Stockholm School of Economics

Bachelor Thesis in Finance

Nordic Private Equity Performance

Do Nordic Private Equity funds outperform public markets, and how do they compare to their global counterparts?

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Abstract

This paper sets out to examine the cross-sectional performance of Nordic Private Equity funds. More specifically, the paper aims to evaluate the performance of the buyout and venture capital funds with vintages 1994-2012, and assess it in relation to relevant benchmarks in order to appraise the value creation potential as compared to public markets, and global competitors within the field. The performance is measured using both conventional return and PME metrics, and also a novel *Time Weighted Return*-based measure devised in the paper. The studied sample consists of 2,224 records with one or more observable performance measures, out of which 75 are attributable to the Nordic region. The synthesized analysis indicates an outperformance by Nordic buyout funds in relation to public market equivalent investments. Its significance and magnitude are however sensitive to assumptions with regard to risk adjustments. The Nordic venture capital funds on the other hand exhibit strong underperformance. A similar pattern can be observed in the regional comparison, with Nordic buyout funds exhibiting statistically significant outperformance as compared to European and US-based peers on the basis of absolute performance metrics, such as the *Internal Rate of Return*. Venture capital funds show underperformance on the basis of PME abnormal returns. Lastly, the paper finds evidence of a robust relationship between the performance of Nordic funds, the fund type, and relative vintage.

Keywords: Private Equity, Nordic, Performance, Public Markets, PME, TWR, TWRA
JEL Classification: G12, G23, G24, G29, G32

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Chapter 1

Introduction

Since it's swift and paradigm shift-inducing[1] emergence as a global phenomenon in the early 1980s, Private Equity has largely remained an enigmatic asset class. It has been loosely associated with a range of characteristics, which more often than not proved to be inconsistent with empirical evidence, and remained relatively poorly empirically understood, particularly on a regional basis. The opaque nature of the industry, inherently secretive characteristics of most fund managers, and consequent lack of readily available data further aggravated the ambiguity and mythos forming around it – it comes as no surprise that given this mostly positively loaded ideological polysemy from a returns-oriented perspective, in today's low volatility and interest rate environment, investors who are increasingly directing capital towards riskier assets in the hunt for yield, opt to enter the asset class in hope of finding alpha without fundamentally understanding it.

In this paper, we explore the performance of Nordic Private Equity funds, and assess it in relation to relevant benchmarks in order to evaluate the value creation potential as compared to public markets, and global competitors within the field. The study is restricted to fund vintages between 1994-2012, and is based on data gathered from *Preqin*. Firstly, our analysis draws upon a meta-application of previously devised metrics, commonly used in related research and prior studies. These consist of the conventional performance (IRR, TVPI, and MIRR) and PME metrics (KS-PME, DirectAlpha, and PME+). It then complements it by introducing a novel measure, TWRA, which allows for greater robustness in the synthesized analysis based on smaller datasets. This feature becomes apparent as the newly formulated measure utilizes the more readily

[1] Already in 1989, Jensen (1999) predicted that a gradual shift to the PE-model as dominant corporate organizational form was likely to occur given its efficient nature.

available TVPI and inferred aggregate industry parameters, rather than individual raw cash flows, as inputs. An elementary attempt to adjust for risk factors is made by raising the break-even level which is assumed to correspond to the transition into abnormal returns. The specific level is based on prior studies and is directly connected to qualitative meaning and implications of the underlying risk factors. Finally, the analysis pivots towards the regional differences, and compares the Nordic funds against their European (excl. Nordics) and US-based peers. Lastly, the study attempts to robustly decompose the drivers which affect the fund returns through a deeper regression analysis.

Within the scope of our research, the Nordic region includes Denmark, Finland, Norway, and Sweden.[1] These countries have been consistently rated near the top of global competitiveness indexes, and tend to be regarded as one of the most economically vibrant parts of Europe (BerchWood, 2013). Moreover, considering *The Nordic Way* has largely become synonymous with high living standards, inclusive welfare states, and resilient economic climate (Eklund et al., 2011), it is fair so assume that the dynamics which underly the region, and subsequently the entities which drive them, such as the prolific funds studied in this paper, are worth exploring in greater detail.

Furthermore, hand in hand with the overarching economic development of the region, the Nordic Private Equity market has seen great proliferation over the last two decades, with Sweden growing into one of the key competitive clusters within the field. Over the last 10 years, more than 1,000 Swedish companies have received funding through Private Equity, adding up to around 15 billion EUR in total (SVCA, 2017). The aggregate fund-raising for the entire Nordic region extended upwards of 70 billion during this period.[2] Moreover, the over 300 fund managers active in the region, a group which includes international hallmark names such as *EQT*, *Nordic Capital*, and *Altor Equity Partners*, have contributed to the creation of a unique PE competence cluster in Stockholm and surrounding areas, which harmonizes very well with the established knowledge economy of the region. We therefore believe there is an economic argument to be made on the basis of the competitive advantage generated by such concentration of expertise, akin to that made in regard to Silicon Valley within technology industry. As described by Porter (1990), once a cluster forms, the whole group of industries[3] becomes

[1] For the purpose of this paper, we have largely excluded Iceland due to the lack of appropriate data.

[2] Based on Preqin Fund raising data as of April 2018, see figure C.6.

[3] In the case of Private Equity, this group would most commonly constitute lawyers, investment bankers, consultants, as well as other actors who become integral to the business processes.

mutually supporting, and has a strong propensity to induce a semi-persistent cycle of innovation which drives the competitive advantage, and by extension potential abnormal returns. This, in turn, points us towards the hypothesis of Nordic outperformance, which becomes central to the conducted research and analysis.

The key findings of the paper are threefold – firstly, we find evidence for statistically significant outperformance of Nordic buyout (BO) funds as compared to public markets, with an approximate annual abnormal return of 5%. The results for venture capital (VC) show the opposite – a significant underpeformance of c. -7% in relation to a public market equivalent investment. The magnitude of the generated alpha is sensitive to the benchmark index – we find that when using a local index which more closely matches properties of the specific fund type[1] the alpha generation is weaker than when compared to the more conventional broader global index by c. -3%. However, after applying adjustments for risk factors through a more conservative assumption with regard to the abnormal returns threshold, the significance drops below the level at which a valid inference can be made. Thus, we cannot fully reject the null-hypothesis of no abnormal returns under the most stringent assumptions in regard to risk. On the other hand, the underperformance of VCs remains significant across the board, and thus the inference can be made that VC's underperform public markets. The general dichotomy in returns of fund types aligns with prior findings on an international level (Harris et al., 2016).

Secondly, we find statistically significant evidence for the outperformance of Nordic buyout firms in relation to their European and US-based peers on the basis of absolute performance metrics (IRR, TVPI, and TWR). Due to the low sample size, we are unable to confirm the robustness in terms of abnormal returns (PME). However, we do note that the outperformance seems to be more defined against the US than Europe. In terms of VC, we find that the Nordic funds seem to underperform both US and Europe in terms of abnormal returns. Due to the low sample size attributable to VC, we do not believe the inference to be as robust as the findings with regard to BO funds. Nevertheless, the finding does point us toward the direction of a phenomenon which yields itself to further research. Notably, considering that the region exhibits comparatively strong foothold in both the fields technology and finance, one would at face value expect the data to point toward the opposite direction given that the field of VC largely draws upon competencies found in both of these fields, thus indicating the value of further research.

[1] Refer to figure C.3, and the methodology section for more details.

Lastly, we find evidence of a robust relationship between the performance of Nordic funds and the fund type and relative vintage. The relationship with fund type has been discussed above and is reaffirmed by the synthesized robust regression analysis, and suggests that Nordic VC funds underperform the buyout funds by 75% (in terms of relative performance). The second independent variable (relative vintage), points towards a gradual decline of performance over the last 20 years, with c. -8% average relative performance drop for each year since 1990. We test the hypothesis of concave relationship between the fund size and performance, however we are unable to find evidence strong enough to reject the null-hypothesis. The two variables have however been connected and associated with the same relationship in international studies (Harris et al., 2016, Kaplan and Schoar, 2005, Kaplan and Strömberg, 2009, Strömberg, 2018), pointing towards an international, rather than local phenomena being in play. Prior research points towards a cyclicality in the PE market, bound to the cost of illiquidity and its intimate link to the fundraising,[1] which has been shown to be a strong predictor of performance. The aforementioned research points towards a negative correlation between the total amount of raised funds, and the performance for a specific vintage. However, due to the small time-frame of our study, we refer to future research to assess the underlying qualitative reasons behind the apparent relationship.

Concludingly, the paper contributes to the existing body of knowledge by introducing an element of regional analysis on an ostensibly unique population, based on a theoretically grounded economical argument for a hypothetically positive divergence in performance as compared to the aggregated global mean. Furthermore, it introduces a novel metric appropriate for analysis of regions with low levels of available data, such as the Nordics explored herewithin. The study also allows us to reaffirm certain globally observable trends such as the divergence between VCs and BOs fund performance through the last decade, or the depressed returns during the majority of 2000s, and thus increases the significance of these findings by confirming their inferred persistence on a more homogeneous and narrow population. Furthermore, it opens up avenues for continued research, which could extend, elaborate, and build upon the fundamental findings identified within the scope of this paper.

[1] In other words, when capital is cheap, fundraising tends to experience a substantial acceleration in terms of capital inflows.

Chapter 2

Background on Private Equity

2.1 The Business of Private Equity

In the strictest sense, Private Equity can simply be defined as the broad asset class consisting of equity-like[1] securities that are not publicly traded (Gilligan and Wright, 2010). However, since its inception, the term has been primarily used to describe the underlying industry consisting of *Asset Management Companies* (AMC) which facilitate the access to the asset class through various forms of structured investment vehicles.

Thus, Private Equity is generally considered a blanket term applied to describe the broad industry and organizational form responsible for the financing provided in a wide variety of situations, ranging from the capital injections provided to business startups, to the Public-to-Private buyouts of large publicly listed companies (British Private Equity & Venture Capital Association, 2010). The industry is typically segmented into two key areas, *Buyouts* (BO) and *Venture Capital* (VC), however it can also encompass more intricate structures in the form of *Fund of Funds* (FOF), *Growth Capital*, *Real Estate investment vehicles*, *Special Purpose Acquisition Companies* (SPAC), and other less recognizable investment structures. Furthermore, the exact scope of the definitions tends to vary by geographical location – in Europe, particularly in the Nordic region, *Risk Capital* is often used as a native label for a wide range of equity investments, meanwhile in the U.S. most entities draw a clear line between both types and stages of funding (Fraser-Sampson, 2007, SVCA, Zarabi, 2009). Nevertheless, the principal and overarching idea which fundamentally defines the industry across all regions is simply the notion of

[1] In recent years, investment through convertibles and other derivates has become more widely adopted.

investments in unquoted equity stakes, or in some cases even their de facto derivatives.

The main difference between the aforementioned *Buyout* and *Venture Capital* firms, which constitute the majority of the industry, is the strategy which underpins their activity – BOs firms typically acquire majority stakes in mature companies, normally using significant amounts of debt. On the other hand, VCs firms tend to focus on smaller minority investments in early-stage business with significantly more aggressive risk profiles. VC funds also tend to have a larger equity focus compared to BO funds given the companies they invest in are not capable of handling the same debt levels. Furthermore, the active role of the BO sponsor which helps to steer the acquired company in a strategic direction post-acquisition, as compared to the typically more limited engagement of VCs, emphasizes the difference in activity and skill sets.

Regarding the underlying legal structures – the vast majority of Private Equity funds are organized as limited partnerships, with the Private Equity firms serving as the general partner (GP), and large institutional investors and high-net-worth individuals (HNWI) committing the majority of callable capital as the limited partners (LP) (Metrick and Yasuda, 2009). However, in order to align interests and avoid agency problems, the GPs tend to co-invest and contribute their own capital. Broadly speaking, the structure exists as a solution to the problem of: *"how can a group of entities create a structure that would bind them together as investors for a finite period without creating multiple tax charges?"*[1]

The funds customarily have a fixed life-time of approximately 10 years, however they typically allow for an extension at the discretion of the manager (typically a so called grace period of 2 years). The first 5 years are generally dedicated to allocating the committed capital (so called "drawdown" period), and then managing the investments for the remaining 3-7 years before executing an exit strategy (Gilligan and Wright, 2010). Successful asset managers stay in business by raising a new fund every 3 to 5 years, a process generally driven by the historic performance which tends to be treated as an indicator of the manager's skill by the LPs (Metrick and Yasuda, 2009).

The compensation structure for the GP is fairly standardized across the industry, and consists of a carry and management fee, as well as capital gains from co-investments (Metrick and Yasuda, 2009). According to Robinson and Sensoy (2013), buyout funds charge an average (median) management fee of 1.78% (2.00%). The corresponding fee for VC funds is 2.24% (2.50%). Meanwhile, the share of the carry equals 20% of all

[1] A more detailed discussion of the presented reasoning can be reviewed in Gilligan and Wright (2010)

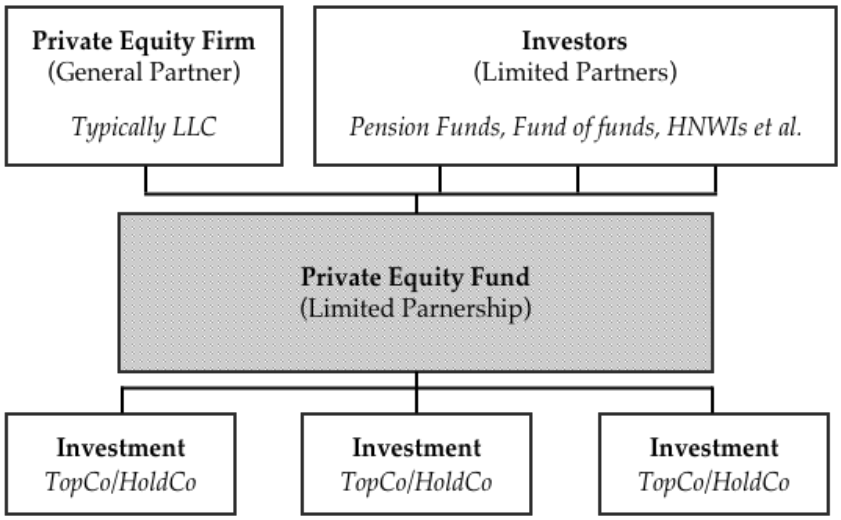


Figure 2.1: Illustrative structure of a Private Equity fund

profits above the hurdle rate for almost all private equity funds. In their sample of 837 funds, 10% of the VC funds and only 1% of the buyout funds charged a higher carry than the aforementioned 20%. The average rate amounted to 20.44% for VC GPs and 19.96% for BO fund GPs.

In contrast to publicly-listed companies, which can often have a fairly diffuse ownership structure, Private Equity firms generally work closely alongside the management teams to enhance the operating performance of the business (Kaplan and Strömberg, 2009). This "active ownership" approach allows the private equity sponsor to enhance the value in the business through involvement in all areas of operation, from the top-line growth, efficiency savings, cash generation and procurement, to supply-chains, marketing and sales, improving reporting and human resources. Furthermore, this approach also allows the GP to use their accumulated industry and operating knowledge to develop and implement value creation plans for the investments, a particularly important value driver for BO funds which often rely on successful operational initiatives.

The underlying business model is backed by several key ideas such as; seekers of market failure (1), solving the principal-agent problem (2), and sacrificing liquidity to solve information asymmetries (3). Firstly, private equity often looks for markets failures to be able to take advantage of them. One aspect that is frequently discussed is the effect of tax deductibility of interest on investment returns. Private equity often uses

large amount of debt to be able to take advantage of the tax shield created by the high leverage. Secondly, private equity try to solve the principal-agent problem by aligning the interest of the managers and shareholders. Private equity addresses one of the main issues, namely corporate governance. By making management owners, private equity firms act as a form of long-term corporate governance form. Another view of private equity is that it acts as a "shock therapy" for underperforming firms. Lastly, by investing in private companies, PE-funds sacrifice liquidity as they are unable to sell and make quick exits. They compensate this by reducing the information asymmetries through thorough due diligence processes. The access to information continues during the life of the investment, as the private equity fund has the right to further information through owning the company and participating on the board of directors.

Lastly, the Nordic region has consistently exhibited strong economic fundamentals, and enterprising cultures which have paved the way for the region's private equity industry. Consisting of over 300 private equity funds managers, the Nordic private equity market is both large and mature.[1] The region has in recent years also seen less economic stress compared to Europe overall, largely due to the region's strong private and public institutions which creates an innovative and creative business environment, thus making the Nordics posed to grow faster than the surrounding European region (BerchWood, 2013). Moreover, the Nordic private equity market has been one of the most dynamic, second only to Ireland/UK in PE-penetration, which is measured as PE-owned business enterprise value in comparison to GDPs in the associated countries.

2.2 Terminology Specification

In order to clarify the industry-specific terms used in the paper, we restrict and specify the PE-related vocabulary as follows: Private Equity is treated by it's general, broader Anglo-Saxon definition which encompasses all non-listed equity-linked investments. However, it is worth noting that the bulk of the presented empirical evidence is restricted to *Buyout* (BO) and *Venture Capital* (VC) due to the natural imbalance of the investment forms in the underlying population.

The Private Equity managers operating the investment structures are referred to as *General Partners* (GP), and the investors as *Limited Partners* (LP). However, for gener-

[1] As of April 2018, the total number of private equity fund managers reached 332 (Preqin 2018).

alization purposes we shall also refer to the firms more broadly as *Asset Management Companies* (AMCs), and the LPs simply as *investors*.

2.3 Performance Metrics and Benchmarking

The most commonly used metrics for the evaluation of private equity performance are the *Internal Rate of Return* (IRR) and the *Total Value to Paid In* (TVPI) multiple, generally referred to as the investment multiple, or more colloquially, the unrealized multiple of money (MoM). For benchmarking against other asset classes, alternative methods have been developed; comparison against public markets is typically done through the *Public Market Equivalent* (PME) methods. By the same token, a less elaborate *Time Weighted Return* (TWR) metric can also be applied in order to establish a potential heuristic benchmark against asset classes with significantly different liquidity characteristics.

The IRR is widely used in corporate finance due to its function as a relative cash flow-based measure of performance – it considers the cash calls and distributions made by a fund and discounts them so as to arrive at a net present value of zero, thus yielding the annualized effective compounded return rate. In other words, it is the annual yield of an investment's underlying cash flows. It is a key measure for benchmarking returns between funds and investments due to its design which intuitively accounts for the time preference of money and investments, and thus by extension the "commitment risk" reflecting the uncertainty with regard to the timing of capital calls and distributions to investors. While in theory the most appropriate measure given the intertemporal nature of Private Equity fund commitments, it has its drawbacks – since it is very sensitive to the timing of cash flows, it becomes easy to manipulate by skilled practitioners. By utilizing bridge loans which delay equity commitments, and taking out aggressively timed dividends through debt-driven recapitalizations, an IRR-maximizing AMC will be able to inflate IRR figures, albeit at the cost of increased financial risk (Gilligan and Wright, 2010, Salehi-Sangari and Hellqvist, 2014). Furthermore, such arrangements will come at the cost of a lower TVPI, since interest paid on the additional debt will lower the cash available for subsequent distributions. Moreover, IRR equals to the effective rate of return if, and only if, intermediary dividends are reinvested at the IRR rate (Phalippou, 2008), which in reality is improbable. This is essential, as this simplification can yield vast logical inconsistencies when the method is applied inappropriately.

While it is possible to some extent adjust the IRR measures to better reflect reality of the achieved returns, by applying a different discount factor to inflows and outflows (the MIRR method), and by weighting each IRR by the duration[1] (Phalippou and Gottschalg, 2009), the measure still remains problematic due to an array of surrounding issues such as the lack of adjustments for the risk associated with the investments.

The MIRR measure enables us to address the larger pitfalls of IRR, by instead of assuming the reinvestment rate, specifying a fixed rate of investing and borrowing. All investments are then discounted back to the time of the initial cash flow to obtain a *Present value* (PV), while all distributions are discounted forward to the ending time to obtain a *Future value* (FV).

$$MIRR = \sqrt[t]{\frac{FV(Distributions)}{PV(Calls)}} - 1 \tag{2.1}$$

While a more robust measure, it becomes subject to many assumptions related to the investment and financing rates (which tend to vary with time, and have idiosyncratic properties), as well as the treatment of the time period t (treatment of start year and investment horizon). The measure nonetheless remains a valuable supplement to the performance evaluation toolkit, however it might be more fit for evaluation of individual funds rather than aggregate performance, due to its sensitivity to assumptions.

TVPI on the other hand is a simpler measure which allows us to gauge the absolute return made on the committed capital irrespective of time frame as per:

$$TVPI = \frac{\sum_{t=1}^{T} CF_t^{Distribution} + NAV_T}{\sum_{t=1}^{T} CF_t^{Contribution}} = \frac{\text{Total distributions} + \text{Unrealized value of fund}}{\text{Total contributions}} \tag{2.2}$$

While the measure lacks the complexity associated with IRR, it provides us with a performance metric less prone to manipulation. Due to the lack of the time-dimension it is less appropriate for comparison of funds with different time horizons. However, given the fairly uniform nature of the industry, it remains a valuable metric for in-group comparisons of the distinct types of private equity investments.

Another, albeit simplistic, approach is to potentially evaluate a form of *Time Weighted*

[1]Duration has to be treated as in a fixed-income context, i.e. by computing the weighted average payment time using the present value of the payments as weights.

Return (TWR) metric. By considering a simple compound annual growth rate (CAGR) for the fund's absolute return in relation to average investment length, we are able to arrive at a fairly reasonable estimate of average performance as per below:

$$TWR = TVPI^{\frac{1}{n}} - 1 \tag{2.3}$$

Where n corresponds to the average time the capital in committed to an investment. In other words, if a fund has a 12 year life span, out of which 7 is spent in the "drawdown" phase, and 5 in active investment, then $n \approx 5$ can be assumed. Alternatively, given large enough sample, it also also possible to estimate n by simply averaging the life-time of underlying deals. While the measure is less robust and doesn't account for the timing of cash flows (CFA Institute, 2012), it is less prone to unwanted manipulations. It is certainly not the most appropriate measure for accurate comparison between funds due to the uncertainty in estimating the exact n for individual funds, however, as the investment horizon is fairly uniform across the industry, stochastic asset-wide comparisons can yield fairly valuable insights. Also, as the returns of public market indexes are generally reported as a TWR-based measure, it is a valuable tool when comparing alternative assets against it. Moreover, its simple nature makes it fairly welcoming to additional discretionary adjustments based on complementary analysis of additional factors related to the structure and risk of the investments.

Considering that the returns attainable through capital placements in public markets constitute an unequivocal opportunity cost to investors, it is essential to evaluate the relative performance of the asset class against it. After all, as the institutional investors have to take an active decision when choosing whether to allocate capital into this fairly long-term, opaque, and inflexible asset class, having a clear measure of relative performance becomes paramount. As the cash flow-based IRR metric is not comparable to time weighted returns (TWR) of public markets, alternative methods have been devised.

The *Public Market Equivalent* (PME) approach is a fairly new concept, first introduced by Long and Nickels (1996) as the *Index Comparison Model* (ICM). The measure compares the performance by synthesizing a theoretical investment into the corresponding public index which mimics the cash flows of the underlying fund. In simple terms, each capital call is treated as an investment, while distributions are instead assumed to correspond to a sell off from the benchmark public market portfolio. Worth noting is that all cash

flows are treated as net of fees. What makes the returns differ between the private equity fund and the benchmark portfolio is the net asset value (NAV), which in the benchmark portfolio is a fictive value calculated as the difference between the sum of the future value of all contributions and the sum of the future value of all distributions, compounded with benchmark returns. The subsequent comparison is made on the basis of the fund's IRR and the fictive portfolio, with the difference corresponding to the average yearly abnormal return. While the measure is very intuitive, it comes with important caveats. Most importantly, frequent large withdrawals from the index result in a net short position in the index comparison, which results in a nonsensical outcome.

More recently, more robust methods have been developed. The PME+ method published by *Capital Dynamics* in 2003 was designed to correct the main issues associated with the original ICM method by introducing a scaling factor which allowed the NAV of the index investment to match the NAV of the fund. Nonetheless, the method came with many of its own issues such as high sensitivity to early distributions.

The KS-PME method developed by Kaplan and Schoar (2005) provides us with another approach to dealing with the problem. In contrast to the prior PME methods, which rely on creating a separate theoretical market portfolio that replicates the fund cash flows, the KS-PME instead approaches the issue by comparing the future values (FV) of distributions and capital calls using a discount rate bound to the relevant public market benchmark returns. The method bears stark resemblance to the TVPI multiple, however includes the time-dimension through the discrete discount factors calculated using benchmark returns as seen below (I_t as discount factor[1]):

$$KS-PME = \frac{\sum_{t=1}^{T} \frac{CF_t^{Distribution}}{I_t} + \frac{NAV_T}{I_T}}{\sum_{t=1}^{T} \frac{CF_t^{Contribution}}{I_t}} = \frac{\text{FV(Total distributions} + \text{Unrealized value of fund)}}{\text{FV(Total contributions)}} \tag{2.4}$$

While the Long Nickels PME needs to be compared to the actual IRR, the KS-PME gives a direct indication of the performance of the fund compared to the performance of the index in the form of a multiple. A KS-PME above 1 indicates that the fund outperformed the index (and vice versa). Furthermore, the method is valid regardless of the risk of PE investments, and is less susceptible to variations in the timing and systematic risks of the underlying cash flows along with potential GP manipulations (Sorensen and

[1]The index derived from compounded annual returns of the underlying public market benchmark.

Jagannathan, 2013). As the KS-PME is more robust than the two previously discussed heuristic counterparts, it will generally generate more reliable results. Unfortunately, the model is not without flaws, as it does not explicitly control for the systemic risk (corresponding to the *beta*) of the funds,[1] and also gives no information about the actual annual abnormal returns – or in other words the *alpha* generated by the fund.

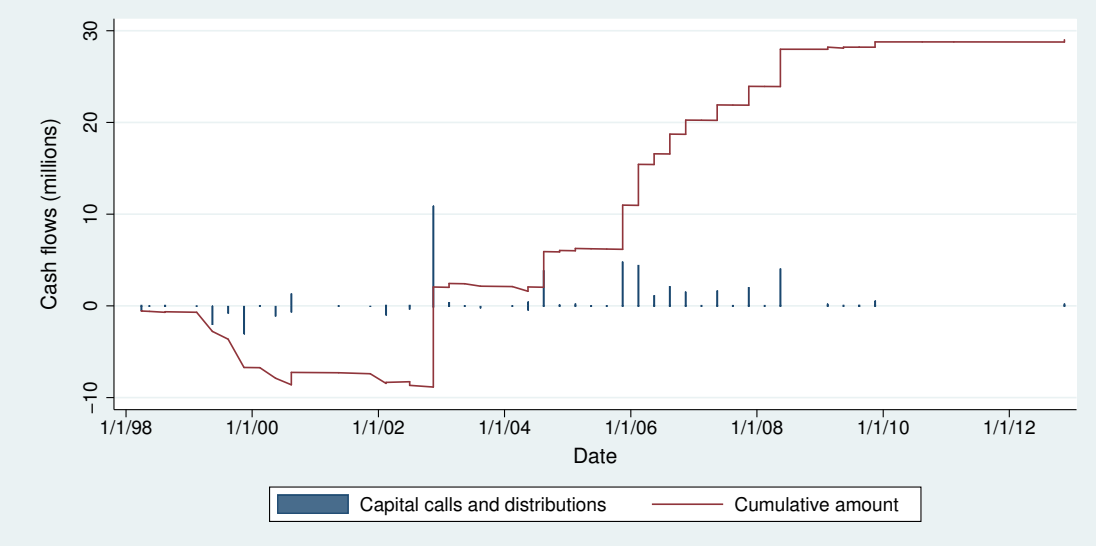
The *DirectAlpha* developed by Gredil et al. (2014) was in turn created to solve the aforementioned problem associated with KS-PME's lack of annual rate-of-return measure. The model builds upon the fundamental methodology established by Kaplan and Schoar (2005), but rather than finding a comparative multiple, it produces the IRR of the indexed future value of cash flows which corresponds to the continuous yearly abnormal rate of return of the fund. More exactly, the *DirectAlpha* is deduced from the KS-PME calculation by computing an IRR using the discounted contributions and distributions, and subsequently taking the natural logarithm of the resulting value.

We are also able to derive a new public-market based benchmark by applying a novel approach based on the aforementioned TWR measure. By comparing the rate of return given by the TWR approach to an appropriate index with the associated returns (r_m), we would be able to arrive at a measure that, on average, provides us with a reasonable heuristic estimate of the potential abnormal returns. As both measures would have comparable units of measure, the calculation would yield a valid result (albeit, with inherited flaws carried over from the TWR). It is worth noting that the estimation of r_m is somewhat problematic due to the nature of TWR, which does not define an exact investment period. However, by using a geometric average of index returns over either the funds total life, or a more specific sub-period, we can yet again arrive at a sensible estimate.

$$TWRA = TWR_{alpha} = TWR - r_m \tag{2.5}$$

Given perfect information access, the TWRA method would be redundant as it is a less robust and precise measure by design. However, as the amount of data available in terms of TVPI measures typically outstrips the available cash flow data by up to 3:1 due to the opaque nature of the industry (see table C.1), by being able to harvest and utilize the remaining $\frac{2}{3}$ which previously remained excluded from most evaluations, we

[1] Albeit, Sorensen and Jagannathan (2013) do show that under the assumption of investor log-utility and of that the benchmark captures total wealth in the economy ($r_w = r_m$), one need not compute betas of PE investments, and any changes in PE cash flow betas due to changes in financial leverage or operating leverage of the business are automatically taken into account in KS-PME.



For legal reasons, the name and other specifications of the fund cannot be disclosed.

Figure 2.2: J-Curve effect: Illustrative cash flows for a 1998 Nordic buyout fund

are able to incrementally boost the robustness of the performed analysis. This becomes particularly important in studies on smaller samples (such as Nordics), as the inclusion of TWRA allows for increased statistical power due to the sample size expansion.

Lastly, it is important emphasize the the *J-curve effect* – a fundamental phenomenon within private equity which illustrates the historical tendency of private equity funds to deliver negative returns in early years. By extension, it clearly illustrates the weaknesses of IRR-based methods when evaluating recently formed funds without properly accounting for the NAV. The *J-curve effect* comes from the structure of cash in- and outflows which in general show companies have a cumulative outflow of capital early in the funds life cycle (often lowest after three years) and steadily increases over time. This creates a situation were the net IRR is negative until the distributions match at least the contributions. The moment when distributions match contributions is called the payback point (Fraser-Sampson, 2007). Given the *J-curve effect*, fund performance with very recent vintages (within three to five years) tends to have fairly low credibility. Therefore, it is generally recommended to discard more recent vintages in analysis, or alternatively only consider liquidated funds. However, when considering the NAV as a factor when estimating returns of active funds, it is worth noting that the most recent research indicates that the valuation of subsequent distributions of active funds tend to be underestimated by an average of 35% (Jenkinson et al., 2013).

2.4 Exploration of Risk Factors

The most prominent and self-evident difference between public and private equity is that the latter is not directly traded on public exchanges. This basic distinction yields the key insight that a *liquidity risk*, and by extension the associated *risk premia*, comes into play when evaluating the returns of the asset class. Due to the nature of the assets, this premium-requiring risk can in turn be classified into two discrete classes, namely *market risk* and *funding risk* (Brunnermeier and Pedersen, 2009).

The *market risk* simply illustrates the limited ability to sell and exchange the asset on a secondary market. The risk, which is not only bound to the idiosyncratic asset liquidity, but also it's covariance with the overall market liquidity, justifies a premium, which varies with time due to changing market conditions. The commonly used Pastor-Stambaugh liquidity factor captures this type of liquidity premium (Pastor, 2003), as illustrated by the fact that publicly traded securities whose returns co-vary positively with aggregate public stock market liquidity are associated with a higher returns.

The *funding risk* on the other hand illuminates the risk induced by the capital commitment by the investors – as the investors do not invest all the money immediately, rather are subject to discrete capital calls over the fund's lifetime (following the typical *j-curve*), they are required to maintain a reasonable liquidity buffer in order to be able to honor their commitments. Due to the discrete nature of the calls, this liquidity requirements induces a risk, for which the investors need to be compensated. It is however worth noting that given the predictable shape of the *j-curve*, the risk can to some extent be diversified away through cross-vintage investment diversification, so as to allow the cash flows from one fund to implicitly cover the liquidity requirements created by the capital calls of another, more recent commitment. However, the systematic liquidity risk remains at all times due to the exogenous factors which can not be diversified away, and thus still requires the compensation through appropriate risk premium.

Interestingly, market liquidity and funding liquidity tend to co-vary and reinforce each other because of investor leverage and margin requirements (Brunnermeier and Pedersen, 2009). As an economic downturn tends to contribute to increased rates of margin-calls for investors, which in turn force sell-offs that decreases market liquidity due to the apparent supply-demand mismatch, thus continuously pushing the asset prices down, it will result in a negative liquidity spiral.

Moreover, Private Equity returns are often evaluated through capital asset pricing models which broadly load the risk into two classes: systematic and idiosyncratic risk. This simplification of the risk factors can yield fair logical approximations on publicly traded assets, private equity might however be affected by systematic risk factors that are not present in public markets due to market segmentation and incompleteness.

Authors such as Ang et al. (2017) provide evidence suggesting that PE returns are not completely spanned by factors contributing to public equity returns. Rather, the returns seem to be more closely related to variables capturing the aggregate activity in the PE market, such as commitments to private equity funds relative to stock market capitalization (Kaplan and Strömberg, 2009), and the cost of high-yield debt financing (Axelson et al., 2013) which has significant impact on returns simply due to the large average assumed leverage for buyout funds. Thus, since PE returns are not perfectly spanned by public equity returns, investing in PE leads to the investors taking on additional undiversifiable risk. Because of this, investors will require additional compensation. It's magnitude is however hard to estimate, and thus determining if the asset class generates abnormal returns, or only compensates for an additional layer of risk, is quite difficult.

Furthermore, even given partial overlap in risk factors, their relative loading can differ significantly, and thus alter the underlying return characteristics of the Private Equity investments (Strömberg, 2018). Based on this however, it should still be possible to evaluate this risk by creating a public market portfolio which caries similar parameters. As shown by Stafford (2015), average returns of small and illiquid value stocks have been highly consistent with that of the pre-fee aggregate private equity, thus by extension indicating that levered small/mid-cap value-focused indexes could prove to be a valuable benchmark for PME analysis, as they would largely implicitly compensate for the unique factor loading of the asset class (however, adjustments would still have to be considered to account for excessive funding risk, and asset-specific systematic risk).

Thus, the risk associated with Private Equity can be broadly connected to three core pillars outlined above – the liquidity risk (1), the unique systematic risk of the Private Equity asset class (2), and finally the difference in other factor loadings compared to publicly traded assets (3). All three have to be in some way considered when trying to distill a performance measure on risk-adjusted basis. Nonetheless, the fairly opaque nature of the asset class, and the at times very blurry distinction between the potential sources of risks, makes proper analysis of risk factors difficult without taking on increasingly restrictive theoretical assumptions.

2.5 Prior Performance Findings

The performance of Private Equity has been the subject of a wide range of research over the past years.[1] Kaplan and Schoar (2005) conducted a study on the returns to BO and VC funds using cash flow data from the database *Venture Economics*. The focus of their study was to analyze how persistent returns across funds of the general partner (GP). The result was that BO investors returned slightly less than the public market. VC funds beat the public markets on a capital-weighted basis and slightly underperformed on an equal-weighted basis. Kaplan and Schoar (2005) work was later updated by Phalippou and Gottschalg (2009). By using updated data, they found qualitatively similar results and reached a similar conclusion except from slightly more negative results for BO funds. The main differences between the papers is that instead of using the net asset value applied by Kaplan and Schoar (2005), any remaining investments held by funds for which VE does not report cash flows after 10 years were assumed to have no value.

Stucke (2011) found problems with the data from *Venture Economics*: he shows strong proof that a large portion of funds had stopped being updated following 2001 and were still retained in the database. Even though no cash flows were recorded, net asset values (NAVs) were instead rolled forward each quarter. This resulted in decreasing fund-level IRRs in the database as time progressed. Multiples of invested capital remained constant instead of increasing. This was in-line with research from Harris et al. (2011) which found that returns stemming from the VE database were consistently lower than those of other commercial databases for most vintage years. The VE data shows clear biases as it understates the returns which would suggest the results from Kaplan and Schoar (2005) and Phalippou and Gottschalg (2009) play down fund results, especially for BO funds.

Prior papers focused on funds that were close to, or already fully liquidated. This resulted in that they only included funds that started investing prior to 1995. Since then, we have seen a rise in the size and number of funds being raised. Around USD 148bn was raised between 1980-1995 by VC and BO funds in the U.S. This can be compared to the USD 668bn for funds between 1996-2004 and the boom of 2005-2008 when VC and BO funds were able to raise USD 794bn.

Newer research, such as Robinson and Sensoy (2011) analyze the returns in BO and

[1] For a full, comprehensive review, please refer to the summary table in Appendix *A*.

VC funds by a large bank LP. Their study found that on average BO firms beat the S&P 500 by 18% over the life of the fund while, VC funds outperformed by about 3%. They also found that funds raised in booming markets underperformed in absolute terms (IRR) but not relative to the PME (S&P 500).

Higson and Stucke (2012) study performance of BO funds in the US using cash flow data from *Cambridge Associates* (CA). Their study finds significant outperformance by BO funds relative to the S&P 500. Their study was exclusively on BO and exclude VC funds. They also find criticality in returns to U.S. BO over time. TVPIs and IRRs show a wave pattern with higher returns in the beginning of each decade (1980s, 1990s and 2000s) and lower in the second half of each period. They also find a decreasing downward trend for absolute returns over all 29 vintage years.

Harris et al. (2016) study fund performance for BO and VC funds using a new dataset from *Burgiss*. Their findings largely reaffirm the inferences found in prior research, in that BO funds have outperformed public market equivalents for the past 30 years. They also find that VC funds outperformed in the 1990s, but have underperformed since. In their study, they compare the databases *Burgiss*, *CA* and *Preqin*, and find that the datasets yield quantitatively and qualitatively similar performance results. Notably, The VE data showed lower performance for BO funds which is consistent with Stucke (2014).

Korteweg and Nagel (2016) study performance persistency. In their paper, the authors use a new variance decomposition model in order to assess the three components of persistency in performance. Their findings indicate large amounts of long-term persistence, but less investible persistence, meaning it is hard to consistently choose top quartile PE funds.

In a study by Korteweg and Nagel (2016) they risk-adjust the returns of VC funds. By using Stochastic discount factor, they generalize the popular PME method, so as to actively risk-adjust the returns. The findings indicate substantially different performance returns, specifically in times with strong public markets and for investments with betas far from one.

Lastly, Sorensen and Jagannathan (2013) research justifies the PME as a performance measure. They find that under certain conditions, the systematic risk in private equity funds performance is already taken into consideration when discounting them with realized market returns.

Chapter 3

Methodology

The existing body of research has largely focused on the evaluation of the Private Equity asset class on a global scale, with a notable emphasis on the US market. While highly relevant, the insights have been largely drawn on a higher macro-plane, with attribute groupings that do not provide insights about the finer details of the studied performance factors on a more local level. Furthermore, the literature encompasses a wide range of approaches, with varying levels of compatibility, in estimating the risk adjustments and their impact on returns. The different methods tend to apply somewhat different theoretical frameworks, and even given partial theoretical overlaps, the subsequent methodology used to estimate the parameters required by the applied models tends to vary, and results in a high inconsistency in the produced estimates. A clear example of this is the vast difference between the CAPM beta (β) estimates produced by existing studies, with a range of approximately $[1, 3]$ for BO funds, and $[2, 4]$ for VC funds (Axelson et al., 2014, Jegadeesh et al., 2012, Lin et al., 2011, Strömberg, 2018).

Therefore, this paper aims to narrow down the scope of the cross-sectional exploration of Private Equity returns in order to gain a finer detail fidelity with respect to the Nordic region. Furthermore, it aims to synthesize a range of performance measures, which when jointly analyzed could yield a more robust heuristic approximation of the abnormal returns produced by the asset class, as compared to the individual approaches. Thus, our approach results in a meta-application of the different methods with a distinct focus on a significantly narrower, and arguably more homogeneous, target population. Furthermore, rather than focusing on estimating the inherent risk parameters, the exploration builds upon estimates derived in previous studies, and in-

stead focuses on qualitative analysis of results yielded given assumptions with regard to the estimated parameters. This more detailed analysis is further complemented by a broader comparison against the performance of the US and Europe.[1]

In order to conduct the study and implement the relevant performance measures, a dataset consisting of investor (LP) cash flows generated by the funds (net of fees on a per-fund level) is required. The cash flows time series has to be the primitive data type as all of the PME measures are principally based on the *Time Value of Money* (TVM), which natively requires this time series format. Fundamentally, the IRR also requires this underlying data, however due to the TVPI and IRR being the de facto standard performance metrics used in the industry, they tend to be reported independently. This reporting dichotomy in the underlying data generally results in the IRR/TVPI data being significantly more available than the underlying raw cash flow data required for proprietary calculations of most risk adjusted metrics (such as the various PME measures or MIRR). Thus, broadly speaking the amount of PME performance observations will be less than TVPI/IRR on a broad cross-sectional basis. However, the TWR, which is a useful, albeit crude, metric that can be compared against public markets, can be derived directly from TVPI,[2] and therefore provides us with an avenue to expand the analysis to previously excluded entities. As shown in table C.1, the overall available data tends to be quickly funneled into a substantially smaller usable sample, and the inclusion of TWR does allow us to extend the analysis outside of the typical scope.

The final engineered dataset used for statistical analysis should thus consist of a cross-sectional sample of funds. The set should then include performance metrics calculated on the basis of raw cash flows and/or reported performance figures, and associated fund metadata such as fund type or vintage, so as to enable more granular analysis.

Regarding available data sources, *Burgiss*, *Preqin*, *Pitchbook*, and *Cambridge Associates* are widely considered to be the primary providers of reliable Private Equity data, and are commonly used within the context of academic research of the asset class. This paper uses *Preqin* as the primary source of Private Equity data, and combines it with other complementary data sources in order to synthesize the final dataset.[3]

Based on the above, the detailed methodology applied in order to compute the pri-

[1] Excluding the Nordic region so as to avoid any data distortions due to dependency between regions.

[2] Given that a reasonable estimate of the average investment length is available, or can be produced from other datasets.

[3] See section *Data Sources* on page 24.

mary return metrics used is as follows; the *Preqin* cash flow data was used to compute the PME+, KS-PME, and DirectAlpha using two distinct public market indexes for each fund, a local **[1]**, and a global **[2]** index. Furthermore, the global index was recomputed for 6 additional discrete beta values between 1 and 4 with a step of 0.5.[1] A *MIRR*[2] measure was then also calculated with the assumptions of a finacing rate of 2% and reinvestment rate of 10%. The rates were chosen so as to emphasize the divergence between potential rates, rather than accurate representation. The cash flow-based measures were then merged with the broader *Preqin* performance data which included funds with reported IRR/TVPI values, and fund metadata.[3] Then, the TWR and TWRA **[3]** measures were calculated for three different assumptions regarding investment length, based on prior empirical findings. The analysis was restricted to the fund vintages of 1994-2012 in order to accommodate the underlying vintage distribution and *j-curve* effect. Lastly, outliers were pruned using the 1.5x IQR method. More details and implementation specifications for each calculated measure can be referenced in appendix B.

[1] As BO fund returns tend to resemble value stocks, and VCs small growth stocks (Strömberg, 2018), a local index was selected for each of the three analyzed regions (Nordic, Europe, and US) and fund types (BO, VC) in order to match the indexes and funds on the basis of fund type and region (see table C.3 for exact mapping). For example, European BO funds were matched with *MSCI SMID VALUE* index, while US VC funds with the *MSCI SMALL GROWTH* index. The pairing was done in order to accommodate the aforementioned similarities in assumed factor loadings – by using a benchmark with hypothetically similar risk properties to each evaluated PE fund, we are able to implicitly account for both systemic risk and sensitivities to the underlying risk factors. While the method is far from perfect due to the naturally imperfect factor parity, it does provide us with a useful heuristic proxy for the results. Moreover, it also follows reason that it is highly relevant to benchmark the Private Equity returns against a public index whose underlying assets (businesses with certain characteristics) are as close as possible to that of the fund (small value businesses).[4]

[2] The *MSCI World Standard* was chosen as the global index in order to accommodate the strong asset pricing justification for using PMEs calculated using the market return

[1] Refer to Appendix A for detailed description of β-adjustment process.
[2] Modified IRR, which produces a more robust and legitimate rate of return (McKinsey, 2015).
[3] The metadata was subsequently recoded into usable dummy variables in order to enable analysis.
[4] In the case of BOs, or small growth companies in the case of VC.

without making assumptions about systematic risk presented by Sorensen and Jagannathan (2013). As the Private Equity investors generally consist of institutional investors and HNWIs, it is reasonable to assume a strong degree of global diversification of constituent wealth, in which case the return on the wealth of individual investors should closely resemble the global returns illustrated by the index ($r_w = r_m$) which satisfies one of theoretical criterions for the justification (the second being log-utility preference of investors). Nevertheless, to further investigate the sensitivity of our conclusions, we also compute the index and associated discount rates that approximate assumed theoretical betas of [1,4], given the assumption that the global index natively corresponds to $\beta = 1.0$, and can thus be re-levered in order to synthesize a theoretically higher beta index through the formulaic application of the fundamental CAPM equation.

[3] Both VC and BO fund investments tend to have lifetime of three to seven years, with a historical average oscillating between 4-6 years (Bain and Company and MacArthur, 2014, Kaplan and Strömberg, 2009). We reaffirm this finding in relation to the Nordic funds by our proprietary analysis of data exported from the *Preqin* database of deal exits, which indicates a mean (median) investment length of 5.1 (4.7) years for BO funds, and 5.4 (4.7) for VC (see table C.2). Based on the empirical findings we then calculate the TWR measure for five years in order to arrive at a metric which represent a crude measure of returns. This measure can in turn be used in conjunction with IRR and MIRR, so as to perform comparisons across groups and draw robust inferences.

In order to evaluate the relative performance of the TWR in comparison to a public index, we calculate the TWRA, for both the local and global index.[1] We assume that the public market yearly returns used as basis for the TWRA calculation equal to the geometric average return of the appropriate index[2] between the fund vintage and ten years forward (or alternatively the closest possible time-period in the case of insufficient data, such as when $Vintage > 2008$). As the metric is not risk adjusted by default, it is bound to be slightly inflated, and might require quantitative or qualitative adjustments and considerations in order to draw legitimate conclusions. It is nonetheless a valuable tool when used to validate the more robust PME analysis. This is particularly essential due to the fact that the measure allows us to tap into data points which normally would not contribute to the statistical analysis, as *funds with cash flows* are in practice more or

[1] See figure C.2 and C.3 for produced distributions.

[2] Local or global as per the same assignment procedure as for all other PME methods (table C.3).

less a subset of *funds with any performance measure*.[1] The sample-size expansion comes with a boost to statistical power, as the TWRA measure, even given it's simpler and less sophisticated nature, can be an important validator of the results obtained with the conventional PME methods. Thus, the introduction of this novel measure results in increased robustness of the synthesized analysis, which is key given our limited data.

After arriving at the final dataset, statistical tests were applied in order to evaluate the significance of the synthesized return measures, and also the differences between groups based on region, fund type, and vintage. The main analysis consisted of a series of: **[1]** tests of significance of Nordic abnormal returns across all relevant measures (both t-test and non-parametric rank-sum tests in order to account for small sample size for PME measures); **[2]** cross-regional evaluation which applied series of one-sided t-tests in order to test null-hypothesis that Europe/US performance is equal or greater than that of the Nordic funds. The tests were performed in order to identify any potential material evidence of Nordic outperformance which would result in the rejection of the aforementioned null-hypotheses on an appropriate confidence levels, and thus infer certain information about the properties of the Nordic Private Equity funds. Finally, a series of linear regression models in the form of $ln(Returns) = ln(FundSize^2) + ln(Vintage) + FundType(Dummy)$ were fit, with white-corrected standard errors in order to account for heteroskedasticity and inherent noise in the data, in order to establish and estimate any potential relationships among a sub-selection of explored variables for the Nordic region. The results were cross-evaluated through a robustness check of the signs and significance of coefficients across the return metrics.

Lastly, as the approach combines a range of methods, it allows us to evaluate the spectrum of results on a more balanced, aggregate basis. Furthermore, the principal focus on a more narrow, and arguably homogeneous population (Nordics), with hypothetically distinct economic properties, potentially allows for a clearer and unambiguous analysis, and by extension contribution to the existing body of research. In particular, given the limited amount of research with a focus on the Nordic region. Lastly, by introducing a novel TWR/TWRA metric into the analysis, a measure rarely found in papers evaluating this asset class, we are able to contribute with the results of this unique approach, which can complement the conventional PME analysis as per the reasoning presented above.

[1] Based on exploratory analysis of data, also refer to table C.1.

Chapter 4

Data and Descriptive Statistics

4.1 Data Sources

The underlying Private Equity data used as basis for the conducted study has been collected from *Preqin*, one of the global leading commercial providers of alternative asset industry data. *Preqin* obtains its data primarily through request based on the *Freedom of Information Act* (FOIA). The data is typically gathered from US and UK pension funds as the FOIA requires these institutions to provide information about their investments. GPs are also aloud to submit information about their funds, which further contributes to the accuracy and general quality of the the underlying data.

The *Preqin* data is further complemented by additional data from other sources such as *MSCI, Carnegie* and the *US Federal Reserve*. The first two are used to construct relevant index benchmarks, and subsequently applied to calculate PME performance measures and other related metrics. The Fed data allows us to access historic risk-free rates, defined by proxy as the T-bill rate, used to relever the global index to higher beta levels.

Overall, out of the 33,693 unique funds available through Preqin, 2,224 had performance metrics, and were associated with relevant regions and fund types. Out of these, c. 75 records were related to Nordic BO and VC funds. The relevant index data for local indexes was available since 1994, hence the fund vintage limitation of the study.

In terms of biases, the data was analyzed in order to identify any potential issues related to any potential underlying biases. Given that the data is collected via the FOIA, we can assume a high credibility for the dataset. This especially holds true for the BO funds, as most larger pension funds invest in them. The data may experience some

backfill bias and lack of fund diversity. Given our specific research region, our data may be prone to lack some of the smaller private equity funds that are active in the Nordic region. As the data is gathered through the FOIA, we will only receive data from funds that have interaction with international pension funds. This may lead to us not capturing the full picture of Nordic private equity performance, as smaller funds may have differing performance compared to the larger ones.

Backfill biases occurs when funds backlog performance into a database, as they are likely to backfill the results of earlier transactions to funds they are currently invested in. This will result in less successful managers not being able to raise a second fund, which will exclude them from the dataset. On the other hand, the successful GPs will more likely be included in the dataset. This is important in regards to the Nordic data. As it has much fewer observations, the results may become extra skewed due to this phenomenon. However, Harris et al. (2011) find in their paper when comparing different databases to *Burgiss*, that all datasets show very similar results. It should however be mentioned that they did not focus on the Nordic region and that using a more region specific comparison could result in a different outcome.

Also, our dataset contains a limited amount of VC performance records in comparison to the BO funds. This may weaken the robustness of results from the fund type. One should also take into consideration that many top performing VC funds oppose to showing their results and thereby do not accept LPs who have report requirements. However, top performing VC funds have excessive amount of investors, meaning that not everyone who wants, can invest in them. Therefore, excluding them could generate a more accurate picture for the average LP, as an average LP will not be able to invest in top performing VC funds. This has bearing on whether the mean or median is more appropriate for analysis.

4.2 Descriptive Statistics

In order to build a fundamental picture of the underlying data, we now quantitatively describe and summarize the identified features associated with it. We aim to summarize the findings obtained from the studied sample, so as to construct a solid foundation for further inferential analysis. Below follows a brief exploration, which presents the key features, and further describes them in relation to the main topic.

Table 4.1: Overview of regional metrics - local index

This table shows the average return for PME and performance ratios, comparing results for PE funds to a local index and their reported performance measures. The first row of each region shows the mean followed by the median and the standard deviation. The table is divided into regions showing the average return for each specific region. The table includes the entire dataset of funds. The PME measures use available cash flow data in their calculation.

Region	PME (Local Index)				Performance			
	KS-PME	DirectAlpha	PME+	TWRA	MIRR	IRR	TVPI	TWR
	1.14	3.79	3.58	2.94	7.77	15.03	1.60	8.40
Europe	1.16	4.73	4.59	3.78	8.17	12.30	1.54	9.16
	0.42	9.32	9.97	10.63	4.02	19.21	0.76	9.75
	0.92	-0.80	-0.84	1.94	7.44	20.87	2.13	8.56
Nordic	0.87	-1.95	-2.44	3.18	7.27	15.60	1.65	9.92
	0.47	12.07	11.82	11.64	4.58	26.88	2.17	11.70
	0.93	-1.15	-0.83	-0.04	7.43	13.28	1.76	7.72
US	0.93	-0.80	-0.82	0.70	7.74	9.70	1.50	8.73
	0.43	10.97	11.73	11.07	4.46	30.57	2.00	10.39
	0.96	-0.43	-0.20	0.79	7.48	13.92	1.73	7.93
Total	0.95	0.13	0.00	1.55	7.82	10.60	1.52	8.88
	0.44	10.90	11.58	11.05	4.40	28.34	1.78	10.28

The table 4.1 shows regional sample performance. The sample shows similar results regarding *performance* between the different explored metrics within the same region. Europe shows alpha generation for all measures (KS-PME, DirectAlpha, PME+, and TWRA) while Nordics and the US show underperformance against their local indexes. The TWRA measure shows higher performance relative to other PME measures in our sample performance, with a higher median compared to the mean. The Nordics and US also show a higher standard deviation for the sample performance. The MIRR exhibits very similar results for all regions, with Europe demonstrating both the highest mean and median. The Nordics is the only region that has a lower median compared to its mean under the MIRR. Nordic funds are the highest performing under the IRR. They have the highest mean, median and difference between the two. The US shows the lowest performance but the highest standard deviation.

Overall the performance of the total dataset is negative under the KS-PME as well as under the mean for DirectAlpha and PME+. The median for the whole dataset under DirectAlpha and the mean and median for TWRA are the only measures showing overperformance for the sample set.

The dataset shows very different results when dividing the dataset into BO funds and

Table 4.2: Buyout funds: Overview of regional metrics - local index

This table shows the average return for PME and performance ratios, comparing results for PE funds to a local index and their reported performance measures. The first row of each region shows the mean followed by the median and the standard deviation. The table is divided into regions and fund type showing the average return for each specific region. The table includes only buyout funds. The PME measures are calculated using cash flow data.

	Buyout							
	PME (Local Index)				Performance			
Region	KS-PME	DirectAlpha	PME+	TWRA	MIRR	IRR	TVPI	TWR
	1.17	4.63	4.18	5.80	7.87	17.83	1.76	10.61
Europe	1.18	5.56	5.15	6.42	8.25	13.90	1.67	10.93
	0.38	8.82	9.61	9.31	3.96	19.64	0.71	8.60
	1.08	3.66	4.13	5.31	9.03	21.97	2.03	12.26
Nordic	1.00	3.34	2.23	5.19	9.45	16.30	1.78	11.84
	0.45	10.85	9.84	9.90	4.00	19.23	1.00	9.35
	1.10	2.59	3.10	3.23	8.64	13.97	1.75	10.47
US	1.07	2.79	2.73	3.66	8.94	13.05	1.68	10.93
	0.38	9.40	10.34	9.10	3.42	14.79	0.72	8.75
	1.11	3.06	3.36	4.14	8.48	15.48	1.76	10.60
Total	1.11	3.27	3.33	4.51	8.81	13.40	1.68	10.93
	0.38	9.34	10.17	9.27	3.57	16.71	0.73	8.73

VC funds. As seen in table 4.2, BO funds generate alpha for all PME performance measures, with Europe having the highest performance across all measures. The Nordics showed higher performance under the DirectAlpha, PME+ and TWRA, while the US sample performance exhibited higher results for KS-PME. Overall the TWRA measure showed higher performance in comparison to PME+ and DirectAlpha for all regions. For the performance measures, the Nordic region was the highest performing. It was also the region which exhibited the largest difference between its mean and median.

For VC funds, the sample shows opposite results from the BO funds. Table 4.3 shows almost all explored metrics generating negative returns. The only region showing positive average fund returns is Europe under the PME+. The European region once again exhibits the highest relative performance of the three regions and the Nordics has the lowest relative returns for all PME measures. The Nordics and US also have much higher IRR values with the Nordic IRR more than twice that of Europe. The Nordics also show a larger difference between the MIRR and IRR compared to other regions and is the only region which has negative time weighted return for both PME and *performance* measures. Also, all regions demonstrate negative TWRA returns but only the Nordic

Table 4.3: VC funds: Overview of regional metrics - local index

This table shows the average return for PME and performance ratios, comparing results for PE funds to a local index and their reported performance measures. The first row of each region shows the mean followed by the median and the standard deviation. The table is divided into regions and fund type showing the average return for each specific region. The table includes only VC funds. The PME measures are calculated using cash flow data.

	Venture Capital							
	PME (Local Index)				Performance			
Region	KS-PME	DirectAlpha	PME+	TWRA	MIRR	IRR	TVPI	TWR
	0.94	-0.99	0.16	-3.23	7.10	7.16	1.26	3.58
Europe	0.83	-1.02	0.92	-3.46	5.95	6.20	1.20	4.73
	0.54	10.8	11.41	10.72	4.50	15.52	0.75	10.36
	0.54	-11.63	-12.20	-7.35	3.22	17.52	2.37	-1.44
Nordic	0.54	-12.02	-15.04	-7.18	4.02	5.75	1.04	-2.41
	0.27	7.18	7.33	11.20	3.26	43.41	3.64	11.75
	0.75	-5.29	-5.21	-3.30	6.10	12.61	1.77	4.90
US	0.71	-5.41	-5.61	-2.96	5.78	5.50	1.29	5.39
	0.42	11.11	11.63	11.87	5.05	40.32	2.68	11.16
	0.76	-5.17	-5.05	-3.37	6.11	11.98	1.70	4.51
Total	0.71	-5.21	-5.35	-3.00	5.76	5.60	1.27	5.22
	0.43	11.09	11.64	11.65	5.02	38.08	2.49	11.06

regions has negative TWR.

The next table (4.4) shows different PME performance metrics with increasing beta values, given the underlying global index corresponds to $\beta = 1$. The Nordic area is the highest performing for BO funds when all companies are compared to a global instead of a local index. They all however, have very similar performance, this does change with increased beta values, with the US becoming the highest performing area as beta levels rise. Also worth noting is that performance generally decreases until around 2.0x beta until they start increasing again. Both Europe and the US have their highest sample performance at 3.0x beta compared to Nordics, whose highest performance is at an unchanged beta level.

For VC funds, Europe is the only area consistently generating positive returns across all three performance measures. The Nordic region shows the lowest KS-PME performance at 1.5-2x beta values, lowest DirectAlpha at 2.5x beta and lowest PME+ at 2.0. The US generates positive sample performance from 2.5x for KS-PME and positive DirectAlpha at 3x beta.

The concave relationship between beta and performance can be attributed to the

Table 4.4: Global PME performance given different beta (β) assumptions

This table shows the the PME average performance on a global index with different beta values for the measures KS-PME, DirectAlpha and PME+. The index used as the global index is the MSCI world index and then leveraged through different beta values. The table is diveded by fund type (buyout and VC) and by region (Nordic, Europe and US). The table uses cash flow data from preqin.

	Buyout			Venture Capital		
	Europe	Nordic	US	Europe	Nordic	US
KS-PME	1.21	1.26	1.25	1.06	0.66	0.95
DirectAlpha	5.28	5.92	5.74	3.32	-8.18	-0.54
PME +	5.28	6.33	6.03	3.63	-8.82	-0.28
KS-PME 1.5x	1.18	1.22	1.23	1.02	0.63	0.93
DirectAlpha 1.5x	3.75	4.61	4.98	1.91	-9.34	-1.15
PME + 1.5x	4.02	4.72	5.16	2.30	-7.34	-0.96
KS-PME 2.0x	1.17	1.12	1.24	1.01	0.63	0.96
DirectAlpha 2.0x	2.95	3.90	4.84	1.02	-9.97	-1.30
PME + 2.0x	3.22	3.56	4.71	1.43	-7.40	-1.01
KS-PME 2.5x	1.17	1.14	1.28	0.96	0.66	1.02
DirectAlpha 2.5x	2.68	3.79	5.33	0.66	-10.04	-0.66
PME + 2.5x	2.92	2.86	4.83	1.04	-6.81	-1.00
KS-PME 3.0x	1.23	1.19	1.36	1.01	0.71	1.13
DirectAlpha 3.0x	3.04	4.34	6.18	0.86	-9.52	0.89
PME + 3.0x	2.23	4.74	5.46	1.15	-5.57	-0.27

effects of leverage. As seen in figure C.1 the synthesized indexes with a beta from 2.0x and up were depressed post 2008 due to the effects of leverage during the market crash. This implies that a sample skewed towards post 2008 will exhibit better returns with higher beta values and vice versa given our time frame.

As seen in table 4.5, BO funds outperform VC funds for the KS-PME measure on almost a year to year basis, but also on an average during the entire time-series. VC funds have shown higher performance when using a weighted average measure instead of a normal mean. The table also shows that BO funds has consistently overperformed even during years of crisis (dotcom bubble and the crash of 2008). VC funds show additional underperformance during years when financial markets were weak. Similar results can be observed when analyzing other metrics across vintages (as seen in tables D.2-D.5).

The Nordic data in table 4.6 shows that the TWRA measure generates the highest return for Nordic funds. The TWRA and KS-PME are the measures which generate positive returns compared to PME+ and DirectAlpha which generate negative returns. The TWRA also has the highest number of observations for all types of measures. The global PME measures generate the highest returns compared to the local variants. Fur-

Table 4.5: KS-PME Performance – local index

This table shows the average, median and weighted average KS-PME returns by vintage year, comparing PE returns to equivalent-timed investments in the a local index using the Preqin data. The local index is based of where the fund is located. Vintage years are defined by the date of the first investment by a fund. Weighted averages are based of the value committed to the fund as a weight. The data only includes funds which had cash flow data in the database.

Vintage	Buyout Funds				Venture Capital			
	Funds	Average	Median	W. Average	Funds	Average	Median	W. Average
1994	15	1.30	1.27	1.34	6	0.91	0.73	1.18
1995	12	0.98	0.91	1.17	7	0.73	0.76	0.90
1996	18	1.11	1.16	1.13	11	0.90	0.98	0.93
1997	21	0.94	1.03	1.08	16	0.99	0.81	1.24
1998	38	0.95	0.90	0.93	24	0.67	0.56	0.79
1999	29	0.94	1.01	0.95	32	0.50	0.47	0.52
2000	33	1.25	1.24	1.27	62	0.56	0.52	0.58
2001	19	1.15	1.14	1.31	43	0.70	0.68	0.72
2002	23	1.24	1.21	1.34	19	0.63	0.54	0.73
2003	15	1.29	1.28	1.55	15	0.70	0.81	0.68
2004	20	1.19	1.24	1.32	19	0.60	0.57	0.61
2005	46	1.20	1.16	1.39	26	0.76	0.75	0.84
2006	57	1.14	1.19	1.27	38	0.70	0.71	0.76
2007	56	1.09	1.01	1.08	41	0.93	0.87	1.04
2008	58	1.09	1.06	1.12	31	0.88	0.65	0.83
2009	25	1.18	1.18	1.22	14	0.95	0.82	0.94
2010	30	1.10	1.14	1.06	13	0.97	0.89	0.94
2011	39	1.01	1.03	1.01	19	1.08	1.17	1.10
2012	46	1.15	1.14	1.12	16	1.02	0.96	1.14
Average	600	1.12	1.12	1.19	452	0.80	0.75	0.87

Table 4.6: Nordic funds: descriptives of performance measures

This table shows number of observations, average returns, standard deviations and max and min values for different performance measures in the Nordic region. The performance measures are based of data from the preqin database except for TWR which instead uses a a 5 year average on the return when time weighted. The PME performance is divided into local and global PME. Local PMEs uses cash flow data and compare against a local index. For the Nordic region this index is the Carnegie Small Cap Index. Global index is based of the MSCI Global Index.

Type	**Variable**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Performance	IRR	65	20.87	26.88	-18.00	168.50
	TVPI	81	2.13	2.17	0.03	16.58
	MIRR	22	7.44	4.58	-2.54	15.53
	TWR	74	8.56	11.70	-19.89	33.24
PME	Local KS-PME	23	0.92	0.47	0.18	1.87
	Local DirectAlpha	24	-0.80	12.07	-20.99	26.95
	Local PME+	23	-0.84	11.82	-21.82	27.83
	Local TWRA	75	1.94	11.64	-27.72	27.64
	Global KS-PME	23	1.08	0.56	0.25	2.37
	Global DirectAlpha	23	1.62	10.67	-17.14	26.19
	Global PME+	22	1.51	10.90	-22.00	28.46
	Global TWRA	75	5.66	11.88	-20.36	31.85

Table 4.7: Correlation between performance measures

The table shows the correlation between the KS-PME, DirectAlpha, PME+, TWRA, IRR, MIRR, TVPI and TWR mean returns for all the funds in the dataset. The returns are in absolute numbers. The funds date from 1994-2012. Data based on Preqin as of April 2018.

	KS-PME	DirectAlpha	PME+	TWRA	IRR	MIRR	TVPI	TWR
KS-PME	1.00							
DirectAlpha	0.93	1.00						
PME+	0.92	0.98	1.00					
TWRA	0.84	0.83	0.79	1.00				
IRR	0.86	0.90	0.90	0.70	1.00			
MIRR	0.85	0.83	0.81	0.78	0.76	1.00		
TVPI	0.89	0.82	0.82	0.90	0.72	0.79	1.00	
TWR	0.87	0.87	0.85	0.94	0.77	0.84	0.96	1.00

thermore, we observe the magnitude between local and global PME metrics is substantial and points towards the importance of the underlying index. Also, the table shows how the PME measures generate similar max and min values compared to each other. These ranges do not differ much between global and local variants.

The IRR generates the highest performance returns of the different measurements. It also has the largest difference between min and max. The TWR and MIRR show similar mean returns. However, they show a larger contrast in their max in min values. The *performance* measures also inhabits a larger sample size, with all measures having similar amount of observations to that of the TWRA.

The final table 4.7 shows the correlation between the different performance measures. It shows that no measure has a lower correlation than 0.72 between each other (between TVPI and IRR). All the PME measures (KS-PME, DirectAlpha, PME+ and TWRA) show high correlations between each other. Except for the perfect correlation between variables, PME+ and DirectAlpha show the highest correlation with a value of 0.98.

Chapter 5

Results and Discussion

5.1 Nordic Returns

The results obtained through both parametric and non-parametric tests of the null-hypothesis of no abnormal returns ($\alpha \leq 0$) infer a statistically significant outperformance of Nordic BO funds. We observe a 95% confidence interval of c. [-2%, 12%] for the alpha returns on an annualized basis across the metrics, with approximate mean overperformance of c. 5% given our data. The results are however sensitive to the choice of underlying index used as basis for PME discounting, and indicate a higher performance when using a broader global market index, as per the argument put forth in Sorensen and Jagannathan (2013). Albeit, based on arguments presented in the background, we do believe that the usage of a local index, chosen on the basis of fund type and region, and which more closely resembles the attributes and risk properties of a Private Equity fund, allows for a more logical comparison on like-for-like basis (as the underlying assets, i.e. small businesses, carry similar properties). The local fund assumption is also not subject to the theoretical restrictions of the Rubinstein CAPM, on which the unadjusted global index argument is based upon (log-utility of investor consumption function, and that the global market returns approximate the investors return on wealth across time, $r_w = r_m$, and thus implicitly accommodates the assumed risk).

The result holds across the various performance measurements, and remains in most cases significant at a 10% significance level for both t-tests and non-parametric rank-sum tests. The very limited sample size of funds with available cash flows hamstrings the statistical power of the tests on associated metrics. However, the derived TWRA measure

Table 5.1: Significance of Nordic PE abnormal returns

The Nordic buyout funds achieve statistically significant abnormal returns. The result is particularly apparent given a global market benchmark, in which all metrics outperform on a 5% significance level. The opposite can be observed on the VC sample, which indicates an underperformance. The sample covers all records with available performance metrics on an equally-weighted basis, based on Preqin data.

							p-value	
Type	**Index**	**Measure**	**Obs**	**Mean**	**[95% CI]**		**t-test**	**rank-sum (one-sided)**
BO	**Local**	KSPME	16	1.08	0.84	1.32	0.24	0.60
		DirectAlpha*	17	3.66	-1.91	9.24	0.09	0.31
		PME+*	16	4.13	-1.11	9.38	0.06	0.30
		TWRA**	55	5.31	2.64	7.99	0.00	0.00
	Global	KSPME**	16	1.26	0.97	1.55	0.04	0.11
		DirectAlpha**	16	5.92	1.04	10.79	0.01	0.04
		PME+**	15	6.33	1.61	11.04	0.01	0.03
		TWRA**	55	8.81	5.95	11.66	0.00	0.00
VC	**Local**	KSPME	7	0.54	0.29	0.79	1.00	1.00
		DirectAlpha	7	-11.63	-18.28	-4.99	1.00	1.00
		PME+	7	-12.20	-18.98	-5.42	1.00	1.00
		TWRA	20	-7.35	-12.59	-2.11	1.00	0.94
	Global	KSPME	7	0.66	0.37	0.95	0.99	0.99
		DirectAlpha	7	-8.18	-14.53	-1.84	0.99	0.99
		PME+	7	-8.82	-16.24	-1.41	0.99	0.99
		TWRA	20	-2.99	-8.21	2.23	0.88	0.94
Both	**Local**	KSPME	23	0.92	0.71	1.12	0.79	0.95
		DirectAlpha	24	-0.80	-5.90	4.30	0.63	0.85
		PME+	23	-0.84	-5.95	4.27	0.63	0.86
		TWRA*	75	1.94	-0.74	4.61	0.08	0.01
	Global	KSPME	23	1.08	0.84	1.32	0.26	0.50
		DirectAlpha	23	1.62	-2.99	6.24	0.24	0.34
		PME+	22	1.51	-3.33	6.34	0.26	0.33
		TWRA**	75	5.66	2.93	8.39	0.00	0.00

H_0: No abnormal returns ($\alpha \leq 0$) | *: 10% significance on either test | **: 5% significance on both tests

which does not rely on raw cash flow data, does reaffirm the identified value creation. As the TWRA measure is directly derived from the vastly more available TVPI data, it allows us to utilize previously inaccessible data points, and thus has higher statistical power due to the sample size expansion, which increases the robustness of the explored statistical inference.

The Nordic VC sub-sample, on the other hand, exhibits the opposite performance trends, with a 95% confidence interval implying negative abnormal returns across the majority of the spectrum of evaluated metrics, in the range [-19%, 2%] on the basis of annual abnormal returns across the metrics (mean underperformance of c. 7%). The result does align with, and reaffirms the prior findings on European and US funds (Harris et al., 2016), which show a statistically significant underperformance for all except

top-quartile VC funds. The studies further indicate broader and more general outperformance of BO funds, which also aligns with our findings. It is however worth noting that the magnitude of the performance does vary, as previous papers (Harris et al., 2016) show that the difference between top and bottom performing quartiles differs by around 100% on average.

There is limited evidence of Private Equity outperformance on aggregate basis across fund types, as illustrated by the significance of the obtained results. This is sensible given that the VC performance on average pulls down the abnormal returns generated by BO funds on equally-weighted basis. On a value-weighted basis, there is however reason to suspect higher significance, due to the, on average, larger size of BO funds in comparison to the VC (as illustrated in figure C.5).

Overall, it is worth noting that due to the slightly negatively skewed distribution of most performance metrics, we expect the median returns to be slightly less than the means. However, as seen in the descriptive exploration, this effect is fairly limited. Whether the average or median return is more relevant from an investor perspective is arguable and depends on the assumptions with regard to the market and the constituent investors – if the investors can choose freely among funds, one should focus on observing the average return. However, if there exists asymmetry in information, access, and fund-picking skill of individual investors, the median becomes more appropriate. Given prior research, we primarily focus on the mean metric, which is generally more accommodating to a broader spectrum of assumptions.

Furthermore, we expect the value-weighted means to be slightly higher than the equally-weighted counterparts, as demonstrated in the descriptive analysis in table 4.5. This is based on the assumption of concave relationship between fund value and performance, which has been found in other regions through prior studies (Lorenzo, 2013). As the distribution of fund value is heavily biased towards mid-market in our sample (mean of c. 150mn EUR, as seen in figure C.5), we expect the value-weighted returns to approach the theoretical maxima under the concave assumption. The relationship will be further explored in more detail in section 5.3.

In terms of validity of the measurements of the various methods, we find the TWRA and KS-PME (and by extension DirectAlpha) to be most reliable. The TWRA benefits from derivation which does not require cash flow data, and thus enables us to vastly

expand our set of usable observations.[1] It is however an inferior measure due to it's approximative nature, and lack of sensitivity to the exact timing of distributions and capital calls. It should therefore not be used as the metric driving the inferences, rather it should contribute as a form of robustness check which can increase our confidence in the distilled conclusions. Instead, the KS-PME and DirectAlpha[2], should be used as the main metrics when evaluating the existence of abnormal returns. In other words, if the KS-PME or DirectAlpha indicates a statistically significant result, it should be validated against the TWRA which then solidifies or rejects the conclusion given its higher statistical power derived from the larger sample size.

Pivoting back to the discussion with regard to the usage of appropriate index, it is also worth to interconnect the other dimensions of risk which have to be considered when evaluating the abnormality of the returns. Firstly, *liquidity risk*, out of which the *market risk* can to some extent be factored in when using a local index due to the inherently lower liquidity of small-cap stocks (in contrast to global index), has to be considered. Is the remaining *funding risk*, and thus the premium required as compensation for being required to retain a liquid position throughout the funds life-time in order to be able to answer the capital calls, large enough to diminish the observed abnormal returns? Likewise, is the idiosyncratic risk associated with industry (or in other words, Private Equity-specific systematic risk), as well as potentially different factor loadings, substantial enough to further devalue the obtained inferences? Prior research by Sorensen et al. (2011) indicates that a 1-2% adjustment has to be made in order to account for these factors. Exact estimation of the adjustment for the different index, region, and fund type combinations is futile due to the inherent uncertainty. Nonetheless, a more stringent null-hypothesis for the existence of abnormal returns could be formulated as $H_0 : (\alpha - 2\%) \leq 0$ in order to evaluate the potential alpha through a more rigorous lens. Given this more conservative approach, most of our cash flow based PME measures fall short in terms of significance, however, the TWRA still remains significant on 5% level, thus pointing to, less certain but still plausible, abnormal returns for the Nordic BO funds. On the other hand, this adjustment further solidifies the inference with regard to the underperformance of VC funds.

[1] As seen in table C.1, only $\frac{1}{3}$ of the records which have TVPI, also have corresponding cash flow data which can be used to synthesize the PME measures.

[2] Which derives an annual alpha through applying the IRR on the discounted cash flows as per the KS-PME method.

5.2 Cross-Regional Comparison

Table 5.2: Cross-regional comparison

The table shows a regression for Nordic performance against Europe and US, by fund type. Small p-values indicate Nordic outperformance, and large p-values point towards statistically significant underperformance. As seen, there is limited evidence of Nordic PE outperformance on PME basis. However, the conventional performance measures do show a statistically significant unilateral performance shift in favour of Nordic BO funds (IRR/TVPI/TWR). It is however worth noting that these measures have a greater sample size (c. 2.5x that of the MIRR, KS-PME and DirectAlpha), and thus more easily achieve statistical power. Albeit, TWRA, with its larger sample, does infer significant potential outperformance in terms of abnormal returns as compared to other regions. *Perf.* column refers to Nordic performance in relation to both of the comparison regions (blank indicates intermediate performance). The sample covers all records with performance metrics on equally-weighted basis, based on Preqin data as of April 2018.

		p-val							
		Buyouts				Venture Capital			
Type	**Measure**	**Europe**	**US**	**Perf.**	**Sig.**	**Europe**	**US**	**Perf.**	**Sig.**
Performance	IRR	0.05	0.00	Over	**	0.15	0.31	Over	
	TVPI	0.01	0.00	Over	**	0.02	0.12	Over	*
	MIRR	0.11	0.34	Over		0.95	0.92	Under	*
	TWR	0.10	0.07	Over	*	0.97	0.99	Under	**
PME	Local KS-PME	0.82	0.56	Under		0.98	0.90	Under	*
	Local DirectAlpha	0.66	0.68	–		0.99	0.93	Under	*
	Local TWRA	0.64	**0.05**	–		0.93	0.94	Under	*
	Global KS-PME	0.34	0.46	Over		0.97	0.94	Under	*
	Global DirectAlpha	0.40	0.47	Over		0.99	0.97	Under	**
	Global TWRA	0.09	0.04	Over	*	0.87	0.96	Under	*

H_0: *Other* $>=$ *Nordic* (coefficients $>= 0$ for regression $Measure \sim factor(Region)$ with *Nordic* as base)
*: 10% significance on either region | **: 5% significance on both regions

Regional comparison between the Nordics, Europe and US yields statistically significant outperformance by Nordic BO firms on the basis of conventional performance metrics as seen in table 5.2. However, due to the limited amount of cash flow data, such inference cannot be made on the basis of derived PME metrics, which rely on the availability aforementioned cash flows. The TWRA measure, which is not constrained by the same limitation, does however point toward potential outperformance in terms of the generated abnormal returns. This however depends on the underlying index, due to the large divergence in index performance across the regions (see figure C.1). As the European index has been significantly lower than the US and Nordic comparison index, the *local* European PME performance has been able to easily outstrip the US and EU-based metrics, simply due to the vast difference in the discount factor derived from the index rate of return. When compared using the same *global* index, the results fall more in line with the conventional performance metrics – TWRA with its larger statistical power, points towards a 10% significance level for both US and EU on the null-hypothesis $H_0 : Other \leq Nordic$ in terms of TWRA returns.

Thus, given the high statistical significance of the Nordic outperformance in terms of TVPI and IRR for BO funds (and interestingly enough TVPI against European VC funds), it is fairly safe to infer that Nordic BO funds are able to perform better within the dimensions explored by those metrics. However, this does not necessarily mean a true outperformance, as the measures are easily manipulated, and do not necessarily tell the whole story (McKinsey, 2015). Nonetheless, the MIRR which accounts for many of the issues, does point towards a similar direction. It is not statistically significant, most likely due to the aforementioned limitations related to the small amounts of available cash flow data. However, it does shed light on the fact that Nordic private equity firms are better at manipulating IRR performance. As mentioned in previous chapters, the IRR can easily be manipulated through a variety of measures delaying cash outflow. The lower statistical significance seen in the MIRR measure against both Europe and US points towards the fact that the Nordics potentially utilize IRR manipulation and are seemingly better at it compared to its global counterparts. Moreover, the measure also provides us with a sanity check and acts as a robustness indicator.

Nordic VCs mostly underperform in comparison to their US and European counterpart. All PME measures demonstrate inferior returns with reverse statistical significance, showing a clear underperformance to the null-hypothesis ($H_0 : Other \leq Nordic$). This underperformance is interestingly enough not reflected in the conventional performance metrics, where we observe a dichotomy between the IRR/TVPI and the other metrics. Interestingly, we also find similar patterns across Europe and the US, with both regions having similar 10% significance in outperforming the Nordic VC funds.

Thus, in a concluding manner, there is robust evidence of a Nordic buyout outperformance in absolute, conventional performance metrics. However, when delving into measures of abnormal returns, the evidence for BO funds is not strong enough to point towards a clear statistically valid inference with regard to the difference in the alpha generated between different regions. The analysis of abnormal returns is very sensitive to the treatment and assignment of the indexes used for the PME calculations, and can vary heavily given a divergence between the indexes used for different regions (as is the case with the *local* measures within our context). However, it is worth noting the statistically significant underperformance of Nordic VC funds on the basis of generated abnormal returns, given both *local* and *global* indexes. This underperformance is however not reflected in the TVPI and IRR measures. The nature of this divergence requires further research to be fully understood.

5.3 Performance Drivers

The regression has shown the robustness of the interaction between the explored performance metrics and the independent variables. As seen in table 5.3, we observe statistically significant correlations.[1] The result is however not significant enough to draw a strong inference. On the other hand, it remains important as it highlights a number of variables, that given appropriate transformations, correlate with the performance, and provide us with an interesting avenue to explore any underlying dynamics of the relationship. The underlying regression model, initially synthesized on the IRR metric, is further applied on three additional performance metrics in order to establish the robustness of the coefficients of the explored independent variables.[2]

Table 5.3: Nordic Performance: Regressions & Robustness checks

The table shows the mixed robust regression for four performance metrics, controlling for the fund type, size, and relative vintage ($Vintage - 1990$). The base model is applied across four metrics in order to establish robustness of coefficients of studied independent variables. We raise fund size to power of two, in order to evaluate the possibility of a concave relationship. The sample covers all records with relevant performance metrics on equally-weighted basis, based on Preqin data as of April 2018.

		Coef.	(Robust) Std. Err.	t-statistic	P>|t|	[95% Conf.	Interval]
ln(IRR)	$VC(Binary)$*	-0.82	0.43	-1.90	0.06	-1.68	0.04
$n = 58$	$ln(FundSize^2)$**	-0.13	0.03	-3.94	0.00	-0.20	-0.06
$R^2 = 0.20$	*RelativeVintage**	-0.06	0.03	-1.80	0.08	-0.12	0.01
	*Constant***	5.09	0.55	9.20	0.00	3.98	6.20
ln(TWR)	$VC(Binary)$*	-0.67	0.36	-1.87	0.07	-1.38	0.05
$n = 58$	$ln(FundSize^2)$	-0.04	0.03	-1.51	0.14	-0.10	0.01
$R^2 = 0.18$	*RelativeVintage***	-0.07	0.02	-4.25	0.00	-0.10	-0.04
	*Constant***	3.84	0.35	11.02	0.00	3.14	4.53
ln(KS-PME)	$VC(Binary)$**	-0.78	0.26	-2.94	0.01	-1.33	-0.22
$n = 23$	$ln(FundSize^2)$	0.04	0.03	1.12	0.28	-0.03	0.10
$R^2 = 0.40$	*RelativeVintage**	-0.07	0.03	-1.96	0.07	-0.14	0.00
	Constant	0.62	0.65	0.96	0.35	-0.73	1.97
ln(TWRA)	VC (Binary)*	-0.89	0.52	-1.72	0.09	-1.94	0.15
$n = 48$	$ln(FundSize^2)$	-0.02	0.05	-0.39	0.70	-0.13	0.09
$R^2 = 0.23$	*RelativeVintage***	-0.11	0.05	-2.18	0.03	-0.21	-0.01
	*Constant***	3.61	0.55	6.59	0.00	2.50	4.71

*: 10% significance | **: 5% significance

[1]Note that in a mixed power/semilog regression in the form $ln(Y) = \beta_0 + \beta_1 ln(X_1) + \beta_2 X_2 + \epsilon$, a change of one percent in the independent variable X_1 will approximately correspond to a change in the dependent variable Y equal to the independent variable's coefficient B_1 (in percent). In other words, B_1 is the elasticity of Y with regard to X_1. On the other hand, an absolute change of one in X_2 will correspond to roughly $B_2 \times 100$ percent change in the dependent variable Y.

[2]We expect the coefficient to retain the same sign across the different dependent variables.

The independent regression variables were selected based on of previous findings and the results presented in the earlier sections. The VC dummy carries important explanatory value as shown by the dichotomy between the inferred mean returns distribution across the two fund types (as seen in previous sections). The fund size is a variable heavily studied in previous literature (Kaplan and Schoar, 2005, Robinson and Sensoy, 2011, Sabrie et al., 2017). We also put forth the argument that larger funds are subject to reversion to the mean, on the basis that the larger funds generally partake in the acquisition of more mature companies. Lastly, vintage is analyzed to add a temporal element to the regression. Yet again, the inclusion of the variable stems from prior research Harris et al. (2016) and a qualitative argument – the private equity market has become more saturated and mature in the Nordics given the rise in popularity of the asset class and the increase in the total amount of private equity firms (BerchWood, 2013), as well as the diffusion of operational expertise into the general industry.

Pivoting back to the variables, the VC dummy highlights the historical underperformance of the fund type. The change in VC will on average incur a decrease in the performance metric, of which the magnitude will vary, but broadly result in around 75% decrease in performance for the studied metrics. The question why this underperformance exists is difficult to answer without a deeper qualitative analysis on the dynamics of the Nordic VC industry, however studies on international results do point towards the surplus of capital injected into the VC funds following the dotcom bubble, all while the actual availability of viable deals grew at a lower pace. This imbalance between capital and investment opportunities with positive NPV depressed the returns of funds on the basis of basic economic principles of supply and demand.

As mentioned above, we speculated that the fund size will exhibit a concave relationship with the fund performance. As mentioned before, this relationship has been found in certain other studies, but also follows a fairly streamlined logical argument.[1] However, the effect was very unpronounced within the scope of our research and couldn't be robustly validated across dependent variables other than the IRR used to devise and construct the core model. Also, the implied magnitude of the effect was fairly limited.

[1] If we consider a firm as a set of loosely correlated units, which might or might not under/overperform during a discrete period t, then given a large enough firm there should be a certain level of reversion to the mean, as the standard error of the average return which makes up the firm performance would decrease. This would in other words mean that the deals would perform more consistently, but would be less likely to reach heavy outperformance levels, and thus we would expect larger funds to less likely perform in the top quartile, simply due to the diminished implicit element of chance which impacts the industry.

Lastly, we observe a robust relationship between the fund vintage and the performance, which shows that funds with higher vintage years perform weaker than their earlier counterparts with statistical significance. Our data indicates that, on average, for each year since 1990, our performance measures have been decreasing by c. 8% a year (on relative basis). This relationship can be explained by considering our earlier findings (see figure C.4 and table 4.5); as the frequency distribution of funds is skewed towards later vintages, with a spike in the early 2000s. The data shows that the returns in the late 90s were lower than that of the early 2000s, however the frequency weighting which implicitly impacts the regression instead provides more explanatory power for the period post 2000. The low amount of observations before the year 2000 simply does not outweigh the more apparent negative relationship observed between 2000 and 2012. This explains why relative vintage year exhibits negative correlation with all explored performance metrics, at least in quantitative terms. It is difficult to pinpoint a comprehensive qualitative explanation for this relation, however we speculate that a more mature market and higher entry multiples all contributed to the lower performance in later years (Bain and Company and MacArthur, 2014).

Overall, we thus find that fund type and relative vintage do have statistically significant (10% level) impact on the different performance measures based on the available data for the Nordic region, and that they are robust across several different performance metrics. However, we do not find enough evidence to support the notion of a concave relationship between fund size and the various performance measures. We however do not believe the evidence to be strong enough to draw a more general inference; as the study has a fairly limited time-frame, and does not account for other data sources, it would be unwise to assume a static relationship. Rather, as previous research indicates a level of cyclicality in the industry, and closer relationship with industry-specific variables, it is fair to assume that the identified relationships are more likely manifestations of other underlying drivers, and are by extension volatile over time. Thus, the research instead points towards the need for qualitative studies which can identify the underlying industry dynamics which result in the observed relationships.

Chapter 6

Conclusion

This paper has investigated the performance of Nordic Private Equity, and assessed it in relation to relevant benchmarks, with the aim of evaluating the underlying value creation potential as compared to public markets, and global competitors within the field. Due to restrictions derived from the required overlaps in underlying data, and uncertainty pertaining to the *j-curve* effect, the study was restricted to funds with vintages of 1994-2012. The raw data was primarily obtained from *Preqin*, but also included complementary sources such as *MSCI, Carnegie*, and the *US Federal Reserve*. The final engineered set used as basis for statistical analysis included 2,224 records with usable performance metrics, out of which c. 75 records could be associated with the Nordic region. The study drew primarily upon existing methods used in the related research (IRR, TVPI, and PME variations), but also devised a novel measure, TWRA, which allowed for greater robustness in the synthesized analysis based on smaller datasets.[1] Lastly, an additional rudimentary approach to risk adjustments was applied based on prior findings to further augment the analysis with an additional layer of complexity.

The synthesized analysis has illuminated three tiers of key findings – the first being the statistically significant outperformance of Nordic BO funds as compared to public markets, with an approximate annual abnormal return of 5%. This result was more pronounced on the basis of a global, rather than local, benchmark index. However, we argue that a local index gives the best representation, as it exhibits similar risk properties, which consequently makes it more appropriate for a like-for-like comparison. On the other hand, the opposite inference was drawn with regard to VC funds, as a signif-

[1] Due to its independence from cash flow data. Instead, the measure is based on TVPI and implied population parameters.

icant underperformance of c. 7% per annum was noted in relation to a public market equivalent investments. However, after adjusting for risk by applying a more conservative abnormal returns threshold, the significance of the BO fund findings fell below a level at which a valid inference could be made. Nonetheless, this adjustment further consolidated the underperformance of VC funds. The identified general divergence in returns of fund types aligns with findings on an international level (Harris et al., 2016).

The second tier consisted of findings regarding regional comparison of returns. The study finds significant evidence for the outperformance of Nordic BO firms in relation to their European and US-based peers on the basis of absolute performance metrics (IRR, TVPI, and TWR). Due to the low sample size, the robustness in terms of abnormal returns (PME) can not be confirmed. In terms of VC, the findings indicate that the Nordic funds seem to underperform both US and Europe in terms of abnormal returns.

Lastly, when decomposing the identified performance drivers or correlation, the study presents evidence of a robust relationship between the performance of Nordic funds and the fund type and relative vintage. The exploration of the relationship with fund type reaffirms the findings based on the first two tiers of findings, and suggests that Nordic VC funds underperform the BO funds by 75% in terms of relative performance. The relative vintage on the other hand points towards a noticeable gradual decline in performance over the last 20 years, with c. 8% average relative performance drop since 1990 on an annual basis. The hypothesis of concave relationship between the fund size and performance is tested, however the evidence is found to be not strong enough to reject the null-hypothesis. The two variables have however been explored in similar fashion in international studies (Harris et al., 2016, Kaplan and Schoar, 2005, Kaplan and Strömberg, 2009, Strömberg, 2018), thus indicating an international, rather than local phenomena. The prior research points towards a cyclicality in the PE market, bound to fundraising aggregates, which have been shown to be strong predictors of performance. However, given the limited time-frame of the study, we refer to future research to assess the underlying qualitative reasons behind the identified relationships.

In terms of issues, the findings and analysis presented within the frame of this paper are mainly constrained by the limitations of the available data. With a more extensive dataset, and larger samples, one could evaluate the performance with greater precision.[1] Moreover, additional datasets such as *Burgiss* or *Cambridge Analytics* could have

[1]Narrower confidence intervals due to the sample size expansion would imply an increase in precision, the accuracy however still remains primarily bound to the validity of the applied methodology.

been used to complement our current data and created a more extensive dataset. This would in turn allow for more complete analysis and comprehensive understanding of the performance. Qualitative discussion with EQT showed that the firm, one of the region's private equity entities, has until recently not submit information to *Preqin*, and has historically cooperated with other vendors, a fact which further substantiates the argument for the use of a more comprehensive dataset in future research.

Additionally, given the opaque nature of the private equity industry, adjustments regarding the various risk factors become hard to estimate and present while maintaining a pragmatic approach to the analysis. As it is hard to calculate exact factor loadings, default risks, and illiquidity premiums, there exists an underlying issue of not being fully able to capture every risk aspect or capture it to its full extent. There will always be large uncertainty in these estimates as there currently is no bullet proof way of properly capturing every aspect of risk in relation to the industry.

Furthermore, there exists a large set of different performance measures available, all trying to show the best possible measure of performance for PE firms. The measures all have their own pros and cons, and thus present us with the issue of knowing which one yields the most credible results. As most of the measures are largely heuristic in nature, and their accuracy depends on the context of application, is is fairly difficult to truly have a "correct" measure, as they all illuminate some aspect of the performance that the others in some way lack. Moreover, as some show statistical significance, and some do not, it is often difficult to draw a strong inference based on their joint analysis.

Looking forward, there are several promising directions in which future research can pivot. Firstly, with a larger dataset, one could expand upon and refine our current research methodology. Secondly, a qualitative study of the underlying drivers for Nordic private equity firms could prove to be valuable. Thirdly, one could research the qualitative differences between fund types, and also the associated competencies. As seen in our study, there is a large difference between the two fund types. Furthermore, a study which would continue to explore the different risk-factors connected to PE investments would be highly relevant. This is particularly true as a significantly more well-functioning secondary market has developed over the last decade, making the conventional illiquidity argument seem less impactful in a more modern context.

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Appendix A

Summary of Prior Studies

Authors	Country	Type	Findings
Kaplan (1989)	US	LBOs	Investors in post-buy-out capital earn a median market-adjusted return of 37%.
Ljungqvist and Richardson (2002)	US	VC and LBOs funds	Mature funds started 1981–1993 generate IRRs in excess of S&P 500 returns net of fees; returns robust to assumptions about timing of investment and portfolio company risk; buy-out funds generally outperform venture funds, these differences partially reflect differences in leverage used in investments; sample from one LP with disproportionate share of larger buy-out funds.
Jones and Rhodes-Kropf (2003)	US	VC and LBOs funds	LBO funds have a value-weighted IRR of 4.6% and VC funds have a value-weighted IRR of 19.3%, commensurate with factor risks borne by investors; considerable variation in fund returns
Cumming and Walz (2004)	US, Europe	MBO/MBI, LBO and VC	Private returns to investors in relation to law quality, fund characteristics and corporate governance mechanisms.
Kaplan and Schoar (2005)	US	VC and buy-out funds	LBO fund returns gross of fees earn returns in excess of S&P 500 but net of fees slightly less than S&P 500; unlike mutual funds is persistence in returns among top performing funds; higher returns for funds raised in 1980s; acknowledge that average returns potentially biased as do not control for differences in market risk and possible sample selection bias towards larger and first-time funds; funds raised in boom times less likely to raise follow-on funds and thus appear to perform less well.
Groh and Gottschalg (2006)	US and non-US	MBOs	Risk-adjusted performance of US buy-outs significantly greater than S&P index.
Knigge, Nowak and Schmidt (2006)	Multi-country	VC and buy-out funds	In contrast to VC funds, the performance of buy-out funds is largely driven by the experience of the fund managers regardless of market timing.
Driessen, Lin and Phalippou (2007)	US	VC and buy-out funds	Data from 797 mature private funds over 24 years shows high market beta for venture capital funds and low beta for buy-out funds, and evidence that private equity risk-adjusted returns are surprisingly low. Higher returns larger and more experienced funds mainly caused by higher risk exposures, not abnormal performance.
Froud, Johal, Leaver and Williams (2007)	UK	Mid- and large-size funds	General partners in successful mid-sized funds can expect carried interest to generate £5–£15m on top of their salaries while general partners in large, successful funds can expect $50–150m

Lerner, Schoar and Wongsunwai (2007)	US	VC and LBOs funds	Early- and later-stage funds have higher returns than buy-out funds in funds raised 1991-1998; considerable variation in returns by type of institution; presence of unsophisticated performanceinsensitive LPs allows poorly performing GPs to raise new funds
Ljungqvist, Richardson and Wolfenzon (2007)	US	LBO Funds	Established funds accelerate investments and earn higher returns when opportunities improve, competition eases and credit conditions loosen; first-time funds less sensitive to market conditions but invest in riskier deals; following periods of good performance funds become more conservative.
Metrick and Yasuda (2007)	US	VC and LBO funds	Buy-out fund managers earn lower revenue per managed dollar than managers of VC funds; buy-out managers have substantially higher present values for revenue per partner and revenue per professional than VC managers; buy-out fund managers generate more from fees than from carried interest. buy-out managers build on prior experience by raising larger funds, which leads to significantly higher revenue per partner despite funds having lower revenue per dollar; buy-out managers build on prior experience by raising larger funds, which leads to significantly higher revenue per partner despite funds have lower revenue per dollar.
Nikoskelainen and Wright (2007)	UK	MBOs	Private returns to investors enhanced by contextdependent corporate governance mechanisms.
Diller and Kaserer (2008)	Europe	VC and MBO funds	Highly significant impact of total fund inflows on fund returns. Private equity funds' returns driven by GP's skills as well as stand-alone investment risk.
Philappou and Gottschalg (2009)	US and non-US	LBO Funds	After adjusting for sample bias and overstated accounting values for non-exited investments, average fund performance changes from slight overperformance to underperformance of 3% pa with respect to S&P 500; gross of fees, funds outperform by 3% pa; venture funds underperform more than buy-out funds; previous past performance most important in explaining fund performance; funds raised 1980–2003.
Lopez di Silanes, Phalippou and Gottschalg (2011)	Worldwide	Private equity investments	Median investment IRR (PME) 21% (1.3), gross of fees; one in 10 investments goes bankrupt but one in four has an IRR above 50%; one in eight investments held for less than two years, but have highest returns; scale of private equity firm investors is influential: investments held at times of a high number of simultaneous investments underperform substantially, with diseconomies of scale highest for independent firms, less hierarchical firms, and those with managers of similar professional backgrounds.
Maula, Nikoskelainen and Wright (2011)	UK	MBOs	Industry growth drives exited buy-out returns and is particularly high in MBOs, divisional buy-outs and top-quartile deals.
Robinson and Sensoy (2011)	US	Buy-out funds	Using data from a single LP, buy-out fund returns outperform public market benchmark.
Stucke (2011)	US	VC and buy-out funds	Previous studies' findings may be biased downwards due to data source used; severe anomalies in underlying data result from ceasing data updates. Many empirical results established using these databases may not be replicable with correct data; the claim that private equity has not outperformed public equity is unlikely to hold with true numbers.
Franzoni, Nowak and Phalippou (2012)	Worldwide	Liquidated buy-out investments	The unconditional liquidity risk premium on private equity is close to 3% annually and, the inclusion of this liquidity risk premium reduces alpha to zero.

Harris, Jenkinson and Kaplan (2012)	US	VC and buy-out funds	US buy-out fund net of fee returns have exceeded those of public markets for most vintages since 1984 using various benchmarks (eg, 3% pa using S&P 500) and various data sources from multiple LPs; but some data sources biased downwards in fund returns; both absolute performance and performance relative to public markets are negatively related to aggregate capital commitment.
Higson and Stucke (2012)	US	Buy-out funds	For almost all vintage years since 1980, US buyout funds significantly outperformed S&P 500. Liquidated funds 1980–2000 delivered excess returns 450 basis points per year. of funds do better than the S&P; excess returns driven by top-decile funds; higher returns for funds set up in the first half of each of the past three decades; significant downward trend in absolute returns over all 29 vintage years; results robust to measuring excess returns via money multiples instead of IRRs.
Kleymenova, Talmor and Vasvari (2012)	Worldwide	Secondary buy-out funds	A PE fund interest is more liquid if the fund is larger, has a buy-out-focused strategy, less undrawn capital, has made fewer distributions and is managed by a manager whose funds were previously sold in the secondaries market; private equity funds' liquidity improves if more non-traditional buyers, as opposed to dedicated secondary funds, provide bids and overall market conditions are favourable
Phalippou (2012)	US	Buy-out funds	Adjusting for size premium as buy-out funds mainly invest in small companies, average buy-out fund return is in line with small-cap listed equity
Axelson, Sorensen, and Stromberg (2013)	Worldwide	Buy-out	Gross of fee betas of 2.2%–2.4% and alphas of 8.3%–8.6% annually.
Castellaneta, Gottschalg and Wright (2013)	Europe and US	Private equity-backed buy-outs	Completeness of feedback on performance of past deals has a positive impact on the IRR of subsequent deals; this positive impact is moderated by the proportion of feedbacks on past deals showing negative returns.
Cornelli, Lichtner, Perembetov, Simintzi and Vig (2013)	Worldwide	Private equity funds	Private equity firms experiencing the highest turnover of executives between funds (or those in the top turnover tercile) outperformed those experiencing the lowest turnover (or those in the bottom turnover tercile) by 13.5%; funds that replenished with operational expertise demonstrated improved performance, especially during recessions; turnover of professionals with financial backgrounds did not impact performance; turnover of professionals with private equity experience negatively impacted performance.
Harris, Jenkinson, Kaplan and Stucke (2013)	US	VC and buy-out funds	Sustained significance for pre-2000 funds for buy-out funds and particularly for venture funds. Post-2000, mixed evidence of persistence in buy-out funds. Sorting by quartile of performance of previous funds, performance of the current fund is statistically indistinguishable regardless of quartile; performance size relationship absent. Post-2000, performance in venture capital funds remains as persistent as pre-2000.
Sensoy, Wang and Weisbach (2013)	US	Investments by LPs in buy-out and venture m funds	Superior performance of endowments in 1991–1998 due to greater access to top-performing VC funds; in 1999–2006 endowments do not outperform as as no longer have greater access to funds that are likely to restrict access, and do not make better investment selections than other types of institutional investors.
Valkama, Maula, Nikoskelainen and Wright (2013)	UK	MBOs	Governance variables have limited role in driving value creation but use of a ratchet is positively related to both equity and enterprise value returns; leverage has a positive impact on median and top-quartile equity returns; returns are driven by buy-out size and acquisitions made during holding period; the effect of industry growth is strong in insider-driven, divisional buy-outs, and top quartile transactions.

Table A.1: Comprehensive overview of prior studies

Key source: Gilligan and Wright (2010)

Appendix B

Performance Formulas

Code Repository

A code repository with modularized utility functions devised and built as part of the research process, and subsequently used to calculate the performance measurements, can be found at: `https://github.com/satzen/PyPME` (Python)

The code is released under open source MIT license and can thus be used to ease implementation of further research. Thus, we hope it might diminish the odds of implementation errors, and increase research agility due to it's straightforward implementation, with native support for raw *Preqin* exported data format (as of April 2018).

IRR

Solving for r using Newtonian method. Adjusted for period lengths (*XIRR*).

$$IRR : 0 = \sum_{t=1}^{T} \frac{CF_t}{(1+r)^t} \tag{B.1}$$

MIRR

The MIRR is calculated by discounting all capital calls back to present (defined as time of first capital call) at the financing rate r_f, and distribution cash flows to the time t at the reinvestment rate r_i.

$$MIRR = \sqrt[t]{\frac{FV(Distributions)}{PV(Calls)}} - 1 \tag{B.2}$$

The rates used in the paper remain conservative, with a $r_f = 2\%$ and $r_i = 10\%$.

TVPI

The TVPI is simply calculated as the sum of the nominal value of all distributions and the net asset value (NAV) at the relevant date, divided by the sum of contributions. In other words, it is the multiple of money (MoM) which accounts for unrealized value through the NAV, as per below:

$$TVPI = \frac{\sum_{t=1}^{T} CF_t^{Distribution} + NAV_T}{\sum_{t=1}^{T} CF_t^{Contribution}} = \frac{\text{Total distributions} + \text{Unrealized value of fund}}{\text{Total contributions}} \tag{B.3}$$

TWR & TWRA

Computed as a compound annual growth rate (CAGR) based on the TVPI (MoM) multiple and average investment length.

$$TWR = \sqrt[n]{TVPI} - 1 \tag{B.4}$$

Where n equals to the average investment length.

An approximate measure of abnormal returns can in turn be computed by comparing the TWR against a public index measure:

$$TWRA = TWR_{alpha} = TWR - r_{market} \tag{B.5}$$

Where r_{market} can be calculated using an appropriate market index and time period.

Within the frame of this paper, we compare the TWR against a global and local index, and assume that r_{market} equals to the geometric average return of the index between the fund vintage and and ten years forward (i.e. 10 years starting from the vintage year). We calculate an array of TWR/A measures for the range [4,6] of value n. The $n = 5$ assumption results are most commonly presented in the paper, as it is the closest to the available empirical findings (see table C.2 and Strömberg (2018) for reference). Others are primarily used for initial data exploration. Thus to further clarify, unless otherwise stated, all TWR and TWRA tables refer to results obtained given $n = 5$ and r_{market} based on a geometric mean of the 10 years starting from the vintage year of the fund. If data is insufficient ($Vintage > 2008$) closest possible date is used instead.

PME+

The PME+ is calculated by synthesizing a theoretical investment into the relevant public market index, which mimics the original cash flows of the PE fund. Distributions are treated as sell-offs, and capital calls as investments. The method then adjusts for the NAV value by introducing a scaling term for distributions (λ), which makes sure that the NAV of the theoretical investment is equal to that of the PE fund, so as to avoid the issues associated nonsensical (negative) NAV values which could occur under certain conditions. Finally, the method then calculates the IRR of the theoretical investment. In order to get the abnormal returns, we then simply subtract it from the fund IRR.

$$PME+_{alpha} = IRR_{PE} - IRR(Contributions, \lambda \times Distributions, NAV) \tag{B.6}$$

KS-PME

KS-PME is essentially a **market-adjusted cash multiple**. The measure is calculated in similar fashion to the TVPI multiple, except for the fact that the distributions and capital calls are discounted at the rate derived from a public market benchmark.

$$KS-PME = \frac{\sum_{t=1}^{T} \frac{CF_t^{Distribution}}{I_t} + \frac{NAV_T}{I_T}}{\sum_{t=1}^{T} \frac{CF_t^{Contribution}}{I_t}} = \frac{\text{FV(Total distributions} + \text{Unrealized value of fund)}}{\text{FV(Total contributions)}} \tag{B.7}$$

DirectAlpha

The DirectAlpha metric builds on the same methodology as the KS-PME upon which it was based, but instead of calculating a cash multiple, it estimates an IRR which corresponds to the yearly abnormal rate (i.e. the alpha). Calculated by solving for r in the following equation, and adjusted for period lengths ($XIRR$):

$$\alpha = \sum_{t=1}^{T} \frac{FV(CF_t)}{(1+r)^t} + \frac{NAV_T}{(1+r)^T} = IRR(FV(Distributions), FV(Contributions), NAV) \tag{B.8}$$

And subsequently taking the natural logarithm as per below:

$$DirectAlpha = ln(1+\alpha) \tag{B.9}$$

Table B.1: Illustrative example: Adjusting index Beta

Date	**Index** x	r^x	Δ **Time**	r^f_{annual}	r^y	**Adjusted Index** y
...	...	...	...	...	...	...
2002-11-29	601	5.3%	0.079	1.4%	7.8%	598
2002-12-31	572	-5.0%	0.088	1.4%	-7.5%	554
2003-01-31	554	-3.1%	0.085	1.4%	-4.7%	527
2003-02-28	543	-1.9%	0.077	1.4%	-2.9%	512
2003-03-31	540	-0.6%	0.085	1.4%	-0.9%	507
2003-04-30	587	8.6%	0.082	1.4%	12.9%	573
2003-05-30	619	5.5%	0.082	1.4%	8.1%	619
2003-06-30	629	1.6%	0.085	1.4%	2.3%	634
2003-07-31	641	1.9%	0.085	1.2%	2.8%	651
2003-08-29	653	2.0%	0.079	1.2%	2.9%	670
2003-09-30	656	0.5%	0.088	1.2%	0.7%	675
2003-10-31	695	5.8%	0.085	1.2%	8.7%	734
2003-11-28	704	1.4%	0.077	1.2%	2.0%	748
...	...	...	...	...	...	...

Given $\beta = 1.5$

Beta adjustments

Given an index timeseries x_t, with subsequent derived return series $r^x_t = \frac{dx}{dt}$, an annual risk-free rate timeseries r^f_t, adjusted arithmetically for the time delta t ($\frac{Days(t)}{365} \times r^f_{annual}$), and new β value, we are able to compute an adjusted index y_t using the CAPM formula.

$$r^y_t = r^f_t + \beta(r^x_t - r^f_t) \tag{B.10}$$

Now let us apply the new returns series as a geometric chain:

$$y_t = y_{t-1} \times (1 + r^y_t) \tag{B.11}$$

With $t = 0$ holding the following equality: $y_0 = x_0$. In other words, at any time T the derived index will be equal to: $y_T = x_0 \times \prod_{t=1}^{T}(1 + r^y_t)$. Refer to table B.1 for more explicit illustrative example calculation.

Appendix C

Supporting Figures

Table C.1: Overview of the data funnel

As seen below, there is a significant disparity between the availability of general fund metadata, general performance metrics (TVPI/IRR), and cash flows required to calculate PME-measures and discretionary adjustments on per-fund level. Only approximately 8% of relevant funds in the database have available cash flows, and 24% have any performance measures. Preqin data as of April 2018.

Scope	Stage	Amount
General	Amount of funds in Preqin database	33,693
	Amount of funds in relevant type, regions, and vintage	12,369
	Amount of funds with perfornance measures (IRR)	2,224
	Amount of funds with cashflows	1,132
Nordic	Nordic funds in Preqin database	643
	Nordic funds in relevant type and vintage	320
	Nordic funds with performance measures (IRR)	75
	Nordic funds with cash flows	25
	Buyout funds with performance measures	53
	Buyout funds with cash flows	18
	VC funds with performance measures	22
	VC funds with cash flows	7

Table C.2: Average investment length for Nordic PE deals

The average length of Nordic deals seem to coincide with prior global findings (Strömberg, 2018), indicating an average of c. 5 years. The Nordic median is slightly less, at 4.7 years, indicating a positive skew in the data. Length remains consistent across study type. Preqin deal data as of April 2018.

Type	Mean Investment Length	Median Investment Length	# observations
Buyout	5.05	4.73	912
Venture Capital	5.48	4.70	684

Calculated as $Years(Date(Exit) - Date(InitialInvestment))$, based on Preqin deal data as of April 2018.

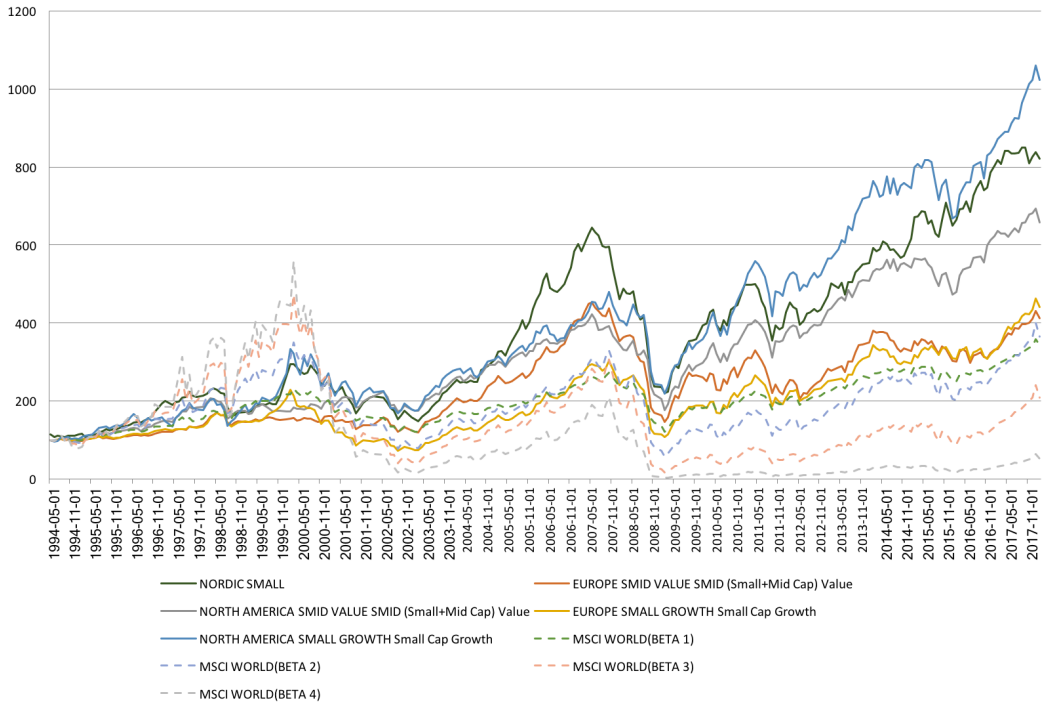

Figure C.1: Comparison of indexes used as basis for PME analysis

Table C.3: Local indexes used as basis for PME

Closest available indexes with appropriate historical length (1994-2014) selected for the local PME analysis. Global benchmark chosen so as to reflect (Sorensen and Jagannathan, 2013) argument stating that a discount rate reflecting the investors average return on wealth would implicitly cover the relevant risk adjustment. As PE investors generally able to diversify internationally, it is reasonable to assume the approximation of global returns as proxy for return on wealth ($r_w = r_m$).

Type	**Region**	**Closest Local Benchmark Index**
Buyout	NA	MSCI NORTH AMERICA SMID VALUE
	EUROPE	MSCI EUROPE SMID VALUE
	NORDICS	CARNEGIE SMALL CAP INDEX NORDIC
Venture Capital	NA	MSCI NORTH AMERICA SMALL GROWTH
	EUROPE	MSCI EUROPE SMALL GROWTH
	NORDICS	CARNEGIE SMALL CAP INDEX NORDIC

Global Benchmark index: MSCI World Standard

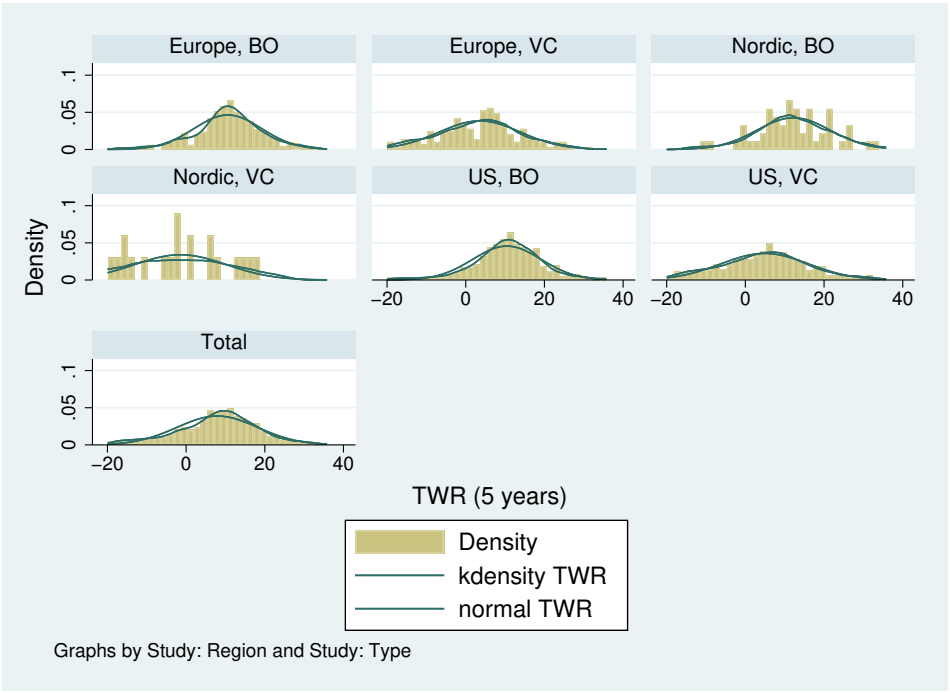

Figure C.2: Histogram: Distribution of TWR for subgroups

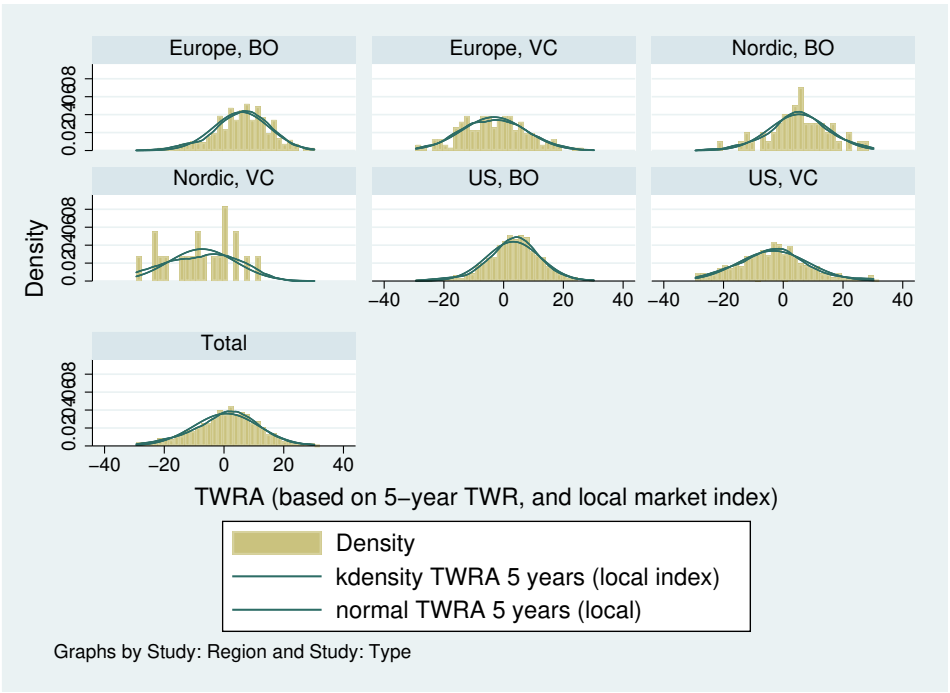

Figure C.3: Histogram: Distribution of TWRA for subgroups

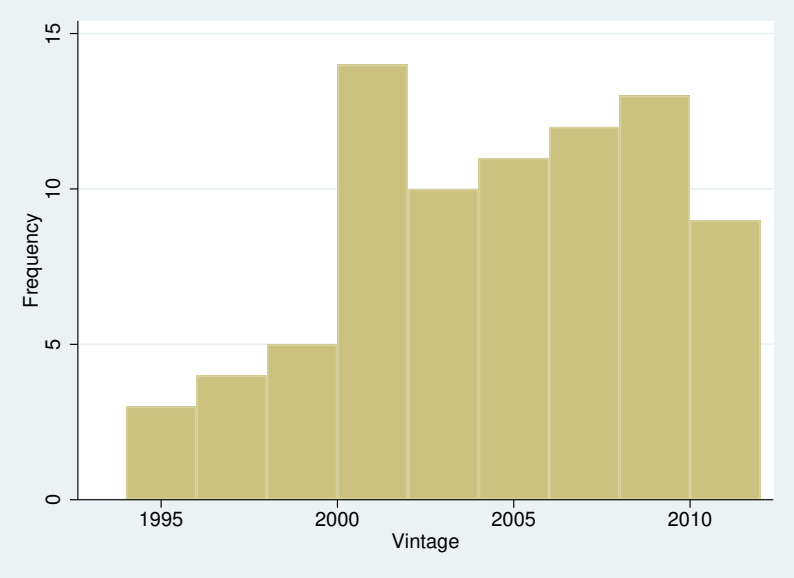

Figure C.4: Histogram: Fund vintage of Nordic sample

Source: Preqin data as of April 2018.

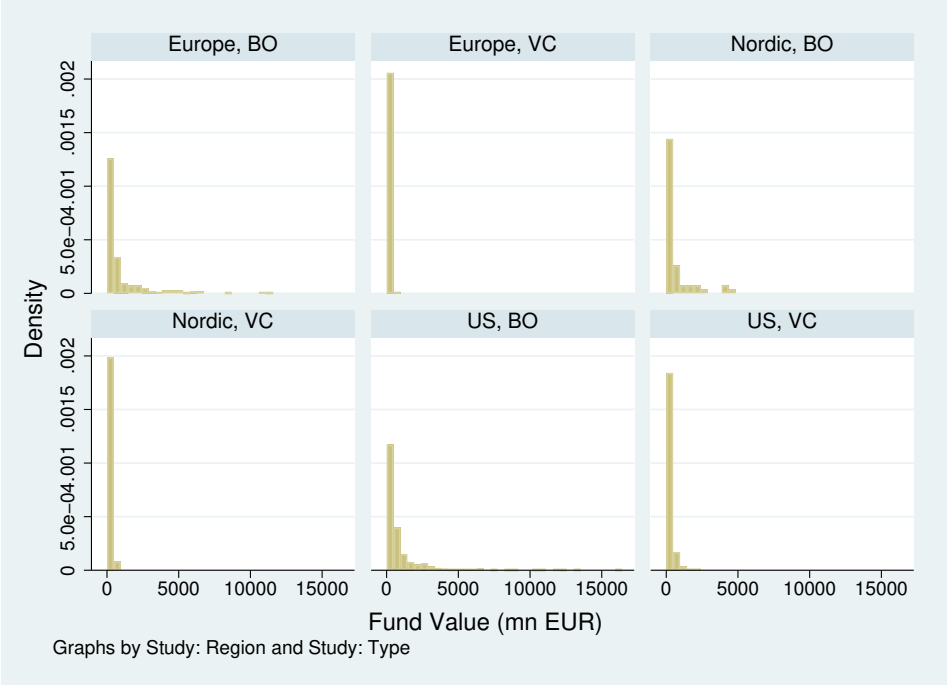

Figure C.5: Histogram: Distribution of fund value

Source: Preqin data as of April 2018.

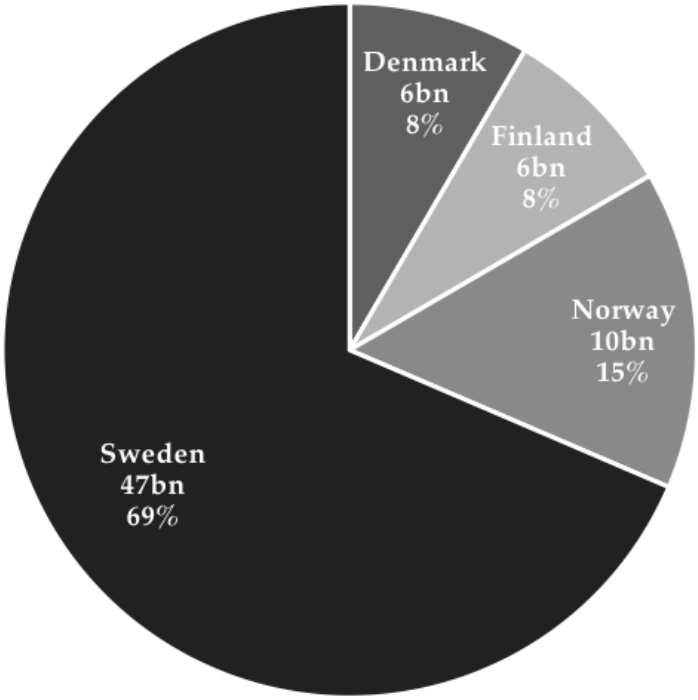

Figure C.6: Nordic fundraising during past 10 years (EUR)

Source: Preqin data as of April 2018.

Appendix D

Extended Findings

The following pages contain content, primarily descriptive tables, with extended findings. The results are provided for reference, as an extension of the key topics discussed within the scope of the body of the paper.

Table D.1: Extended: Full Nordic performance descriptives

This table shows the extended results for Nordic VC and buyout funds. It is divided into *Performance* and *PME* measures showing total number of observations, average performance returns, standard deviation and max and min values. The IRR and TVPI are collected from the database Preqin. The local and global PME measures use the underlying cash flows and compares PE returns to equivalent-timed investments into the respective local and global index. The data includes all available Nordic PE funds. Preqin data as of April 2018.

Fund	Type	Measure	Obs	Mean	Std. Dev.	Min	Max
BO	**Performance**	IRR	49.0	22.0	19.2	-5.5	79.8
		TVPI	56.0	2.0	1.0	0.6	5.8
		MIRR	16.0	9.0	4.0	2.9	15.5
		TWR	54.0	12.3	9.3	-11.3	33.2
	PME	Local KS-PME	16.0	1.1	0.5	0.2	1.9
		Local DirectAlpha	17.0	3.7	10.8	-16.7	27.0
		Local PME+	16.0	4.1	9.8	-7.3	27.8
		Local TWRA	55.0	5.3	9.9	-21.5	27.6
		Global KS-PME	16.0	1.3	0.5	0.2	2.4
		Global DirectAlpha	16.0	5.9	9.1	-10.4	26.2
		Global PME+	15.0	6.3	8.5	-3.8	28.5
		Global TWRA	55.0	8.8	10.6	-17.8	31.9
VC	**Performance**	IRR	16.0	17.5	43.4	-18.0	168.5
		TVPI	25.0	2.4	3.6	0.0	16.6
		MIRR	6.0	3.2	3.3	-2.5	7.3
		TWR	20.0	-1.4	11.8	-19.9	18.0
	PME	Local KS-PME	7.0	0.5	0.3	0.2	0.9
		Local DirectAlpha	7.0	-11.6	7.2	-21.0	-1.6
		Local PME+	7.0	-12.2	7.3	-21.8	-1.8
		Local TWRA	20.0	-7.4	11.2	-27.7	11.0
		Global KS-PME	7.0	0.7	0.3	0.2	1.1
		Global DirectAlpha	7.0	-8.2	6.9	-17.1	2.3
		Global PME+	7.0	-8.8	8.0	-22.0	2.4
		Global TWRA	20.0	-3.0	11.2	-20.4	16.4
Totals	**Performance**	IRR	65.0	20.9	26.9	-18.0	168.5
		TVPI	81.0	2.1	2.2	0.0	16.6
		MIRR	22.0	7.4	4.6	-2.5	15.5
		TWR	74.0	8.6	11.7	-19.9	33.2
	PME	Local KS-PME	23.0	0.9	0.5	0.2	1.9
		Local DirectAlpha	24.0	-0.8	12.1	-21.0	27.0
		Local PME+	23.0	-0.8	11.8	-21.8	27.8
		Local TWRA	75.0	1.9	11.6	-27.7	27.6
		Global KS-PME	23.0	1.1	0.6	0.2	2.4
		Global DirectAlpha	23.0	1.6	10.7	-17.1	26.2
		Global PME+	22.0	1.5	10.9	-22.0	28.5
		Global TWRA	75.0	5.7	11.9	-20.4	31.9

Table D.2: TWRA Performance (local index)

This table shows the number of funds, average , median and weighted average TWRA (5 year basis) returns by vintage year, comparing PE time-weighted returns to equivalent-timed investments in the a local index using the Preqin data. The local index is based of where the fund is located. Vintage years are defined by the date of the first investment by a fund. Weighted averages are based of the value committed to the fund as a weight. The sample only includes funds which with relevant performance metrics (TVPI). Preqin data as of April 2018.

Vintage	Buyout Funds				Venture Capital			
	Funds	Average	Median	W. Average	Funds	Average	Median	W. Average
1994	40	4.36	4.25	6.27	23	2.48	3.80	6.34
1995	32	0.05	1.72	-1.00	24	4.69	5.50	6.38
1996	31	-1.00	2.08	0.10	31	-0.69	-0.06	-0.42
1997	53	-2.13	-1.82	-1.05	55	3.11	0.91	6.40
1998	66	-0.22	0.61	-1.77	57	-7.16	-3.93	-7.41
1999	65	6.90	8.93	6.12	61	-5.97	-7.62	-7.15
2000	84	8.67	9.84	8.12	107	-5.07	-3.98	-4.59
2001	45	7.90	8.03	9.41	78	-4.39	-2.89	-2.61
2002	46	7.43	8.07	8.71	39	-6.50	-5.49	-3.88
2003	50	4.59	4.19	6.85	36	-6.94	-5.85	-7.03
2004	47	5.02	4.64	5.11	27	-7.77	-6.06	-6.79
2005	91	4.19	4.51	5.72	56	-3.52	-4.69	-2.99
2006	113	5.19	6.44	4.69	71	-3.94	-2.48	-2.87
2007	106	7.67	8.84	6.91	73	1.46	1.32	3.84
2008	89	6.57	6.84	7.66	62	-0.21	-0.91	-3.06
2009	41	0.65	0.03	1.66	33	-9.18	-8.55	-5.51
2010	45	1.07	1.75	0.81	29	-3.18	-3.97	-2.73
2011	60	2.57	2.90	3.01	41	-2.54	-1.69	-0.07
2012	69	-1.32	-1.84	-1.51	40	-6.13	-7.39	-3.90
Average	1173	3.59	4.21	3.99	943	-3.23	-2.84	-2.00

Table D.3: Extended: MIRR performance

This table shows the average, median and weighted average *Modified internal rate of return* (MIRR returns) by vintage year, calculated by discounting all capital calls back to present at the financing rate, and distribution cash flows to the time t at the reinvestment rate. Weighted averages are based of the value committed to the fund as a weight. The data only includes funds which had cash flows data in the database. Preqin data as of April 2018.

Vintage	Buyout Funds				Venture Capital			
	Funds	Average	Median	W. Average	Funds	Average	Median	W. Average
1994	16	10.28	10.57	10.17	9	11.24	12.65	12.17
1995	12	7.78	8.36	8.98	12	10.79	11.14	13.93
1996	18	8.60	9.49	8.88	14	9.32	9.36	9.22
1997	21	8.19	8.68	9.12	19	9.37	9.37	10.00
1998	39	8.18	8.04	8.22	22	6.41	6.85	6.96
1999	29	8.10	8.74	8.21	30	4.10	3.75	3.86
2000	34	10.09	10.08	10.22	61	3.79	4.15	4.12
2001	20	10.20	10.82	11.14	41	5.36	5.80	5.88
2002	23	9.89	10.66	10.74	19	4.46	4.34	5.33
2003	14	9.49	9.36	10.62	15	4.66	5.85	4.51
2004	22	9.01	9.33	10.05	16	4.03	4.95	3.89
2005	50	7.71	7.76	8.45	25	5.31	4.91	6.06
2006	56	6.98	7.67	7.06	34	4.06	4.07	5.21
2007	55	7.60	7.90	7.44	38	7.94	8.43	8.92
2008	58	8.18	8.61	8.29	25	6.08	5.58	4.69
2009	24	9.91	10.11	10.04	14	7.02	5.06	7.17
2010	28	9.19	9.66	7.49	13	7.30	6.38	6.98
2011	35	8.60	8.50	7.56	18	9.29	10.66	9.43
2012	44	8.25	8.93	7.92	14	8.89	8.33	10.25
Average	598	8.75	9.12	8.98	439	6.81	6.93	7.29

Table D.4: Extended: DirectAlpha performance (local index)

This table shows the average, median and weighted average DirectAlpha returns by vintage year, comparing PE returns to equivalent-timed investments in the a local index using the Preqin data. The local index is based of where the fund is located. Vintage years are defined by the date of the first investment by a fund. Weighted averages are based of the value committed to the fund as a weight. The sample only includes funds which had cash flow data in the database. Preqin data as of April 2018.

Vintage	Buyout Funds				Venture Capital			
	Funds	Average	Median	W. Average	Funds	Average	Median	W. Average
1994	15	6.35	5.73	10.12	6	-2.08	-6.27	3.81
1995	11	2.17	-2.45	5.12	6	-4.63	-3.35	-1.30
1996	18	1.44	2.85	2.93	10	-1.56	-0.47	-1.93
1997	21	-1.65	0.58	1.59	15	-2.56	-7.35	0.34
1998	36	-1.88	-2.67	-3.08	21	-5.97	-6.98	-2.98
1999	26	-0.13	0.93	0.85	29	-12.80	-12.11	-11.72
2000	34	5.16	5.50	5.21	57	-9.29	-9.19	-9.04
2001	18	4.27	3.72	10.04	40	-6.79	-5.73	-5.86
2002	23	4.59	6.57	6.60	19	-9.31	-8.56	-6.16
2003	14	7.10	5.86	10.13	14	-7.32	-3.35	-7.95
2004	21	8.49	6.41	10.51	18	-8.83	-6.94	-7.63
2005	48	3.14	2.79	6.80	26	-4.10	-5.17	-3.11
2006	54	3.20	3.88	5.30	38	-8.40	-6.12	-5.84
2007	55	1.48	1.69	1.94	42	0.61	1.20	2.06
2008	59	2.06	3.43	3.26	28	-3.59	-3.59	-3.26
2009	23	6.06	6.71	6.55	14	-1.42	-2.25	-1.79
2010	30	4.14	4.85	4.03	15	3.19	0.93	2.01
2011	38	2.07	1.69	4.71	19	0.28	5.09	0.84
2012	47	5.60	6.32	7.79	17	3.10	3.27	5.15
Average	591	3.35	3.39	5.28	434	-4.29	-4.05	-2.86

Table D.5: Extended: PME+ performance (local index)

This table shows the average, median and weighted average PME+ returns by vintage year, comparing PE returns to equivalent-timed investments in the a local index using the Preqin data. The local index is based of where the fund is located. Vintage years are defined by the date of the first investment by a fund. Weighted averages are based of the value committed to the fund as a weight. The sample only includes funds which had cash flow data in the database. Preqin data as of April 2018.

Vintage	Buyout Funds				Venture Capital			
	Funds	Average	Median	W. Average	Funds	Average	Median	W. Average
1994	13	4.75	0.22	10.65	6	-2.06	-6.60	5.34
1995	11	-2.10	-2.95	4.06	7	-3.74	-2.48	-0.69
1996	18	2.65	3.03	4.76	10	-1.47	-0.52	-2.10
1997	21	-1.47	0.60	1.80	13	-2.77	-10.22	2.15
1998	39	-1.83	-2.48	-2.67	20	-6.46	-8.46	-2.58
1999	26	0.09	1.05	1.22	30	-11.76	-11.11	-10.91
2000	33	6.26	5.56	6.41	59	-9.82	-9.41	-9.12
2001	18	5.75	4.49	13.29	41	-7.74	-6.69	-6.32
2002	22	5.72	8.66	9.29	19	-10.19	-10.85	-6.69
2003	14	9.03	7.30	14.43	14	-7.53	-3.22	-8.15
2004	20	8.89	6.59	12.25	19	-8.10	-7.17	-7.37
2005	47	4.16	3.01	7.39	24	-2.33	-4.35	-1.23
2006	55	3.14	3.75	5.09	37	-7.56	-6.18	-5.27
2007	56	1.16	1.24	1.74	39	-0.46	0.00	1.98
2008	58	1.71	3.49	3.60	28	-3.37	-4.74	-2.89
2009	23	7.39	7.97	7.68	14	-0.81	-2.46	-1.60
2010	30	5.21	5.59	5.01	15	5.42	1.04	3.73
2011	37	2.69	2.26	5.94	19	1.72	6.50	2.10
2012	46	6.19	5.82	9.16	17	5.38	1.85	6.58
Average	587	3.65	3.43	6.37	431	-3.88	-4.48	-2.27