the cash outflows and inflows associated with the investment. This is the rate of return that is earned from the investment (Copeland et al. 2005, 28). However, it has three important pitfalls: it tends to favour shorter-term funds, there is no standard method to calculate this measure which can potentially lead to different results and the IRR fails to take into account various fund characteristics (i.e. risk profile) (Gompers and Lerner, 2003).

The profitability index (PI) is a measure based on the net present value (NPV) and it is defined as the net present value of cash flows over the initial investment. The PI addresses several of the problems present in the IRR measure. The central question is the discount rate to be used.

Arguably, the public market equivalent (PME) is more meaningful for the limited partners since it is the PI which compares an investment in a private equity

fund to an investment in the public market (by discounting all the cash flows at the return to some public market index). The selection of the proper benchmark is thus crucial.

The cash on cash ratios, also known as the money multiples or TVPI ratios, use the simplest approach to measuring fund performance and therefore are the most common metric used in the private equity industry. These multiples are the ratios of distributed and yet undistributed portfolio value to the initially invested capital. The main advantage of the return multiples is their simplicity, but the drawback is that they completely ignore the notion of the time value of money.

In our thesis, we use only IRR and TVPI metrics to proxy for performance due to the complications connected with calculations of PI and PME, which are discussed in the following subsection. We assume all of the performance metrics to be highly correlated, and hence, find two of them sufficient for the cross-check of the results.

3.1.1. Risk associated with investments in private equity funds

When measuring performance of private equity funds using PI or PME metrics, we should consider the relevant risk of such investments. The challenge of measuring the risk of private equity as an asset class was mentioned in several academic works. There is no unified view on this problem and a number of approaches for addressing the risk of the private equity funds have been developed.

The pioneering study in this field was conducted by Gompers and Lerner in 1997. This work examines the risk-adjusted performance of a single fund group by marking-to-market each investment quarterly. The obtained time series of portfolio value is regressed on various pricing factors, giving a performance alpha, which was found to be positive and significant.

The more recent approach is the one developed by Ljungqvist and Richardson (2003). To estimate the risk of each private equity fund, they suggest assigning the risk (beta in this case) to each portfolio company. Using the capital disbursements as weights, the average equity beta of the fund is calculated.

In our research, we avoid the problem of selecting the appropriate risk level for the private equity investments since the IRR and TVPI metrics do not require a discount rate as an input.

3.2 Independent Variables

Having researched literature on determining sources of PE funds performance, we singled out three broad areas of possible factors to test: characteristics of the fund itself, competence of GP and GP/LP relationship within limited partnership.

Fund Characteristics

The first area of fund characteristics encompasses numerous determinants, such as fund size and specialization:

Size

Fund size can alter performance through economies of scale effects, but previous studies documented diverse forms of correlation. Kaplan and Schoar (2005) have found relationship to be concave in cross-section, but negative for individual GP's. Concavity can be attributed to limited availability of profitable deals, which becomes more evident when fund grows beyond certain threshold. Moreover, authors argue concavity of the PE production function to also be the cause, as managerial skills require time consumption. Phalippou and Gottschalg (2009) on the other hand have found the relationship to be positive and linear.

We measure fund size by the total amount of capital committed to it. As previous studies showed contradicting results, we expect size to have either negative or positive correlation with performance.

Vesting period

Vesting period is contractually specified investment horizon of the fund measured in months. Vesting period of the fund determines performance in a number of ways, namely in terms of investment and managing decisions timeframe. It also alters the GP's target return rate to compensate for illiquidity. According to the views in the existing literature, this relationship is expected to be negative.

Specialization

Specialization is wide set of characteristics of the funds which focus on certain dimensions. Among those dimensions most prominent are geographic specialization, industrial specialization and stage specialization (VC vs. buyout). Specialization determines how narrow the focus is within one or couple of those

dimensions. Overall, studies have revealed narrow industrial focus and early stage specialization to have positive correlation with performance (De Clercq 2003). Narrow geographic focus was found to have negative correlation with performance by Manigart et al. (1994), although positive correlation might be expected due to local network effects. Competing effects of the specialization are negative impact from loss of diversification and benefit of focused skills and knowledge accumulation, which are "hard to imitate" as postulated by Manigart et al (2002).

Stage specialization is measured as dummy variable taking value of 1 for VC specialized funds and zero otherwise. Positive correlation is expected.

Industrial specialization is represented by the dummy variable, where 1 indicates the presence of the distinctive industrial focus as defined by the fund itself and 0 − the absence of such. Expected variable sign for industrial specialization is positive.

We measure *geographic specialization* by the number from 1 to 5 which reflects the degree of the geographical specialization. The scale is as follows:

Value	Scope
1	Single country
2	Nordics
3	Northern Europe
4	Europe
5	Global

Expected sign for geographical specialization variable is positive, i.e. positive correlation between the fund returns and broader geographical focus.

GP Characteristics

Second broad area is characteristics of GP with respect to their competence, knowledge and skills, which could be proxied by performance persistence and fund sequence:

GP Persistence

Persistence outlines continuity of GP in generating returns, or in other words how much current fund performance is determined by previously managed funds results. It is expected that such continuity will signal of GP skills development and experience accumulation. Kaplan and Schoar (2005) find economically and statistically significant persistence in PE funds performance even for funds two lags apart. Phalippou and Gottschalg (2009) support this argument as well by showing that current fund is most likely to perform in the same tercile (performance band) as GP's previous fund.

In our approach, measuring persistence involves regressing focus fund performance on lagged values of performance measures for previous funds run by corresponding GP. Positive correlation is expected.

Sequence

Sequence is the order of the fund raised by GP. In general, it is characteristic both of the fund and GP. However, we have chosen to attribute it to GP, as higher sequence is another signal of previous success and managing reputation. Both Kaplan and Schoar (2005) and Phalippou and Gottschalg (2009) document positive correlation between sequence and performance. Nevertheless, well performing GP has higher chance of raising next fund, which triggers survivorship bias to control for.

Obvious ordinal measurement for the variable is the chronological ranking of the focus fund in GP's managerial history and positive sign is predicted by research.

Principal-Agent Relationship Characteristics

The last set of determinants comes from the principal-agent relationship between LP and GP, aimed at reducing agency costs and incentivizing GP's managing performance. Such determinants outline the mechanisms of corporate governance within the fund, and we chose most quantifiable measures – GP capital commitment, management fee, GP's profits carry (allocation of gains from investments) and number of funds managed simultaneously.

GP Capital commitment

Capital committed by GP to invest in the fund provides incentive to maximize funds value and hence returns, of which GP retains share proportional to commitment. We would expect GP to perform better when more of their capital is at stake. Thus, we measure GP commitment as a percentage share in total fund commitments and expect positive sign if this incentivisation mechanism if effective.

Managerial fee

Management fee is performance-independent part of compensation, and thus might provide insufficient incentive if too high. Number of issues arises and suggests fee level should be tested with respect to level and possibly fee composition, whether it is fixed or proportional. Fixed fee might provide insufficient compensation for large funds. Still, proportional fee could induce GP to inflate fund size beyond scope of investment opportunities on the market.

Managerial fee variable is measured in percentage relative to total funds committed with positive expected sign. In addition, we include dummy variable *fee rigidity* to reflect whether fee is fixed on level or proportional (1=fixed, 0 otherwise) with expected sign undetermined due to contradicting incentive forces.

Carry interest

Carry interest is profit share of GP's when profits surpass a determined percentage level (hurdle). Thus, this is the most refined compensation mechanism, as it provides incentive to grow and a benchmark to achieve. Potential conflict of interest might arise, e.g. when GP chasing to bypass high benchmark hurdle allocates money to inappropriately high-risk investments.

Therefore, we include both hurdle percentage and a profit sharing percentage as our measurements of these independent variables (since they proxy for conflicting incentives and hazards). Hurdle is expected to correlate either negatively or positively with performance, while profit share is predicted to have positive correlation.

In addition to testing levels of carry interest, it is sensible to test structure of realized fees, i.e. share of GP's carry profit in their total returns. Metrick and Yasuda (2010) have found that 2/3 of revenues by GP are earned as fixed

management fees, which might suggest weakened link between performance and GP reward (Chung et al. 2011). We examine this peculiar relationship in descriptive statistics.

Simultaneous management

Number of funds managed at one time creates potential conflict of interest across those funds. As outlined by Baks and Benveniste (2010), simultaneous involvement of GPs in several funds might lead to suboptimal management, such as focusing on high-performance fund and disregarding sinking one, engaging in as many funds as possible to collect more fees, simultaneous involvement in one investment project by means of two funds (e.g. by investing in different securities types) etc. All in all, simultaneous management by GPs requires testing for adverse incentives effects on performance. Therefore, we measure this variable by number of funds measured with focused fund and generally expect negative sign.

3.3 Model Setup

As described in Section 4.1, the fund's performance is the dependent variable in our model. Practically, it is represented by two measures: IRR and TVPI. We use both of them in the empirical part of our research to capture any sensitivities arising from the specifics of the performance metric used. Hence, the dependent variable will have the values of Y_1: Internal Rate of Return (IRR) and Y_2: Total Value to Paid-In capital (TVPI).

Subsequently, our research goal is to test the effects of three sets of factors described in part 4.2 on Nordic PE funds performance. Those factors have either been proven by previous studies to demonstrate significant correlation with performance, or are expected to have impact by our theoretical setup (as in case with governance mechanisms). Tests are conducted both on univariate and multivariate levels to control for adverse effects and verify robustness.

We generalize our testable model in the following multivariate regression:

$$Y_i = \alpha + \beta_1 \times Size + \beta_2 \times Vesting\ period + \beta_3 \times Stage\ specialization + \beta_4 \times Industrial\ specializaion + \beta_5 \times Geographical\ specialization + \beta_6 \times GP\ persistence + \beta_7 \times Sequence + \beta_8 \times GP\ capital\ comm. + \beta_9 \times Managerial\ fee + \beta_{10} \times Fee\ rigidity + \beta_{11} \times Carry\ hurdle + \beta_{12} \times Carry\ profit + \beta_{13} \times Simultaneous\ management$$

The model is summarized in the table 1 below.

Table 1. Summary of the specified model.

Theoretical variable	Empirical proxy	Expected sign
Size	*TCC*/ln(TCC)*	+ or -
Vesting period	*Fund contractual horizon, months*	-
Specialization:		
- stage	*VC/Buyout dummy*	+
- industrial	*Dummy*	+
- geographical	*Scale from 1 to 5*	+
GP persistence	*Lagged performance of n previous GP funds*	+
Sequence	*Chronological order of fund in GP track record*	+
GP Capital committed	*GP cap. comm. proportional to TCC*	+
Managerial fee	*Fee level proportional to TCC*	+
Fee rigidity	*Fixed/proportional dummy*	+ or -
Carry hurdle	*Hurdle profit rate to surpass*	+ or -
Carry profit	*Profit share of GP above hurdle*	+
Simultaneous management	*Number of funds managed simultaneously*	-

* Total capital committed

4. Dataset Description

Our main sources for collecting data are Private Placement Memoranda (PPM), Limited Partnership Agreements (LPA) and investor reports over various time spans (quarterly and annual). Cubera AS[4] provided us with proprietary data of funds from mid-90's and up to the most recent. Data came both in printed and digitalized formats. In addition, we were provided with cash flow data for selected funds. All aforementioned resources are private and confidential, hence require NDA compliance. Furthermore, we utilized private equity database Eureka Hedge, press releases and other online resources.

PPM is issued upon fund commencement to inform and attract potential investors. It defines key terms of the fund itself, commitment covenants and remuneration schedule for the parties. In addition it presents GP's track record and investment policy. LPA is a legally binding document, which solidifies conditions stated in PPM as an official agreement. Reports are distributed to investors within defined time intervals and present current fund status and performance. Fund reporting is not standardized, and thus provides varying degree of scope and details.

Resulting sample comprises of 52 private equity funds with operations in the Nordic region. Nordic region is defined as area covering Norway, Sweden, Denmark and Finland. Sample funds have their investment advisor office and/or business operations located in at least one of those countries. For tax purposes most of the funds are registered in tax havens, predominantly Channel Islands.

We proceed with providing descriptive analysis of the sample. Some fund features are not reported by all the managing partnerships, and for those variables there are cases with missing data in our sample[5]. To be consistent we firstly describe sample characteristics within three broad areas as defined in section 4: fund characteristics, GP characteristics and principal-agent relationship characteristics. We then describe the dependent variable of fund performance.

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[4] Cubera Private Equity AS is a secondary private equity firm operating in Nordic market. http://www.cubera.no/
[5] Only limited number of observations could be collected for GP persistence variable, thus we exclude it from further regression analysis.

4.1 Fund Characteristics

Size

	Sample size	Mean	Median	Standard Deviation	Min.	Max.
Size, EUR mn	49	612.47	256.00	985.19	14.00	4750.00

49 funds have reported their realized size in terms of total capital commitments from investors, which we have standardized to single Euro currency (EUR). Fund size ranges from EUR 14mn to EUR 4.75bn. With mean of EUR 612.47mn being much higher than the median size of EUR 256mn we conclude that few large funds cause fund size distribution to be skewed to the right.

In addition to realized size, PPM presents target size which partners expect to raise. Of 31 funds reporting their targets, 9 fell short of them.

Vintage year
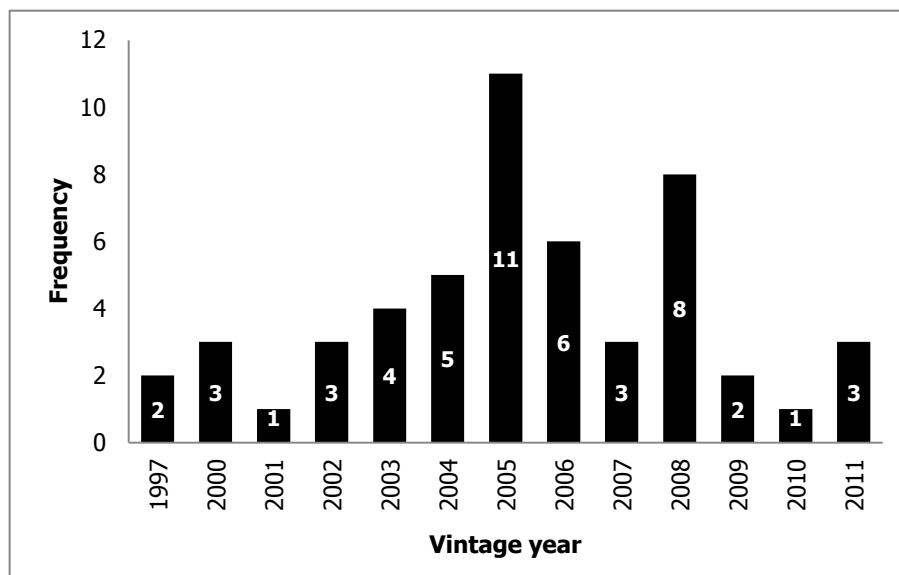
Figure 1: Sample funds distribution by vintage year

All 52 funds in the sample have been classified by their vintage year, with frequency distribution presented in Figure 1. Funds have been raised in 1997 and between 2000-2011, with most in 2005 and 2008. Funds with vintage year 5 years ago or less are likely to have made few to no exits up to date and thus distributed less proceeds to GPs. Hence performance measure for such funds is either based on subjective valuation of their residual portfolio or not reported at all, which could put certain constraints on our dependant variable.

Vesting period
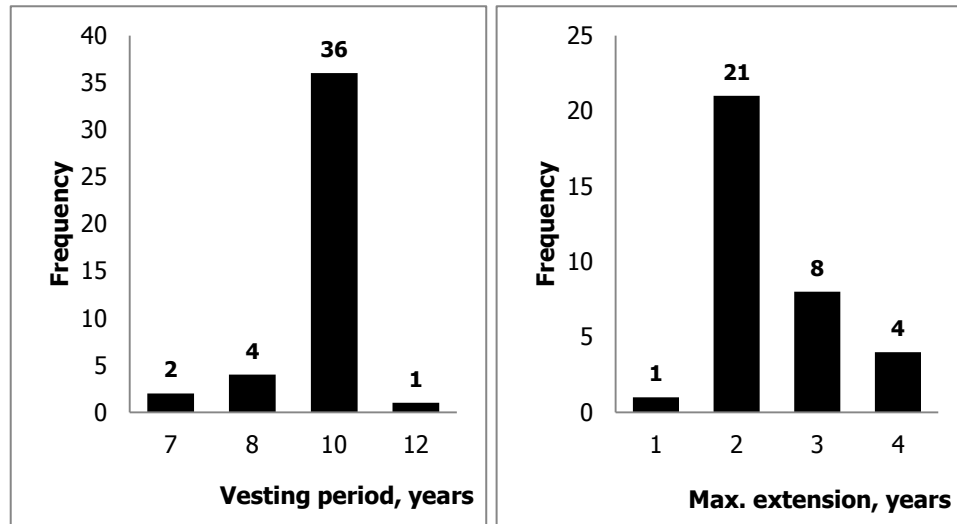
Figure 2: Sample funds distribution by vesting and extension cap

Another important feature of the fund is the vesting period, which defines the contractual lifetime of the partnership. In addition, LPA leaves the option of extension of the fund life by predefined increments. Both characteristics are presented as distributions in Figure 2. Majority of the funds are vested for 10 years, with other occurrences being 7, 8 and 12 years. Also, most funds could be extended for up to 2 years.

However, we must note that vesting period albeit contractually binding is not an indicator of realized fund lifetime, but more of a target investment horizon. Some funds having sold most of their investments can be trapped with a single portfolio company not able to locate an exit opportunity. Thus, they continue to remain de-jure active long past their maximal extension, although effectively they can be considered terminated. This could be the case for partnerships, where distribution in specie (i.e. in equity) is restrained.

Termination status
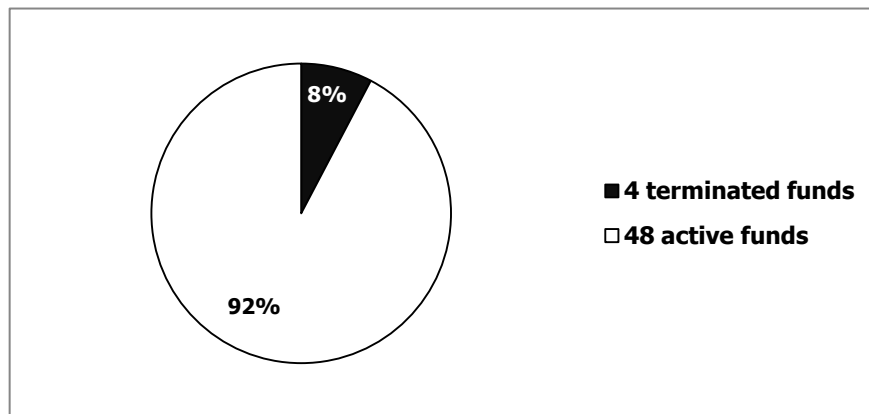
Figure 3: Funds by termination status

Continuing the case above, we describe the funds termination status in Figure 3. Consequently, 48 or 92% of the funds remain active, meaning that at least one portfolio company is still under GP's management. As mentioned before, when calculating aggregated performance measure for such funds we must include unrealized residual value in addition to distributions from realization.

Specialization
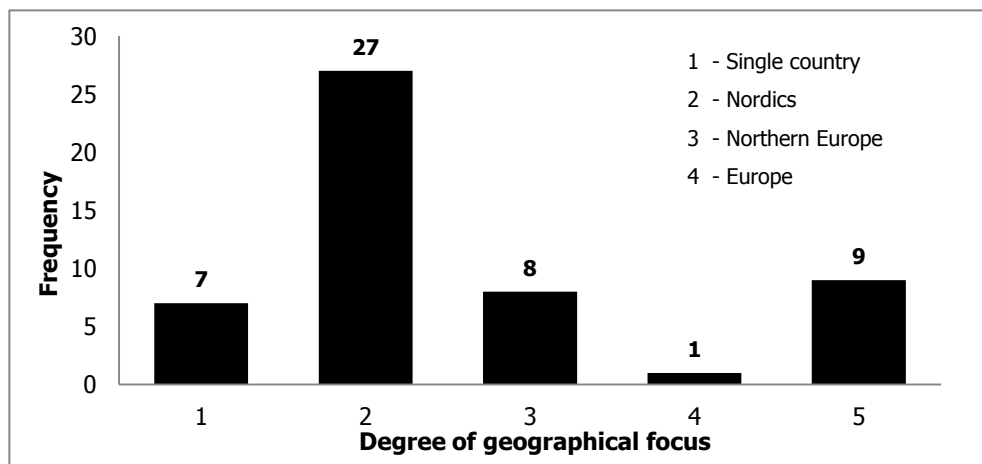
Figure 4: Funds by geographical focus

Now we proceed to analyzing funds by their postulated investment strategy, beginning with geographical scope. Each GP commits to limit the location for investments to certain area, and we have developed a simplified scale to capture the degree of such geographical specialization. The scale, together with distribution, is presented in Figure 4. To clarify, Northern Europe in addition to Nordics includes countries surrounding the Baltic Sea, Austria, Switzerland and UK.

As observed in the histogram, 27 funds commit to limit their investment area to Nordics, while one single fund pursued pan-European scope. Overall, geographic specialization is prevalent in our sample, with just 9 funds choosing to encompass global equity market.
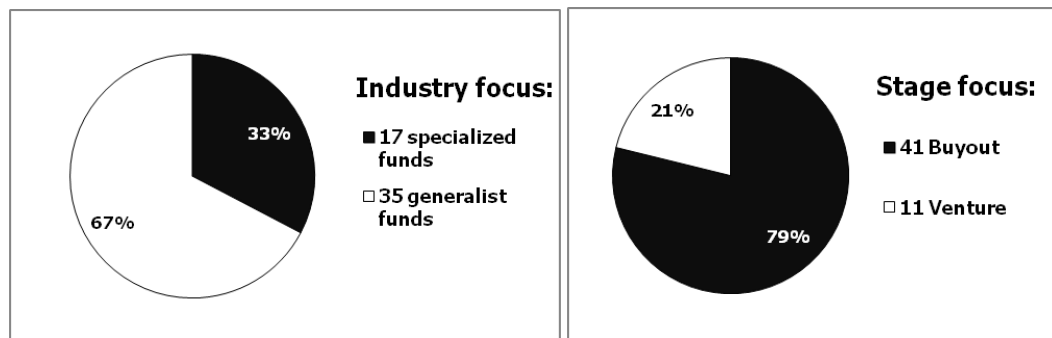
Figure 5: Funds by industrial and stage focus

Due to wide scope and overlapping classifications of the reported industrial strategies, which are impractical to quantify, we consider it prudent to analyze sample by presence of industrial focus. Figure 5 presents the distribution of funds by industrial focus, which suggests that a third of 52 sampled funds limit their investments by industry. Common areas of specialization include technology (IT, communication, industrial), medical industries and energy (oil and gas). Possible reason for lower extent of industrial specialization might stem from the need for diversification from geographically focused funds. This is further demonstrated in correlation matrix between those variables.

Also in Figure 5 we present distribution by the stage of investment, with only 11 out of 52 funds specializing on venture capital (usually defined in contracts as early stage investment focus). VC funds tend to be smaller in size, distributed to the left of the mean with largest fund having EUR 339.6 mill commitments.

All in all, our sample is composed of mostly active PE funds with prevailing Nordic specialization, which typically invest in diverse industries. They mainly engage in buyout transactions and are vested for around 10 years.

4.2 GP Characteristics

Fund sequence

We continue to classify sample funds with characteristics, which are deemed to proxy for the GP's skills and competence.
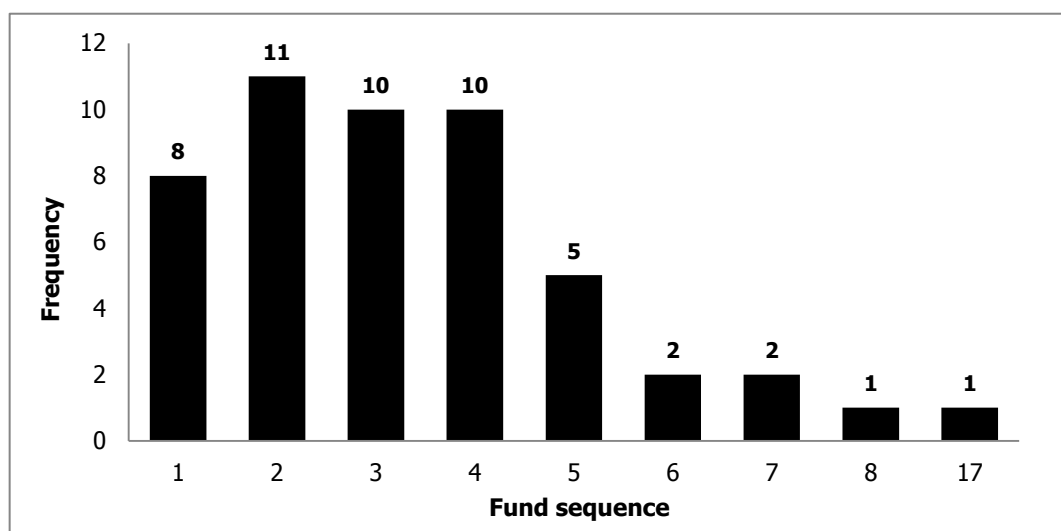
Figure 6: Funds distribution by raising sequence

As described before, sequence in which the fund is raised shall signal of GP managerial talent perceived by investors, who choose to commit cash for each consecutive vintage. Our sample distribution by sequence is summarized in Figure 6, which suggests most funds are in 2nd-4th sequential succession for their managers. 8 funds are raised by the managing team for the first time. Smaller incidence of funds with sequence 6 or higher can be attributed to relatively recent boost of PE industry in Nordics and long-term nature of investment.

4.3 Principal-Agent Relationship Characteristics

The final set of descriptive data encompasses the features of PE contracts, which are relevant to managerial effort exerted by GP.

Capital commitment

	Sample size	Mean	Median	Standard Deviation	Min.	Max.
Capital commitment by GP, %	38	2.35	1.17	2.68	0.00	13.50

As seen from table above, GP commitment share in the fund ranges from 0% to 13.5%, with 2.35% in mean.

Compensation structure

	Sample size	Mean	Median	Standard Deviation	Min.	Max.	t-value	p-value
Management Fee	46	2.06	2.00	0.33	1.50	3.00	1.3055	0.1984
Carry Interest	47	19.79	20.00	1.20	12.00	20.00	-1.2189	0.2291
Hurdle Rate	44	7.61	8.00	0.99	4.00	8.00	-2.5799	0.0134

The next table presents descriptive statistics of the compensation parts. The median management fee is 2% of compensation, and to receive median carry interest of 20% GP must surpass on median a hurdle return of 8%. Those values are used most frequently in contracts. Hence, we test if they can be considered a population mean for respective variables. We cannot reject the hypothesis of them being a mean for management fee and carry interest based on p-value at 5% significance level, but we can reject the null hypothesis for the hurdle rate, meaning that the mean hurdle rate can be different from 8% in the population. In our sample, managerial fee was always set proportionally to the total capital committed, hence, there is no need in the fee rigidity variable, which we specified above.

Simultaneous management
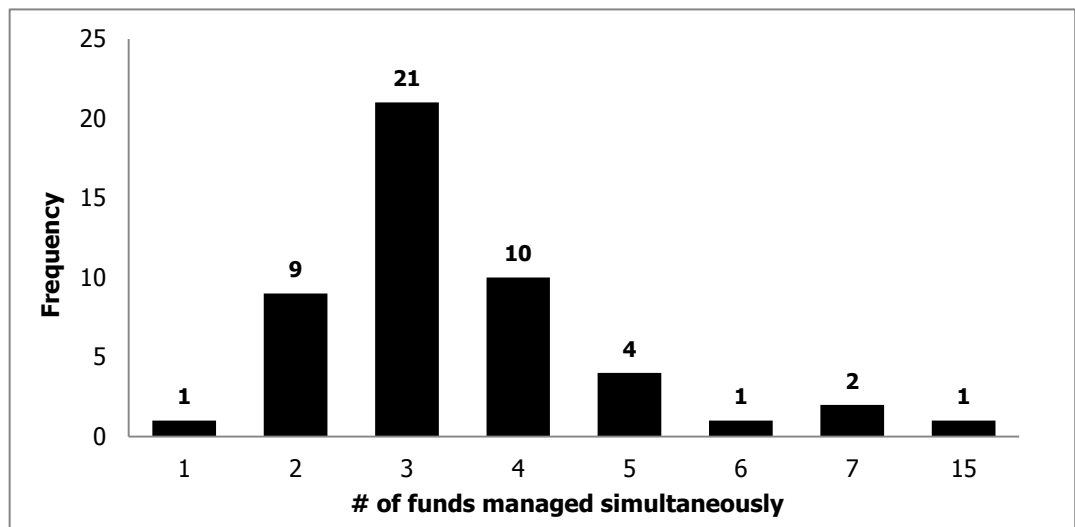
Figure 7: Funds distribution by simultaneous management

Finally we study the number of funds management simultaneously with the one in consideration. Figure 7 suggests most GPs manage 3 funds, while the common number falls in bracket 2-4. Only one out of 49 sampled GPs concentrates on single fund.

4.4 Fund performance

We acquired two fund performance measures: IRR for the sample of 29 funds and TVPI for the sample of 38 funds.

	Sample size	Mean	Median	Standard Deviation	Min.	Max.	t-value	p-value
IRR	29	0.17	0.11	0.22	-0.13	0.81	4.23	0.00

The mean IRR is 17% with median around 11%. Based on p-value test we can reject the hypothesis of reference IRR of 0% to be the population mean.

	Sample size	Mean	Median	Standard Deviation	Min.	Max.
TVPI	38	1.68	1.35	1.08	0.46	6.00

TVPI, also known as multiple on cash (MOC) is performance valuation used more frequently and therefore reported more often. GP's on average multiplied their managed commitments by a factor of 1.68, with maximum being 6 times the investment.

As mentioned above, the two performance metrics are expected to be highly related. Indeed, the correlation coefficient between the IRR and TVPI calculated from their intersection set is 0.91 and significant at 5%. This result allows us to use the two performance measures interchangeably.

Now we proceed to study how these performance measures of the funds are influenced by independent factors.

5. Empirical Analysis

We commence the empirical part of the research by studying correlation between variables for samples with IRR and TVPI as performance measures. Results are presented in the respective matrices in the tables 2 and 3 below.

As highlighted in the subsequent section, some dependent variables have been excluded from the regression analysis due to lack in variability or insufficient number of observations. Therefore, we omit them in correlation matrix as well.

In IRR sample, fund size is significantly positively correlated with vesting period and stage specialization. Thus, GP tends to attract more commitments for longer vested and buyout funds. Also, geographical specialization measure is highly positively correlated with industrial focus, which for the inverted scale used means those factors are negatively related. This relation is expected in the light of aforementioned need for diversification. We also observe negative correlation between buyout (stage) specialization and geographical/industrial focus. Hence buyout funds are likely to be less industrially bound, but more geographically focused than VC. Hence local expertise appears to be more vital for buyout funds than industrial. Finally, we detect strong positive correlation between simultaneous management and sequence. This finding is straightforward, since each new fund contributes to management simultaneity.

We get quite similar results for the TVPI sample matrix. Additional findings include negative correlation between size and the managerial fee, implying larger funds to provide less fixed compensation. Since total compensation increases proportionally with size due to carry profit, this relation is intuitive. Also, vesting period is positively correlated with stage specialization, meaning that buyout funds have longer lifetime. Yet again we observe strong positive correlation between simultaneous management and sequence.

Table 2. Correlation matrix, IRR sample.

Notes: Bold print indicates correlations that are significant at the 5 percent level. Some variables were omitted due to the lack of the variability in the data or too few observations.

	IRR	Size	Vesting	Geo. spec.	Industr. spec.	Stage spec.	Sequence	Mngrl. fee	Carry profit	Simult.
IRR	1									
Size	-0.39	1								
Vesting	*-0.47*	*0.46*	1							
Geo. spec.	0.10	0.00	-0.22	1						
Industr. spec.	0.16	-0.39	-0.26	*0.84*	1					
Stage spec.	-0.28	*0.43*	0.40	*-0.55*	*-0.65*	1				
Sequence	-0.24	0.29	0.19	0.07	-0.07	0.16	1			
Mngrl. fee	-0.13	-0.39	-0.28	0.27	0.35	-0.39	-0.25	1		
Carry profit	0.09	0.05	0.08	-0.09	0.04	0.05	0.14	-0.17	1	
Simult.	-0.08	0.12	0.03	0.07	-0.05	-0.07	*0.91*	-0.09	0.07	1

Table 3. Correlation matrix, TVPI sample.

Notes: Bold print indicates correlations that are significant at the 5 percent level. Some variables were omitted due to the lack of the variability in the data or too few observations.

	TVPI	Size	Vesting	Geo. spec.	Industr. spec.	Stage spec.	Sequence	Mngrl. fee	Carry profit	Simult.
TVPI	1									
Size	*-0.54*	1								
Vesting	*-0.71*	0.34	1							
Geo. spec.	0.29	0.05	-0.22	1						
Industr. spec.	*0.38*	-0.34	-0.27	*0.83*	1					
Stage spec.	*-0.60*	0.33	*0.40*	*-0.55*	*-0.67*	1				
Sequence	-0.33	0.33	0.17	0.06	-0.09	0.15	1			
Mngrl. fee	0.09	*-0.44*	-0.16	0.06	0.18	-0.22	-0.08	1		
Carry profit	0.04	0.02	-0.03	-0.03	0.10	-0.06	0.13	-0.01	1	
Simult.	-0.07	0.08	0.04	0.02	-0.08	-0.04	*0.89*	0.11	0.08	1

5.1 Regressions

We carry on with running multiple regressions for both datasets with IRR and TVPI as performance measures. Variables demonstrating low variability or lack of observations have been excluded from the panel.

6.1.1. Multivariate linear regression – base case model

$Y_i =$

$\alpha + \beta_1 \times \ln(Size) + \beta_2 \times Vesting\ period + \beta_3 \times Stage\ specialization + \beta_4 \times Industrial\ specializaion + \beta_5 \times Geographical\ specialization + \beta_6 \times Sequence + \beta_7 \times GP\ capital\ comm. + \beta_8 \times Managerial\ fee + \beta_9 \times Fee\ rigidity + \beta_{10} \times Carry\ hurdle + \beta_{11} \times Carry\ profit + \beta_{12} \times Simultaneous\ management$

For both panel regressions, *managerial fee* is significant coefficient at 5% level with considerably negative estimated effect on the performance. In addition, TVPI panel yielded more significant estimates. *Vesting period* is negatively related to performance with high 1% level of significance, meaning that longer vested funds tend to perform worse. *Size* has negative impact of TVPI as well with 5 % significance level. *Geographical specialization* variable (inverted in our case) is positively related to the performance at marginal 10% level of significance. Consequently wider regional scope of investment is related to higher performance. Increasing *sequence* of the fund is associated with lower TVPI at 5% significance level. Lastly, TVPI increases significantly (at 5%) in *simultaneous management* variable. Adjusted R-squared suggests that TVPI panel explains 74% in performance variance, which is a high value and signals of good fit. For IRR dataset only 28% of variance in dependant variable around its mean is explained by specified model.

The obtained adjusted R-squared of 74% indicates a very high explanatory power. We should be careful with over-interpreting it, since the limited size of the sample combined with the high number of explanatory variables, and hence, lower degrees of freedom, might cause a certain degree of over-fitting in the model. This does not, however, disqualify our results, since our main interest lies in the signs of the coefficients, which allows studying the interaction between the fund

Table 4. Multivariate linear regression, base case model.

Notes: Standard errors in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Some variables were omitted in the regressions due to the lack of the variability in the data or too few observations.

Independent variable	Dependent variable	
	Net IRR[6]	TVPI
Constant	2.62 **	14.77 ***
	(1.21)	(3.67)
Size	-0.09	-0.37 **
	(0.06)	(0.18)
Vesting period	-0.00	-0.05 ***
	(0.00)	(0.01)
Specialization:		
-stage	0.09	-0.57
	(0.18)	(0.54)
-industrial	-0.16	-0.85
	(0.24)	(0.74)
-geographical	0.08	0.33 *
	(0.06)	(0.18)
Sequence	-0.07	-0.26 **
	(0.04)	(0.11)
GP Capital committed	n/a	n/a
	n/a	n/a
Managerial fee	-0.50 **	-0.99 **
	(0.20)	(0.38)
Carry profit	0.02	0.08
	(0.02)	(0.07)
Carry hurdle	n/a	n/a
	n/a	n/a
Simultaneous management	0.07	0.28 **
	(0.05)	(0.13)
Multiple R-squared	0.76	0.91
Adjusted R-squared	0.28	0.74
F-test	1.95	9.84
Sample size	23	29

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[6] Net IRR is calculated based on the cash flows after fees

performance and its determinants, rather than in the overall goodness of fit of the suggested model.

The key economic implications of those findings are interpreted in the upcoming subsection.

5.1.2. OLS assumptions

An important step in the econometric analysis is to ensure that the general assumptions of the Ordinary Least Squares method hold. Only this can guarantee the valid results and BLUE[7] estimates.

One of the basic assumptions under the OLS model is the constant variance of residuals, or no heteroscedasticity. The usual method of detection if this assumption holds is a visual inspection of the graph of residuals. In our case, there is no pattern in the scatter plot of residuals versus the dependent variable, so it is not possible to identify any signs of heteroscedasticity from a visual inspection (Appendices A and B).

Residuals of the regression should not be autocorrelated, or in other words, should be time-independent. Since our sample consists of a cross-section and not time series, the autocorrelation problem cannot arise.

The OLS requires no perfect multicollinearity in the data. Multicollinearity problem might be present if several independent variables are closely correlated with each other. As the correlation matrix of the independent variables shows, there are several pairs of variables in our sample that have a high degree of correlation (e.g. *sequence of the fund* and *simultaneous management*). However, the standard errors of the independent variables tend to be inflated in the presence of multicollinearity, which reduces the t-statistic and causes these variables to be statistically insignificant. We do not experience this effect in our regression: both *sequence of the fund* and *simultaneity* variables are statistically significant. Moreover, as presented further in the section on robustness of the results, these variables are statistically significant only if the other variable is present in the regression equation. This indicates that the variables are likely to contain different information and none of them is redundant. Therefore, even if present,

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[7] BLUE = Best Linear Unbiased Estimator

the degree of multicollinearity in our model is acceptable. We see no reason to omit any of the specified variables from the regression, as it might cause the omitted variable bias, which is much graver than the effects of multicollinearity.

For the validity of the statistical inference, the distribution of the residuals should be close to the normal distribution. This can be checked by inspecting the histogram of the residuals (Appendices C and D). In our case, the distributions of the residuals from the two regressions are reasonably close to the normal curve.

All in all, there are no distinguishable patterns in the residuals, which makes us believe the omitted variable bias is not present and the model was specified correctly. There are no indications that any of OLS assumptions are violated. A high R-squared and F-test indicate the validity of the model.

5.2 Main economic implications

The table 5 below presents the comparison of the predicted signs of the variables with the realized signs from the multivariate regression described in the previous section. The comparison is not available for variables that were not included in the regression equation (GP capital commitment and Carry hurdle) and those which exhibit no statistical significance (Stage and industrial specialization and Carry profit).

The previous studies have shown the contradicting result as for the relationship between the *size* of the fund and its performance. Our results show that in our sample, the correlation is negative. This can be explained by the diminishing return to scale: it is harder to find profitable deals for the large funds as the investment opportunities at the given point in time are limited, and the attention of the team is more dispersed.

The predicted and realized sign of the *vesting period* is negative. Technically, the longer the timeframe before a particular exit, the lower the returns as the implication of the basic time value of money principle, since the same cash flows are discounted more heavily. Also, in practice, the most successful and profitable company exits happen early in the life of the fund, as there is a strong incentive for the fund managers to realize successful investments sooner than later as the business environment might change in the future. This negative relationship can

also be connected to the differences between the venture capital and buyout funds: for venture capital, vesting period is typically lower, and returns are expected to be higher than for buyout funds to compensate for the higher risk.

The obtained results do not provide a clear result as for the relationship between the *stage specialization* of the fund (VC vs. buyout) and its returns – this variable is statistically insignificant. We believe this reflects the uneven distribution between the VC and buyout fund in our sample: only about 10 funds in our sample can be considered such which focus on early-stage and seed financing. The previous part (Descriptive statistics) points out the strongly skewed distribution of the size of the funds, with the right tail of the distribution (medium to large funds) significantly overweighting the left tail. Therefore, we contribute the insignificance of the stage specialization dummy to the small amount of the VC funds compared to buyout funds in our sample.

The regression does not prove the *industry specialization* variable to be significant. This can be interpreted as the absence of the direct link between the industrial specialization and the performance of the fund: the success of the industrially focused versus opportunistic funds depends on other variables.

It is clear from the results of our multivariate regressions that the *geographical specialization* negatively correlates with the potential higher returns of the private equity funds. This is consisted with the previous studies. The positive sign arises due to the fact that in our methodology, the geographical specialization index increases in larger geographical exposure, which is equivalent to lower geographical specialization. The likely explanation of this effect is the decreased number of the attractive deals available to the fund given the narrow geographical focus. However, we should be cautious with this result as our sample is biased towards the funds that focus on Nordics solely.

Table 5. Variables with predicted and realized sign

Theoretical variable	Predicted sign	Realized sign
Size	+ or -	-
Vesting period	-	-
Specialization:		
-stage	+	insignificant
-industrial	+	insignificant
-geographical	+	+
Sequence	+	-
GP Capital commitment	+	n/a
Managerial fee	+	-
Carry profit	+	insignificant
Carry hurdle	+ or -	n/a
Simultaneous management	-	+

Both regressions, based on Net IRR and TVPI, unanimously yielded the negative sign for the *sequence of the fund* variable, as opposed to the predicted positive sign. According to this result, the funds raised later in the lifetime of the given fund manager are likely to be less profitable. One possible reason for this is the fact that the most attractive and profitable opportunities have been already exploited, and it becomes harder to deliver the results on par with previous. However, one would expect that the new investment opportunities arise on continuous basis. Given that our sample mostly consists of the funds being raised and realized during more or less the same period of time (the earliest vintage year is 1997, the latest is 2011), this negative relationship could be a reflection of the fact that private equity returns are correlated with the economic cycle, and earlier funds have captured "better times". This assertion would need a more thorough testing though. In addition to the aforementioned argument, an incentives argument can apply - the manager might be less motivated to exert substantial effort to deliver the returns as good as in the previously raised funds due to decreased need to build the reputation and trust of investors. In other words, the managers become "lazier". We should be cautious with the interpretation of this variable, as it might reflect the two different effects – the physical passage of time in the life of the given fund manager as well as the managerial skill accumulation. The sequence of the fund variable is also subject to the survivorship bias.

Due to the scarcity of data and low variation in the sample it was not possible to include the *capital committed by the General Partner* in regressions and obtain meaningful results about this variable.

The realized sign for the *managerial fee* is negative, which is inconsistent with the prediction. Managerial fee is a performance-independent part of the GP's compensation, which is usually proportional to the size of the fund. The negative relationship between the return and managerial fee might indicate that the fixed fee, which is too high, hinders the incentive part (i.e. performance-dependent) of the fee structure and hurts motivation to deliver high returns.

Due to the small sample, the realized sign of the *carry interest* and the *carry hurdle* variables cannot be determined from regression, or they are insignificant. However, both multivariate regressions returned the positive sign for the carry profit, which is consistent with the previous studies. Carry interest is the

incentive part of the private equity structure – the larger the return, the more GP earns. We can also presume that the higher the hurdle rate, the more incentivized fund managers are to achieve the return that will exceed the hurdle so that they can get hold of their carry interest. Given the fact that these variables have very little variation in our sample, it is hard to draw a distinct conclusion. We believe that the positive coefficient for the carry profit variable will be significant in the larger sample.

The realized sign for the *number of funds under simultaneous management* is positive. According to the previous research, it should be negatively correlated with the ability of the fund managers to generate superior returns: the more funds they manage, the less attention and time they can devote to each fund. Nonetheless, many fund managers can extract significant synergies from managing more funds simultaneously: they might use standardized procedures or professional services to cut the administrative and other costs both on the fund level and in portfolio companies, which is a common practice and one of the techniques to add value in the private equity industry. It can also reflect the skill accumulation. This can explain the positive correlation.

The differences in the obtained and predicted signs of the coefficients could also arise from the specificities of the Nordic funds, as most of the empirical results of the previous research were based on the data samples from the US. For any conclusive results, a more thorough comparative study should be conducted.

5.2.1. Implied characteristics of the higher-performing private equity fund

According to the achieved results and our data sample, the Nordic fund which would be likely to deliver high returns would possess the following characteristics:

- not excessively large in size;

- shorter than average vesting period;

- relatively broad geographical focus;

- one of the first funds raised by the respective managing PE firm (in a given timeframe, i.e. 1997-2011);

- low managerial fee (low performance-independent compensation part);

- fund is being managed simultaneously with other fund/several funds.

5.3 Robustness tests

Robustness tests are designed to check consistency of the model results across various specifications. They are performed to test if the findings are resistant (robust) to changes in the model, such as addition or removal of regressors, or alteration of proxies used to measure theoretical variables of interest to researcher. If such sensitivity analysis reveals variation in signs and magnitudes within plausible band, one can infer variables to be representative of factors they proxy for. Otherwise, one can suspect a specification error in the model, which prohibits forming any conclusion due to low explanatory power of such unstable variables. In other words, robustness confirms structural validity of the model, or adequacy of the framework laid out to research the problem (White and Lu 2010).

White and Lu warn against mistreating robustness in number of ways. First, robustness by no mean implies causality; it only reaffirms correlation in each case ("correlation does not imply causation" holds). Furthermore, only critical variables are required to make economic sense and generate robust findings. A researcher may arbitrary define critical core variables, whose effects are of primary importance and a subset of non-core variables.

Robustness is important in our case, because even when assumptions of the model are satisfied vaguely, robust estimators will still produce reasonably accurate description of correlation.
Overall, the literature does not suggest unified or standardized approach to robustness tests. They might range from highly statistical and quantitative as in White and Lu (where separate tests are conducted just to single out core factors) to simple tests across multiple variations of factors combinations based on economic prudence. We believe the latter approach suits our small sample better.

5.3.1. Single linear regressions

The most simplistic approach for checking the resilience of the independent variable coefficients is to check if the signs of coefficients from the multivariate regressions hold in case of single linear regressions. To implement this technique, we run regressions of the following form:

$Y_i = \alpha + \beta_k \times \text{Factor}$

The results are presented in the table below. Both Net IRR and TVPI performance measurements were used. The table does not provide the measures of the model fit (R-squared), as we are only interested in the sign and significance of the beta coefficients.

Most of the independent variables do not exhibit statistical significance in single regressions. Those variables that are statistically significant maintain the sign of the multivariate regressions. These variables are *size*, *vesting period* and *sequence of the fund*. Given that there are no contradictions between the signs of multivariate and single linear regressions coefficients, we do not get any indications that results are not robust.

Table 6. Single linear regressions

Notes: Standard errors in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Some variables were omitted in the regressions due to the lack of the variability in the data or too few observations.

Independent variable	Dependent variable	
	Net IRR	**TVPI**
Size	-0.03	-0.45 ***
	(0.04)	*(0.15)*
Vesting period	-0.01 **	-0.06 ***
	(0.00)	*(0.01)*
Specialization:		
-stage	-0.08	-1.38 **
	(0.12)	*(0.53)*
-industrial	-0.04	0.49
	(0.09)	*(0.43)*
-geographical	0.01	0.17
	(0.03)	*(0.13)*
Sequence	-0.01	-0.10 *
	(0.01)	*(0.06)*
GP Capital committed	-0.01	-0.03
	(0.01)	*(0.05)*
Managerial fee	-0.11	0.38
	(0.20)	*(0.65)*
Carry profit	0.01	0.02
	(0.02)	*(0.13)*
Carry hurdle	0.08	n/a
	(0.10)	*n/a*
Simultaneous management	-0.01	-0.02
	(0.02)	*(0.08)*

Table 7. Comparison of the realized signs obtained in multivariate and single regressions.

Theoretical variable	Realized sign Multivariate regressions	Realized sign Single regressions
Size	-	-
Vesting period	-	-
Specialization:		
-stage	insignificant	-
-industrial	insignificant	insignificant
-geographical	+	insignificant
Sequence	-	-
GP Capital commitment	n/a	insignificant
Managerial fee	-	insignificant
Carry profit	insignificant	insignificant
Carry hurdle	n/a	insignificant
Simultaneous management	+	insignificant

5.3.2. Groups of factors

We now apply an alternative approach to test robustness over broad areas of factors by regressing their combinations as shown in the table 8 below. Thus we may observe how these groups interact with each other and infer if factor coefficients they consist of are robust. Bands of characteristic seem to be more important than separate factors, as it is the pool of characteristics that matters for specification (e.g. when incentive system is set up optimally or GP is more skilled, fund characteristics might become less relevant etc.)

We omit the two variables, the GP capital commitment and carry hurdle, which proved have too little variation to be used in a regression.

To run the specified regressions, only the TVPI performance metric was used, since this sample is larger than the Net IRR sample, and the correlation between the two performance metrics is relatively high (0.91). Table 9 shows the obtained results.

We will now analyze these results in the framework of the three broad groups of factors – Fund Characteristics, Manager Characteristics (e.g. Skill) and Incentive Structure Characteristics.

Table 8. Alternative model specifications.

Notes: ◆ *indicates which variables are included in the respective regression.*

	REGRESSIONS / FACTORS	1	2	3	4	5	6	7
FUND	**Size**	◆	◆			◆	◆	
	Vesting period	◆	◆			◆	◆	
	Specialization:							
	-stage	◆	◆			◆	◆	
	-industrial	◆	◆			◆	◆	
	-geographical	◆	◆			◆	◆	
SKILL	**Sequence**	◆		◆		◆		◆
INCENTIVE	**Managerial fee**	◆			◆		◆	◆
	Carry profit	◆			◆		◆	◆
	Simultaneous management	◆			◆		◆	◆

Table 9. Combined regressions.

Notes: ***, **, and * in the column right of the respective regression indicate statistical significance at the 1, 5, and 10 percent levels, respectively. The abbreviation of n.s. means "not significant".

	REGRESSIONS / FACTORS	1		2		3		4		5		6		7	
FUND	**Size**	-	**	-	*					-	*	-	***		
	Vesting period	-	***	-	**					-	**	-	***		
	Specialization:														
	-stage	-	n.s.	-	n.s.					-	n.s.	-	**		
	-industrial	-	n.s.	-	n.s.					-	n.s.	-	**		
	-geographical	+	*	+	n.s.					+	n.s.	+	*		
SKILL	**Sequence**	-	**			-	*			-	n.s.			-	***
INCENTIVE	**Managerial fee**	-	**					+	n.s.			-	*	-	n.s.
	Carry profit	+	n.s.					+	n.s.			+	n.s.	+	n.s.
	Simultaneous man.	+	**					-	n.s.			-	n.s.	+	***

The variables in the first group, Fund Characteristics, all maintain their signs. *Size* and *vesting period* variables are significant under all the alternative model specifications. The geographical specialization variable is only significant if the variables of the third group (Incentive) are present. We conclude that the variables in this group are robust.

The only variable in the GP Characteristics group, the *sequence of the fund*, maintains the sign in all the regressions, and exhibits the highest statistical significance in the regression 7, which is the combination of the variables of the second and third group. The conclusion is that negative sign of sequence of the fund coefficient is robust.

The variables of the third group, the Incentive Structure Group, exhibit some instability of the sign, however, all the results that are statistically significant maintain the same sign – *managerial fee* coefficient is only negative when statistically significant, while the *simultaneous management* coefficient is only positive. The *carry profit* coefficient is not statistically significant under any model alternatives. We can therefore conclude the robustness of the results in this group of variables as well.

The variables *simultaneous management* and *sequence of the fund* interact in an interesting way: the coefficient of the *simultaneous management* variable is significant and positive only in the presence of the *sequence of the fund* variable in the regression equation, and the *sequence* variable is insignificant in regression 5, which omits the third group of variables. This effect is connected to the high correlation between the two variables (0.91 in IRR sample and 0.89 in TVPI sample), as shown in the correlation matrix of the independent variables. The two variables are likely to be complementary and to reflect the same characteristic – the skill accumulation of the manager, but they have to be combined to convey this information. We do not suspect that these two variables can cause a severe multicollinearity problem, as they are likely to bring in different information, which is indicated by the fact that they are statistically insignificant without the presence of the other variable.

6. Conclusions

In our sample of Nordic PE funds we have found the following factors to increase performance:

   i.   smaller funds,

   ii.   shorter vesting periods,

  iii.   wider geographical scope,

  iv.   lower performance-independent compensation,

   v.   being raised earlier in the manager's tenure,

  vi.   more funds under simultaneous management.

The latter two factors were found to be strongly connected. No significant effect was observed with industrial specialization or carry profit. Nevertheless, in a larger sample, we would expect carry profit to be a significant, positive, performance contributor.

Our findings are robust across various specifications of the model, with all significant coefficients maintaining signs in both multivariate and single linear regressions.

Testing and contrasting the drivers on a larger sample from a different region and globally, poses significant interest for further research. Nordic proprietary information transparency could be one cause of such regional distinctiveness.

7. Limitations

Our study is inherently biased in that the data used for this research were based only on the sample of funds provided to us by the investment firm specializing in the secondary private equity investments. Hence, the selected funds are subject to the survivorship and sample selection biases - the professionals of Cubera Private Equity AS have applied their skills and expertise to select these particular funds for screening in their investment universe. Therefore, the funds in our data sample might be systematically different from those outside the sample in that the former exhibit superior performance or potential thereof. Due to the proprietary nature of most of the data in the private equity industry, we have to accept these biases, as the possibilities for data collection from public sources are limited.

The lack of the standardization of reporting in the private equity industry hinders the reliability of our dataset. This issue is crucial for the performance measures, especially the IRR. In cases where the cash flows of the funds were not available, the funds' own estimates or data from proprietary databases were used, which might lead to some level of inconsistency in the sample.

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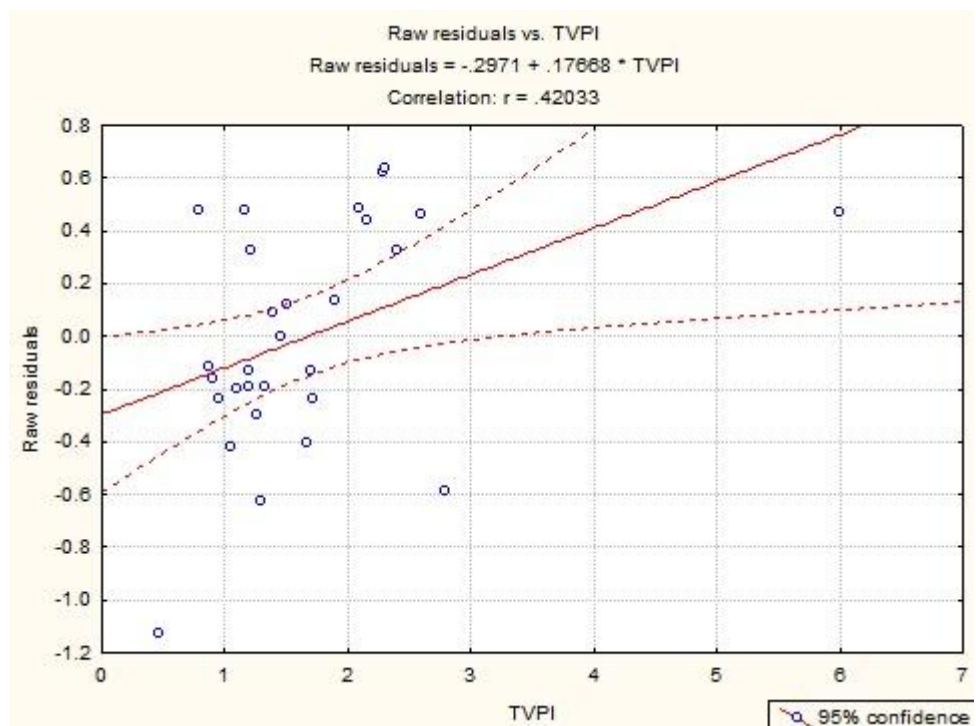
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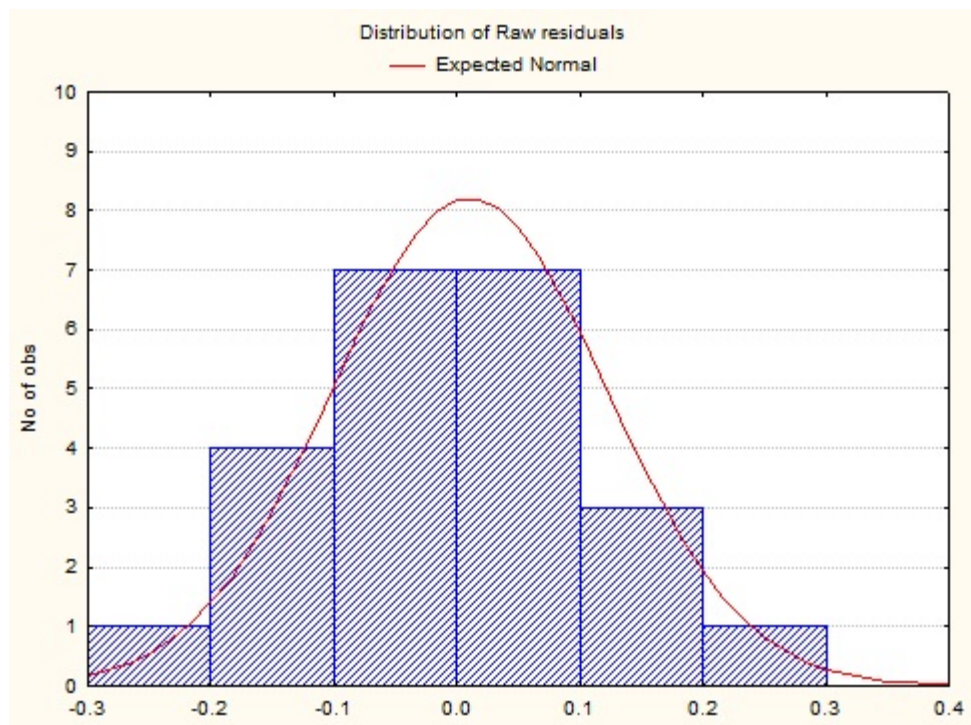
APPENDICES

Appendix A. Graph of residuals versus the dependent variable (Net IRR)

Raw residuals vs. IRR
Raw residuals = -.0645 + .42529 * IRR
Correlation: r = .65214
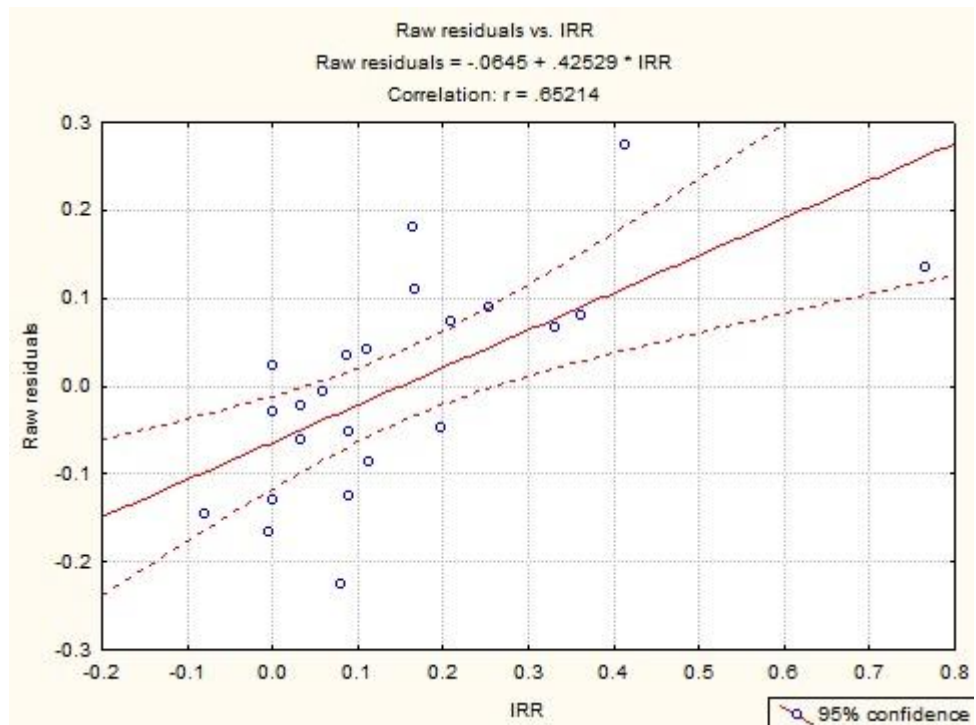
Appendix B. Graph of residuals versus the dependent variable (TVPI)

Raw residuals vs. TVPI
Raw residuals = -.2971 + .17668 * TVPI
Correlation: r = .42033

Appendix C. Histogram of residuals – IRR regression

Appendix D. Histogram of residuals – TVPI regression
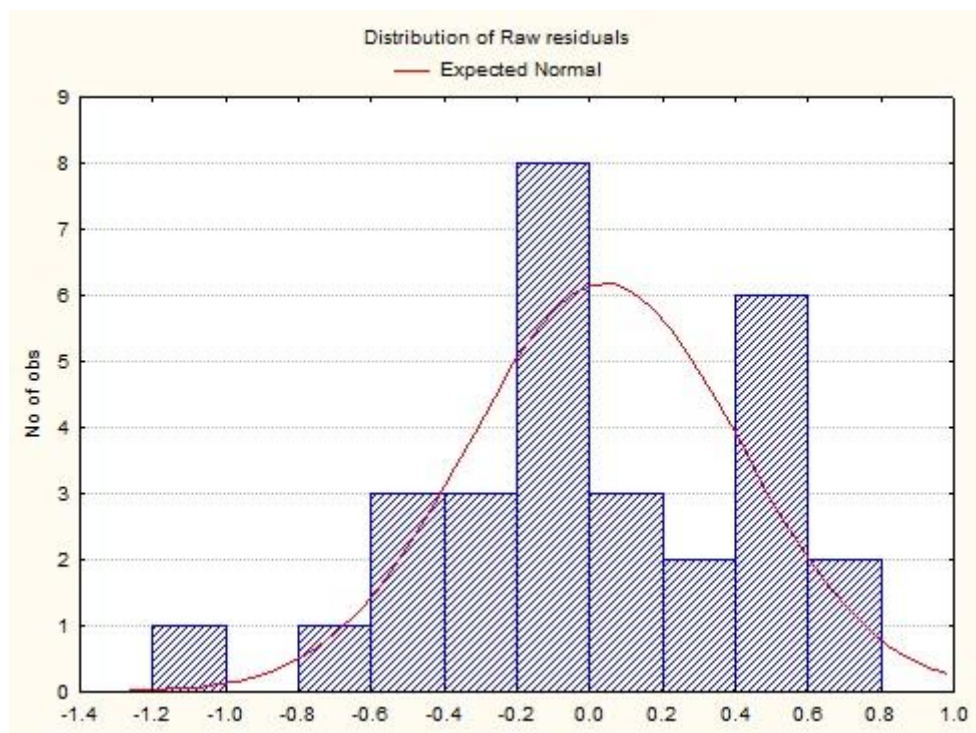
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ATTACHMENT: Preliminary Thesis Report

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1. Objective and Motivation

The research topic covers the private equity industry[8] with the focus on Nordic funds. Despite private equity having been gaining importance as a class of financial assets in the world[9] and in Nordics in particular[10], the in-depth analyses of the main factors behind the performance of the private equity funds in Nordic countries are scarce.

Our research is focused on the secondary private equity market, which is the market for the secondary transactions with the pre-existing investments in private equity funds. Inherently, private equity is an illiquid asset class and is aimed to be a buy-and-hold long term investment. However, the desire of many investors to increase and diversify exposure to private equity, as well as their liquidity needs, have led to a significant growth of the secondary market during the past two decades. It has been estimated to have increased from about $4.4 bn in 1997, to about $63 bn in 2007 (Peterman and Lai, 2009). 2011 was named "the busiest year on record in the private equity secondary market" by Cogent Partners, private equity-focused investment bank providing focused advisory services to the private equity secondary market.

One of the reasons why secondary private equity market is so hot even during the global financial downturn is that sellers view it as a source of liquidity and exit. For the buyers, on the other hand, it is an opportunity to hand-pick the funds, and buy interests at possibly discounted prices. Portfolio diversification and optimization is also an important driver of the rise of the secondary private equity market.

Secondary PE transactions can be generally divided into two categories: sales of limited partnership interests (to a fund of funds typically) and sales of direct interests in portfolio companies (a buyer typically being another private equity fund) (Dodge and Leibler, 2010). The incentives driving those two kinds of transactions can be slightly different: limited partners might be motivated to sell their interest due to a change in strategic positioning, regulatory change or cash

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[8] We consider so-called private equity funds, which primarily invest in buyout and venture capital.
[9] Capital raised globally by PE funds has increased from $33 bn in 1995 to $666 bn in 2008 (Global Private Equity Report 2011 by Bain & Company)
[10] An outstanding example is NBIM considering investments in private equity according to the strategy plan for 2011-2013 http://www.nbim.no/en/About-us/nbim-organisation/nbim-governance/strategy-plan-2011-2013-/

flow needs, while general partners would seek to sell the assets in case of the lack of management capacity (partner talent is limited), insufficient capital for follow-on funding or unavailability of other exit opportunities, as well as to realize greater IRR. The buyers are attracted by the opportunity to enter the fund at the later stage of its life, which promises a faster return on their investment, and also possibility to track the performance of the fund. The understanding of the factors which drive performance of the private equity funds is crucial for secondary investors during the selection process and that constitutes the main aspiration of our research.

The Nordic secondary private equity market has experienced dynamics similar to the global. According to Thomson Reuters, the number of trade sales and secondary buyouts in Nordics has increased over the last decade as did the number of all private equity deals, and the percentage of secondary deals in all the deals has grown from 31% in 2000 (28 deals) to 42% in 2010 (84 deals). Preqin, the leading provider of data and intelligence on alternative assets industry, reports that there are currently 61 investors located in the Nordic region that are considering the possibility of purchasing private equity or real estate fund stakes on the secondary market within the next 24 months, while, from the seller side, there are currently 26 investors based in the Nordic region that are potentially looking to sell private equity or real estate fund interests.

Given such developments in the global and Nordic private equity market, we see the secondary PE market as an exciting area of research, and will therefore concentrate our efforts in studying the private equity industry on the fund level, i.e. we will aggregate the data on portfolio companies belonging to the same fund.

1.1 Contribution

In our research, we will use a comprehensive dataset (described below), obtained from a private source and not analyzed before. The main problem of the thesis is to identify and explore the driving factors of the Nordic private equity funds and estimate their inputs into funds' excess returns.

2. Introductory Review of Previous PE Studies

The literature on private equity investments can be divided into two sets: the one focusing on performance of individual venture capital investments and another

focusing rather on funds than on separate investment projects and including buyout investments. We are interested in the latter category since we concentrate our attention on various funds' performance.

2.1 Performance Measurement

In our research, we will face the problem of the adequate measurement of the fund performance. This question was addressed in the following papers: Gompers and Lerner (1997) is a pioneering work, describing the calculation of risk-adjusted fund returns (i.e. performance alpha). This issue is also discussed in Ljungqvist and Richardson (2003) and Kaplan and Schoar (2005). Phalippou and Zollo (2005) take a different approach to fund performance estimation by making several adjustments (like corrections for sample selection bias and "living dead" investments) to the previously used value-weighted average performance approach. Further discussion of the relevant measurements of the fund performance follows in Section 4.1 Independent Variable.

2.2 Determinants of Fund Performances

The results of previous works will be used to identify the probable drivers of the fund performance. In Ljungqvist and Richardson (2003), the *fund size*, *a dummy variable for first-time funds*, *the portfolio beta*, *measures of portfolio diversification*, *vintage year*, *amount of committed capital*, *fund life*, *cost of funds*, *availability of investment opportunities* and *competition among private equity funds* are explored as the determining factors of the PE funds performance. Jones and Rhodes-Kropf (2003) examine how the *principal-agent problem* impacts the fund returns. Lopez-de-Silanes, Phalippou and Gottschalg (2010) include several other variables pertaining to PE firm's scale and scope (controls for firm-specific structure, firm's age etc.). We elaborate more on the factors of fund performance that might be of interest for our research in Section 4.2 Dependent Variables.

2.3 Agency Problem in Private Equity setting

One characteristic which crucially differentiates private equity investors from public market investors is the *active ownership* of the former. Therefore, we wish to draw particular attention to this issue. The concept of active ownership, or a hands-on management style, means a high degree of involvement in portfolio companies. In its core, the phenomenon of active ownership in private equity industry is closely tied to the *principal-agent interaction*. Evidently, primary

problems arising in the principal-agent relationship are information asymmetry (hidden information) and moral hazard (hidden action) (Pratt and Zeckhauser, 1985).

To elaborate, private equity funds are managed by General Partners (GP), while investors in the funds are Limited Partners (LP). Thus active ownership is a governance mechanism used to mitigate agency problem between GP and target firm management. This agency level has been covered widely in academia and was identified as a genuine value driver in private equity (Heel and Kehoe, The McKinsey Quartelry, 2005). In this research, the details of 60 PE deals from 11 PE companies (defined by authors as leading) are investigated. Company outperformance relative to industry peers is said to be the primary source of value creation (accounting for 63% of it). Hence, it is concluded that PE firms create value through improving the companies they invest in. Authors name five common features that characterize the top performers. First, the top deal partners seek out expertise before making investments. Second, the substantial and focused performance incentives are employed (we will elaborate more on this issue). Third, they craft a more elaborate value creation plans, together with a rigid set of key performance indicators. Fourth, they devote more hours to managing their investments. Fifth, the management is replaced early in the life of a deal by the more successful deal partners.

However, we are concerned with performance determinants of the fund on aggregate. On this level GP are subject to a different kind of principal-agent problem, with LP's as principal and GP as an agent. To assure sufficient effort from GP at maximizing fund's value, limited partnership contracts are designed to combat principal-agent problem in PE setting. Thus, in the framework of our research, we are interested in contractual compensation structure and peculiar covenants of limited partnership agreement. More in detail, we examine the impact of principal-agent problem between LP and GP on PE funds performance. To be more precise, we want to relate the performance to incentives provided within limited partnership contracts, which are the dominant organizational form worldwide in PE industry (Gompers and Lerner, 1997) (and in case of our dataset too).

Further data assessment is needed to distill variables that signal contractual incentives. There could be a different contractual balance between fixed fund-size proportional fee and performance-based fee, charged by GP. We would be interested to compare performance results of funds with different contractual compensation structures. For the sake of example, some contracts in our dataset include carry fee by GP, which implies that manager has a claim to certain share of profits should they exceed predetermined level (hurdle rate).

3. Dataset

Cubera AS[11] will provide us with proprietary data on performance of around 160 exits from mid-90's and up to most recent, with each observation focused on single company under fund's management. Since we focus on fund level, data will undergo relevant aggregation. Data will come both in printed format for exits two and more years ago and digitalized data for exits less than two years back in time.

Overall data points will include type of investment (i.e. buyout, venture …), fund name, company name, vintage year, holding period, initial investment, value of the company 1 quarter preceding exit sales price and comparison multiples. Those are peculiar data points which cannot be obtained from other sources and thus firms' identities are subject to disclosure agreement. Overall, printed data is presented in various layout and depth of coverage, but reflects mentioned points. All other in-depth financials and soft data can be either obtained from those reports or found on the internet, as this information is mostly publicly accessible (like income statements or corporate governance qualitative observations). Our main data source for limited partnership structure covenants (including compensation) are private placement memoranda for the funds, provided by Cubera.

3.1 Data Prioritizing Approach

Each observation will start with a fund exit from a defined company. First, we will dig for the hard data, which in our case will be data points mentioned above as well as financials. Typically, we will have high level financial data already

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[11] Cubera Private Equity AS is a secondary private equity firm operating in Nordic market. http://www.cubera.no/

compiled, which include sales/profitability/debt data. Any additional information required by our model can be distilled either from reports available or public sources. Our goal is to aggregate those observations for fund level to calculate its performance.

Next step would be to acquire soft data, which presents a challenge of qualitative data assessment. The data like fund investment strategy or specialization would first require an adequate data measuring system to be laid out. On the other hand, aforementioned soft data will not pose availability constraint as it is integral part of typical private placement memoranda to which we would have access.

4. Model and Variables

In short, our aim is to create a multivariate model which can describe relations between fund performance and defined factors in conceptual form of:

$$Fund\ Performance = \Sigma[\ Factor_i \times \beta_i\ ]$$

Now, we proceed with defining dependant variable and independent factors expected to determine it.

4.1 Dependent Variable

The dependent variable in our model is the private equity fund performance. However, there is an ambiguity of how it can be measured.

The basic measures of the private equity performance at the fund level are the internal rate of return (IRR), profitability index (PI) and the public market equivalent (PME) and return multiples (cash on cash ratios, e.g. total value to paid-in capital – TVPI). Each of these measures has some advantages and drawbacks, and previous studies have indicated that regression results are sensitive to the performance measure used. At the same time, it was shown that different private equity funds performance measures are highly correlated empirically (Kaplan and Schoar, 2005).

The internal rate of return (IRR) is the prevalent measure in the industry. The IRR of an investment is defined as any rate which equates the present value of the cash outflows and inflows associated with the investment. This is the rate of return that is earned from the investment (Copeland et al., 2005). However, it has three important pitfalls: it tends to favour shorter-term funds, there is no standard

method to calculate this measure which can potentially lead to different results and the IRR fails to take into account various fund characteristics (i.e. risk profile) (Gompers and Lerner, 2003).

The profitability index (PI) is a measure based on the net present value (NPV) and it is defined as the net present value of cash flows over the initial investment. The PI addresses several of the problems present in the IRR measure. The central question is the discount rate to be used.

Arguably, the public market equivalent (PME) is more meaningful for the limited partners since it is the PI which compares an investment in a private equity fund to an investment in the public market (by discounting all the cash flows at the return to some public market index). The selection of the proper benchmark is thus crucial.

The main advantage of the return multiples is their simplicity, but the drawback is that they completely ignore the notion of the time value of money.

In our thesis, we will calculate several measures of performance and use all of them in regression models as a means of robustness check.

4.1.1. Risk associated with investments in private equity funds

When measuring performance of private equity funds, we should consider the relevant risk of such investments. The challenge of measuring the risk of private equity as an asset class was mentioned in several academic works. A number of approaches for addressing the risk of the private equity funds have been developed.

The pioneering study in this field was conducted by Gompers and Lerner in 1997. This work examines the risk-adjusted performance of a single fund group by marking-to-market each investment quarterly. The obtained time series of portfolio value is regressed on various pricing factors, giving a performance alpha, which was found to be positive and significant.

The more recent approach is the one developed by Ljungqvist and Richardson (2003). To estimate the risk of each private equity fund, they suggest assigning the risk (beta in this case) to each portfolio company. Using the capital disbursements as weights, the average equity beta of the fund is calculated.

In our research we use another approach. Instead of trying to figure out the inherent risk of the private equity investments, we will use the return on the broad public equity index as a discount rate (this is relevant for PI and PME measures, but not for IRR). We acknowledge that if private equity has beta higher than one, our measures will yield biased results by overstating the true risk-adjusted return to private equity. However, in the analysis that follows, we will attempt to consider differences in risk by controlling for observable differences (industry/geographical specialization, partner competence etc.). Given that our goal is to identify and study the drivers of private equity funds performance, this approach is sensible. Yet, would our task be to compare the performance of private equity to the performance of another asset classes (e.g. public equity), we would have to adjust for the risk of private equity as a separate asset class explicitly.

4.2 Independent Variables

Having researched literature on determining sources of PE funds performance, we singled out three broad areas of possible factors to test: characteristics of the fund itself, competence of GP and GP/LP relationship within limited partnership.

Fund Characteristics

The first area of fund characteristics encompasses numerous determinants, such as fund size, duration and specialization:

Size

Fund size can alter performance through economies of scale effects, but previous studies documented diverse forms of correlation. Kaplan and Schoar (2005) have found relationship to be concave in cross-section, but negative for individual GP's. Concavity can be attributed to limited availability of profitable deals, which becomes more evident when fund grows beyond certain threshold. Moreover, authors argue concavity of the PE production function to also be the cause, as managerial skills require time consumption. Phalippou and Gottschalg (2007) on the other hand have found the relationship to be positive and linear.

We measure fund size by the total amount of capital committed to it. As previous studies showed contradicting results, we expect size to have negative,

positive or concave correlation with performance. Hence, linear and quadratic function forms will both be tested.

Duration and vesting period

Duration of the fund determines performance in a number of ways, namely in terms of investment and managing decisions timeframe. It also alters the GP's target return rate to compensate for illiquidity. Phalippou and Gottschalg (2007) find this relationship to be negative.

Approach analogous to one used for fixed income securities is employed to calculate fund duration. Thus duration is the difference between average month of exit and average month of initial investment, with months weighted by present value of corresponding cash flows. Previous studies hint at inverse expected correlation.

Vesting period is contractually specified investment horizon into the fund measured in months with expected negative relationship.

Specialization

Specialization is wide set of characteristics of the funds which focus on certain dimensions. Among those dimensions most prominent are geographic specialization, industrial specialization and stage specialization (VC vs. buyout). Specialization determines how narrow is the focus within one or couple of those dimensions. Overall, studies have revealed narrow industrial focus and early stage specialization to have positive correlation with performance (De Clercq 2003). Narrow geographic focus was found to have negative correlation with performance by Manigart (1994), although positive correlation might be expected due to local network effects. Competing effects of the specialization are negative impact from loss of diversification and benefit of focused skills and knowledge accumulation, which are "hard to imitate" as postulated by Manigart et al (2002).

Stage specialization will be measured as dummy variable taking value of 1 for VC specialized funds and zero otherwise. Positive correlation is expected.

We measure *geographic specialization* and *industrial specialization* using concentration technique. We assume concentration of investments across given dimension to proxy specialization of a fund in this dimension. Hence, percentage share of fund investments across industries/geographic regions is calculated and

find consequential Herfindahl index of industrial/geographical concentration as sum of squared shares. Resulting index will measure the degree of specialization with value of 1 for highly specialized fund in single industry/region and approaching zero with decreasing degree of specialization (thus higher diversification). Expected variable sign is positive for industrial specialization index and negative for geographical.

GP Characteristics

Second broad area is characteristics of GP with respect to their competence, knowledge and skills, which could be proxied by performance persistence and fund sequence:

GP Persistence

Persistence outlines continuity of GP in generating returns, or in other words how much current fund performance is determined by previously managed funds results. It is expected that such continuity will signal of GP skills development and experience accumulation. Kaplan and Schoar (2005) find economically and statistically significant persistence in PE funds performance even for funds two lags apart. Phalippou and Gottschalg (2007) support this argument as well by showing that current fund is most likely to perform in the same tercile (performance band) as GP's previous fund.

In our approach, measuring persistence involves regressing focus fund performance on lagged values of performance measures for previous funds run by corresponding GP. Positive correlation is expected.

Sequence

Sequence is the order of the fund raised by GP. In general, it is characteristic both of the fund and GP. However, we have chosen to attribute it to GP, as higher sequence is another signal of previous success and managing reputation. Both Kaplan and Schoar (2005) and Phalippou and Gottschalg (2007) document positive correlation between sequence and performance. Nevertheless, well performing GP has higher chance of raising next fund, which triggers survivorship bias to control for.

Obvious ordinal measurement for the variable is the chronological ranking of the focus fund in GP's managerial history and positive sign is predicted by research.

Principal-Agent Relationship Characteristics

The last set of determinants comes from the principal-agent relationship between LP and GP, aimed at reducing agency costs and incentivizing GP's managing performance. Such determinants outline the mechanisms of corporate governance within the fund, and we chose most quantifiable measures – GP capital commitment, management fee, GP's profits carry (allocation of gains from investments) and number of funds managed simultaneously:

GP Capital commitment

Capital committed by GP to invest in the fund provides incentive to maximize funds value and thus returns, of which GP will retain share proportional to commitment. We would expect GP to perform better when more of their capital is at stake. Thus, we measure GP commitment as a percentage share in total fund commitments and expect positive sign if this incentivisation mechanism if effective.

Managerial fee

Management fee is performance-independent part of compensation, and thus might provide insufficient incentive if too high. Number of issues arises and suggests fee level should be tested with respect to level and possibly fee composition, whether it is fixed or proportional. Fixed fee might provide insufficient compensation for large funds. Still, proportional fee could induce GP to inflate fund size beyond scope of investment opportunities on the market.

Mangerial fee variable will be measured in percentage relative to total funds committed with positive expected sign. In addition, we include dummy variable *fee rigidity* to reflect whether fee is fixed on level or proportional (1=fixed, 0 otherwise) with expected sign undetermined due to contradicting incentive forces.

Carry interest

Carry interest is profit share of GP's when profits surpass a determined percentage level (hurdle). Thus, this is the most refined compensation mechanism, as it provides incentive to grow and a benchmark to achieve. Potential conflict of

interest might arise, e.g. when GP chasing to bypass high benchmark hurdle allocates money to inappropriately high-risk investments.

Therefore, we include both hurdle percentage and a profit sharing percentage as our measurements of these independant variables (since they proxy for conflicting incentives and hazards). Hurdle is expected to correlate either negatively or positively with performance, while profit share is predicted to have positive correlation.

In addition to testing levels of carry interest, it is sensible to test structure of realized fees, i.e. share of GP's carry profit in their total returns. Metrick and Yasuda (2010) have found that 2/3 of revenues by GP are earned as fixed management fees, which might suggest weakened link between performance and GP reward (Chung et al, 2010). We will examine this peculiar relationship in descriptive statistics.

Simultaneous management

Number of funds managed at one time creates potential conflict of interest across those funds. As outlined by Baks and Benveniste (2010), simultaneous involvement of GPs in several funds might lead to suboptimal management, such as focusing on high-performance fund and disregarding sinking one, engaging in as many funds as possible to collect more fees, simultaneous involvement in one investment project by means of two funds (e.g. by investing in different securities types) etc. All in all, simultaneous management by GPs requires testing for adverse incentives effects on performance. Therefore, we measure this variable by number of funds measured with focused fund and generally expect negative sign.

4.3 Model Setup

As described in Secion 4.1, the fund's performance is the dependent variable in our model. Practically, it can be represented by three measures: IRR, PI and PME. We will use all of them in the empirical part of our research to capture any sensitivities arising from the specifics of the performance metric used. Hence, the dependent variable will have the following values:

- Y_1: Internal Rate of Return (IRR)

- Y_2: Profitability Index (PI)

- Y_3: Public Market Equivalent (PME)

Subsequently, our research goal is to test the effects of three sets of factors described in part 4.2 on Nordic PE funds performance. Those factors have either been proven by previous studies to demonstrate significant correlation with performance, or are expected to have impact by our theoretical setup (as in case with governance mechanisms). Tests will be conducted both on univariate and multivariate levels to control for adverse effects and verify robustness.

We generalize our testable model in the following multiple regression form:

$$Y_i = \alpha + \beta_1 \times Size + \beta_2 \times Size^2 + \beta_3 \times Duration + \beta_4 \times Vesting\ period + \beta_5 \times Stage\ specialization + \beta_6 \times Industrial\ specializaion + \beta_7 \times Geographical\ specialization + \beta_8 \times GP\ persistence + \beta_9 \times Sequence + \beta_{10} \times GP\ capital\ comm. + \beta_{11} \times Managerial\ fee + \beta_{12} \times Fee\ rigidity + \beta_{13} \times Carry\ hurdle + \beta_{14} \times Carry\ profit + \beta_{15} \times Simultaneous\ management$$

The summary of the model is as follows:

Theoretical variable	Empirical proxy	Exp. sign
Size	*TCC*/TCC squared*	+ or - /concave
Duration	*Fixed-income method, months*	-
Vesting period	*Fund contractual horizon, months*	-
Specialization:		
- stage	*VC/Buyout dummy*	+
- industrial	*HHI** for investments conc. within industries*	+
- geographical	*HHI** for investments conc. within regions*	-
GP persistence	*Lagged performance of n previous GP funds*	+
Sequence	*Chronological order of fund in GP track record*	+
GP Capital committed	*GP cap. comm. proportional to TCC*	+
Managerial fee	*Fee level proportional to TCC*	+
Fee rigidity	*Fixed/proportional dummy*	+ or -
Carry hurdle	*Hurdle profit rate to surpass*	+ or -
Carry profit	*Profit share of GP above hurdle*	+
Simultaneous management	*Number of funds managed simultaneously*	-

* Total capital committed
** Herfindahl index