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Listed Private Equity

– A Study of Discount/Premium to NAV Characteristics –

Carl von Heijne[*]
Major in Finance
Stockholm School of Economics

Claes Melander[*]
Major in Finance
Stockholm School of Economics

Abstract: Combining findings from earlier research on the closed-end fund puzzle with research on private equity characteristics, we study the discount/premium properties of listed private equity funds. The sample includes 13 buyout funds and 144 venture capital funds, during the period 1988-2008. The mean discount is 12% for the buyout funds and 11% for the venture capital funds. We find that managerial ability, measured through the proxy historical net asset value returns, and liquidity are positively related to premium. We find support for the investor sentiment theory measured with the proxies net retail fund flows, peer premium and ftse small cap returns. Buyout and venture capital funds do not receive a higher premium for holding illiquid assets. The credit spread is negatively related to premium for buyout funds. Neither fund type show any performance persistency in net asset value returns. Lastly we see that the premium has no ability to predict future NAV returns, whereas it can predict future total stock returns due to the mean reverting pattern of discounts/premiums.

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[*] 19695@student.hhs.se, [*] 19701@student.hhs.se

1 Introduction

Listed investment funds have attracted lots of academic and investor interest because they usually trade at a discount to their net asset value (NAV). In other words, on average, the market values of these funds are less than the value of their investment portfolios. The phenomenon, commonly referred to by researchers as the closed-end fund[1] puzzle, is especially interesting since it seems to contradict with the theory of one price and investors acting rational, which are standard assumptions in modern finance. Dimson & Minio-Kozerski (1999) reviewed 70 studies on closed-end fund discounts and found that the incapability in rational models of explaining the closed end fund discount has led to the emergence of irrational models. However, the existing rational and irrational explanations are still not able to explain the full dynamics of the puzzle.

Private Equity (PE) emerged in US in the 1980s. A recent trend is that these funds are being listed on stock exchanges. The listed entities are referred to as Listed Private Equity funds (LPEs). LPEs and regular investment funds are both closed-end funds (CEFs). The characteristics of LPEs are somewhere in between traditional PE and regular investment funds. Like regular investment funds they trade on a stock exchange making them accessible for a broad range of investors. However, in contrast to regular investment funds their holdings are in unlisted assets making them more similar to private equity funds.

Examining LPE in the light of the closed-end fund puzzle is interesting for several reasons. Firstly, there is a limited amount of research on LPEs and to the best of our knowledge no previous research has been devoted to describe their discount to NAV characteristics. Second, the relation between market value and NAV is less evident for LPEs than regular investment funds since their holdings are unlisted and valuation methodologies are restrictive. Third, LPEs can be believed to exhibit similar characteristics to PE e.g. showing performance persistency and being sensitive to borrowing conditions.

The starting point in our analysis will hence be the factors that earlier researchers have found to be of importance for explaining the investment fund NAV discount. Combining this with PE characteristics we form testable hypotheses that are expected to be able to explain the NAV discount for LPEs. Lastly we study if the level of the NAV discount/premium has any predictive ability for future NAV return and total stock return.

[1] A closed-end fund is a regulated investment company that issues a fixed number of shares and is traded on a stock exchange.

We use a data sample spanning from 1988-2008 and covering 157 LPEs of which 13 are classified as buyout funds (BOs) and 144 as venture capital funds (VCs). To verify our findings we use a reference sample of 146 investment funds (Peers).

In summary we are able to establish that LPEs on average trade at a discount to NAV which varies over time. The determinants managerial ability, measured through the proxy *historical NAV return*, *size* and *liquidity,* all based on rational arguments, are found to have a significant positive relationship to the premium. The size and liquidity measures are however highly correlated making it hard to determine their independent effect. It would have been interesting to also investigate management fees relation to NAV premium as it is regarded as one of the more important determinants based on rational arguments. However, we were not able to obtain such data. The results from assuming irrational investors support the importance of investor sentiment. Net retail fund flows and Peer premium are both significantly positively related to premium for LPEs whereas the development of ftse small cap index only can determine the premium for BOs. Extending our study by including more variables based on investor sentiment. Examining the PE-characteristics of LPEs we find no performance persistency among LPEs. A probable reason for this is that our LPEs do not belong to the top quartile of the PE sector as a whole. It would therefore be interesting to compare listed and unlisted top quartile PE performance. LPEs do not trade at a higher premium for holding illiquid assets. We are able to confirm the dependence of leverage for BOs whose premium is negatively related to credit spread. Using other PE specific variables such as leverage, age and management turnover could further explain the premium for LPEs but are not studied in this thesis. Lastly, we cannot find that the premium has any power to predict future NAV returns. It can however predict future total stock returns, probably because LPE premiums seem to follow a mean reverting pattern just like the premiums of other CEFs[2].

The paper proceeds as follows. Section 1 presents an introduction to the field of study. Section 2 introduces our hypotheses and the rationale behind them. Section 3 describes the data. Section 4 describes the methodology used in our study. Section 5 presents a descriptive look of the premium and the results of independent analyses of the hypotheses. Section 6 examines the premiums/discounts ability to predict future NAV and total stock returns. Section 7 describes results and analyses done with a joint regression model. Section 8 concludes and presents suggestions for future research.

[2] Thompson (1978), Richards, Fraser and Groth (1980), Anderson (1986) and Brauer (1988) amongst others found this pattern.

1.1 The closed end fund puzzle

The part of the closed-end fund puzzle which we will study with our LPE sample is the presence of a mean discount that varies over time. There are two main tracks in explaining this phenomenon. The first track assumes that CEF investors are rational and the second assumes that they are limitedly rational or potentially irrational.

The main rational argument is based on that an investment company generating returns below (above) the market's required rate of return of the underlying portfolio will motivate a discount (premium) in order for investors to be willing to invest in it (Karlsson, 1999). Thus, in order for an investment company to trade at a premium, value adding activities needs to exceed the value draining activities. Malkiel (1977) argue that value added by managers motivates a premium. A problem with his approach was highlighted by Berck and Stanton (2004) who argue that value adding managers will either demand increased compensation to remain as fund managers or leave the fund. The value draining activities are the costs of running the fund displayed in the management fees. Given no value adding activities the presence of fees motivates a systematic discount equal to the net present value of management fees. However, the level of fees for CEFs has been shown to be incapable of explaining neither the cross sectional variation in discount to NAV, nor why discount varies over time. [3]

Other rational factors affecting the premium/discount to NAV are:

- Liquidity-creation: Investment funds serve the purpose of making an illiquid asset more liquid motivating a lower discount according to Cherkes et al. (2007).
- Asset-bundling: The product bundling effect motivates a discount since an investor might not like all components in the bundle as much as the marginal investor in the market.
- Tax-timing: Holding shares of a closed-end fund, investors lose valuable tax-trading opportunities[4]. Nevertheless, there is evidence that only a small proportion of investors trade to reduce their tax payments, and the large majority buy and hold stocks for the longer term.[5] This would imply that the loss of tax-timing ability should not be a major reason for a NAV discount.

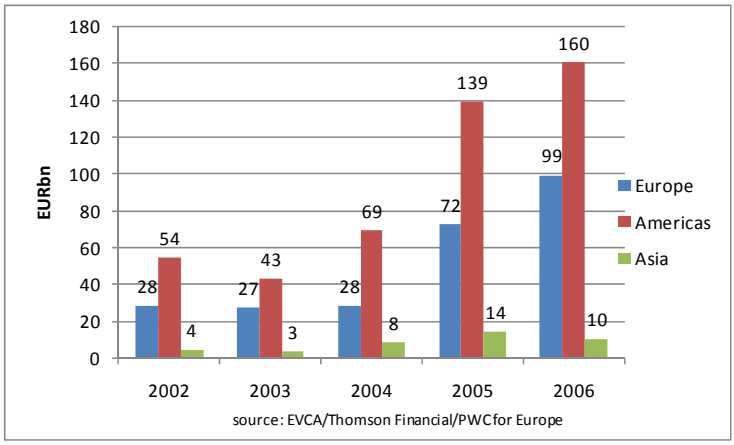
[3] Malkiel found this already in 1977.
[4] Brickley et al. (1991) and Kim (1994) amongst others present this argument.
[5] Seyhun and Skinner (1994) show that only 5-7% of US investors trade to reduce taxes and 90% buy and hold stocks for the long term.

Lee et al. (1991) were among the first to argue that CEF discounts are a sign of market irrationality. Their model, referred to as the sentiment theory, takes it's starting point in that listed investment funds to a great extent attracts investments by small private investors whom are viewed to be limitedly rational. They argue that the small private investors alter between periods of more positive and more negative views on investments, referring to this as changes in investor sentiment. Given that the change in sentiment is systematic, i.e. it affects many assets at the same time, it will be priced in equilibrium. This will be observed through a long term discount which varies over time with changes in investor sentiment. The authors call this the noise trader risk, which can be interpreted as the uncertainty that negative (positive) investor sentiment cause a downward (upward) pressure on the stock price resulting in a larger (smaller) discount. A weak point of their study is that they have a limited dataset with sometimes as little ten funds.

1.2 PE characteristics

PE has since its emergence in the US in the 1980s spread around the world and the capital going into the asset class has rapidly increased which Figure 1.1 clearly shows.

Figure 1.1: Global private equity funds raised



PE firms are normally divided by type of investments into buyout (BO) and venture capital (VC) firms. BOs typically invest in large, mature companies in need of restructuring. The funds raised by the BOs are often used to acquire entire public companies and take them private. VCs typically invest in new and rapidly growing companies in need of financing operational development and capital intensive investments. Depending of their investment stage focus, VCs can be divided into types investing in early, middle and late stage ventures. VCs are typically considered riskier than BOs, with a risk that decreases

as the investment focus moves towards later stage ventures. BOs could hence be considered a more homogenous group than VCs.

According to Sahlman (1990) most PE firms are run as limited partnerships. He describe the general PE firm structure as being represented by a general partner (GP), who identifies investment opportunities with value enhancing possibilities. To finance the transaction the GP turns to limited partners (LPs) who agree to provide capital for the funds investments when called upon. Together with a small stake provided by the GP this represents the equity part of the investment. The LPs are typically institutional investors such as pension funds, university endowments and wealthy individuals (Fenn et al. 1997). Debt financing plays a vital role for BOs, which logically makes them more sensitive to borrowing conditions. For the smaller[6] and riskier VC deals the debt component is less pronounced.

BO investments are normally held for a period of 3-7 years and when exited the capital is distributed back to the LPs after the deduction of a management fee, typically around two percent of the committed capital, and 20 percent of the carried interest. The carried interest represents the value created in the investment, often over a benchmark, and the LP gets 80 percent[7] of this created value. A PE fund normally[8] has a maximum lifetime of about ten years, which in special cases can be extended in one year increments to 13 years Sahlman (1990).

One reason why PE investing has gained in popularity is that it is perceived as an asset class with little correlation to other asset classes. This would imply that through investing in PE an investor can diversify his exposure to other asset classes. The term private suggest that there is a difference with respect to governance in these investments. PE firms can work with their companies in private, without the scrutiny that a listed company is exposed to. Kaplan and Schoar (2005) found that PE firms on average do not outperform their benchmarks. However, for both BO and VC investments they found that performance persistency is strong in the top quartile with the best performing funds consecutively outperforming their benchmarks. Stated reasons for this are that the GPs in these funds are more skilled and thus are able to add more value in their portfolio companies beyond just financial capital. Other explanations stated by amongst others Fenn et al. (1997) are that the best funds have access to

[6] Fenn et al. (1997) some early stage VCs are as small as $10m whereas some BOs are $1bn or larger.
[7] Gompers and Lerner (1994a) find a striking degree of uniformity with more than 80% of the PE funds examined use the 80/20 division of carried interest
[8] Sahlman (1990) found that 70% of the Venture Economics funds they studied had a life length of then years and that the standard exemption time was three years through separate one year increments.

superior, international investor networks and proprietary deal flow and hence are able to participate in the best investment opportunities.

When it comes to fund raising the best performing funds generally has little difficulty raising enough capital to their funds. In fact, they tend to raise less capital than possible. According to Kaplan and Schoar (2005) this is because of limitations in scalability of good investments and skilled managers. In contrast worse performing funds often grow too large too fast. In boom times, most PE funds can show a good track record and many new funds are raised since there is plenty of capital available for PE investments. This leads to capital also being allocated to funds with less skilled managers. In line with this reasoning, Kaplan and Schoar (2005) argue that the proportion of bad funds is higher after a boom period, leading to a period of worse PE returns.

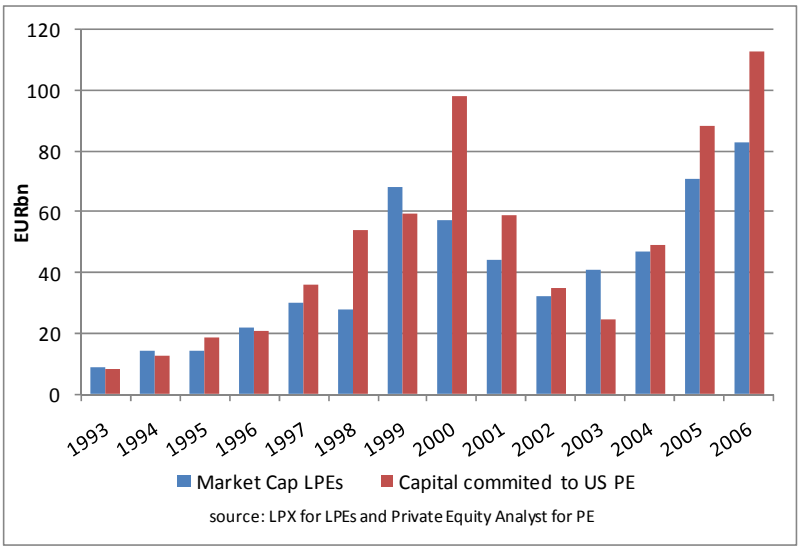
When it comes to size and age of the fund evidence have been found that performance increases with fund size and with the GP's experience. The relation between fund size and performance in PE is concave according to Kaplan and Schoar (2005) (the best performing funds raise less capital than possible) in contrast to the convex relationship found by Chevalier and Ellison (1997) and Sirri and Tufano (1998) for mutual funds (the best performing funds grows largest).

1.3 Comparison of LPE and PE

There are currently over 250 LPEs worldwide[9], with a total market capitalization of over EUR 80 billion. As can bee seen in Figure 1.2 the total market capitalization of listed private equity has increased about nine times between 1993-2006 and the increase seems to be quite cyclical. The same pattern is identifiable when comparing to committed capital to PE funds in US.

[9] AIG Private Equity 2008

Figure 1.2: Market cap for LPEs globally and capital committed to US Private Equity 1993-2006



LPEs can be both BOs and VCs. The listed entity can take on several shapes; it can be an entire GP, a partial listing of a GP, a LP (funds-of-funds) and a LP investing in a certain GP.

There are several differences between LPEs and traditional PE. From an investor point of view LPEs enable smaller investors the opportunity to invest in the PE asset class since large investments are not required. They serve the role of making illiquid assets, the underlying PE investments, liquid through a stock exchange listing. The LPEs usually charges less fees than traditional PEs (AIG Private Equity 2008). Moreover, the investor can hold the LPE as long as he wish, not being constrained by the funds life as in regular PE. Given that the fund is fully invested the investor in LPEs is not exposed to the traditional J-curve[10] of PE. Instead the investor will capture the benefits from realizations of investments continuously. Finally, the transparency associated with a listing with respect to information about the development in the net asset value in the underlying investments and description of the evolution of the investments may reduce the risk for the investor. Disadvantages of the LPE from an investor point of view can for the two GP investment types be that the investor is not able to monitor and put pressure on the GP in the same way as a large LP in a traditional PE fund can do. LPEs of the LP type have the disadvantage of adding an extra layer of fees for the investor. The co-investment opportunities, were the LP is offered to co-invest for a stake in the PE investment enabling it a share of any carried interest without having to pay fees on the investment (Fenn et al. 1997), in traditional PE targets are not present

[10] The j-curve illustrates cash flows for investors in private equity. During the first 2 years, cash flows are negative as investors provide capital for investments. After a few years, as the first realizations are made, cash flows turn positive.

in LPE. A LPE investor can on the other hand at any time increase his stake in the fund through buying additional shares. A risk with LPE investing is that the fund may trade at a discount that varies in an unpredictable way.

At the fund level advantages with LPEs are that the fund managers doesn't need to spend time and resources procuring capital for new funds given that the fund is sufficiently capitalized. If the fund on the other hand is undercapitalized, issuing additional equity can be both costly and troublesome if market conditions are disadvantageous. Additionally, the LPE is not contractually constrained by a maximum duration for its investments and can keep its holdings for as long as it is financially optimal. From this feature one could argue that the pressure put on traditional PE firms to seize the quick value enhancing measures is not present for LPEs. Disadvantages are that in contrast to the traditional PE funds the LPE is not always fully invested, however this naturally reduces the risk in the company. Another disadvantage could be the important information requirements associated with a listing. This consumes resources but might also be more disadvantageous from an overall perspective. After all, one of the key benefits with PE is their possibility to undisturbed engage in value creation in their portfolio companies.

Regarding performance of LPEs there is limited amount of research to date. Marin and Pretty (1983) studied eleven listed VC firms during the period 1973-79 and found superior returns relative to the public market. However, the period studied coincides with a strong period for VC returns generally. Brophy and Guthner (1988) examine 12 LPEs during 1981-1985 and found that these have superior performance relative to S&P500 and growth oriented mutual funds. Huss (2005) compare the performance of PEs and LPEs during 1993-2004 measuring internal rate of return (IRR) and public market equivalent (PME)[11]. Over 1700[12] PEs (both BO and VC) are compared against the LPX50TR[13], which serves as the proxy for listed private equity. When comparing mean and median IRRs Huss found that unlisted VC outperformed listed whereas unlisted BOs slightly underperformed listed. Looking at mean PMEs no statistically significant difference between listed and regular PE was found. Regarding median PMEs a slight underperformance of listed VCs were found and a larger underperformance for listed BOs. From this Huss draws the conclusion that PE and LPE has performed almost equally. Zimmermann et al. (2005) study 287 LPEs from 1986-2003. After imposing several liquidity constraints

[11] PME calculation assumes all capital distributions are invested in the market index implying that the beta of the fund is 1.
[12] The same data set of unlisted PEs where used by Lerner et al. (2005)
[13] Index provided by LPX

their sample is reduced to 114 funds. They form three portfolios (two of the portfolios are partially rebalanced and one is fully rebalanced) and compare their returns to the MSCI World using Sharpe ratios and Jensens alpha. When studying the time period 1986-2000 they find that LPEs outperform MSCI World. However, when extending the period to 2003 the pattern is inconclusive with one of the portfolios outperforming and two underperforming the MSCI World index.

1.4 Comparison regular investment funds and LPEs

The most significant difference between regular investment funds and LPEs is that the prior mainly invest in listed equity whereas the holdings of the LPE are mostly in unlisted equity. This has its primary implications when considering valuations and liquidity of the assets.

In order to harmonize valuation of unlisted holdings European Venture Capital Association (EVCA) has produced valuation guidelines[14] for private equity. The guidelines are typically a bit conservative which rationally would motivate a premium. They stipulate that the investments value should not be written up until it is certain. The effect seems to be that LPEs keep many investments at cost until the realization point. On the other hand a discount may be required by investors to hold an asset with uncertain realizable market value. Lastly, since many of the investments are in unlisted companies it is often impossible to replicate an LPE portfolio and thus it will not be possible to exploit irrational levels on discount/premium, which should enable them to last longer.

Dimson (1979) and Scholes and Williams (1977) highlights another aspect of the valuation problems concerning stale asset valuations[15]. Phallipou and Gottschalg (2008) addresses the problem with the relation between NAV value and market value. They argue that mature funds report their longly held and unexited investments at NAV even though most of them represent *living deads*[16] and therefore more appropriately should be written off. Taking this into account considerably reduces performance in the PE asset class.[17]

[14] See reference EVCA valuation guidelines for web link to guidelines
[15] Stale valuation means that the market value of the funds assets adjusts slower than the market value.
[16] A defaulted investment with NAV reported at acquisition cost.
[17] Phallipou and Gottschalg (2008) find that PE underperform the S&P500 with 3% yearly when studying mature PE funds and writing off living dead investments.

2 Hypothesis

2.1 Rational arguments

2.1.1 Managerial ability and performance persistency

Researchers argue that historical NAV return can be used as a proxy for managerial ability. If managers have superior managerial abilities then they should be able to make their portfolio companies perform above average persistently over time and therefore historical NAV returns should be positively related to premium. However, results have been varying. Dimson and Minio-Paluello (2001) find no evidence of persistence in NAV returns, but Bal and Leger (1996) and Leger (1997) find evidence of performance persistence in UK closed-end funds, and Bers and Madura (2000) find similar evidence for US funds. Chen et al. (2001) and Cao and Esman (2002) find evidence of superior performance among managers of Chinese closed-end funds.

H1: Historical NAV return is positively related to premium

H2: NAV returns are persistent over time for LPEs

2.1.2 Liquidity

Liquidity is one of the fundamental risk components of an investment. Its importance in explaining stock returns has been empirically demonstrated by amongst others Datar et al. (1998). The results imply that rational investors will demand a higher return, i.e. a liquidity premium, to be compensated for the extra risk associated with holding illiquid assets. A more liquid stock would hence motivate a higher premium to NAV. To measure the liquidity determinant we use two proxies, one of liquidity; trading volume and one of illiquidity; bid-ask spread.

H3: Trading volume is positively related to premium

H4: Bid-ask spread is negatively related to premium

PE fund investments are illiquid, often inaccessible or only accessible at a high transaction cost to the average investor. Cherkes et al. (2006) argue that CEFs with illiquid holdings, such as LPEs, through its listed entity provides a service to investors, making illiquid assets liquid. This service should represent a value adding activity that would justify a lower discount. Since regular investment funds invests in more liquid assets they don't add the same value as LPEs, and given equal trading liquidity we expect LPEs to trade at a higher premium than Peers.

H5: LPEs trade at a higher premium than Peers controlling for liquidity

2.1.3 Payout-ratios

Applying rational arguments a company generating returns below the required rate of return will trade at a discount. Such a company can either choose to keep its earnings investing them below the market's required rate of return or distribute the earnings to investors who, in theory, can earn the market's required rate of return. Evidently investors would prefer the latter *ceteris peribus*. In line with this reasoning Karlsson (1999) argues that CEFs should increase their payout ratio when traded at a discount in order to reduce their discount. If the company on the other hand realizes returns above the required rate of return it is optimal from an investor point of view that the company reinvests its earnings.

One empirical study performed Cherkes et al. (2006) finds however that the CEF premium was positively related to the fund's payout-ratio for a comprehensive sample of investment funds in the US between 1986 and 2006.

Our interviews have indicated that closed-end funds are unlikely to adjust their payout ratios depending on if they trade on a discount or a premium. We therefore examine whether the payout ratio as such has an ability to predict premium by looking at three months lagged payout ratios.

H6: Payout-ratio$_{t-3}$ is negatively related to premium

2.1.4 Borrowing conditions

Larger corporate credit spread should make value creation in BO type investments harder since they rely heavily on debt financing (Kaplan and Strömberg 2008). This could translate into a larger discount when credit spread rises and a smaller discount when credit spread falls. The effect should be less profound for the Peer and VC fund categories since these funds rely less on debt financing.

H7: Credit spread is negatively related to premium for BO funds

H8: Credit spread is stronger related to premium for BO funds than for VC and Peer funds

2.1.5 Size

It is logical to assume that LPEs like PEs exhibit a concave relationship between size and performance. Since good performance attracts investors it should also push down discount levels. Therefore we expect to see a positive and concave relationship between our proxy for size, market cap, and the premium level for LPEs.

H9: Market cap is positively related to premium for LPEs

H10: Market cap is positively related to premium in a concave pattern for LPEs

2.2 Irrational arguments

The investor sentiment model suggests that the discounts and its variations are primarily driven by the investor sentiment of individual investors, which are considered limitedly rational. Since investor sentiment cannot be measured directly various proxies has been used in prior research of which we will investigate few.

2.2.1 Net retail fund flows

Malkiel (1977) use mutual fund flows as proxy for investor sentiment. He found that discounts on CEFs narrow when net fund flows to mutual funds are positive, suggesting that similar market forces drive the demand for both open- and closed-end funds. Lee et al. (1991) reproduced Malkiel's analysis with an extended time period and also found indications that change in net mutual fund flows affects CEF discounts.

H11: Net retail fund flows are positively related to premium

2.2.2 Ftse small cap index

Lee et al. (1991) find that the same investor sentiment affecting CEF discounts is attributable to small cap stocks, which are also found to be invested in to a great extent by small private investors, and that the returns in small cap stocks covaries with CEF discounts. We use ftse small cap index returns as a proxy for investor sentiment believing that high index returns represent a positive investor sentiment which should translate into a narrowing of the funds discount. It is reasonable to believe that the same effect will apply for LPEs as for Peers.

H12: Ftse small cap returns are positively related to premium

2.2.3 Peer NAV discount

Many studies aim to explain how investor sentiment proxies affect CEFs NAV discounts. However, Lee et al. (1991) argue that the level of premium/discount itself can be used as a proxy for investor sentiment. This leads us to use the mean discount of our Peer group to describe the variations in LPEs' NAV premium/discount.

H13: Mean peer premium is positively related to LPE premium

2.3 Predictability

The stock market valuations are merely affected by the values existing today but rather by future expectations. Therefore it is not farfetched to assume that today's discount/premium incorporates information on future performance. However, in an efficient market all available future information is incorporated in prices at all times and future performance will depend only on the emergence of new information. By the definition of the premium, there are two components that could incorporate future information, price and NAV. If the market is not efficient either of these components, or them jointly, can contain predictive information regarding future performance in price or NAV. To further investigate this we examine the premiums ability to predict future total NAV returns and future total stock returns.

2.3.1 Predictability of future total NAV return

Following a rational perspective the premium should reflect companies' ability to create excess value after charged managerial fees. Assuming fixed management fees the discount should reflect investors' perception of managers' expected ability. If NAV return is a proxy for managerial ability and investors can predict managers' ability, then today's discount should be able to predict future NAV returns. Berck and Stanton (2007) argue that it can be hard to detect such relations because the assumption of fixed management fees is unreasonable. They mean that strong performing managers are likely to demand higher compensations, which will partially offset the managerial ability and fund performance relationship. Further Deaves and Krinsky (1994) found that managers in poor performing closed-end funds are more likely to get fired, which also would reduce the relationship

Previous research on CEFs has reported indefinite results. Lee et al. (1991) and Pontiff (1995) find an insignificant or negative relation between premium and future NAV return. Chay (1992), Chay and Trzcinka (1999), and Wu and Xia (2001) find a positive relation between premiums and future NAV returns. Most relevant for our study is Dimson and Minio-Paluello (2001) and Bleaney (2002), who review and study UK data and are both unable to find a relation between the premium/discount and future NAV returns. Bleaney and Smith (2003) studied UK and US funds and found weak (not statistically significant results) evidence on the discount being able to predict future NAV returns.

H14: The premium is positively related to future NAV returns

2.3.2 Predictability of future total stock return

In order for premium to have any predictive ability on price, we must assume a deviation from market efficiency. Such assumption could be viable short term but looking at a medium or long term most

markets are regarded as efficient[18]. Many researchers e.g. Power (1992), O'Hanlon (1994) and Pontiff (1995) find that discounts follow a mean reverting pattern. Minio-Paluello (1998) found mean reverting patterns in a sample of 244 UK closed-end funds during 1980-1997 making the study most relevant for ours. This would imply that funds with premiums or low discounts will have worse future returns than funds with high discounts. This is because discount is expected to increase in the future for the former group whereas it is expected to decrease for the latter. We hence expect that any predictability of premium on future total returns will be due mean reversion in the premium.

H15: Premiums are negatively related to future total stock returns

3 Data description

Our sample includes monthly data from Thomson Financial Datastream on closed-end funds (CEFs) traded during the period 1988-2008. The funds are both listed private equity firms (classified as BOs and VCs) and regular investment funds (Peers).

The number of LPEs during a particular year ranges from 6 in the beginning of the period to 124 at the end. The universe of LPEs is about 250 but since we require NAV to be reported in Datastream this reduces the sample substantially. The required data is only available for UK listed entities imposing two potential selection biases. The first, funds reporting NAV in Datastream might not be representative of the whole LPE universe. This is most likely to create a positive reporting bias. The second concerns country bias since our sample only includes UK data. However, considering that UK has the second most developed PE market in the world we think that our findings will be applicable to LPEs worldwide. In total the sample contains 157 LPEs (13 BOs and 144 VCs) and 146 CEFs but because of disparity in listings, delistings and availability of data the sample never contains the full set of funds. The sample gives us a total of 23 743 observations available for statistical testing.

The LPEs were selected in three steps (1.) Classification in the Capital IQ database. (2.) By constituents in the LPE indices PRIVEX[19] and Listed Private Equity Index[20] (3.) Firms registered as Venture Capital Trusts[21] (VCT) in Datastream, not investing in the Alternative Investment Market[22]. The LPEs were then

[18] In the long term abnormal returns revert back to the industry mean returns which equal the WACC according to Koller et al. (2005).

[19] The Private Equity Index developed by Société Générale in collaboration with Dow Jones Indexes

[20] A listed private equity index developed by Red Rocks Capital LLC

[21] VCTs are companies listed on the London Stock Exchange, and are similar to investment trusts. The Venture Capital Trust scheme started on 6 April 1995. It is designed to encourage individuals to invest indirectly in a range of small higher-risk trading

classified into two sub categories, Buyout firms (BOs) and Venture Capital firms (VCs). Firms with VCT registrations or a clearly stated business focus has been classified directly. For the rest of the funds we have relied on information on company websites. The Peers were randomly selected from Datastream out of an entire population of about 2500 investment funds investing in listed equity and reporting NAV. The random selection and large sample of Peers should ensure that we obtain an unbiased sample. Data for all the variables tested were retrieved from Datastream.

In order to get an expert point of view with regards to the explanations for the discount to NAV puzzle and the discounts/premiums predictive ability, we also chose to perform interviews with knowledgeable practitioners from some of the most important Swedish CEFs; Öresund and Industrivärden as well as the Swedish LPE Ratos.

4 Methodology

This section will describe the general method used analyzing the closed-end fund discount characteristics' for listed private equity funds. First the variables are described. Then the categories are explained followed by a description of the generic methodology for hypothesis analysis and the methodology for the joint regression analysis.

companies whose shares and securities are not listed on a recognized stock exchange, by investing through Venture Capital Trusts (VCTs). (http://www.hmrc.gov.uk/guidance/vct.htm#1)

[22] The Alternative Investment Market (AIM) is the London Stock Exchange's list for small cap growth stocks.

4.1 Variables

Table 4.1: Variable descriptions

Variable	Definition	Unit	Expected sign*
Premium	(Price - NAV) / NAV	ratio	+**
Total NAV return	Total NAV return index (NAVRI) -> NAVRI / NAVRI lagged -1***	ratio	+
Total Price return	Total return index (RI) -> RI / RI lagged -1***	ratio	+
Trading volume	Price · Volume	volume in £	+
Bid-ask spread	Ask price - Bid price	spread in £	-
Payout ratio	Dividend per share / Earnings per share	ratio	-
Creadit spread	Moody's 30 year BAA spread over international treasury bills	Basis points	+****
Market cap	Market capitalization	in m£	+
Net retail fund flows	Retail fund sales - retail fund redemptions	in m£	+
Ftse small cap index	Index development or change in index development	index in £ or ratio	+
Peer premium	Mean peer group premium to NAV	ratio	+

* Expected sign determining premium to NAV

** Expected sign predicting future NAV and price returns

*** Variable is lagged for historical returns and reversed lagged for future returns

**** Expected sign for BOs

4.2 Categories

Our *firm categories* are: Buyout firms (*BOs*) and Venture Capital funds (*VCs*), which together are referred to as Listed Private Equity funds (*LPEs*), and our reference category of investment funds investing in listed equity which we refer to as Peers. Our *other categories* are: First, observations based on whether they occur during an exogenously defined boom or bust period. The definition was done using several indicators such as the development of MSCI Europe and MSCI World indices and the evolution in market capitalization for our three different categories. We have also considered Axelsson et al. (2008) classification of stock market boom and bust periods. Second, companies delisting or dying during our sample period. The latter category is defined as an observation associated with a company that delists or dies within a period of three years.

4.3 Hypothesis analysis

The hypothesis analysis is performed to determine all economically founded relationships between our variables and the premium. Each analysis is tailor made for each specific hypothesis. However, we use a general methodology that begins with analyzing descriptive statistics for each hypothesis' relevant variable(s) by category. Then a correlation matrix for each category is presented and analyzed to determine if the variables co-vary without the restriction of causality. This gives us an initial sense of the level of the effect and if it differs between the different groups. We continue by investigating if there exists a causal relationship between the variables and the premium by performing simple regression analyses. In the regression analysis we cluster the observations by month resulting in that all monthly observations are given equal weight disregarding that there are more observations available during the

later part of the time series. The benefit obtained by clustering is a reduced effect of a skewed number of observations over time. The regression estimates will be consistent in the presence of heteroskedasticity and multicollinearity. The drawback with giving each month same weight regardless of the number of observations is that all available information will not be captured since the months with most observations are not given additional weight. Single variable regression models are likely to suffer from specification biases and the results generated should therefore only be viewed as indicative. Also, when needed, we run models with fund fixed effects to analyze and ensure robustness of the regression estimates. Finally, when appropriate, observations are ranked by the explanatory variable and then plotted against the dependent variable in order to confirm relationships found in earlier analyses and to evaluate the degree of linearity in the relationship.

Especially for the hypotheses on historical NAV return and predictability we regress category based portfolios with Newey West standard errors to be able to account for the overlapping effect created using larger than monthly return periods. This method uses ordinary OLS for estimating the regression parameters, but uses a different estimator for the variances; one that is consistent in the presence of auto correlated disturbances. The drawback using this method is that creating weighted (both value weighted and equally weighted) portfolios by months and categories considerably reduces the sample size reducing the power of the regressions.

4.4 Joint regression analysis

Based on the separate analyses of each variable we perform a multivariable OLS regression with clustered observations, the joint regression model. Estimates are also controlled for fixed effects in order to handle potential misspecifications. The results produced in the model are analyzed for the whole time period and for boom and bust classified periods separately. We also run the same regression model on a sample of funds about to delist or die in order to discover any survivorship bias potentially affecting the model estimates.

5 Results and analysis

5.1 Premium dynamics and descriptive statistics

A first look at our sample confirms that LPEs just like other CEFs, on average, trade at a discount to their NAV. Table 5.1 shows that VC has the smallest mean discount of 11%, followed by BO with 12% and Peer with 13%. The differences in premiums between the categories are also statistically significant at a 5% significance level. Looking at the median premium VC still has the smallest discount of 11% followed by 12% for Peer and BO with 14%. A test of equal medians also shows that they are different between the three categories.

Table 5.1: Summary statistics premium (discount)

limit	category	obs	mean	median	std. dev.	min	max
All	**BO**	2 334	-0.12	-0.14	0.17	-0.54	0.91
	VC	8 900	-0.11	-0.11	0.16	-1.00	0.98
	Peer	12 509	-0.13	-0.12	0.14	-0.99	0.98
Premium => 0	**BO**	471	0.13	0.09	0.14	0.00	0.91
	VC	2 116	0.07	0.05	0.10	0.00	0.98
	Peer	1 641	0.07	0.04	0.10	0.00	0.98
Premium < 0*	**BO**	1 863	-0.18	-0.17	0.10	-0.54	0.00
	VC	6 784	-0.17	-0.14	0.12	-1.00	0.00
	Peer	10 868	-0.16	-0.14	0.12	-0.99	0.00

*Premium < 0 are discounts

Funds trade at a premium to NAV in 18% (4228 observations) of our observations. In relation to the size of each category LPEs tend to trade more frequently at a premium compared to the regular investment funds.

Yearly descriptive means for the sample in Table 5.2 and Figure 5.1, shows that premiums varies between -26% and 2% for BOs, between -37% and -2% for VCs and between -20% and -6% for Peers. The VC category is likely to undergo some structural change, which could cause biases, as the number of VC funds increases dramatically during the later part of the sample period.

Figure 5.1: Mean premium in % over time

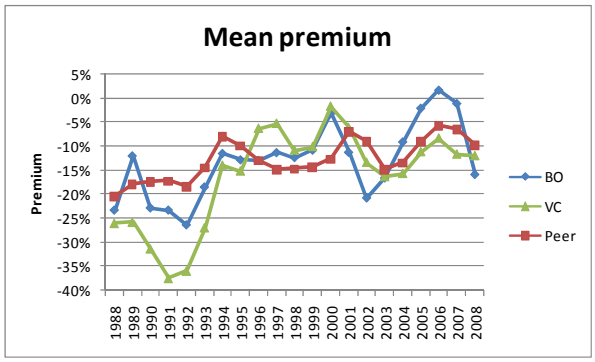


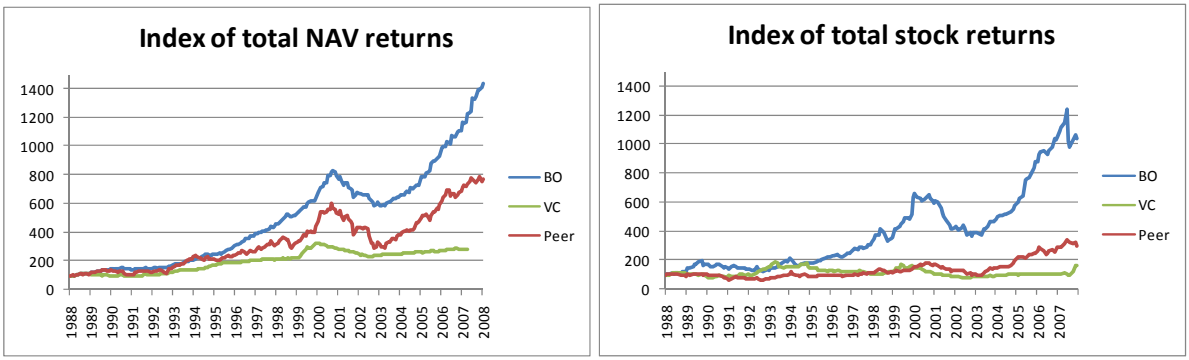
Table 5.2: Mean descriptive statistics of sample per year[α]

	BOs					VCs					Peers				
Year	**premium**	**premium (median)**	**market cap**	**NAV**	**# of funds**	**premium**	**premium (median)**	**market cap**	**NAV**	**# of funds**	**premium**	**premium (median)**	**market cap**	**NAV**	**# of funds**
1988	-0.23	-0.25	64.5	84.1	6	-0.26	-0.26	15.9	21.5	1	-0.20	-0.20	61.9	77.8	44
1989	-0.12	-0.19	93.1	105.8	6	-0.26	-0.26	17.5	23.5	1	-0.18	-0.18	63.8	77.7	36
1990	-0.23	-0.28	88.7	115.0	6	-0.31	-0.30	12.0	17.5	2	-0.17	-0.17	50.2	60.9	37
1991	-0.23	-0.29	78.7	102.7	6	-0.37	-0.37	9.8	15.7	2	-0.17	-0.16	49.0	59.1	41
1992	-0.26	-0.28	71.7	97.4	6	-0.36	-0.36	10.7	16.7	2	-0.18	-0.17	47.3	58.0	46
1993	-0.19	-0.20	86.2	105.9	7	-0.27	-0.28	12.5	17.1	3	-0.14	-0.13	62.2	72.7	52
1994	-0.12	-0.11	242.9	274.7	9	-0.14	-0.18	21.5	25.0	4	-0.08	-0.06	74.5	81.1	61
1995	-0.13	-0.15	346.0	397.2	9	-0.15	-0.18	23.2	27.4	7	-0.10	-0.09	72.0	80.0	63
1996	-0.13	-0.16	405.5	466.1	10	-0.06	-0.02	19.6	20.9	14	-0.13	-0.12	82.0	94.4	70
1997	-0.11	-0.14	450.1	508.0	10	-0.05	-0.04	23.5	24.9	22	-0.15	-0.14	94.1	110.6	69
1998	-0.12	-0.16	518.1	591.5	10	-0.11	-0.11	24.6	27.6	31	-0.15	-0.16	100.4	118.1	67
1999	-0.11	-0.15	628.9	705.5	10	-0.10	-0.12	24.8	27.6	37	-0.15	-0.17	115.1	135.0	65
2000	-0.03	-0.09	928.0	959.3	12	-0.02	-0.05	37.1	37.8	54	-0.13	-0.13	154.0	177.7	65
2001	-0.11	-0.15	682.3	769.4	13	-0.06	-0.06	29.0	31.0	64	-0.08	-0.08	126.1	136.6	66
2002	-0.21	-0.21	440.5	556.3	13	-0.13	-0.12	20.9	24.1	71	-0.11	-0.12	100.7	112.6	63
2003	-0.17	-0.19	400.7	480.8	13	-0.16	-0.17	17.2	20.5	72	-0.15	-0.16	100.0	118.1	60
2004	-0.09	-0.13	453.1	498.8	13	-0.16	-0.15	17.9	21.2	79	-0.13	-0.13	127.5	147.4	56
2005	-0.02	-0.05	562.6	574.9	13	-0.11	-0.11	18.1	20.4	106	-0.09	-0.09	164.1	180.4	60
2006	0.02	-0.03	672.7	661.9	12	-0.08	-0.08	20.0	21.8	118	-0.06	-0.06	202.7	215.4	62
2007	-0.01	-0.06	735.3	743.9	12	-0.12	-0.10	20.5	23.2	123	-0.07	-0.07	232.3	248.7	58
2008	-0.16	-0.16	667.0	793.4	11	-0.12	-0.09	20.3	23.1	113	-0.10	-0.10	241.0	267.4	51

[α] Market cap and NAV are expressed in m£ where NAV is the total net asset value of the fund.

Plotting indices of total NAV and stock returns for the different categories (Figure 5.2) there seem to be a consistent over performance in the BO category and a consistent underperformance for VCs in relation to Peers.

Figure 5.2: Total return indices of NAV and stock return



5.2 Independent analysis of rational arguments

5.2.1 Managerial ability

H1: Historical NAV return is positively related to premium

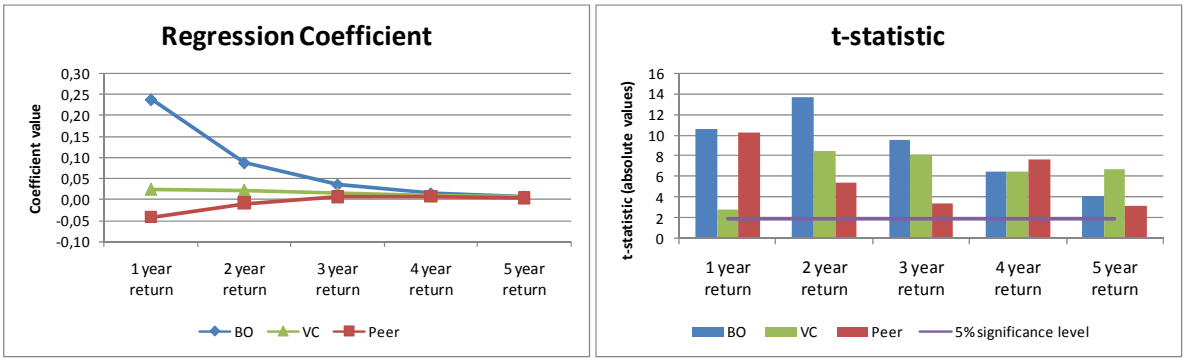
The correlation between historical NAV return and premium in Table 5.3 shows a positive correlation for BOs. VCs also show a positive but weaker correlation between premium and historical NAV return. The Peer category is for shorter return periods, less than 3 year, negatively correlated and weakly positively correlated for longer return periods. We find no problems of overlapping caused by the use of monthly data when investigating longer than monthly historical returns.

Table 5.3: Correlation historical NAV return and premium

Category	1 yr historical NAV return	2 yr historical NAV return	3 yr historical NAV return	4 yr historical NAV return	5 yr historical NAV return	obs
BO	0.231	0.289	0.226	0.157	0.120	1 554
VC	0.051	0.157	0.167	0.133	0.141	3 077
Peer	-0.287	-0.226	0.064	0.147	0.094	6 303

The regression analysis with clustered observations (Figure 5.3) indicates a positive relationship between historical NAV returns and premium for the LPE categories. BOs show a strong relationship for one year historical NAV return with a coefficient of 0.24. This means that, on average, a percentage unit increase in the annual return for BOs will result in 0.24 percentage units increased one year premium. For VCs the relationship is economically insignificant and for Peers the results are ambiguous. All results are statistically significant on a 5% significance level.

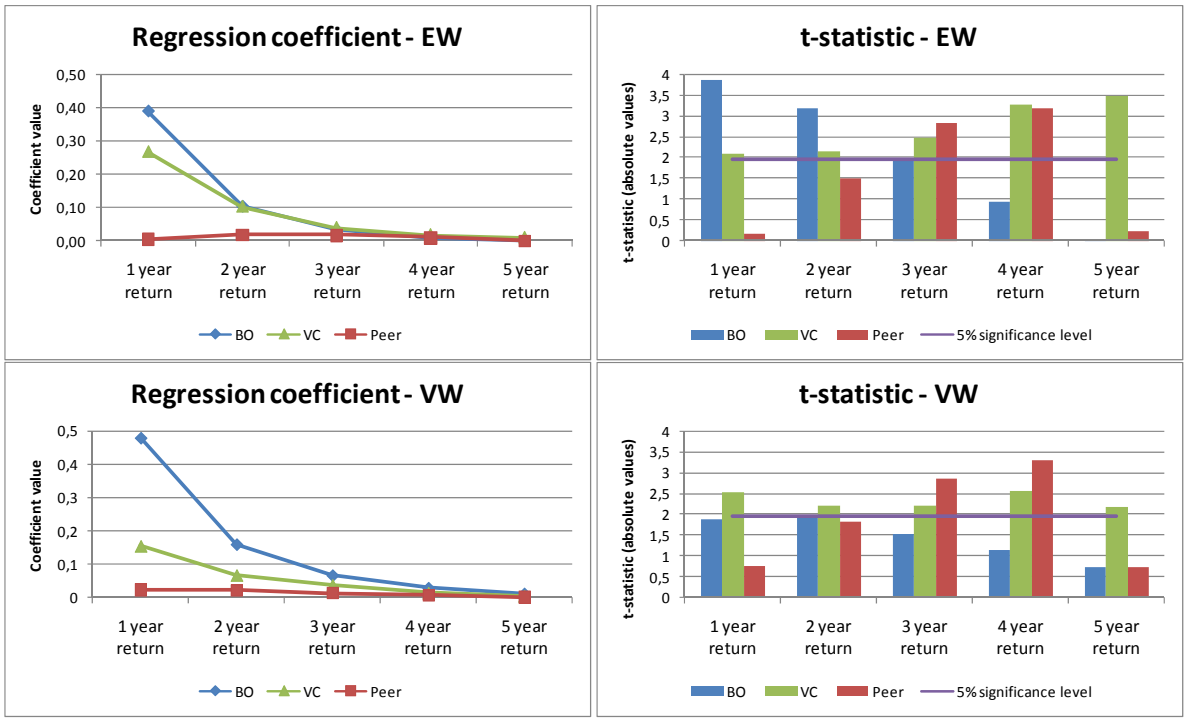
Figure 5.3: Regressions with observations clustered by month[α]



[α] The *Regression coefficient* graph display estimates of separate regressions for the different categories and time periods. Regression coefficients expressed in annualized return and the corresponding t-statistics are presented in absolute terms for easier comparison.

The regression analysis with Newey West standard errors (Figure 5.4) and equally weighted portfolios confirms a positive relationship between historical NAV returns and premium for LPEs. BOs produce significant coefficients for return periods up to 3 years. For VCs the significance is reduced but still significant for all return periods. The peer category shows a small economical significance and a statistical significance only for return periods of 3 and 4 years. Reproducing the analysis with value weighted portfolios produce a more pronounced relationship for BOs, however not statistically significant, whereas the relationship for VC turns less pronounced with only a slight change in significance.

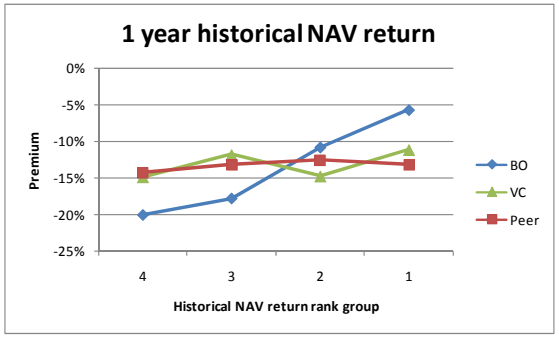
Figure 5.4: Regressions with Newey-west standard errors, with equally and value weighted portfolios [α]

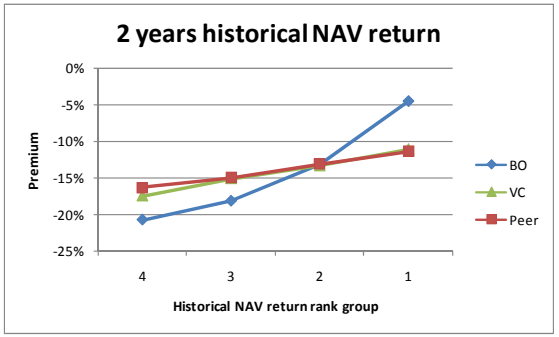


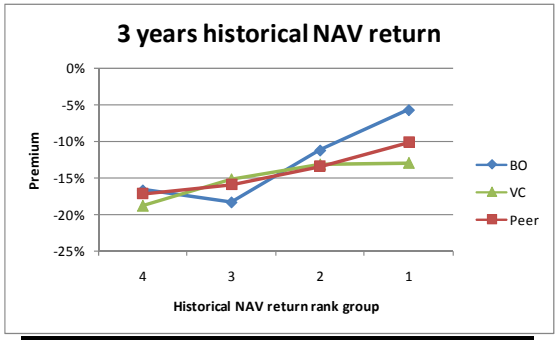
[α] The *Regression coefficient* graph display estimates of separate regressions for the different categories and time periods. Regression coefficients expressed in annualized return and the corresponding t-statistics are presented in absolute terms for easier comparison.

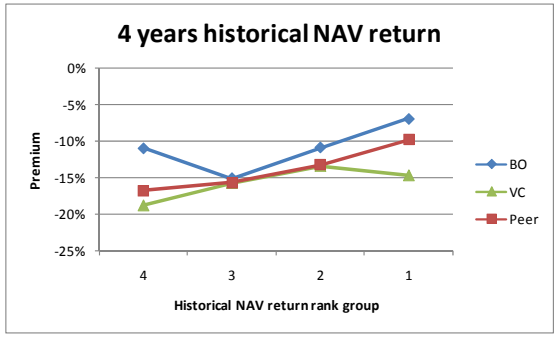
An overall examination of the rank graphs in Figure 5.5 with mean premium for each category ranked by historical NAV return reveals signs of a positive relationship between historical NAV returns and premium. The 2 year NAV return period gives most support for the main hypothesis with no ambiguity in the relationship. In the figure we also report number of observations within each rank group. The scatter plots (see Appendix Figure 10.1) confirm the findings from the ranked plots for BOs and VCs. However, the plots suggest that there is rather a negative relationship between the premium and historical NAV returns for the Peer category. To ensure the robustness of our rank analysis we test for difference in premium in our rank groups which renders a majority of significant results in favor of our hypothesis.

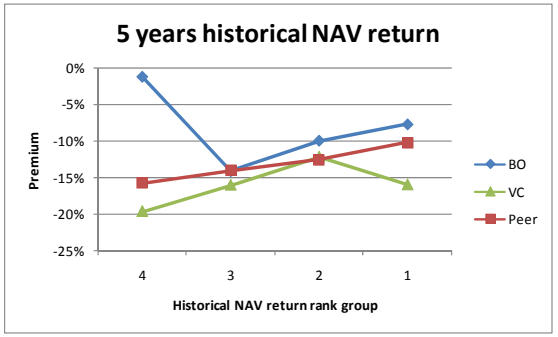
Figure 5.5: Premium by historical NAV return ranked groups and number of observations per rank group and category[α]











NAV return	Rank	BO	VC	Peer
1 year	1	753	745	3588
	2	727	1602	2757
	3	427	2880	1779
	4	271	2089	2725
2 years	1	804	536	3011
	2	590	1278	2483
	3	406	2040	1905
	4	222	2007	2121
3 years	1	779	399	2566
	2	525	912	2306
	3	368	1620	1755
	4	194	1835	1714
4 years	1	734	295	2191
	2	437	715	2068
	3	394	1218	1608
	4	145	1677	1398
5 years	1	664	209	1861
	2	448	473	1813
	3	365	934	1435
	4	77	1461	1195

[α] Categories are grouped after rank by historical NAV return for the entire sample. Quartile four contains the worst historical NAV return funds and quartile one contains the best historical NAV return funds.

To conclude our analysis we find support for the hypothesis that historical NAV return is positively related to the premium for LPEs. The relationship is stronger for the short NAV return periods and especially clear for the 2 year period. For Peers we find no evidence of the existence of such relationship.

5.2.2 Performance persistency

H2: NAV returns are persistent over time for LPEs

To analyze performance persistency we divide our sample of firms by category into quartiles based on one year historical NAV performance. The years 1998 and 2003, which are expected to represent two average years, are chosen. The quartile distribution for the subsequent year is then registered. To further identify any performance persistency pattern the distribution of funds from the top two quartiles are registered for an additional subsequent year. Table 5.4 show that the performance persistency results are ambiguous and there is no larger performance persistency in the top quartile in contrary to what was expected.

Table 5.4: Performance persistency

BOs

Quartile 1998	Quartile distribution 1999				
(# of funds)	1	2	3	4	delist
1 (3)	33%	33%	33%	0%	0%
2 (2)	0%	0%	0%	100%	0%
3 (3)	33%	33%	33%	0%	0%
4 (2)	50%	0%	50%	0%	0%

Quartile 1999	Quartile distribution 2000				
(# of funds)	1	2	3	4	delist
1 (1)	0%	100%	0%	0%	0%
2 (1)	0%	100%	0%	0%	0%

BOs

Quartile 2003	Quartile distribution 2004				
(# of funds)	1	2	3	4	delist
1 (3)	0%	0%	50%	50%	0%
2 (1)	33%	67%	0%	0%	0%
3 (3)	67%	0%	33%	0%	0%
4 (3)	33%	33%	0%	33%	0%

Quartile 2004	Quartile distribution 2005				
(# of funds)	1	2	3	4	delist
1 (1)	0%	100%	0%	0%	0%
2 (2)	0%	100%	0%	0%	0%

VCs

Quartile 1998	Quartile distribution 1999				
(# of funds)	1	2	3	4	delist
1 (4)	25%	0%	25%	50%	0%
2 (3)	67%	0%	0%	33%	0%
3 (4)	50%	25%	25%	0%	0%
4 (3)	33%	33%	33%	0%	0%

Quartile 1999	Quartile distribution 2000				
(# of funds)	1	2	3	4	delist
1 (3)	67%	33%	0%	0%	0%
2 (0)	0%	0%	0%	0%	0%

VCs

Quartile 2003	Quartile distribution 2004				
(# of funds)	1	2	3	4	delist
1 (16)	31%	38%	31%	0%	0%
2 (16)	25%	19%	38%	19%	0%
3 (16)	31%	19%	13%	38%	0%
4 (15)	20%	13%	13%	53%	0%

Quartile 2004	Quartile distribution 2005				
(# of funds)	1	2	3	4	delist
1 (9)	22%	33%	22%	22%	0%
2 (9)	22%	11%	44%	0%	22%

Funds quartile distribution in 1998 or 2003 and their quartile distribution in the subsequent period

Funds quartile distribution in 1999 or 2004 and their quartile distribution in the subsequent period, conditional on having been a top two quartile performer the preceding period, 1998-1999 or 2003-2004

One possible explanation for the results could be that if performance persistency only exists in the top quartile of the PE industry as a whole then the listed PE firms in our sample do not belong to the top

quartile of the PE industry. This explanation was confirmed during the interview with Arne Karlsson[23] who mentioned that compensation levels are generally higher for unlisted private equity firms and if the best managers only values monetary compensation they will probably work for such firms.

5.2.3 Liquidity

H3: Trading volume is positively related to premium

H4: Bid-ask spread is negatively related to premium

The descriptive statistics in Table 5.5 shows that both mean and median trading volume is largest for BO followed by Peer and VC. This is natural considering the size relationship of the three categories. By analogy, the mean bid–ask spread indicates that BOs are least illiquid followed by Peers and VCs.

Table 5.5: Descriptive statistics[α]

variable	category	obs	mean	median	std. dev.	min	max
Trading volume	**BO**	1 495	5 117 533	438 463	15 700 000	0	160 000 000
	VC	4 564	45 402	3 757	239 951	0	10 800 000
	Peer	7 534	555 338	177 806	1 186 414	0	28 900 000
Bid-ask spread	**BO**	2 129	0.026	0.020	0.023	0.001	0.205
	VC	8 383	0.157	0.111	0.142	0.003	1.571
	Peer	11 119	0.040	0.022	0.072	0.002	1.293

[α] Trading volume and Bid-ask spread in £.

The correlation matrix displayed in Table 5.6 shows that the correlation between trading volume and premium is highly positive for BOs, slightly negative for VCs and slightly positive for Peers. The relationship is hence as expected for BOs and Peers but opposite than expected for VCs. The correlations between bid-ask spread and premium are of the expected sign for all categories.

Table 5.6: Correlation liquidity, bid-ask spread and premium

Category	Trading volume	Bid-ask spread	obs
BO	0.505	-0.369	1 494
VC	-0.029	-0.004	4 557
Peer	0.022	-0.063	7 505

[23] CEO of Ratos AB, Swedish LPE

The regression analysis in Table 5.7 shows the same pattern as the correlation matrix. BO and Peer show positive relations between trading volume and premium whereas the relation for VC is negative. Controlling for fixed effects, not reported, the VCs estimate change sign to the expected positive however it is still not statistically significant. The relationship between bid-ask spread and premium is negative, as expected, for all three categories, however, the estimates are only statistically significant for the BO category and the VC estimate is not robust when controlling for fixed effects.

Table 5.7: Liquidity regression results[α]

Variable	Expected sign	BOs	VCs	Peers
trading volume	+	0.00545*	-0.0176	0.00208*
bid-ask spread	-	-2.321794*	-0.0149572	-0.1607901

* Coefficients significant on a 5% signifiance level
** Coefficients significant on a 10% signifiance level

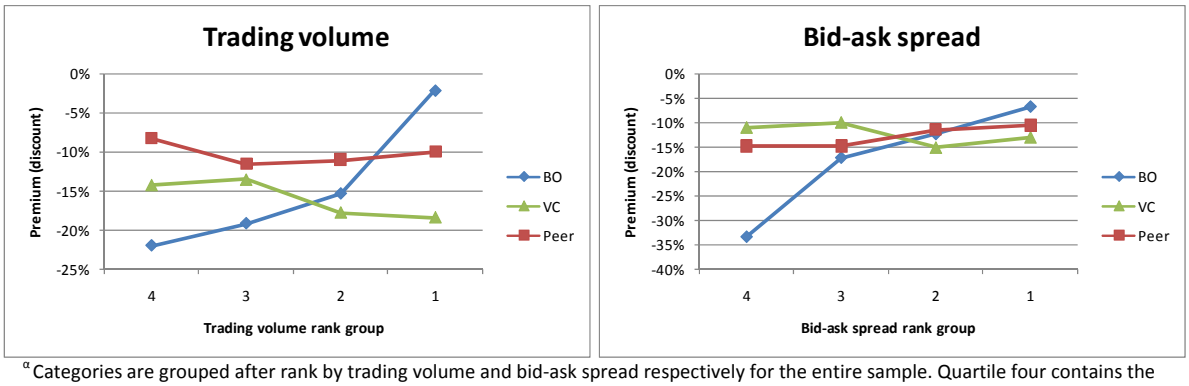
[α] The dependent variable is premium to NAV. Trading volume coefficient in m£.

To conclude we find support that our liquidity proxy, trading volume, is positively related to premium in our sample. Further our illiquidity proxy, bid-ask spread, is found to be negatively related to premium as expected. However, the relationship is nonexistent for VCs, which leads us to believe that there could exist a convexity in the relationship with lower levels of liquidity not affecting the premium while higher levels do.

H5: LPEs trade at a higher premium than Peers with the same liquidity

Ranking funds by trading volume and bid-ask spread and plotting them against premium by category (Figure 5.6) displays indications of a positive pattern at least for BOs. Table 5.8 show that the rank groups are somewhat skewed with regards to number of observations in each group by category. The results from testing whether LPEs have a statistically higher premium than Peers within each rank group (table 5.9) indicates the contrary. Peers have a statistically higher premium than both BOs (one liquidity rank shows a smaller discount for BO than Peer) and VCs comparing trading volume (liquidity) ranks. The results from bid-ask spread (illiquidity) ranks, are more ambiguous and even though we can find some evidence of lower discounts for VCs compared to Peers there is no clear pattern.

Figure 5.6: Premium by liquidity and bid-ask spread ranked groups[α]



[α] Categories are grouped after rank by trading volume and bid-ask spread respectively for the entire sample. Quartile four contains the least liquid funds and quartile one contains the most liquid funds.

Table 5.8: Observations per rank group and category

	Rank	BO	VC	Peer
Trading volume	**1**	769	125	2 531
	2	407	375	2 630
	3	272	1 485	1 648
	4	47	2 579	778
Bid-ask spread	**1**	900	145	4 360
	2	828	1 075	3 523
	3	366	2 455	2 606
	4	35	4 708	688

Table 5.9: *p*-values of premium t-tests within rank groups

	Rank	BO < Peer	VC < Peer
Trading volume	**1**	0	1
	2	1	1
	3	1	1
	4	1	1
Bid-ask spread	**1**	1	0
	2	0.997	0
	3	0.9842	1
	4	0	0.9998

To conclude we do not find any evidence supporting the idea that LPEs trade at a smaller discount than Peers with the same trading liquidity or illiquidity.

5.2.4 Payout-ratios

H6: Payout-ratio$_{t-3}$ is negatively related to premium

The descriptive statistics of the payout-ratio per category in Table 5.10 shows that the mean payout-ratio is between 80% and 100%. However, all categories contain significantly larger max values which can indicate that extra ordinary dividends play a special role. The correlation between payout-ratio and premium in Table 5.11 is negative for LPEs (strongest for BO) and positive for Peers.

Table 5.10: Payout-ratio descriptive statistics

Category	obs	mean	median	std. dev.	min	max
BO	2 056	0.82	0.81	0.59	0.00	6.50
VC	5 101	0.99	0.88	1.55	0.00	35.42
Peer	8 649	0.87	0.91	0.63	0.00	12.95

Table 5.11: Correlation matrix

Category	Correlation	obs
BO	-0.1407	2 056
VC	-0.0324	5 101
Peer	0.0200	8 649

Since the descriptive statistics shows the presences of very large payout-ratios we decided to separate the sample into ordinary payout-ratios (less than 100%) and extra ordinary payout-ratios (larger than 100%). An ocular inspection (Appendix Figure 10.2) reveals no apparent relationship between discount and ordinary payout-ratios and a weak negative relationship for extra ordinary payout-ratios. Regressing payout-ratios against premium (Table 5.12) shows that the relationship is negative for BOs and VCs and positive for Peers. The coefficients are larger for extra ordinary payout-ratios than ordinary. Controlling for fixed effects neither the VC nor the Peer estimates are robust as their coefficient signs change.

Table 5.12: Payout-ratio regression results[α]

Variable	Expected sign	BOs	VCs	Peers
ordinary payout-ratio	-	-0.0162617*	-0.0021084**	0.0027373**
extra ordinary payout-ratio	-	-0.061221*	-0.0195578*	0.0140384*

* Coefficients significant on a 5% signifiance level

** Coefficients significant on a 10% signifiance level

[α] The dependent variable is premium to NAV. Ordinary payout-ratios are payout-ratios smaller than one. Extra ordinary payout-ratios are payout-ratios larger than one.

To conclude we find indications of H6 being true for BOs and VCs (not robust for fixed effects) but not for Peers. The indications are stronger for extra ordinary than ordinary dividends.

5.2.5 Borrowing conditions

H7: Credit spread is negatively related to premium for BO funds

H8: Credit spread is stronger related to premium for BO funds than for VC and Peer funds

As proxy for credit spread we use Moody's 30 year BAA spread over international treasury bills, which according to Angbazo et al. (1998) represents the typical borrowing conditions faced for senior debt in highly levered transactions. The 30 year length is chosen since it has data available for our entire sample period. An ocular inspection (Appendix Figure 10.3) shows that credit spread is highly cyclical. This property will be addressed in the joint regression with boom and bust periods in section 6. Descriptive statistics are displayed in Table 5.13 were credit spread is expressed in basis points.

Table 5.13: Credit spread descriptive statistics[α]

obs	mean	median	std. dev.	min	max
241	169.34	156	42.40	121	281

[α] Credit spread is expressed in basis points.

Studying the correlation between credit spread and premium in Table 5.14 for our three categories we can see that BO show a large negative correlation while correlations for VCs and Peers are small or nonexistent.

Table 5.14: Credit spread and premium correlation

category	correlation	obs
BO	-0.249	1 192
VC	0.092	7 539
Peer	0.000	5 411

The regression analysis in Table 5.15 yields statistically significant estimates of the expected sign for BOs. The coefficients for VCs and Peers are positive but only significant for the VC category. The BO coefficient is different to the VC and Peer coefficients at 5% significance level. BO and VC estimates are robust when controlling for fixed effects while the Peer category significantly change signs.

Table 5.15: Credit spread regression results[α]

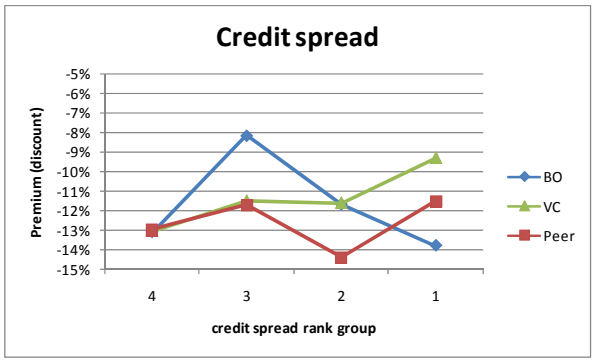
Variable	Expected sign	BOs	VCs	Peers
credit spread	-	-0.0002502*	0.0002639*	0.0000603

* Coefficients significant on a 5% signifiance level

[α] The dependent variable is premium to NAV.

Ranking the categories on credit spread and plotting it against premium reveals somewhat consistent positive linear patterns for VCs and Peers. The BO category show as strong positive relationship initially for lower levels of credit spread then returns to the expected negative relationship as credit spread rises. A potential explanation for the increase in premium between rank 4 and 3 for BO could be that the low credit spreads come in an early phase of a boom period. The borrowing conditions are then good and BO funds can find lots of positive NPV project under the current interest rate.

Figure 5.7: Premium by credit spread ranked groups



To conclude, we find support for both H7 of BO funds showing a negative relationship between credit spread and premium and that the relationship is stronger for BO than VC and Peer funds in line with H8.

5.2.6 Size

H9: Market cap is positively related to premium for LPEs

Descriptive statistics in Table 5.16 show that mean market cap is £ 455m for BO, £ 22m for VC and £ 108m for Peer. The corresponding figures for median market cap are £ 91m, £ 16m and £ 42m, indicating a great dispersion in the sample. In Table 5.17 we see that all three categories show positive correlation between market cap and premium. The correlation is strong for BO and quite weak for VCs and Peers.

Table 5.16: Descriptive statistics[α]

	obs	mean	median	std. dev.	max	min
BO	2 334	455	91	1 127	10 514	8
VC	8 900	22	16	25	300	0
Peer	12 655	108	42	185	2 279	0

[α] Market cap is expressed in m£.

Table 5.17: Correlation premium and market cap

category	correlation	obs
BO	0.551	2 334
VC	0.024	8 900
Peer	0.120	12 509

The regression analysis (Table 5.18) indicates a positive relationship between market cap and premium for all categories. All estimates are also robust when controlling for fixed effects.

Table 5.18: Market cap regression results[α]

Variable	Expected sign	BOs	VCs	Peers
market cap	+	0.0000807*	0.0001549*	0.0000887*

* Coefficients significant on a 5% signifiance level

[α] The dependent variable is premium to NAV.

Ranking the observations in four different quartiles based on market cap and plotting against premium for each category (Figure 5.8) confirms the earlier found patterns for BO and Peer that increasing market

cap leads to smaller discount. For VC however, the results are more dubious even tough quartile 1 has a slightly lower discount than quartile 4. Our Peer category shows a discount in between BO and VC for all four market cap ranked categories.

A potential problem with this comparison would be that the three categories have different sizes on average. However, Table 5.19 indicates that all rank groups include a sufficient number of observations in order to draw any conclusions.

Figure 5.8: Premium by market cap ranked groups[α]

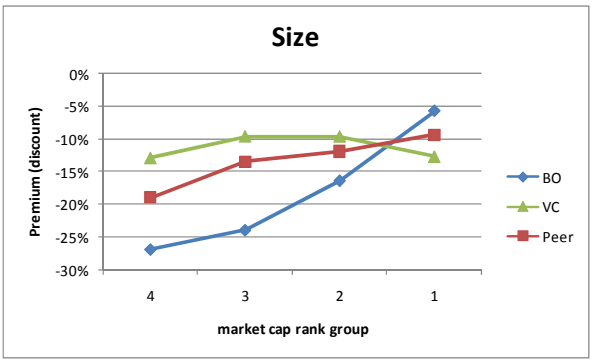


Table 5.19: Observations per rank group and category

Number of observations			
Rank	***BO***	***Peer***	***VC***
4	82	2 026	3 880
3	341	2 646	3 001
2	594	3 634	1 765
1	1 317	4 349	254

[α] Categories are grouped after rank by market cap for the entire sample. Rank group four contains the funds with the smallest market cap and rank group one contains the funds with the largest market cap

An ocular inspection of scatter plots with market cap against premium indicates a presence of severe heteroskedasticity for BOs (Appendix

Figure 10.4). Even if heteroskedasticity is accounted for in the regressions by the use of clustering observations and robust standard errors we continue to investigate this BO pattern. Dividing the sample into market cap smaller and larger than £ 2000m removes the heteroskedastic pattern for the larger group. Regressing the two groups produces statistically significant estimates of 0.0001831 for the low market cap group and 0.000101 for the large market cap group. Interestingly the latter regression produces a very good linear fit with an R-square of 84%.

Summarizing the analysis we find clear and robust indications of a positive relationship between market cap and premium in line with H9.

H10: Market cap is positively related to premium in a concave pattern for LPEs

Regressing the BO and VC rank groups by market cap, controlling for fixed effects, yields a clearly concave pattern with regression estimates decreasing in magnitude as the size in the rank groups increase.

Table 5.20: Market cap rank groups, fixed effects regression results

Rank group	Expected sign	BOs	VCs
1	Weakly positive	0.0001029*	0.001344*
2	|	0.0009537*	0.0071887*
3	|	0.0022179*	0.0175885*
4	Highly positive	0.0050484*	0.055497*

* Coefficients significant on a 5% signifiance level

[α] Categories are grouped after rank by market cap for the entire sample. Rank group four contains the funds with the smallest market cap and rank group one contains the funds with the largest market cap.

The ranked regression analysis support the hypothesis that *market cap is positively related to premium in a concave pattern for LPEs,* suggesting that larger funds have smaller discounts and that the marginal size effect on discount is decreasing with size.

5.3 Independent analysis of irrational arguments

5.3.1 Net Retail Fund Flows

H11: Net retail fund flows are positively related to NAV premium

Retail fund flows data is available from 1992 and onward, thus all analysis will be confined by this limitation. Descriptive statistics is reported in Table 5.21.

Table 5.21: Net retail fund flows descriptive statistics[α]

obs	mean	median	std. dev.	min	max
193	682.81	561	541.89	-551	3 033

[α] Net retail fund flows are expressed in m£.

The correlation matrix in Table 5.22 indicates a positive correlation between net retail fund flows and premium for BOs and Peers, however weaker for the Peers. VCs do not seem to co-vary significantly.

Table 5.22: Correlation net retail fund flows and premium

Category	Correlation	Observations
BO	0.249	2 046
VC	0.042	8 842
Peer	0.132	10 925

Regressing fund flows against premium yields positive coefficients for retail fund flows for all categories (Table 5.23). The relationships appear to be more significant both economically and statistically for BOs and VCs compared to Peers. VCs and BOs are robust when controlling for fixed effects while Peers are not and their estimate change sign. Scatter and rank plots of net retail fund flows and premium (Appendix Figure 10.5 and

Figure 10.6) supports the coefficient signs generated by the regression analysis.

Table 5.23: Net retail fund flows regression results[α]

Variable	Expected sign	BOs	VCs	Peers
retail fund flows	+	0.0000725*	0.000037*	0.0000101**

* Coefficients significant on a 5% signifiance level

** Coefficients significant on a 10% signifiance level

[α] The dependent variable is premium to NAV.

To conclude, the results support the hypothesis that net retail fund flows are positively related to premium, meaning that higher fund flows result in lower discounts.

5.3.2 Ftse small cap – investor sentiment

H12: Ftse small cap returns are positively related to premium

Descriptive statistics are displayed in Table 5.24.

Table 5.24: Ftse small cap descriptive statistics[α]

variable	obs	mean	median	std. dev.	min	max
ftse small cap	241	2 032.78	1 829	975.02	760	4 564
ftse small cap return	240	0.008	0.013	0.050	-0.192	0.175

[α] Index in £ and return as ratio.

In Table 5.25 we can see that the correlation between ftse small cap and premium is positive for all categories and especially strong for BOs. Correlation should be a good measure for studying the effect since we anticipate no lag between the change in investor sentiment, captured by the change in ftse small cap index and the effect on the level of the discount.

Table 5.25: Correlation Ftse small cap and premium

	Correlation	# of observations
BO	0.4112	2 334
VC	0.0989	8 900
Peer	0.2021	12 655

Regressing ftse small cap returns against monthly change in discount (Table 5.26) produces positive coefficients for all three categories. The regression indicates for BO, that a one percent return in ftse small cap on average results in a 0.37 percentage points increase in premium. For VC the corresponding figure is 0.043 and for Peer the size is not meaningful. The reason for looking at the change in discount is that we wish to examine the instant effect on changes in the index instead of the lagged effect which would be the case if studying merely the level of discount at the end of the monthly return period used for calculating the index return. Controlling for fixed effects confirms robustness of the estimates.

Table 5.26: Ftse small cap regression results[α]

Variable	Expected sign	BOs	VCs	Peers
ftse small cap return	+	0.3681165*	0.0506082**	0.1340683

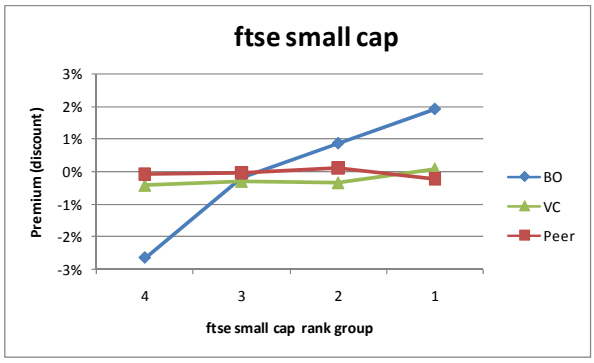
* Coefficients significant on a 5% signifiance level

** Coefficients significant on a 10% signifiance level

[α] The dependent variable is change in premium to NAV.

Figure 5.9 plots ftse small cap ranked returns against monthly change in premium. We can see that the ftse small cap returns looks almost linearly positively related to the change in premium for BOs. It is hard to make any conclusions for VC and Peer funds.

Figure 5.9: Monthly premium change by ftse small cap return ranked groups[α]



[α] Categories are grouped after rank by ftse small cap for the entire sample. Quartile four contains the funds with the smallest changes in ftse small cap and quartile one contains the funds with the largest changes in ftse small cap.

Our analysis hence indicates that H12 seems to be confirmed for BOs but not for VCs and Peers funds but not funds. For BO our data suggest that ftse small cap returns are positively related to premium. Thus this analysis is in line with the previous investor sentiment analysis on net retail fund flows.

5.3.3 Peer NAV premium/discount

H13: Peer mean premium is positively related to LPE premium

Already in our initial look at the dynamics of the premium a co-varying pattern was identified between the different categories. Figure 5.1 displaying mean premium per category over time clearly shows this co-variation. Table 5.27 shows high correlations between the premiums of our categories.

Table 5.27: Correlations of mean premiums between categories

	BO	VC	Peer
BO	1		
VC	0.674	1	
Peer	0.610	0.586	1

Regression analysis results (Table 5.28) align with previous indications of strong significant estimates for BOs and VCs. The BO coefficient is larger than the VC coefficient in line with what we found regressing ftse small cap against premium. Controlling for fixed effects reveals that the VC estimate is not robust as it changes sign. However, the change is not statistically significant.

Table 5.28: Peer premium regression results[α]

Variable	Expected sign	BOs	VCs
peer premium	+	1.231704*	0.415554*

* Coefficients significant on a 5% signifiance level

[α] The dependent variable is premium to NAV.

To conclude correlation and simple regression analysis gives initial support for H13 indicating that Peer premium is positively related LPE premium.

6 Predictive ability

6.1 Predictability of future NAV return

H14: The premium is positively related with future NAV returns

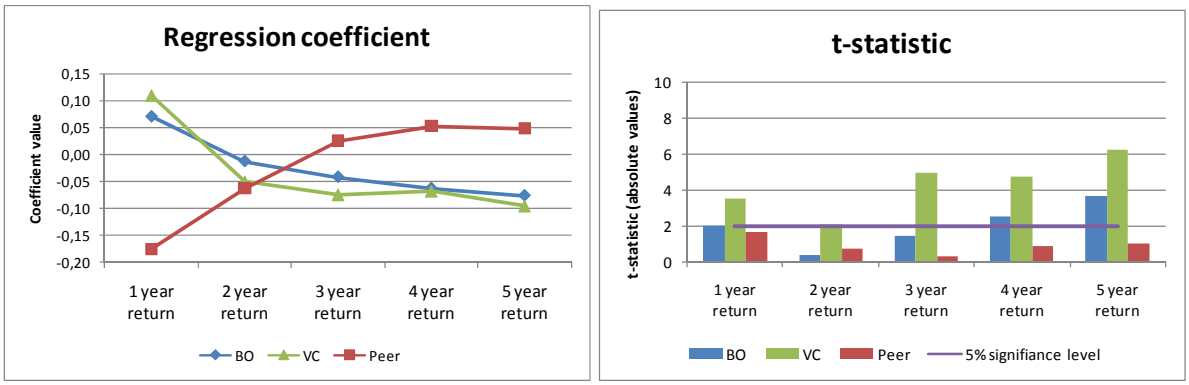
Table 6.1 shows that the correlation between future NAV return and the premium is weakly negative for the one year return period for BOs and VCs. The correlation is still weak, but somewhat more negative for return periods of two to five years. For Peers the correlation starts off weakly negative for the shortest return periods and then turns weakly positive for longer return periods.

Table 6.1: Correlation premium and future NAV return

Category	1 yr future NAV return	2 yr future NAV return	3 yr future NAV return	4 yr future NAV return	5 yr future NAV return	obs
BO	-0.02	-0.09	-0.09	-0.10	-0.10	1 594
VC	-0.01	-0.13	-0.16	-0.15	-0.18	3 415
Peer	-0.05	-0.03	0.01	0.03	0.03	9 196

The regression analysis summarized in Figure 6.1 shows a positive relationship between premium and one year future NAV returns for BOs and VCs. The coefficient for BOs is 0.07 and is significant on a 5% level meaning that, on average, a percentage unit increase in the premium will result in 7 percentage units increased one year future NAV return. The coefficient for VCs is 0.11 and is significant on a 5% level meaning that, on average, a percentage unit increase in the premium will result in 11 percentage units increased one year future NAV return. The relationship turns negative for return periods longer than one and the five year return period shows a strongly negative relationship. The Peer category shows a negative relationship for return periods up to two years and a positive relationship for longer return periods, however all relationships a non significant.

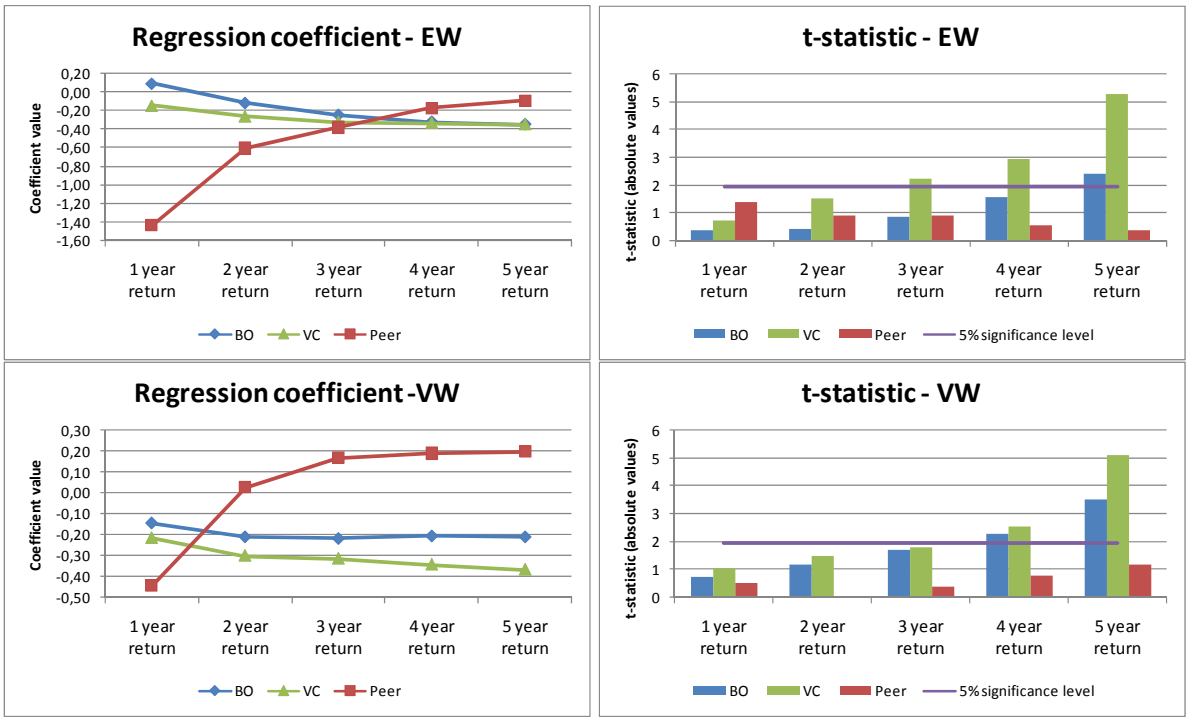
Figure 6.1: Regressions with observations clustered by month[α]



[α] The *Regression coefficient* graph display estimates of separate regressions for the different categories and time periods. Regression coefficients expressed in annualized return and the corresponding t-statistics are presented in absolute terms for easier comparison.

The regression analysis with Newey West standard errors contradicts our findings of a positive relationship for BOs and VCs for the one year return period. All but one coefficient (BO, 1 year, EW) indicates a negative relationship. The relationship between premium and future NAV return for BOs and VCs seems fairly independent of return period lengths, which suggest that there might exists a long term structural discount level. The relationships are less pronounced for BOs than VCs and of different signs for Peers in the value weighted regression. A possible explanation for this behavior is the existence of firms defaulting during the sample period which are given less weight in the value weighted regression. The results are however limited in significance, except for longer return periods. The Peer category shows a negative relationship when regressed against equally weighted category portfolios and a positive when value weights are used. However, none of the weighting methods are statistically significant for any of the five return periods.

Figure 6.2: Regressions with Newey-west standard errors, with equally and value weighted portfolios[α]



[α] The *Regression coefficient* graph display estimates of separate regressions for the different categories and time periods. Regression coefficients expressed in annualized return and the corresponding t-statistics are presented in absolute terms for easier comparison.

Examination of rank graphs (Appendix Figure 10.7) shows no apparent signs of a positive relationship between the premium and future NAV return. The BO category shows no relationship for any time period. The VC category indicates a negative relationship when examining return periods of 2 years or more. The Peer category express a slight negative relationship for return periods 1-2 years which turns into a positive relationship for return periods longer than 2 years consistent with earlier results.

To conclude we do not find any definite evidence to support the hypothesis that the premium is positively related with future NAV returns. There are weak indications of such a relationship for BOs and VCs for one year future NAV returns, the indications are however not robust when analyzed with Newey-West standard errors. The results from the Peer category are ambiguous and not statistically significant.

6.2 Predictability of future total stock return

H15: Premiums are negatively related with future total stock returns

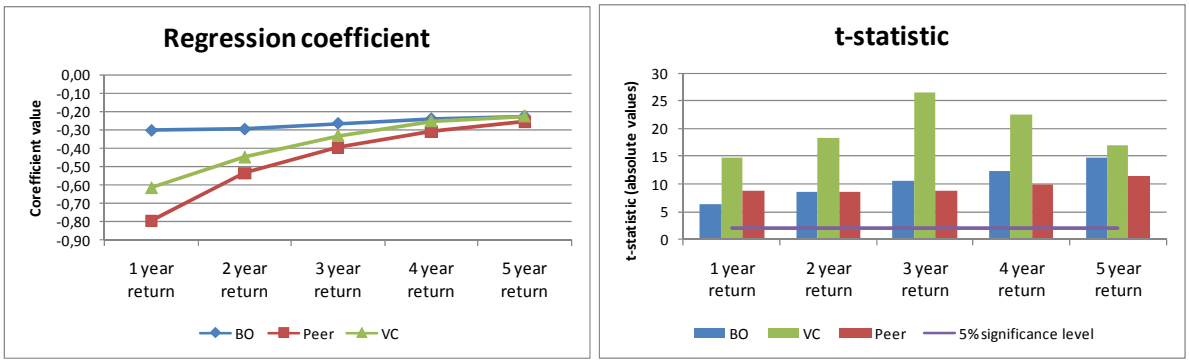
Table 6.2 shows a strong negative correlation between premium and future total return for all three categories.

Table 6.2: Correlation future total stock return and premium

Category	1 yr future Tot return	2 yr future Tot return	3 yr future Tot return	4 yr future Tot return	5 yr future Tot return	obs
BO	-0.23	-0.29	-0.30	-0.29	-0.31	1 594
VC	-0.24	-0.34	-0.45	-0.45	-0.42	3 415
Peer	-0.20	-0.22	-0.21	-0.21	-0.24	9 388

The regression analysis shows a negative relationship between the premium and future total returns for all periods and categories. All estimates are statistically significant at a 5% significance level. The coefficients display a pattern consistent with the theory of mean reversion for all categories. They are larger for short return periods and smaller for longer return periods.

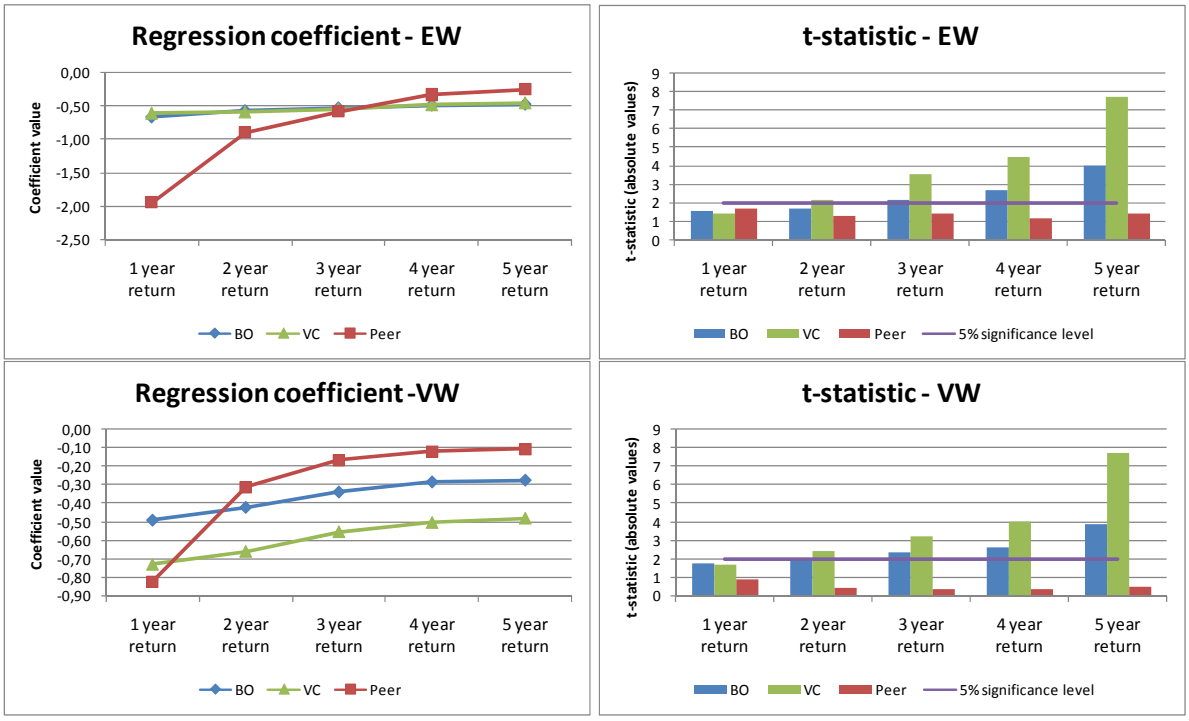
Figure 6.3: Regression results with clustered observations by month[α]



[α] The *Regression coefficient* graph display estimates of separate regressions for the different categories and time periods. Regression coefficients expressed in annualized return and the corresponding t-statistics are presented in absolute terms for easier comparison.

The regression analysis with Newey West standard errors confirms prior results indicating a negative relationship between our categories (Figure 6.4). The BO and VC coefficients are significant for all return periods except one year and the Peer coefficient is not significant for any return period. The regression with equally weighted portfolios displays weaker mean reversion for the BOs and VCs than the value weighted regression stronger mean reversion compared to the ordinary regression.

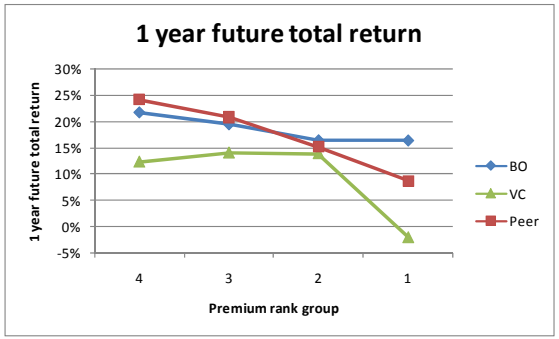
Figure 6.4: Regressions with Newey-west standard errors, with equally and value weighted portfolios[α]

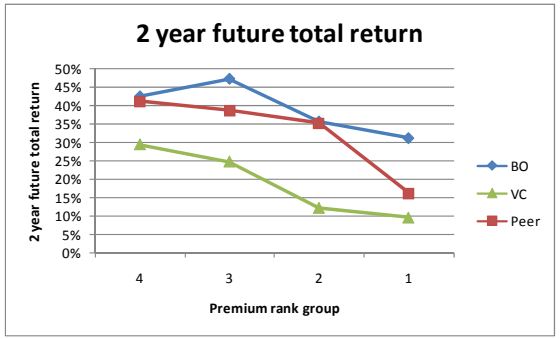


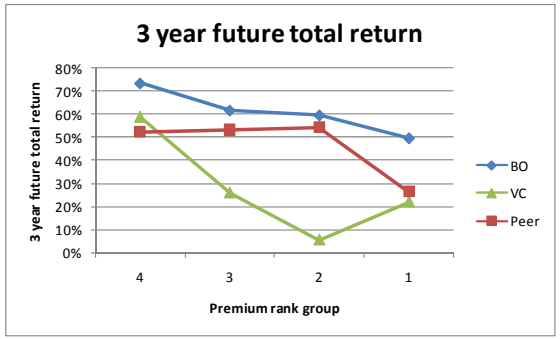
[α] The *Regression coefficient* graph display estimates of separate regressions for the different categories and time periods. Regression coefficients expressed in annualized return and the corresponding t-statistics are presented in absolute terms for easier comparison.

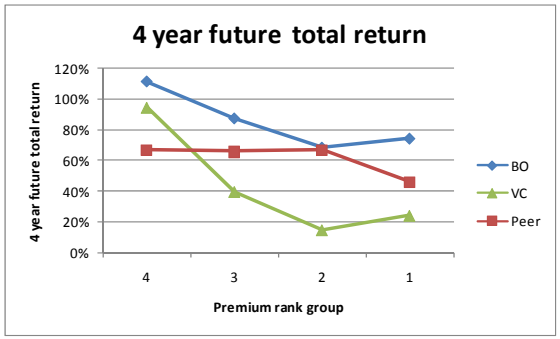
Examination of rank graphs Figure 6.5 supports the hypothesis of a negative relationship between the premium and future total return for all categories. The rank graphs do not always indicate a linear pattern. However, such dynamic does not contradict the theory of mean reversion, even if it weakens the validity of using linear regressions.

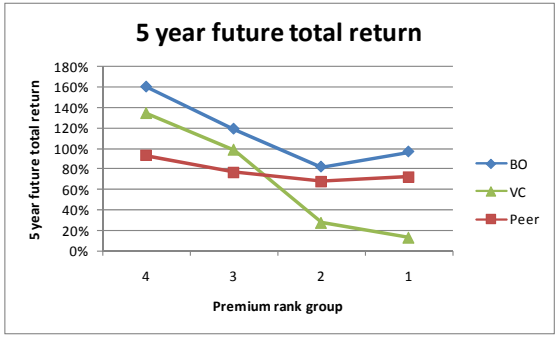
Figure 6.5: Premium by future total return ranked groups and number of observations per rank group and category[α]











Total return	Rank	BO	VC	Peer
1 year	1	42	62	52
	2	64	67	39
	3	43	72	59
	4	80	28	70
2 years	1	30	50	45
	2	64	67	34
	3	43	72	59
	4	80	28	70
3 years	1	18	39	44
	2	64	66	26
	3	43	72	56
	4	80	28	70
4 years	1	16	38	44
	2	55	55	25
	3	42	72	46
	4	80	28	69
5 years	1	16	38	44
	2	55	49	25
	3	36	66	35
	4	74	28	68

To conclude we find evidence in support of H15 looking at correlations, ordinary regression analysis and regression analysis with Newey West standard errors. The rank graph analysis however indicates that the relationship is not linear.

7 Joint regression model

This section will begin with a short recapitulation of the model described in the initial methodology section, followed by regression analysis and hypotheses testing. Then the sample is broken down further for analysis of the effects of boom and bust periods and the potential biases of delisting and dying firms.

7.1 Model

As described in the methodology section, the model is a multivariable OLS regression with clustered observations. The model has been specified by the variables analyzed in the previous section, which each have their own rationale for being a determinant of the premium.

Equation 1: Multivariable model specification

$$\text{Premium}_{ti} = \beta_1(\text{marketcap}_{ti}) + \beta_2(\text{payout-ratio}_{(t-3)i}) + \beta_3(\text{liquidity}_{ti}) + \beta_4(\text{bidask-spread}_{ti}) + \beta_5(\text{ftse smallcap}_{ti}) + \beta_6(\text{retail fund flows}_{ti}) + \beta_7(\text{credit spread}_{ti}) + \beta_8(\text{2 yr historical NAV return}_{ti}) + u_{ti}$$

The main advantage with the joint regression model is that it should suffer less from specification biases than the single regression models. However, also the joint regression model can significantly reject the null hypothesis of being correctly specified.

7.2 Results

Regression results from the joint regression with observations clustered by month are displayed in Table 7.1. In Table 7.2 the results from the joint regression model with fixed effects are presented. We also preformed a regression with observations clustered by fund (Appendix Table 10.1).

Table 7.1: Joint regression results with observations clustered by month

Variable	Expected sign	BOs	VCs	Peers	Pooled (BOs+VCs)
market cap	+	0.0000818*	0.0005054*	0.000062*	0.0000824*
payout-ratio	-	0.0037672	-0.0008566	0.0115103*	-0.0009555
trading volume	+	-0.00000000105*	-0.000000133*	-0.0000000103*	-0.000000000669*
bidask-spread	-	-0.9566699*	0.0269168	-0.1224455	0.0628855*
ftse smallcap	+	0.0000315*	0.0000083	0.0000161*	0.0000193*
net retail fund flows	+	0.0000197*	0.00000676**	-0.0000101*	0.0000119*
credit spread	-	-0.0324189*	0.008812*	0.0022562	-0.0065143*
2yr historical NAV return	+	0.1312167*	0.0441644*	-0.0006861	0.0841634*
peer premium	+	0.1346814	0.2174438*	n/a	0.1797257*

* Coefficients significant on a 5% signifiance level
** Coefficients significant on a 10% signifiance level

Table 7.2: Joint regression results with fixed effects model

Variable	Expected sign	BOs	VCs	Peers	Pooled (BOs+VCs)
market cap	+	0.0000943*	0.0019203*	0.0000839*	0.0001028*
payout-ratio	-	-0.0031597	0.0006053	-0.0018806	-0.0004061
trading volume	+	-0.000000000508*	-0.0000000403*	-0.00000000415*	-0.000000000206
bidask-spread	-	-1.169166*	-0.1123775*	-0.1883339	-0.0477078
ftse smallcap	+	0.0000262*	0.00000373	0.0000000716	0.0000219*
net retail fund flows	+	0.0000232*	0.00000577	-0.00000995*	0.0000139*
credit spread	-	-0.0201898*	-0.0027739	0.0070587*	-0.0050127
2yr historical NAV return	+	0.1128273*	-0.0544468*	0.0141133*	0.0470503*
peer premium	+	0.078404	0.3333696*	n/a	0.1285153

* Coefficients significant on a 5% signifiance level
** Coefficients significant on a 10% signifiance level

Testing hypothesis H1, that historical *NAV return is positively related to premium*, we find coefficients of the expected sign significant at a 5% significance level for BOs and VCs. However, the VC estimate is not robust when controlling for fixed effects as the estimate change sign. The Peer category at first produces an insignificant coefficient of the wrong sign but when considering fixed effects a positive, significant estimate is produced.

For hypothesis H3, that *trading volume is positively related to premium,* our coefficients are negative and significant for all categories. The sign contradicts the theory that liquidity should lower the discount to NAV. However, trading volume is highly correlated with market cap (0.6 for BOs, 0.26 for VCs and 0.39 for Peers) and the liquidity effects might therefore be transferred via the market cap variable. Regressing the model dropping the market cap variable turns the coefficient positive for BOs and slightly lowers the magnitude of the negative coefficients for Peers and VCs. Again, all coefficients are significant at a 5% level. Because of the structural size difference between the categories, BOs being larger than the others, these findings indicate that positive liquidity effects on premium first emerge for very large liquidity values.

Our hypothesis on illiquidity that, *bid-ask spread is negatively related to premium,* does not find clear support in the regression clustered by month. However, controlling for fixed effects yields significant estimates of the expected sign.

The results to prove hypothesis H6, that the *payout-ratio is negatively related to premium*, are ambiguous. The VC category and the pooled regression supports the hypothesis even if the estimates are non significant. The BO and Peer category contradicts our expectations having positive but non significant coefficients. Controlling for fixed effects only the pooled estimate is robust.

Testing H7, that *credit spread is negatively related to premium for BOs,* produces a coefficient of -0.032 significant at a 5% significance level. Thus, on average a one percent increase in credit spread produces a 3.2 percentage units decrease in premium. The estimate is robust controlling for fixed effects.

In accordance with H8 that, c*redit spread has a stronger relation to premium for BO funds than for VC and Peer funds*, we see that the coefficients are less pronounced for VCs and Peers than for BOs both for the ordinary regression and the regression controlling for fixed effects. Testing the coefficients shows that this relationship is statistically significant at a 5% significance level.

In line with H9 that, *market cap is positively related to premium for LPEs*, the regression estimates are positive and statistically significant for all categories. All estimates are robust controlling for fixed effects.

Hypothesis 10, *market cap is positively related to premium in a concave pattern LPEs*, is tested but not reported with the joint regression model. Regressing the model ranked by market cap per category yields a clear decreasing coefficient with size, i.e. a concave pattern. One exception is the lowest BOs rank group which deviates. However, controlling for fixed effect the deviation disappears and the hypothesis is supported.

Testing H11, that *net retail fund flows are positively related to NAV premium,* we find the coefficients to be positive for BOs and VC and negative Peers. BO show a statistically significant coefficient at a 5% significance level, VCs at a 10% significance level and the Peer estimate is insignificant. Pooling BOs and VCs also yields a statistically significant estimate. All estimates are robust controlling for fixed effects.

Testing H12, that *ftse small cap returns is positively related to premium,* generates positive and statistically significant coefficients at a 5% level for BOs and Peers but not for VCs. It should be noted that we are not testing against the change in premium in the final regression since we which to test all

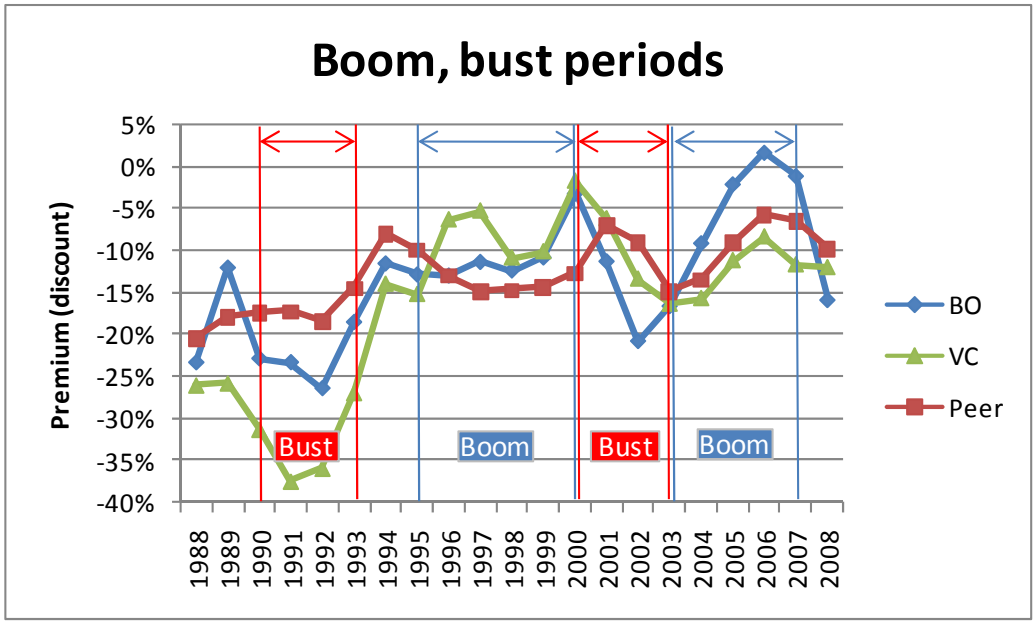
hypotheses in a joint regression. Comparing to the independent hypothesis results the relationship are the same for all categories and robust controlling for fixed effects.

Hypothesis 13, that *peer mean premium is positively related to LPE premium*, finds partial support in the joint regression. Both LPEs have positive coefficients, the BO estimate is however not significant. Controlling for fixed effect strengthens the relation for VCs and decreases the relation for BOs.

7.2.1 Boom and Bust periods

As premiums are calculated on assets and not on equity, discounts will mathematically narrow in boom periods and widen in bust periods[24]. Plotting mean premiums with highlighted boom and bust periods in Table 7.1 indicates that discount increases during bust period and decreases during boom periods. Statistical tests confirm this pattern. Moreover, t-tests indicate that boom periods are associated with lower discount levels than bust periods.

Figure 7.1: Mean premium (discount) in % over boom and bust periods



Since we have found differences in premium/discount characteristics during boom and bust periods, we choose to perform the joint regression model with interaction effects for boom and bust periods. As anticipated this produces differences in the coefficients of our variables as they capture the difference in premium/discount characteristics (Appendix 10.2.2).

[24] See Appendix: 10.2.1: Mathematical derivation for discount behavior in boom and bust periods

7.2.2 Delisting/dying funds

The size of the mean discount among LPEs is assumed, at least, by rational explanations to sum up to the present value of sub-return of the investment fund compared to the market return of its underlying portfolio. An important assumption for this explanation is that the investment fund is an ongoing business, i.e. has an infinite life horizon. However, our dataset is known to have funds dying and delisting over time and we believe that such funds can be a potential error source since they can put the ordinary determinants out of play. Our data shows that funds that are about to die trade at very large discounts. Regarding delisting firms Brauer (1984) and Brickley and Schallheim (1985) has showed that discount narrows and finally disappears when a funds decides and executes an open ending. Therefore it is important to investigate the effects of firms that are about to die or delist have on our coefficients.

Since we anticipate differences in the premium/discount characteristics for funds that are about to delist or die, we run the joint regression model with interaction effects accounting for this. This results in important changes in sign and size of the coefficients as they capture the differences in fund characteristics (Appendix 10.2.3).

8 Conclusion

This section will summarize our hypotheses and results, conclude our most significant findings and suggest areas for future research.

This study has aimed to describe the determinants of discount to NAV for LPEs. The main goal has been to investigate the dynamics of two pieces of the closed-end fund puzzle (a) that funds, on average, trade at a discount to NAV and (b) that the discount varies over time. The theoretical frameworks used have been theories of the closed-end fund puzzle, one assuming rational and one assuming irrational investors. These theories have been combined with research on PE characteristics. We have also analyzed the ability for the discount/premium to predict future NAV returns as well as future total stock returns.

Table 8.1 summarizes the findings made investigating each hypothesis. The independent analysis showed whether we were able to find evidence that support the hypotheses. In the independent analysis we generally examined correlation matrices, rank group analysis and single variable regressions to investigate each variables effect on the premium. However, the single variable regression models are likely to suffer from specification biases and the results generated should therefore only be viewed as

indicative. In the joint regression we combined all variables into a single multivariable model, expecting it to generate more valid results.

Table 8.1: Hypotheses summary

Hypothesis	Independent analysis, support?	Joint regression, support?	Framework
H1: Historical NAV return is positively related to premium	Yes	Yes	Rational
H2: NAV returns are persistent over time for LPEs	No	-	PE-characteristic
H3: Trading volume is positively related to premium	Yes for BOs, No for VCs	Yes, when excluding market cap	Rational
H4: Bid-ask spread is negatively related to premium	Yes for BOs, No for VCs	Yes, when controlling for fixed effects	Rational
H5: LPEs trade at a higher premium than Peers controlling for liquidity	No	-	PE-characteristic
H6: Payout-ratio $_{t-3}$ is negatively related to premium	Yes	No	Rational
H7: Credit spread is negatively related to premium for BO funds	Yes	Yes	PE-characteristic
H8: Credit spread is stronger related to premium for BO funds than for VC and Peer funds	Yes	Yes	PE-characteristic
H9: Market cap is positively related to premium for LPEs	Yes	Yes	Rational
H10: Market cap is positively related to premium in a concave pattern for LPEs	Yes	Yes	PE-characteristic
H11: Net retail fund flows are positively related to premium	Yes	Yes	Irrational
*H12: Ftse small cap returns are positively related to premium**	Yes for BOs, No for VCs	Yes for BOs, No for VCs	Irrational
H13: Peer mean premium is positively related to LPE premium	Yes	Yes	Irrational
H14: The premium is positively related with future NAV returns	No	-	Rational
H15: Premiums are negatively related with future total stock returns	Yes	-	Rational

*Tested against change in premium in independent and against premium in joint regression

The presence of a discount among LPEs was established in section 5, with a mean discount of 12% for BOs and 11% for VCs. The corresponding figure for the Peer category was 13%. In the same section it was established that the discount varies over time for all our categories. To describe these dynamics we used five rational, three irrational and five PE-characteristics based hypotheses. Among the hypotheses assuming rational investors we found two conclusions standing out in significance. (1) Managerial ability, measured through the proxy Historical NAV returns, is positively related to the level of premium for LPEs. (2) Size and liquidity, which are highly correlated, both are significantly positively related to current premium levels for LPEs. The results from the hypotheses assuming irrational investors support the importance of investor sentiment. (3) Net retail fund flows and Peer premium are both significantly

positively related to premium for LPEs whereas the development of ftse small cap index only can determine the premium for BOs. Regarding the PE-characteristics based hypotheses we conclude that: (4) Performance persistence does not exist among LPEs. (5) LPEs do not receive a higher premium for holding illiquid assets. (6) The premium for BOs is negatively related to credit spread.

A secondary goal was to investigate the predictive power of the premium. (7) We found that the premium has no ability to predict future NAV returns. (8) However, the premium has the ability to predict future total stock returns, probably since the LPE premium follow a mean reverting pattern.

Our findings hence give support for some of our rationally based arguments. However, a few of the hypotheses such as those concerning performance persistency and liquidity creation for LPEs indicates that the market doesn't seem to appreciate the characteristics related to the motivation for the existence of LPEs. Our hypotheses assuming irrational investors, based on the investor sentiment theory, are given much support and we also find it possible to exploit irrational levels of discount due to mean reversion of the premium/discount. This leads us to consider that the LPE market is neither fully developed nor fully efficient.

8.1 Suggestion for future research

Our study has analyzed the discount characteristics for listed private equity funds using some of the most established theories in the area of closed-end fund discount combined with research on PE characteristics. However, limitations with regards to availability of information make additional research valuable. One area for future research is to adopt a cross country perspective as our sample is derived from UK based CEFs. Also extending the model with additional variables could prove valuable. Some of the most interesting variables to include from a rational-framework perspective are management fees, fund leverage, fund age and management turnover as some of the most interesting. Regarding irrational variables we believe a consumer confidence index variable and information on small private investor ownership concentration would be of interest to examine. Finally a more detailed division of VC funds depending on stage of investments could help to clarify the determinants relationship to premium as they are now somewhat cluttered and do not produce as evident relationships as the smaller and more homogenous BO category.

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10 Appendix

10.1 Hypotheses results

Figure 10.1: Scatter plots of historical NAV returns and premium (discount) with fitted line

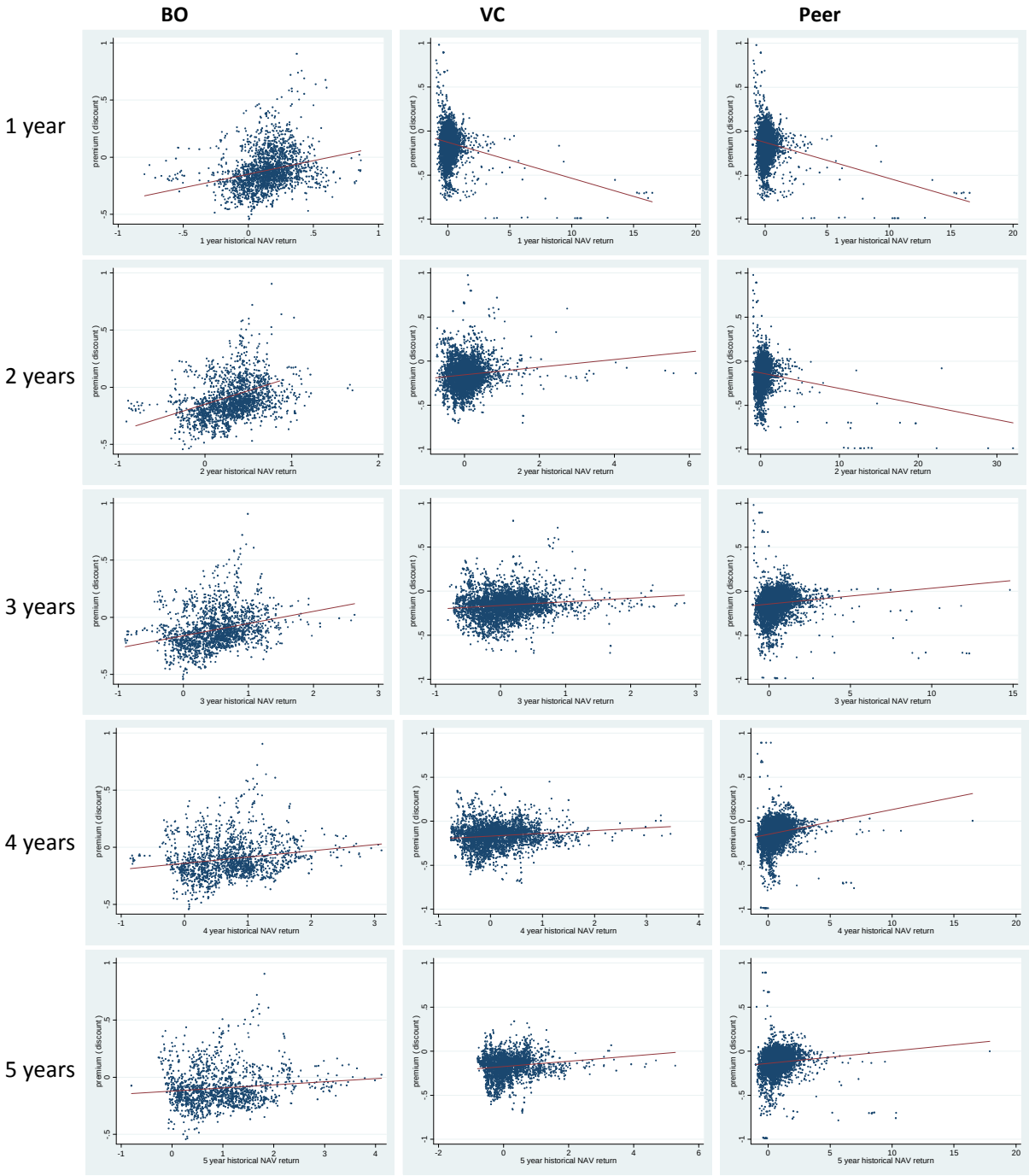
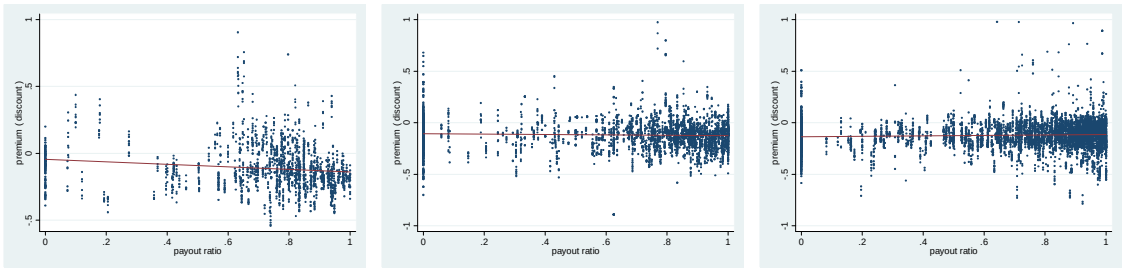


Figure 10.2 Scatter plots of payout ratio and premium (discount) with fitted line

BO **VC** **Peer**

Ordinary payout ratios



Extra ordinary payout ratios

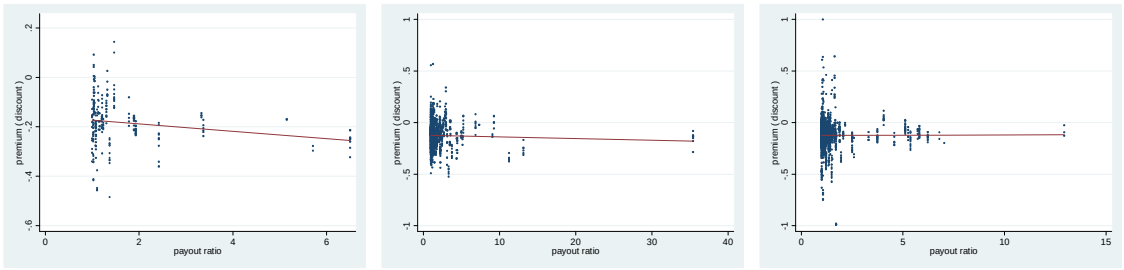


Figure 10.3: Scatter plot of credit spread over time

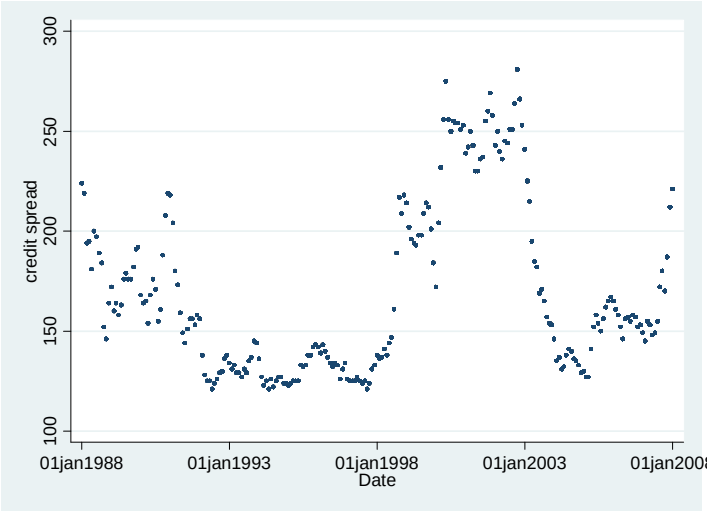


Figure 10.4: Scatter plot of market cap and premium (discount) with fitted line

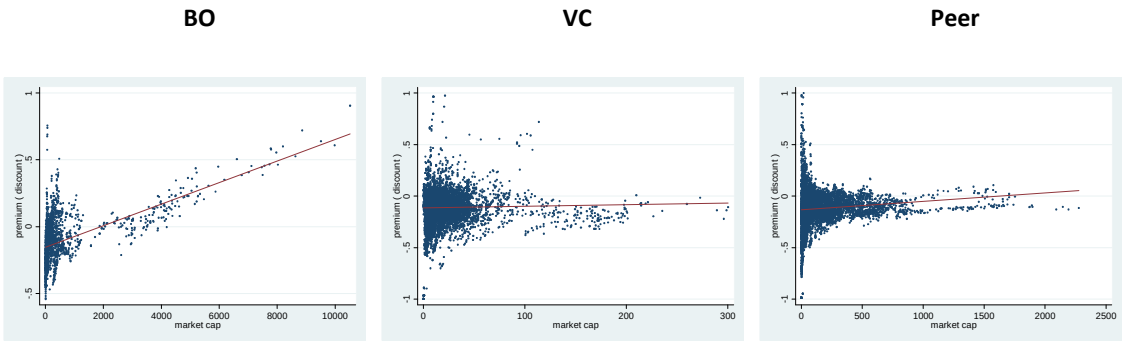


Figure 10.5: Scatter plots of net retail fund flows and premium(discount) with fitted line

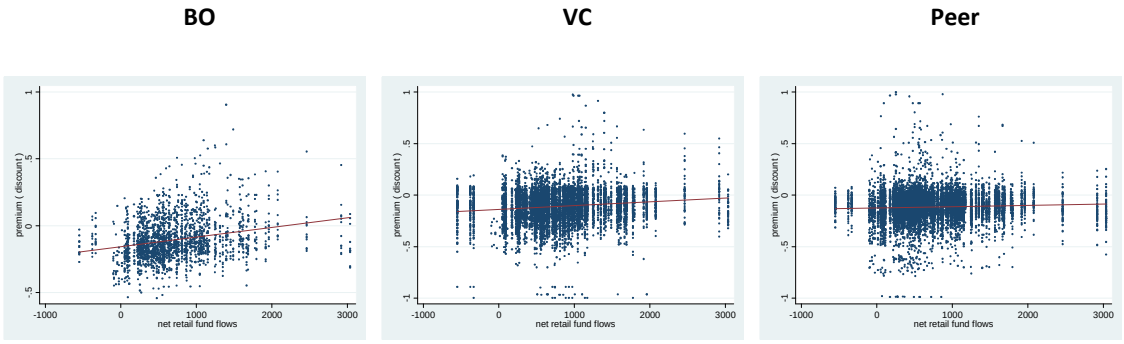
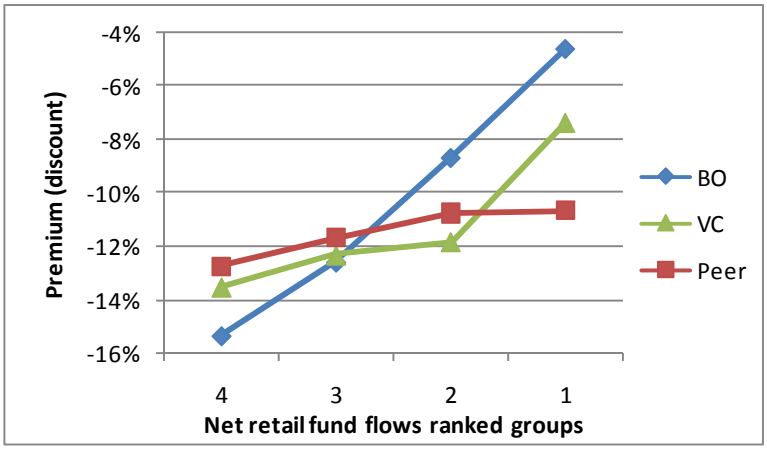
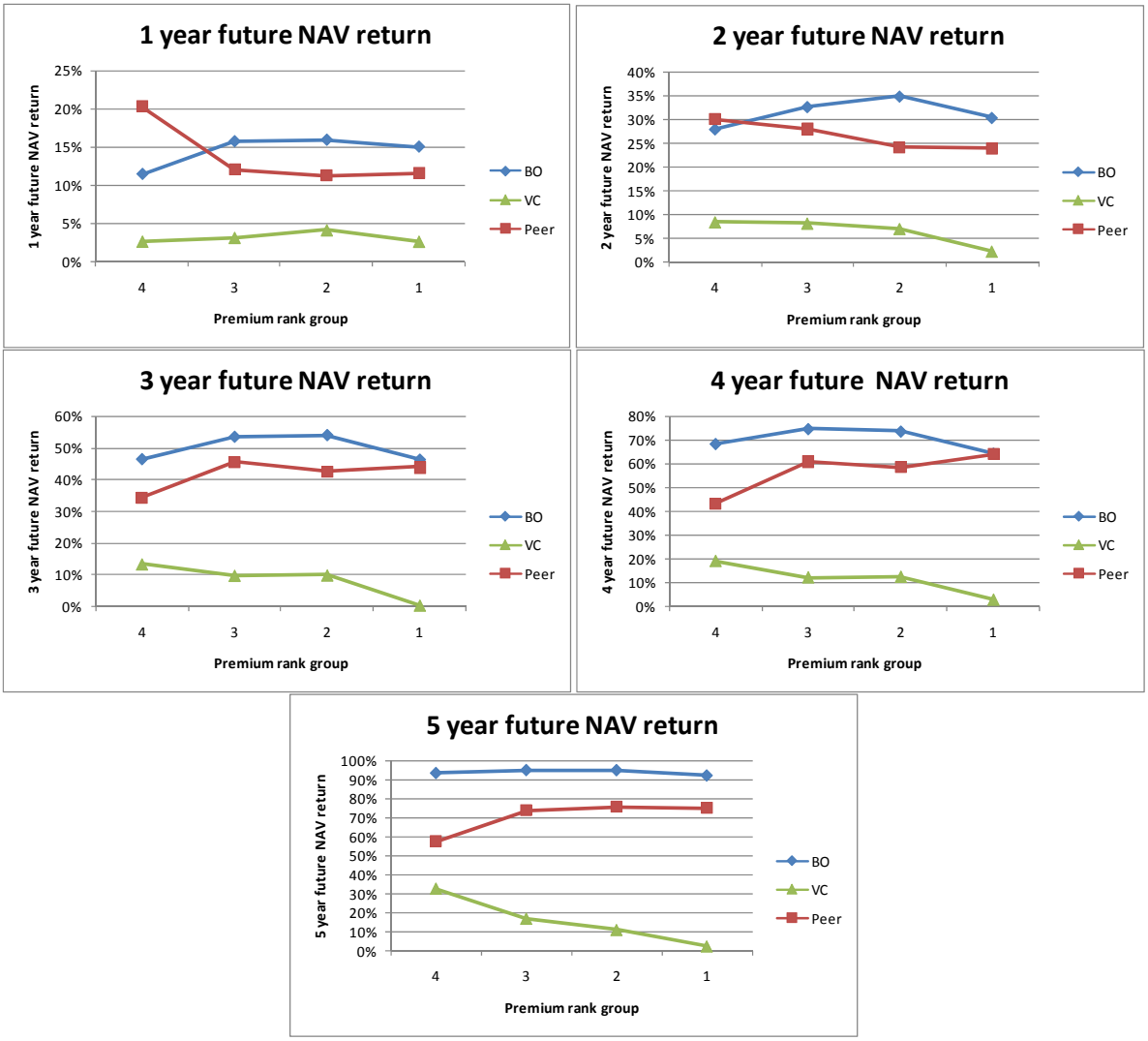


Figure 10.6: Plot of net retail fund flows ranked groups and Premium (discount)



10.1 Predictive ability

Figure 10.7 - Ranked future total NAV return against premium by category



10.2 Joint regression results

Table 10.1: Joint regression results with observations clustered by fund

Variable	Expected sign	BOs	VCs	Peers	Pooled (BOs+VCs)
market cap	+	0.0000818*	0.0005054	0.000062	0.0000824*
payout-ratio	-	0.0037672	-0.0008566	0.0115103	-0.0009555
trading volume	+	-0.00000000105**	-0.000000133**	-0.0000000103*	-0.000000000669
bidask-spread	-	-0.9566699*	0.0269168	-0.1224455	0.0628855
ftse smallcap	+	0.0000315*	0.0000083	0.0000161*	0.0000193*
retail fund flows	+	0.0000197*	0.00000676	-0.0000101*	0.0000119*
credit spread	-	-0.0324189**	0.008812	0.0022562	-0.0065143
2yr historical NAV return	+	0.1312167*	0.0441644	-0.0006861	0.0841634*
peer premium	+	0.1346814	0.2174438	n/a	0.1797257

* Coefficients significant on a 5% signifiance level
** Coefficients significant on a 10% signifiance level

10.2.1 Mathematical derivation for discount behavior in boom and bust periods

By a mathematical relationship boom periods should generate smaller discounts (more buying pressure) than bust periods. According to Anders Elsell (Investment AB Öresund) this is because discount is calculated on assets from an investor point of view and not on equity. To illustrate this we look at the following example. In 1 the market is in boom and the fund trades at a market cap of 27 representing a ten percent discount on equity and a three percent discount on assets. The market then moves into bust. The question is does this lead to situation a or b. If discount would be calculated on assets the market cap moves down to 17 representing a three percent discount on assets and a 15 percent discount on equity. Since the reported discount is the discount on equity the statistics will show that the discount has risen from ten to 15 percent, a widening of the discount when moving into boom. The reason for this mechanism is that it merely represents is a shift in capital structure which in theory the investor can compensate by increasing or decreasing leverage on the personal level.

1. Assets = 100, Equity = 30, Debt = 70, market cap = 27
    - ⇨ Discount on equity = 10%
    - ⇨ Discount on assets = 3%

a. Assets = 90, Equity= 20, Debt = 70, market cap = 18
    - o Discount on equity = 10%
    - o Discount on assets = 2,2%

b. Assets = 90, Equity= 20, Debt = 70, market cap = 17
    - o Discount on equity = 15%
    - o Discount on assets = 3%

10.2.2 Boom bust regression results

Regressing the determinants of the premium in detail under boom and bust periods (table 6.5) we see that many of their relationships to premium are altered. Test of interaction effects being equal to zero (Table 10.2) indicates that estimates of market cap, payout-ratio, trading volume, bid-ask spread, ftse small cap and peer premium are statistically different for BOs during bust periods compared to boom periods. The estimates of retail fund flows, credit spread and historical NAV return are not statistically significant. The VCs interaction estimates are statistically different from zero for market cap, bid-ask spread, ftse small cap, credit spread, historical NAV return and peer premium. The estimates of payout-ratio and trading volume are not statistically significant.

Table 10.2: Significance values from tests of interaction terms being equal to zero

Variable	BOs	VCs	Peers	Pooled (BOs+VCs)
market cap	0.0196*	0.0009*	0.1845	0.0806**
payout-ratio	0.0001*	0.1834	0.01*	0.8447
trading volume	0.017*	0.8364	0.2408	0.0107*
bidask-spread	0*	0*	0.073**	0.2471
ftse smallcap	0.0716**	0*	0.0076*	0*
net retail fund flows	0.1571	0.1348	0.452	0.0838**
credit spread	0.1836	0.0289*	0.1748	0.0978**
2yr historical NAV return	0.4559	0.0005*	0*	0*
peer premium	0.0003*	0.0554**	0*	0.0176*

* Significant on a 5% signifiance level

** Significant on a 10% signifiance level

Summarizing the most important differences we note that market cap coefficients become larger for BO and Peer in bust. The coefficient becomes negative but insignificant in bust for VCs. The trading volume coefficient becomes more negative in bust for all categories. Ftse small cap becomes larger and positive in bust for all categories. The credit spread coefficient becomes more negative in bust for BO.

Table 10.3: Boom and bust regression with interaction effects and clustered by month[α]

	Variable	BOs	VCs	Peers	Pooled (BOs+VCs)
Boom	market cap	0.0000745*	0.0006434*	0.0000739*	0.0000794*
	payout-ratio	-0.0081569	0.0029289	0.0048062	0.000064
	trading volume	-0.000000000371	-0.000000114*	-0.0000000114*	-0.000000000171
	bidask-spread	0.08748	0.0764672*	-0.1610896	0.0462815
	ftse smallcap	0.0000474*	-0.00000575	0.0000311*	0.0000171*
	net retail fund flows	-0.00000819	0.000000942	-0.0000137*	-0.00000116
	credit spread	-0.0240639*	-0.0106338*	0.0102114*	-0.0212176*
	2yr historical NAV return	0.1296424*	0.0719376*	-0.014312*	0.1172965*
	peer premium	0.1722192	0.4765879*	n/a	0.1879103*
Bust	market cap	0.0000173*	-0.0008191*	0.0000296	0.0000149**
	payout-ratio	0.0889118*	-0.0059946	0.0234645*	-0.0009601
	trading volume	-0.00000000179*	-0.00000000952	-0.00000000578	-0.00000000241*
	bidask-spread	-1.849056*	-0.280279*	0.4223803**	-0.0677679
	ftse smallcap	0.0000305**	0.0001204*	-0.0000016	0.0000868*
	net retail fund flows	0.0000145	0.00002	-0.00000741	0.0000179**
	credit spread	-0.0146914	-0.0509264*	-0.0335265*	-0.0152726**
	2yr historical NAV return	-0.0218918	-0.1086509*	0.0245587*	-0.1173685*
	peer premium	-0.8549635*	-0.4223753**	n/a	-0.3409888*

* Coefficients significant on a 5% signifiance level

** Coefficients significant on a 10% signifiance level

[α] The dependent variable is premium to NAV. Boom estimates as base case and bust estimates are interaction effects

10.2.3 Dying/delisting regression results

Test of interaction effects being equal to zero (Table 10.4) indicates that for BOs estimates of market cap, payout-ratio, trading volume, historical nav return and peer premium are statistically different when funds are about to delist. The estimates of bid-ask spread, ftse small cap, net retail fund flows and credit spread are not statistically different. The VCs interaction estimates are statistically different from zero for market cap, trading volume, bid-ask spread and ftse small cap. The estimates of payout-ratio, net retail fund flows, credit spread, historical nav return and peer premium are not statically different.

Table 10.4: Significance values from tests of interaction terms being equal to zero

Variable	BOs	VCs	Peers	Pooled (BOs+VCs)
market cap	0*	0*	0*	0.0207*
payout-ratio	0.0073*	0.7643	0.0001*	0.5597
trading volume	0.0617**	0.0001*	0.7796	0.2578
bidask-spread	0.2301	0.0241*	0*	0.4748
ftse smallcap	0.1763	0.0642**	0.2175	0.458
net retail fund flows	0.7904	0.3655	0.6815	0.4488
credit spread	0.8488	0.7285	0.1124	0.0003*
2yr historical NAV return	0*	0.1481	0.0901**	0.4391
peer premium	0.0776**	0.905	0.993	0.718

* Significant on a 5% signifiance level

** Significant on a 10% signifiance level

Market cap coefficients increase in magnitude when firms are about to delist. This pattern is consistent and statistically significant for all categories. The bid-ask spread coefficient changes from negative to positive for BOs and Peers. However, the change is not statistically significant for BOs and not economically logical for either category since this would mean that a larger bid-ask spread would lead to a narrowing of the discount. The ftse smallcap coefficients increase in magnitude for both LPEs and Peers. The changes are statistically significant and indicate that delisting/dying funds are more likely to be affected by private investor sentiment. In contrast Peer premium contradicts that indication and the ned retail fund flows interaction effects are ambiguous. Finally the relationship between the premium and the 2 year historical NAV return turns negative for both LPE categories, however not statistically significant for VCs. This would indicate that the market do not rely on historical NAV return when assessing the premium of funds that are about to delist or die.

Table 10.5: Delisting/dying funds regression with interaction effects and clustered by month[α]

	Variable	BOs	VCs	Peers	Pooled (BOs+VCs)
Normal	market cap	0.0000817*	0.0005147*	0.0000458*	0.0000819*
	payout-ratio	0.0082268	-0.0006075	0.0159978*	-0.0005931
	trading volume	-0.00000000104*	-0.000000138*	-0.00000000973*	-0.000000000645*
	bidask-spread	-0.9721754*	0.0023741	-0.5708147*	0.0406022
	ftse smallcap	0.0000311*	0.00000748	0.0000144*	0.0000177*
	net retail fund flows	0.0000194*	0.00000756**	-0.0000104*	0.0000123*
	credit spread	-0.0336497*	0.008714**	-0.0006701	-0.0082695*
	2yr historical NAV return	0.1309761*	0.0505703*	-0.0030486	0.0899598*
	peer premium	0.1375809	0.1817773**	n/a	0.1687946*
Dying / delisting	market cap	0.0033248*	0.0091491*	0.0007628*	0.000634*
	payout-ratio	-0.0566769*	0.0023544	-0.0292024*	-0.0046047
	trading volume	-0.0000000488**	0.000000207*	-0.00000000209	-0.0000000683
	bidask-spread	1.793711	0.2530735*	1.155242*	0.0769163
	ftse smallcap	0.0000397	0.000053**	0.0000255*	0.0000137
	net retail fund flows	0.000005	-0.0000173	-0.00000328	-0.0000113
	credit spread	0.0046241	0.0066642	0.0108116	0.0598242*
	2yr historical NAV return	-0.452432*	-0.0518392	0.0039561	-0.0308164
	peer premium	-0.6302836**	-0.0415055	n/a	0.1107388

* Coefficients significant on a 5% signifiance level

** Coefficients significant on a 10% signifiance level

[α]The dependent variable is premium to NAV. Normal estimates as base case and dying/delisting estimates are interaction effects