Private Equity and Liquidity Risk

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JEL Classification: G24, G12

Keywords: Private equity, liquidity risk, liquidity factors

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1. Introduction

From 2003 to mid-2007, two phenomena grew in parallel on financial markets. Liquidity was at record highs and private equity (PE) firms distributed increasingly large amounts of cash to their investors. These investors in turn were re-investing the cash in newly raised private equity funds and much new money was flowing into the PE industry. Mid-2007, the music stopped. Liquidity suddenly dried up and PE firms hardly distributed any cash to their investors thereafter.

Figure 1 illustrates this phenomenon by plotting the monthly pay-out of private equity investments in our data set and the Ted spread[1], a commonly accepted measure of liquidity. Strikingly, the run-up and subsequent fall in private-equity pay-outs goes hand in hand with the dramatic drying up of liquidity in the financial system at large.

This episode suggests that PE investors may receive higher returns in times of higher liquidity. In light of the recent literature on the pricing of liquidity risk, this fact, if confirmed on a large dataset, would have important consequences for the evaluation of private equity performance and the valuation of private equity investments.

Pastor and Stambaugh (2003), Acharya and Pedersen (2005), and Liu (2006), among others, show that (systematic) liquidity risk is priced for public equity and that investors require a sizeable liquidity risk premium for stocks.[2] In private equity, the effect may be even more dramatic, because investment exits appear to cluster at times of high IPO and M&A activities, both of which are related to market liquidity (see Cumming, Fleming and Schwienbacher, 2005).

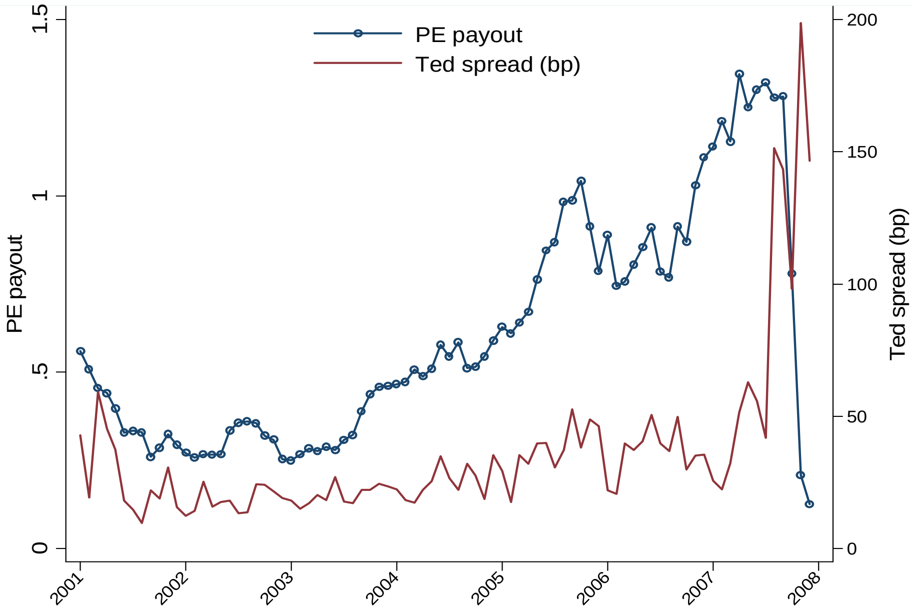
That private equity returns may need a sizeable adjustment because of a large exposure to liquidity risk is also highlighted by Metrick (2007). Using an index of venture capital returns and a time-series regression, he estimates a 1% annual premium for liquidity risk. The objective of this paper is to see whether the anecdotal evidence mentioned above and Metrick's early result hold in a comprehensive dataset of pre-crisis PE investment returns. In addition, the unique depth of our dataset enables us to document which type of investments are most sensitive to liquidity risk. Finally, our data enables us to further document the issue of private equity performance. Previous research finds that private equity buyout funds underperform

[1] The Ted spread is defined as the three-month LIBOR rate minus the Fed Funds rate in basis points.
[2] Other articles include: Chordia, Subrahmanyam, and Anshuman (2001), Baekert, Harvey, and Lundblad (2005), Watanabe and Watanabe (2008), Martinez, Nieto, Rubio, and Tapia (2005), Bandi, Moise, and Russel (2008), Fontaine and Garcia (2008), and Hasbrouck (2009).

public equity *after* fees (Kaplan and Schoar, 2005, Phalippou and Gottschalg, 2009) but the quality of the data is sometimes questioned. Here, we report evidence *before* fees from a different and detail-rich dataset.

Figure 1

The figure plots the monthly dividend payout of private equity deals in the CEPRES dataset (PE payout) and the monthly Ted spread (defined as the three-month LIBOR rate minus the Fed Funds rate in basis points). Dividend payout is constructed as the six-month moving average of the total dividends paid divided by the six-month moving average of the total investments in those deals.



Our dataset contains detailed cash-flow information for 3,421 PE investments made between 1981 and 2000 (and realized by December 2004) in 32 countries. We do not know the identity of each investment or fund but have information on industry, stage, exit type, and country of the investment. We also have information about fund size and fund sequence number.

We first show that investment performance is significantly related to the average innovation in aggregate liquidity during the investment's lifetime. This result holds for all four non-traded liquidity measures that are available for our sample period (Pastor and Stambaugh, 2003, Acharya and Pedersen, 2005, and Sadka's, 2006, two measures).

Second, we use traded liquidity factors to measure more directly the liquidity risk premium of private equity investments. Depending on the measures applied, the premium ranges from 5% to 15% per year.

Third, we investigate which investment characteristics affect the exposure of PE to liquidity risk. Our preliminary analysis suggests that investment size is a positive and significant determinant of exposure to liquidity risk. Larger investments are indeed more sensitive to exit conditions than smaller investments and thus potentially via this channel, more sensitive to liquidity risk.

Our study is related to that of Cumming, Fleming and Schwienbacher (2005). They show that venture capitalists invest in different type of companies as a function of market liquidity, which they proxy by the number of IPOs per year. They conclude that their results are "consistent with the view that illiquidity is one reason why venture capitalists require higher returns on their investments".

Our paper also relates to two important strands of literature. First, we connect to the literature on the pricing of liquidity risk.[3] A number of papers provide theoretical arguments as to why investors want to be compensated for liquidity risk (e.g. Holmstrom and Tirole, 2001, Acharya and Pedersen, 2005, Lustig, 2009). The empirical literature was pioneered by Amihud and Mendelson (1986) and more recent work emphasizes the importance of systematic liquidity risk in public equity returns (e.g. Amihud, 2002, Pastor and Stambaugh, 2003, Acharya and Pedersen, 2005, Sadka, 2006).

Second, we relate to the literature on risk and return of private equity investments (e.g. Cochrane, 2005, Cumming, Schmidt and Walz, 2009, Kaplan and Schoar, 2005, Phalippou and Gottschalg, 2009, Driessen, Lin and Phalippou, 2008, Lerner, Schoar and Wongsunwai, 2007, Jones and Rhodes Kropf, 2003, Ljungqvist, Richardson and Wolfenson, 2007, Hochberg, Ljungqvist and Vissing-Jorgensen, 2008).[4]

This paper continues as follows. Section 2 describes the data. Section 3 describes the liquidity measures. Section 4 discusses the methodology. Section 5 shows the main empirical results. Section 6 offers some robustness tests and section 7 briefly concludes.

[3] See Amihud, Mendelson, and Pedersen (2005) for a survey.
[4] See Phalippou (2007) for a survey.

2. Data

2.1. Data source and comparable datasets

The dataset is provided by the Center for Private Equity Research (CEPRES). CEPRES is a private consulting firm established in 2001 as a co-operation between the University of Frankfurt and Sal. Oppenheim Banking Group. CEPRES obtains data from private equity fund managers in exchange for free exclusive access to information services. The data are received through standardized information request sheets. CEPRES then validates the data with due diligence reports, including audited filings, to guarantee accuracy. An earlier version of the CEPRES database covering mainly or exclusively venture capital is used by Cumming and Walz (2004) and Cumming, Schmidt and Walz (2009), respectively.

The unique aspect of the dataset is that it contains monthly cash flows for each investment (i.e. Portfolio Company) of a fund. Such a feature is important because it enables us to construct precise performance measures for each investment (IRRs and Modified IRRs), which is essential for accurate estimation of the relation between performance and liquidity risk.

The only other database we know of that contains cash flows at the investment level is that of Ljungqvist, Richardson and Wolfenson (2008). Our data spans a longer time period (1981 until 2007 versus 2003) and, in addition, contains more twice as many investments (from 1981 to 2003, they report a total of 2,274 investments while our data set contains 4,401 buyout investments from 1981 to 2007). Importantly, they show descriptive statistics only at the fund level. This means that the descriptive statistics we show below are novel.

Another database with cash flow details is provided by Thomson Venture Economics, but it contains this information only at the fund level.[5] Having cash flow information at the investment level rather than at the fund level gives us more power to detect a relation between performance and liquidity and enables us to study the interaction between investment characteristics and liquidity exposure.

Finally, Lopez-de-Silanes and Phalippou (2009) have a dataset with the performance of a large panel of investments, which comes from hand-collected private placement memoranda (PPMs). They do not have cash flow details for each investment but only a cash multiple and an IRR. The major benefit of our data compared to theirs is that we can compute different performance measures (e.g., Modified IRR) and thus make more precise inferences thanks to the cash flow details.

[5] It has been used by Kaplan and Schoar (2005), Phalippou and Gottschalg (2009), Jones and Rhodes-Kropf (2003) and Driessen, Lin and Phalippou (2008).

2.2. Sample selection

Table 1 shows how we select our sample. To gauge sample bias in performance, we show the mean and median *Cash multiple* in each sub-sample. *Cash multiple* is the only performance indicator that we observe for all the investments; it is defined as the total amount distributed divided by the total amount invested.[6]

CEPRES defines private equity buyout investments according to the following categories: Acquisition financing, Leveraged Buy-Outs (LBO), Management Buy-Outs and Buy-Ins (MBO/MBI), Growth, Recapitalisation, Spin off, and Turnaround. We count 4,401 buyout investments undertaken from 1981 until 2007. As young investments are often held at cost, we focus on investments made between 1981 and 2000. This increases performance precisely because many investments held at cost (hence, with a multiple of 1) are removed. That sample has 3,944 observations and a mean and median performance of 2.60 and 1.93 respectively, compared to 2.59 and 1.95 in the full sample.

Next, we select only the investments that are liquidated by December 2004. This is because i) their performance is final (and not influenced by subjective accounting valuations), ii) we have cash flow information only for liquidated investments and iii) we have liquidity factors up until December 2004. The sample size decreases to 3566. Consistent with the conjecture in Phalippou and Gottschalg (2009), funds liquidate their winners more quickly, making the liquidated sample tilted towards winners. The difference in performance is however relatively small in our dataset.

Finally, we require information about duration. This is missing for 175 investments. As pointed out by Ljungqvist, Richardson and Wolfenson (2008), the date at which investments are officially written off are often missing in such datasets. Once, we require duration information, many bankrupted investments are excluded and performance increases further. However, the difference in performance between the full sample and the selected sample is relatively small; though we ought to bear in mind that we have a tilt towards better performers. The final sample has 3,421 observations and mean and median multiple of 2.766 and 2.076 respectively.

[Insert Table 1 about here]

[6] Only the cash multiple in local currency is available to us for all the observations.

2.3. Performance Measures

Our main performance measure is the Internal Rate of Return (IRR). We compute it on both the cash flows expressed in their original currency and the cash flows converted in US dollars; we label them IRR (local) and IRR (dollar) respectively.

The main issue with IRR is that of the re-investment assumption. This means that, if so measured, both the average performance and the dispersion of performance is exaggerated (Phalippou, 2009). However, since we use IRR for a cross-sectional regression, its flaws may not significantly bias our results on factor exposure as the correlation between IRR and effective rate of return is likely to be high. On the other hand, the alphas from these regressions are not meaningful. Hence, we abstain from interpreting a positive (negative) constant in our multifactor regression models with liquidity as out-performance (under-performance) after adjusting for risk factors.

The effective rate of return is not observable. For that, we would need to know the re-investment rate of the representative investor at each point in time. Instead, to gauge whether our results are sensitive to the re-investment assumption, we use two additional performance measures. First, a Modified IRR with a constant 8% re-investment rate and another Modified IRR with the S&P 500 as the re-investment rate. We label them MIRR (8%) and MIRR (S&P), respectively. The first one is computed on the cash flows in the original currency, while the second one is computed on the cash flows converted in US dollars.[7]

We observe fat tails for all the performance measures. For this reason, we winsorize all of them at the 95th percentile. When converting to monthly returns, the annual IRRs that equal -100% are set to -99% to flatten the left tail of the resulting distribution. Figure 2 shows the final distribution of our performance measures at the annual frequency.

[Insert Figure 2 about here]

Table 2 shows the correlation between the four performance measures. The correlation is very high which confirms that cross-sectional results will not be significantly affected by the re-investment assumption. The mean and median is however different. The mean IRR is at 23% while the mean Modified IRR is at 10% and 14% when we change the re-investment assumption to 8% and S&P 500 respectively. This shows that only changing the re-investment

[7] In a similar context, Ljungqvist et al. (2008) use a Modified IRR with 0% re-investment rate. We will use an 8% re-investment rate and the S&P 500 as a re-investment rate in the robustness section.

assumption brings private equity performance close to public equity market returns, gross-of-fees. Phalippou (2009) estimates fees to be in the range of 6-8% for an investment whose performance matches that of the S&P 500. Net-of-fees, performance thus seems to be rather low.

[Insert Table 2 about here]

2.4. Raw performance statistics

Table 3 shows the descriptive statistics of our working sample of private equity investments. We convert all cash flows into US dollars, and investment size is expressed in year 2000 US dollars. VW is the (investment-size) value-weighted mean, and DVW is the duration-times-value-weighted mean. *Duration* is measured from the first to the last cash flow. Performance measures are *cash multiple* (total amount distributed divided by total amount invested), *Internal Rate of Return* (IRR) and *Modified IRR* with either a flat 8% or S&P 500 index as re-investment rate. Performance and sample distributions are displayed by year (Panel A), by industry (Panel B), by investment stage (Panel C), by exit type (Panel D), and by country (Panel E).

[Insert Table 3 about here]

Panel A shows that the number of investments starts slowly and then takes off rapidly in the second half of the 1980s peaking to 354 investments in 1997. Median size of investment is almost monotonically increasing throughout most of the sample period.

Panel B shows statistics by industry. Most investments are in industrial/manufacturing (640 investments) and consumer/food (359), the traditional private equity industries. A large number of investments are also reported for less traditional industries like healthcare (311) and services (304).

Panel C shows that almost three quarter of the number of investment stages are classified as MBOs (2322). Exit channel is provided for about half of the investments. Panel D shows that the majority (1112 exits) are realized through a trade sale. There are only 288 IPO exits. These exits have the highest performance. The second best exit in terms of performance is public merger.

3. Liquidity

3.1. Liquidity risk and liquidity level

Our paper focuses on the compensation for systematic risk originating from time-varying liquidity. A recent literature in asset pricing has argued that investors prefer assets that pay out $1 in times of low liquidity than in times of high liquidity. The current crisis illustrates clearly these arguments and emphasizes how private equity was particularly sensitive to liquidity risk. Large PE investors (Endowments such as Harvard, Pension funds such as Calpers) would have most probably preferred receiving large dividends from their PE portfolio in 2008 rather than receiving them in 2006 (ex-post). Harvard endowment has tried to sell a staggering $1.5 billion of PE stakes in 2008 in an attempt to receive some cash from its PE division. It failed to sell this stake at a reasonable discount and as of Q1-2009 has not sold it.[8]

A related topic is the compensation for the level of liquidity, i.e. the level of transaction costs and the trading restrictions associated with PE investments. The only study we are aware of in private equity is that of Lerner and Schoar (2004). They propose a model and supporting empirical evidence which show that the liquidity level of PE funds is a decision variable for the fund managers. Namely fund managers make the fund stakes illiquid on purpose and the degree to which they do it depends on the type of investments the fund makes.

Future research may focus on the discount required for the illiquidity level of private equity. Having part of a portfolio in an illiquid asset class can be costly if one needs to sell this

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[8] Private Equity Online – *November 7, 2008*: "Harvard Management Company is looking to unload roughly $1.5 billion in private equity stakes in the secondary market. A secondary market source described the university endowment, which had $36.9 billion in assets as of 30 June, as a highly sophisticated limited partner making a proactive decision to seek liquidity and rebalance its portfolio based on cash flow models. Although the volume of supply in the secondary market has risen of late, secondary investors expect it to surge further in the first half of 2009 as more LPs make a similar move to access needed liquidity. Harvard is ahead of many limited partners in going to the secondary market and will obtain a more attractive price for its assets than those heading to market six months down the line as the result of supply demand dynamics, the investor said. Harvard's secondary sale will drive down prices in the secondaries market because it will take $1.5 billion of demand out of the market at a time when supply is not rising, the investor added." THEN Bloomberg – *January 23, 2009*: "Harvard University didn't sell most of the $1.5 billion of stakes in private-equity funds it put on the market last year because offers were too low, said three people familiar with the matter. The university's $28.8 billion endowment, the richest in higher education, rejected deals as sellers, including schools and pension funds, flooded the market and pushed down prices, said the people, who asked not to be identified because the bidding is private. The Cambridge, Massachusetts university remains interested in unloading the private-equity investments. Harvard, Duke University and Columbia University were among institutions that last year put buyout and venture capital stakes up for sale on the secondary market, where middlemen broker deals. Schools are looking to raise cash as distributions from fund managers dry up and losses on stocks and bonds mount. As much as $40 billion in private-equity interests may go unsold this year as sellers hold out for higher prices, according to Nyppex Holdings LLC, a firm that trades stakes in buyout pools."

part of the portfolio for whatever reason (like Harvard endowment in the example above). Studying this problem is interesting but needs considerable assumptions and data that we do not have. For example, one needs to conjecture the ex-ante probability that an investor has to sell a given PE stake.

Another related issue is that investors effectively grant a credit line to the PE fund. The relation between the speed of draw down and the liquidity of the rest of an investor's portfolio is then crucial to evaluate the cost of this credit line.

3.2 Liquidity measures

Non-traded Market-wide Liquidity Measures

The literature has proposed several measures of shocks to aggregate (market-wide) liquidity. We use the four measures that are available for our sample period. First, we use the (innovation in the) aggregate liquidity measure of Pastor and Stambaugh (2003), which we denote PS-LIQ. It is the aggregate of firm-level (OLS) coefficients of daily returns on signed daily trading volume. Our second measure is the innovation in market *illiquidity* as computed by Acharya and Pedersen (2005), where the firm-level illiquidity is measured by the ratio of Amihud (2002). We multiply this measure by minus one to obtain a liquidity measure and denote it AP-LIQ. Third and fourth, we apply the measures of Sadka (2006). He proposes a measure of market-wide price impact, which he decomposes in a permanent (variable) and a transitory (fixed) part, which we label Sadka-pv and Sadka-tf, respectively.

Traded Liquidity Risk Factors

We also choose all the traded liquidity factors proposed in the literature that are available for our sample time period. First, Pastor and Stambaugh (2003) have created two time-series of long-short portfolios. One is equally weighted and the other is value-weighted; we denote them IML_ew_PS and IML_vw_PS, respectively. We should keep in mind that Pastor and Stambaugh privilege the equally-weighted measure in their paper. They argue that it is a more stable measure. Second, Liu (2006) proposes a liquidity measure for individual stocks which is a standardized turnover-adjusted number of zero daily trading volumes over the prior 12 months. Stocks are then assigned to deciles as a function of their liquidity. The return on the low deciles minus the return on the high deciles portfolio is the mimicking liquidity factor.

3.3. Descriptive statistics

Table 4 shows the cross-correlation and distribution of the pricing factors and aggregate liquidity factors. The table shows the correlation matrix for the (time-series of the) six pricing factors (the usual three factors Rm-Rf, HML, SMB, and three illiquid minus liquid factors) plus the four aggregate measures of liquidity. Time period is from January 1981 to December 2004.

[Insert Table 4 about here]

The Liu liquidity factor returns a high 0.91% per month. Pastor and Stambaugh factors return 0.56% and 0.40% per month. The liquidity measures have zero mean by construction. We also note that the liquidity measures and factors are not highly correlated with one another. They capture different dimensions of liquidity. Consequently, it is important to show results with all the measures. Also of interest, the Liu factor is highly correlated with HML. Hence, as in Liu (2006) we will use his factor only in addition to the market factor (a two-factor model). In contrast, Pastor and Stambaugh (2003) use their factor in addition to the three Fama-French factors. The four factors have low correlation with one another. In sub-sequent analysis, we will also use this four factor model.

4. Methodology

For each investment, we observe all the cash flows. To begin, let us assume that each investment *i* consists of only one negative cash flow (*I*) and one positive cash flow (*D*). Let us further assume a two factor model as in Liu (2006), in which the factors are the market risk premium (r_{mt} - r_{ft}) and the liquidity risk premium (LIQ_t). Denoting u_t the idiosyncratic shocks, it follows from standard asset pricing theory that:

$$D_i = I_i \prod_{t=0}^{T} (1 + \alpha + r_{f,t} + \beta(r_{m,t} - r_{f,t}) + \beta_l LIQ_t + u_t)$$

Dividing by *I* and taking the natural logarithm on both sides gives

$$\ln(1 + R_{i,t})^T \equiv \ln\left(\frac{D_i}{I_i}\right) = \sum_{t=0}^{T} (1 + \alpha + r_{f,t} + \beta(r_{m,t} - r_{f,t}) + \beta_l LIQ_t + u_t)$$

Which we can approximate by the following (we work at a monthly frequency):

$$R_{i,t} = \alpha \quad + \left(\bar{r}_{f,t} + \beta_m\left(\bar{r}_{m,t} - \bar{r}_{f,t}\right) + \beta_l \overline{LIQ}_t\right) + \overline{u_t}$$

or

$$R_{i,t} = \alpha \quad + \bar{r}_{f,t} + \beta_m\left(\bar{r}_{m,t} - \bar{r}_{f,t}\right) + \beta_l \overline{LIQ}_t \; + \; \varepsilon_{i,t}$$

This approximation can be avoided by making a distributional assumption. Assuming the u_t are normally distributed or lognormally distributed, then maximum likelihood can be used. Alternatively, techniques such as that of Driessen, Lin and Phalippou (2008) can be used here. We leave these alternative estimation approaches as a robustness test for future versions.

The other assumption we made here is that of no intermediary cash flows. In the analysis that follows we use IRR and two modified IRR to proxy for $R_{i,t}$ and thereby gauging whether the existence of intermediary dividends significantly affect results. In the next version, we will also create factors mimicking IRRs to further judge the sensitivity of results to the presence of intermediary cash flows.

5. Empirical Results

5.1. Non-traded Market-wide Liquidity Measures

Table 5 shows the result of OLS regressions of PE returns on (non-traded) market-wide liquidity factors. Standard errors are based on a three dimensional clustering (month/year of the investment, fund country and investment industry); and corresponding t-statistics are reported below each coefficient in italics. Dependent variables include the usual three asset pricing factors and four aggregate (market-wide) liquidity measures. Each dependent variable is the time-series average during the investment's life of the corresponding variable.

The results on the non-traded aggregate liquidity factors are all significant at conventional levels. In simple regressions (specs 1, 4 and 10) the effect is largest. As the other risk factors, such as the excess return on the market, HML, and SMB are correlated with the liquidity variables, the marginal effect of liquidity decreases (but remains significant) when these factors are added to the regressions. Hence, we find that PE returns are sensitive to systematic liquidity risk.

[Insert Table 5 about here]

5.2. Traded Liquidity Risk Factors

Table 6 shows the result of OLS regressions of PE returns on traded liquidity risk factors. Again, standard errors are based on a three dimensional clustering (month/year of the investment, fund country and investment industry), and corresponding t-statistics are reported below each coefficient in italics. Dependent variables include the usual three asset pricing factors and three zero-cost illiquid minus liquid portfolios (i.e. traded liquidity risk factors). Each dependent variable is the time-series average during the investment's life of the corresponding variable.

The traditional one factor model (spec 1) shows that private equity returns are positively related to public equity return (beta is 1.7). Next, we show results with the two-factor model of Liu (2006). We find a very large effect of the liquidity factor. It is significant at the 1% level test and the economic magnitude is very large. The average IML of Liu is 0.91% per month (see table 4), making a liquidity premium of 1.17% per month or 15% per year.

Next, in specification 3, we adopt the three-factor model of Fama and French (1993). The evidence suggests that private equity returns, as commonly believed, co-move positively and significantly with the returns on value stocks. Next, in specifications 4 and 5, we show results for a four-factor model that includes Pastor and Stambaugh's (2003) liquidity factor. The effect is significant only for the equally-weighted measure, which is the one favored by Pastor and Stambaugh (2003). Under this measure the annual liquidity premium is 5.3%.

[Insert Table 6 about here]

5.3. Abnormal Performance

We now go back to the evidence on private equity performance that we discussed above. We have shown raw performance numbers. Now that we have measures of risk, it is interesting to measure the decrease in NPV due to risk correction and, in particular to liquidity risk.

Results are shown in Table 7. We display the average NPV across vintage years and the average Profitability Index across vintage years (present value of aggregated dividends divided by present value of aggregated investments). We also show the NPV and PI on the aggregated cash flows (all vintage years pooled together).

We begin by discounting with a beta of one on the market factor. We find a large PI and positive NPV. Next, we show the result for the two factor model of Liu if we set the market beta to one and if we set it to 2.35 (as estimated in Table 6). We observe that both the NPV and PI decrease significantly. After market risk and liquidity risk correction, PI on the aggregate cash flow is only 1.06. This means that gross of fees, the value created is 6% of the value invested (for the whole investment's life). Metrick and Yasuda (2008) estimate fees to be about 20% in present value terms, which means that net of fees, and after risk adjustment, it is a deeply negative NPV investment for PE fund investors.

We repeat the same exercise with the Pastor and Stambaugh measure. Consistent with a lower liquidity premium with this measure, we find a higher PI and NPV. But the results are qualitatively the same as those above.

[Insert Table 7 about here]

5.4. Investment characteristics and exposure to liquidity risk

Next, we investigate which investment characteristics affect the exposure of PE to liquidity risk. Results in Table 8 suggests that investment size is a positive and significant determinant of exposure to liquidity risk. Larger investments are indeed more sensitive to exit conditions than smaller investments and thus potentially via this channel, more sensitive to liquidity risk.

[Insert Table 8 about here]

6. Robustness

6.1. US versus non-US

In this version, we have used only US liquidity factors. As pointed out by Bekaert, Harvey and Lundblad (2007) liquidity risk is mainly local. Although their results are on emerging markets, we expect a similar situation for European countries (roughly half of our sample). In the next version, we plan on using global and local liquidity risk measures. In this version, we show results separately for the sub-sample of US and non-US investments.

Table 9 shows the sub-sample of US investments. The Pastor and Stambaugh measure is stronger economically and statistically. The liquidity premium raises to 11.5% per year. The liquidity premium of Liu stays the same at about 15% per year. The aggregate liquidity measures of Sadka are not significant on this sub-sample, the other two stays significant.

In the non-US sample, the Pastor and Stambaugh measure is not significant while the Liu measure remains significant and of the same order of magnitude. All aggregate liquidity measures are significant except Acharya-Pedersen. Results are similar if we use local currencies to compute performance.

[Insert Table 9 about here]

6.2. Modified IRR

As pointed out above, IRR suffers from a re-investment assumption and our approach was an approximation given the existence of intermediary cash flows. We changed the assumption on the re-investment rate. We use either a flat 8% or the S&P 500 and in either case, we find that the results are very similar (Table 10). This gives credit to our performance measure and to the accuracy of the liquidity risk premium we estimate.

[Insert Table 10 about here]

7. Conclusion

Using a comprehensive dataset containing the cash flows of 3,421 liquidated private equity investments made between 1981 and 2000, we find positive and significant loadings of investment returns on aggregate liquidity innovation measures and liquidity risk factors. The premium for liquidity risk of private equity is up to 15% per year. After adjusting performance for liquidity risk, (gross-of-fees) private equity investments have an NPV close to zero. We also find that larger investments have higher exposure to liquidity risk. These results are robust to various changes in the empirical design. Our study has important implications for the performance evaluation of private equity investments.

References

Acharya, Viral V., and Lasse Heje Pedersen, 2005, Asset Pricing with Liquidity Risk. *Journal of Financial Economics*, 77: 375-410.

Amihud, Yakov, 2002, Illiquidity and Stock Returns: Cross-Section and Time-Series Effects. *Journal of Financial Markets,* 5(1): 31-56.

Amihud, Yakov, and Haim Mendelson, 1986, Asset Pricing and the Bid-Ask Spread. *Journal of Financial Economics*, 17: 223-249.

Amihud, Yakov, Haim Mendelson, and Lasse Heje Pedersen, 2005, *Foundations and Trends in Finance*, 1(4): 269-364.

Bandi, Federico M., Claudia E. Moise, and Jeffrey R. Russell, 2008, The Joint Pricing of Volatility and Liquidity. Working Paper, Chicago Booth and Case Western.

Bekaert, Geert, Campbell Harvey, and Christian Lundblad, 2007, Liquidity and Expected Returns: Lessons from Emerging Markets. *Review of Financial Studies,* 20(6): 1783-1831.

Chordia, Tarun, Avanidhar Subrahmanyam, and V. Ravi Anshuman, 2001, Trading Activity and Expected Stock Returns. *Journal of Financial Economics,* 59: 3-32.

Cochrane, John, 2005, The Risk and Return of Venture Capital. *Journal of Financial Economics*, 75: 3-52.

Cumming, Douglas J., 2008. Contracts and Exits in Venture Capital Finance. *Review of Financial Studies*, 21(5): 1947-1982.

Cumming, Douglas J., Grant Fleming and Armin Schwienbacher, 2005, Liquidity Risk and Venture Capital Finance. *Financial Management*, 34: 77-105.

Cumming, Douglas J., Daniel Schmidt, and Uwe Walz, 2009, Legality and Venture Capital Governance around the World. *Journal of Business Venturing*, forthcoming.

Cumming, Douglas, and Uwe Walz, 2004, Private Equity Returns and Disclosure around the World. Working Paper, EFA 2004 Maastricht.

Driessen, Joost, T. Chun Lin, and Ludovic Phalippou, 2008, A New Method to Estimate Risk and Return of Non-Traded Assets from Cash Flows: The Case of Private Equity Funds. NBER Working Paper 14144.

Fontaine, Jean-Sebastien and Garcia, Rene, 2008, Bond Liquidity Premia. SSRN Working Paper 966227.

Gompers, Paul A. and Josh Lerner, 2000, Money Chasing Deals: The impact of fund inflows on private equity valuations. *Journal of Financial Economics*, 55: 281–325.

Hasbrouck, Joel, 2009, Trading Costs and Returns for US Equities: Estimating Effective Costs from Daily Data, *Journal of Finance*, forthcoming.

Hochberg, Yael V., Alexander Ljungqvist, and Annette Vissing-Jorgensen, 2008, Informational Hold-up and Performance Persistence in Venture Capital. Working Paper.

Hochberg, Yael V., Alexander Ljungqvist, and Lu Yang, 2007, Whom You Know Matters: Venture Capital Networks and Investment Performance. *Journal of Finance*, 62 (1), 251-301.

Holmström, Bengt, and Jean Tirole, 2001, LAPM: A Liquidity-Based Asset Pricing Model. *Journal of Finance*, 56 (5): 1837-1867.

Jones, Charles, and Matthew Rhodes-Kropf, 2004, The Price of Diversifiable Risk in Venture Capital and Private Equity. Working Paper, Columbia University.

Kaplan, Steve and Antoinette Schoar, 2005, Private Equity Performance: Returns, Persistence and Capital Flows. *Journal of Finance*, 60: 1791-1823.

Kaplan, Steve N., Berk A. Sensoy and Per Strömberg, 2002, How well do venture capital databases reflect actual investments? Working Paper, University of Chicago.

Lerner, Josh, Antoinette Schoar, and Wan Wongsunwai, 2007, Smart Institutions, Foolish Choices? The Limited Partner Performance Puzzle. *Journal of Finance*, 62 (2): 731-764.

Lopez De Silanes, Florencio, and Ludovic Phalippou, 2009, Private Equity Investments: Performance and Diseconomies of Scale. Working Paper.

Liu, Weimin, 2006, A Liquidity-Augmented Capital Asset Pricing Model. *Journal of Financial Economics*, 82: 631–671.

Ljungqvist, Alexander and Matthew Richardson, 2003, The Cash Flow, Return and Risk Characteristics of Private Equity. Working Paper, NYU Stern School of Business.

Ljungqvist, Alexander, Matthew Richardson, and Daniel Wolfenzon, 2008, The Investment Behavior of Buyout Funds, NBER Working Paper W14180.

Lustig, H., 2009. The Market Price of Aggregate Risk and the Wealth Distribution. NBER Working Paper W11132.

Martínez, Miguel A., Belén Nieto, Gonzalo Rubio, and Mikel Tapia, 2005, Asset Pricing and Systematic Liquidity Risk: An Empirical Investigation of the Spanish Stock Market. *International Review of Economics and Finance,* 14: 81-103.

Metrick, Andrew, 2007, Venture Capital and the Finance of Innovation, Wiley & Sons.

Metrick, Andrew and Yasuda, Ayako, 2008, The Economics of Private Equity Funds, Swedish Institute for Financial Research Conference on The Economics of the Private Equity Market. Available at SSRN: http://ssrn.com/abstract=996334.

Pástor, Lubos and Robert F. Stambaugh, 2003, Liquidity Risk and Expected Stock Returns. *Journal of Political Economy*, 111(3): 642-685.

Petersen, Mitchell A., 2009, Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches. *Review of Financial Studies*, 22(1): 435-480.

Phalippou, Ludovic, 2009, Beware of Venturing into Private Equity, *Journal of Economic Perspectives*, 23(1): 147–66.

Phalippou, Ludovic and Oliver Gottschalg, 2009, The Performance of Private Equity Funds. *Review of Financial Studies*, forthcoming.

Sadka, Ronnie, 2006, Momentum and Post-Earnings-Announcement Drift Anomalies: The Role of Liquidity Risk. *Journal of Financial Economics*, 80: 309-349.

Watanabe, Akiko and Masahiro Watanabe, 2008, Time-Varying Liquidity Risk and the Cross Section of Stock Returns. *Review of Financial Studies*, 21 (6): 2449-2486.

Table 1: Sample selection and Performance

This table shows the (equally weighted) mean and median cash multiples. *Cash multiple* is the total amount distributed divided by total amount invested. All cash flows are in local currency. Liquidated investments are those officially liquidated as of December 2004. Some investments (mainly written-offs) do not have information about duration.

	Cash Multiple (local currency)		
	Mean	Median	N_obs
All buyout investments (1981-2007)	2.593	1.952	4401
All buyout investments (1981-2000)	2.607	1.933	3944
Liquidated buyout investments (1981-2000)	2.654	1.958	3566
Working sample:			
Liquidated buyout investments (1981-2000) with duration information	2.766	2.076	3421

Table 2: Correlation and distribution of performance measures

This table shows the correlation matrix for the natural logarithm of duration plus five performance measures. Performance measures are winsorized at the 95th percentile. Mean is value weighted by deflated investment size expressed in US dollar. The distribution of each variable is displayed underneath the correlation matrix. * denotes that the performance is computed on cash flows in local currency.

	Duration	IRR*	IRR	MIRR_8%	MIRR_S&P	Multiple
Duration	1.000					
IRR*	-0.126	1.000				
IRR	-0.129	0.998	1.000			
MIRR_8%	-0.094	0.937	0.938	1.000		
MIRR_S&P	-0.087	0.928	0.924	0.978	1.000	
Multiple	0.067	0.740	0.740	0.717	0.709	1.000
Mean (VW)	51.765	0.216	0.231	0.095	0.143	2.441
Median	49.000	0.252	0.261	0.173	0.201	2.076
St. Deviation	29.049	0.770	0.778	0.529	0.511	2.733
5th percentile	12.300	-1.000	-1.000	-0.956	-0.842	0.000
95th percentile	117.000	2.047	2.096	1.216	1.294	10.174

Table 3: Descriptive statistics

This table shows the descriptive statistics for our working sample. All cash flows are converted in US dollars. Investment size is expressed in 2000 US dollars. VW is value-weighted using investment size and DVW is duration-times-value-weighted. Duration is measured from first to last cash flow. Performance measures are cash multiple (total distributed divided by total invested), Internal Rate of Return and Modified IRR with either a flat 8% or S&P 500 index as re-investment rate. Performance and sample distribution are displayed by year (Panel A), by industry (Panel B), by investment stage (Panel C), by exit type (Panel D), by country (Panel E).

Panel A: Performance per year

		Size	Mutiple		IRR			MIRR_8%			MIRR_S&P		
Year	N_obs	Median	Median	Mean VW	Median	Mean VW	Mean DVW	Median	Mean VW	Mean DVW	Median	Mean VW	Mean DVW
1981	8	0.484	0.576	5.216	-0.074	0.017	0.073	-0.072	0.029	0.080	-0.053	0.139	0.171
1982	10	0.681	0.180	4.768	-0.222	0.433	0.250	-0.211	0.224	0.106	-0.117	0.316	0.213
1983	17	0.835	0.435	3.906	-0.183	0.181	-0.017	-0.151	0.128	0.063	-0.014	0.245	0.201
1984	19	2.223	4.106	5.480	0.362	0.561	0.514	0.245	0.245	0.191	0.280	0.321	0.281
1985	49	2.449	2.834	3.887	0.463	0.731	0.285	0.252	0.444	0.197	0.311	0.518	0.277
1986	72	2.164	2.672	3.445	0.262	0.247	0.135	0.187	0.085	0.085	0.257	0.145	0.162
1987	107	1.788	1.443	2.254	0.110	0.304	0.143	0.065	0.188	0.069	0.136	0.227	0.116
1988	160	1.565	1.523	2.561	0.104	0.336	0.217	0.079	0.240	0.122	0.121	0.295	0.186
1989	141	2.743	1.508	3.484	0.121	0.157	0.181	0.094	0.099	0.118	0.141	0.167	0.185
1990	194	3.081	1.695	2.735	0.147	0.318	0.219	0.110	0.208	0.124	0.153	0.277	0.197
1991	238	3.738	2.817	2.851	0.346	0.372	0.285	0.220	0.244	0.181	0.271	0.295	0.240
1992	249	4.503	2.178	2.578	0.278	0.295	0.248	0.190	0.184	0.144	0.229	0.248	0.223
1993	239	4.269	2.628	2.940	0.424	0.432	0.322	0.269	0.260	0.175	0.349	0.328	0.233
1994	375	4.620	2.394	2.771	0.326	0.427	0.405	0.214	0.151	0.143	0.263	0.242	0.232
1995	300	6.777	1.822	2.373	0.212	0.224	0.209	0.158	0.132	0.121	0.170	0.194	0.179
1996	345	6.876	1.848	2.447	0.252	0.294	0.195	0.172	0.162	0.099	0.184	0.243	0.168
1997	354	8.773	1.870	2.450	0.307	0.238	0.275	0.204	0.069	0.103	0.187	0.102	0.131
1998	251	11.906	1.758	1.804	0.195	0.003	0.035	0.174	-0.058	-0.014	0.149	-0.011	0.028
1999	218	10.399	1.147	1.649	0.067	-0.066	0.115	0.059	-0.118	0.060	0.058	-0.133	0.051
2000	220	6.046	0.215	1.021	-0.544	-0.359	-0.001	-0.506	-0.382	-0.036	-0.520	-0.385	-0.032

Panel B: Per industry

Industry	N_obs	Size Median	Mutiple Median	Mutiple Mean VW	IRR Median	IRR Mean VW	IRR Mean DVW	MIRR_8% Median	MIRR_8% Mean VW	MIRR_8% Mean DVW	MIRR_S&P Median	MIRR_S&P Mean VW	MIRR_S&P Mean DVW
Industrial/Manufacturing	640	4.996	1.844	2.479	0.207	0.235	0.240	0.158	0.081	0.088	0.179	0.140	0.153
Consumer industry/Food	359	6.393	1.944	2.468	0.237	0.202	0.224	0.170	0.100	0.126	0.194	0.149	0.173
Healthcare/LS	311	3.746	1.670	2.469	0.171	0.192	0.200	0.109	0.110	0.115	0.142	0.140	0.154
Other Services	304	5.457	1.994	1.902	0.232	0.042	0.064	0.163	-0.013	0.017	0.189	0.061	0.104
Software	279	1.243	2.083	3.121	0.287	0.328	0.284	0.193	0.119	0.095	0.215	0.157	0.142
Retail	201	7.668	2.092	2.947	0.243	0.277	0.303	0.162	0.126	0.156	0.205	0.169	0.193
Media	190	11.606	2.325	2.547	0.333	0.296	0.299	0.201	0.173	0.181	0.233	0.213	0.222
IT	172	3.505	2.127	1.974	0.262	-0.070	0.329	0.140	-0.215	0.122	0.208	-0.200	0.148
Telecom	134	4.761	2.193	1.747	0.232	-0.249	0.089	0.157	-0.300	0.022	0.221	-0.272	0.072
Financial Services	118	6.203	2.522	2.032	0.397	-0.002	0.216	0.207	-0.081	0.112	0.257	-0.052	0.155
Internet	66	4.784	0.088	1.061	-0.754	-0.397	0.039	-0.691	-0.445	-0.053	-0.626	-0.414	-0.012
Leisure	66	4.852	3.007	2.818	0.631	0.436	0.479	0.296	0.193	0.207	0.422	0.274	0.293
Semiconductor	63	8.430	1.333	1.885	0.107	0.133	0.136	0.066	0.064	0.059	0.098	0.136	0.125
Materials	58	4.305	1.826	2.575	0.195	-0.028	0.100	0.116	-0.040	0.131	0.177	-0.002	0.191
Textiles	56	6.632	1.096	1.562	0.015	0.009	0.128	0.015	-0.089	-0.011	0.081	-0.011	0.083
Business Services	49	7.354	1.846	2.388	0.364	0.357	0.287	0.214	0.218	0.145	0.237	0.285	0.209
Construction	47	5.967	2.876	3.008	0.355	0.799	0.685	0.298	0.311	0.243	0.304	0.418	0.337
Natural Resources/Energy	39	8.127	2.101	1.914	0.294	0.130	0.079	0.239	0.098	0.069	0.224	0.140	0.111
HighTech	38	4.509	1.072	2.233	0.020	0.376	0.428	0.018	0.066	0.095	0.027	0.146	0.166
Logistics	37	7.923	2.618	2.347	0.334	0.173	0.201	0.273	0.063	0.147	0.286	0.085	0.174
Transportation	29	5.688	2.570	2.663	0.392	0.350	0.318	0.198	0.217	0.183	0.280	0.250	0.239
Traditional products	22	4.707	1.666	1.822	0.156	0.045	0.069	0.111	0.052	0.067	0.137	0.089	0.104
Hotel	18	6.766	1.776	2.081	0.217	0.194	0.169	0.157	0.177	0.153	0.209	0.184	0.151
Waste/Recycling	10	6.469	1.590	1.997	0.342	0.615	0.455	0.226	0.282	0.146	0.249	0.303	0.202
Environment	5	1.609	0.127	0.258	-0.875	-0.806	-0.810	-0.825	-0.698	-0.666	-0.288	-0.413	-0.274

Panel C: Per investment stage

Investment stage	N_obs	Size Median	Mutiple Median	Mutiple Mean VW	IRR Median	IRR Mean VW	IRR Mean DVW	MIRR_8% Median	MIRR_8% Mean VW	MIRR_8% Mean DVW	MIRR_S&P Median	MIRR_S&P Mean VW	MIRR_S&P Mean DVW
MBO/MBI	2322	6.618	1.983	2.213	0.253	0.155	0.207	0.180	0.034	0.087	0.205	0.081	0.142
Growth	806	1.433	1.384	2.133	0.102	0.033	0.132	0.077	-0.056	0.043	0.104	0.009	0.112
LBO	184	7.031	2.732	2.775	0.305	0.180	0.237	0.217	0.109	0.161	0.237	0.125	0.183
Acquisition Financing	110	13.074	2.080	2.544	0.312	0.430	0.369	0.205	0.280	0.238	0.218	0.327	0.278
Recapitalisation	105	4.620	2.230	2.824	0.315	0.223	0.273	0.176	0.099	0.164	0.242	0.157	0.222
Turnaround	33	5.042	1.618	1.185	0.174	0.025	-0.085	0.148	-0.038	-0.105	0.149	-0.018	-0.076
Spin Off	6	2.710	0.109	0.804	-0.883	-0.681	-0.834	-0.706	-0.608	-0.664	-0.627	-0.496	-0.502

Panel D: Per exit channel

Exit channel	N_obs	Size Median	Mutiple Median	Mutiple Mean VW	IRR Median	IRR Mean VW	IRR Mean DVW	MIRR _8% Median	MIRR _8% Mean VW	MIRR _8% Mean DVW	MIRR _S&P Median	MIRR _S&P Mean VW	MIRR _S&P Mean DVW
Sale	1112	6.307	2.061	2.443	0.286	0.315	0.248	0.213	0.196	0.145	0.230	0.231	0.183
Write off	420	4.549	0.000	0.023	-1.000	-0.984	-0.975	-0.997	-0.922	-0.813	-0.999	-0.800	-0.555
IPO	288	8.182	3.528	3.599	0.599	0.543	0.417	0.395	0.332	0.237	0.432	0.376	0.293
Public merger	73	7.614	3.264	2.517	0.355	0.408	0.393	0.254	0.191	0.181	0.290	0.252	0.227

Table 4: Correlation and distribution of the factors

This table shows the correlation matrix for the (time-series of the) six traded factors (market premium, value premium, size premium and three illiquid minus liquid factors) plus the four aggregate measures of liquidity. The time period is from January 1981 to December 2004. The frequency is monthly.

	Rm-Rf	HML	SMB	IML_Liu	IML_ew_PS	IML_vw_PS	PS_LIQ	AP_Liq	Sadka_tf	Sadka_pv
Rm-Rf	1.000									
HML	-0.503	1.000								
SMB	0.186	-0.432	1.000							
IML_Liu	-0.751	0.683	-0.292	1.000						
IML_ew_PS	-0.110	-0.230	0.135	0.061	1.000					
IML_vw_PS	-0.095	-0.184	0.187	0.025	0.777	1.000				
PS_LIQ	0.330	-0.062	0.037	-0.170	-0.003	-0.035	1.000			
AP_Liq	0.090	0.020	0.114	0.030	0.000	0.010	0.061	1.000		
Sadka_tf	-0.047	0.142	0.090	0.246	-0.005	0.030	0.084	0.217	1.000	
Sadka_pv	0.108	-0.002	0.114	0.058	0.080	0.044	0.226	0.183	0.187	1.000
Mean	0.594	0.500	0.123	0.910	0.559	0.401	0.002	-0.012	0.000	0.000
Median	1.030	0.405	-0.010	1.305	0.873	0.466	0.008	-0.015	0.000	0.001
St. Deviation	4.478	3.220	3.337	4.057	4.559	5.301	0.048	0.166	0.002	0.006
5th percentile	-6.910	-4.220	-4.330	-6.109	-7.303	-6.948	-0.068	-0.260	-0.003	-0.010
95th percentile	7.100	5.630	4.890	7.504	5.930	7.281	0.061	0.255	0.003	0.007

Table 5: Private Equity Returns and Market-wide Liquidity

This table shows the result of OLS pooled panel regression. Standard errors are based on a three dimensional clustering (month/year of the investment, fund country and investment industry); corresponding t-statistics are reported below each coefficient in italics. Dependent variables include the usual three asset pricing factor (market premium, value premium, size premium) and four aggregate (market-wide) liquidity measures. Each dependent variable is the time-series average during investment's life of the corresponding variable.

	Dependent variable: IRR in US dollar											
	spec 1	spec 2	spec 3	spec 4	spec 5	spec 6	spec 7	spec 8	spec 9	spec 10	spec 11	spec 12
PS_LIQ	1.422	0.947	0.930									
	7.380	*3.680*	*3.570*									
AP_LIQ				0.268	0.182	0.159						
				4.080	*2.720*	*2.180*						
Sadka_tf							15.553	15.507	14.837			
							2.160	*2.280*	*1.730*			
Sadka_pv										15.699	9.331	7.946
										4.210	*2.410*	*1.970*
Rm-Rf		0.967	1.492		1.563	1.965		1.697	1.734		1.484	1.873
		3.060	*2.930*		*6.390*	*4.210*		*7.080*	*3.540*		*5.830*	*4.010*
HML			0.633			0.536			0.160			0.501
			1.510			*1.210*			*0.320*			*1.170*
SMB			0.304			0.118			-0.189			0.100
			0.720			*0.270*			*-0.410*			*0.230*
Constant	-0.003	-0.009	-0.015	0.008	-0.006	-0.011	-0.003	-0.015	-0.015	-0.001	-0.011	-0.015
	-1.980	*-3.530*	*-3.000*	*3.010*	*-1.530*	*-1.670*	*-1.460*	*-5.630*	*-3.400*	*-0.440*	*-4.740*	*-3.230*
N_obs	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421
Adj. R-square	0.039	0.045	0.047	0.012	0.040	0.041	0.005	0.040	0.040	0.016	0.040	0.041

Table 6: Private Equity Returns and Traded Liquidity Risk Factors

This table shows the result of OLS pooled panel regression. Standard errors are based on a three dimensional clustering (month/year of the investment, fund country and investment industry); corresponding t-statistics are reported below each coefficient in italics. Dependent variables include the usual three asset pricing factor (market premium, value premium, size premium) and three zero-cost illiquid minus liquid portfolios (i.e. traded liquidity risk factors). Each dependent variable is the time-series average during investment's life of the corresponding variable.

	Dependent variable: IRR in US dollar				
	spec 1	spec 2	spec 3	spec 4	spec 5
IML_Liu		1.292			
		4.120			
IML_ew_PS				0.769	
				2.450	
IML_vw_PS					0.558
					1.550
Rm-Rf	1.698	2.352	2.221	2.261	2.233
	7.070	*8.380*	*5.240*	*5.280*	*5.240*
HML			0.719	1.507	1.096
			1.740	*3.020*	*2.230*
SMB			0.177	0.459	0.235
			0.410	*1.050*	*0.540*
Constant	-0.013	-0.027	-0.019	-0.023	-0.021
	-5.450	*-6.220*	*-4.150*	*-4.720*	*-4.270*
N_obs	3421	3421	3421	3421	3421
Adj. R-square	0.035	0.049	0.037	0.042	0.040

Table 7: Abnormal Performance of Private Equity Investments

The table reports Net Present Value (NPV) and Profitability Index (PI) with different discount rates. The sample is all liquidated investments made between 1981 and 2000. Each performance measure is computed either as a size-weighted (VW) average of the measure for each investment-year in the sample or aggregating all the cash flows in the sample (Agg.). The NPV is computed using the sum of the cash flows in each month of the relevant investment period and is expressed in million of US dollars. The monthly discount rate in the NPV is the sum of one, the risk free rate in the month, and the products of the risk loadings times the realization of the risk factors in the month. The profitability index is the ratio of the discounted value of the aggregate dividends over the discounted value of the aggregate investments.

Risk exposures					Abnormal PE performance			
β_{capm}	β_{Liu}	β_{smb}	β_{hml}	β_{ew_PS}	NPV (VW)	PI (VW)	Agg. NPV	Agg. PI
1.00	0.00	0.00	0.00	0.00	2.45E+09	1.84	5.31E+09	1.78
1.00	1.23	0.00	0.00	0.00	7.73E+08	1.32	4.51E+08	1.31
2.35	1.23	0.00	0.00	0.00	4.75E+08	1.14	6.89E+07	1.06
1.00	0.00	0.00	0.00	0.77	2.98E+09	1.84	1.83E+09	1.75
1.00	0.00	0.46	1.51	0.77	1.28E+09	1.42	3.29E+08	1.46
2.26	0.00	0.46	1.51	0.77	1.13E+09	1.28	7.31E+07	1.16

Table 8: Risk exposure as a function of size

The table reports estimates from pooled regressions with IRR (based on US dollar cash flows) as dependent variable. Where indicated, the factors are multiplied by deflated US dollar investment size. Also, where indicated, the factors are multiplied by both investment year dummies and the investment size.

Panel A: Traded factors

			IML_Liu			IML_ew_PS				IML_vw_PS			
Liquidity factor			0.137	1.266	7.001	0.675	-0.018	0.520	1.501	0.718	-0.008	0.440	-0.417
			0.440	*3.510*	*2.120*	*2.860*	*-0.060*	*1.490*	*1.070*	*2.350*	*-0.020*	*1.100*	*-0.380*
Liquidity factor * Size			-0.006	0.003	0.008	0.005	0.007	0.011	0.009	0.005	0.006	0.005	0.008
			-0.750	*0.260*	*0.830*	*2.750*	*2.500*	*1.840*	*1.490*	*1.920*	*1.960*	*0.640*	*1.300*
Size	-0.051	-0.049	-0.021	-0.090	-0.155	-0.038	-0.002	-0.128	-0.174	-0.070	-0.034	-0.097	-0.186
	-0.940	*-0.380*	*-0.220*	*-0.630*	*-1.220*	*-0.790*	*-0.030*	*-1.050*	*-1.420*	*-1.450*	*-0.580*	*-0.670*	*-1.430*
Rm-Rf	1.606	2.151		2.220	5.937		1.656	2.138	0.773		1.634	2.132	-0.192
	6.040	*4.470*		*6.880*	*2.840*		*4.920*	*4.410*	*0.460*		*5.550*	*4.420*	*-0.110*
Rm-Rf * Size	0.005	0.005		0.008	0.011		-0.004	0.009	0.014		0.000	0.008	0.015
	0.840	*0.400*		*0.960*	*1.370*		*-0.450*	*0.770*	*1.220*		*0.070*	*0.630*	*1.250*
HML		0.839						1.225	1.639			1.073	-2.536
		1.830						*2.160*	*0.510*			*1.930*	*-1.260*
HML * Size		-0.004						0.017	0.021			0.004	0.017
		-0.360						*1.140*	*1.540*			*0.210*	*1.210*
SMB		-0.003						0.351	-0.162			0.096	0.655
		-0.010						*0.720*	*-0.110*			*0.200*	*0.420*
SMB * Size		0.010						0.002	0.004			0.007	0.007
		0.960						*0.190*	*0.380*			*0.700*	*0.640*
Year * factors	No	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
N_obs	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421
Adj. R-square	0.035	0.038	0.001	0.049	0.106	0.016	0.037	0.044	0.110	0.010	0.036	0.040	0.113

Panel B: Non-traded factors

	PS_LIQ				AP_LIQ				Sadka_tf				Sadka_pv			
Liquidity factor	1.279	0.734	0.722	0.666	0.176	0.099	0.080	1.024	16.271	15.468	15.607	23.859	12.649	6.281	4.936	-12.295
	6.130	*2.640*	*2.570*	*0.730*	*2.440*	*1.330*	*1.010*	*3.140*	*2.050*	*2.070*	*1.650*	*0.750*	*3.120*	*1.470*	*1.110*	*-0.590*
Liquidity factor * Size	0.008	0.015	0.013	0.010	0.007	0.007	0.006	0.006	-0.020	0.031	-0.136	-0.143	0.265	0.271	0.251	0.266
	2.940	*2.330*	*2.100*	*1.600*	*3.740*	*3.260*	*3.060*	*3.440*	*-0.070*	*0.120*	*-0.350*	*-0.360*	*4.170*	*3.450*	*2.740*	*2.890*
Size	0.027	0.103	0.115	-0.016	0.243	0.268	0.315	0.173	-0.092	-0.067	-0.095	-0.118	-0.084	-0.031	-0.020	-0.055
	0.660	*1.430*	*1.100*	*-0.130*	*2.840*	*2.570*	*1.960*	*1.930*	*-1.350*	*-1.060*	*-0.740*	*-0.940*	*-2.150*	*-0.720*	*-0.180*	*-0.480*
Rm-Rf		1.130	1.660	0.058		1.555	1.979	0.486		1.603	1.619	-0.197		1.490	1.905	0.397
		3.220	*2.950*	*0.040*		*5.730*	*3.800*	*0.340*		*6.060*	*2.920*	*-0.120*		*5.220*	*3.630*	*0.220*
Rm-Rf * Size		-0.013	-0.014	-0.002		-0.001	-0.007	0.002		0.005	0.010	0.012		-0.002	-0.003	-0.001
		-1.350	*-1.330*	*-0.160*		*-0.200*	*-0.590*	*0.210*		*0.860*	*0.660*	*0.790*		*-0.400*	*-0.290*	*-0.070*
HML			0.726	-1.687			0.641	-1.645			0.238	-2.668			0.601	-2.234
			1.560	*-1.070*			*1.320*	*-1.180*			*0.430*	*-1.360*			*1.270*	*-1.190*
HML * Size			-0.005	0.006			-0.008	0.003			0.001	0.009			-0.003	0.004
			-0.430	*0.520*			*-0.740*	*0.330*			*0.100*	*0.600*			*-0.340*	*0.360*
SMB			0.171	-0.364			-0.029	-2.225			-0.400	-0.480			-0.013	0.340
			0.370	*-0.220*			*-0.060*	*-1.400*			*-0.760*	*-0.230*			*-0.030*	*0.240*
SMB * Size			0.003	0.008			0.001	0.004			0.014	0.013			0.005	0.004
			0.320	*0.760*			*0.140*	*0.460*			*0.880*	*0.780*			*0.550*	*0.420*
Years * factors	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
N_obs	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421
Adj. R-square	0.040	0.048	0.049	0.106	0.018	0.045	0.046	0.109	0.006	0.040	0.041	0.108	0.021	0.043	0.044	0.119

Table 9: US versus Non-US investments

This table shows the result of OLS pooled panel regression. Standard errors are based on a three dimensional clustering (month/year of the investment, fund country and investment industry); corresponding t-statistics are reported below each coefficient in italics. Dependent variables include the usual three asset pricing factor and either of the seven liquidity measures used in Tables 4 and 5. Each dependent variable is the time-series average during the investment's life of the corresponding variable. Panel A includes only US investments while panels B and C include non-US investments. In panel B performance is in US dollars while in panel C performance is in local currency.

Panel A: US investments, performance in US dollars

	Dependent variable: IRR in US dollar						
Liquidity variable is:	IML_ew_PS	IML_vw_PS	IML_Liu	PS_LIQ	AP_LIQ	Sadka_tf	Sadka_pv
Liquidity	1.636	1.048	1.145	1.389	0.255	-2.211	-3.847
	3.530	*2.060*	*1.920*	*3.410*	*2.310*	*-0.280*	*-0.620*
Rm-Rf	4.519	4.454	3.837	3.363	4.060	4.658	4.765
	6.230	*6.250*	*7.380*	*3.900*	*4.950*	*6.440*	*6.220*
HML	3.107	2.052		1.267	1.173	1.535	1.546
	3.730	*2.580*		*1.810*	*1.530*	*2.060*	*2.170*
SMB	1.522	0.996		1.124	0.827	1.125	1.114
	2.160	*1.380*		*1.640*	*1.110*	*1.530*	*1.490*
Constant	-0.039	-0.034	-0.032	-0.026	-0.020	-0.033	-0.034
	-4.850	*-4.370*	-3.920	*-3.150*	*-1.890*	*-4.320*	*-4.210*
N_obs	1151	1151	1151	1151	1151	1151	1151
Adj. R-square	0.148	0.131	0.124	0.147	0.131	0.122	0.123

Panel B: Non-US investments, performance in US dollars

	Dependent variable: IRR in US dollar						
Liquidity variable is:	IML_ew_PS	IML_vw_PS	IML_Liu	PS_LIQ	AP_LIQ	Sadka_tf	Sadka_pv
Liquidity	0.172	0.272	1.435	0.549	0.065	31.829	15.269
	0.450	*0.610*	*3.930*	*1.660*	*0.690*	*2.490*	*3.050*
Rm-Rf	1.395	1.401	1.750	0.969	1.287	0.301	0.719
	2.770	*2.750*	*5.430*	*1.600*	*2.350*	*0.480*	*1.300*
HML	0.783	0.800		0.560	0.526	-0.602	0.163
	1.310	*1.320*		*1.120*	*0.990*	*-0.930*	*0.320*
SMB	-0.069	-0.091		-0.043	-0.146	-0.941	-0.275
	-0.130	*-0.170*		*-0.080*	*-0.280*	*-1.600*	*-0.520*
Constant	-0.016	-0.016	-0.027	-0.013	-0.012	-0.008	-0.009
	-2.800	*-2.700*	*-5.160*	*-2.150*	*-1.470*	*-1.500*	*-1.630*
N_obs	2270	2270	2270	2270	2270	2270	2270
Adj. R-square	0.015	0.016	0.045	0.019	0.016	0.026	0.027

Panel C: Non-US investments, performance in local currency

	Dependent variable: IRR in local currency						
Liquidity variable is:	IML_ew_PS	IML_vw_PS	IML_Liu	PS_LIQ	AP_LIQ	Sadka_tf	Sadka_pv
Liquidity	0.098	0.218	1.384	0.497	0.027	34.235	14.800
	0.260	*0.490*	*3.760*	*1.490*	*0.290*	*2.690*	*2.960*
Rm-Rf	1.440	1.448	1.746	1.059	1.393	0.271	0.791
	2.860	*2.850*	*5.380*	*1.750*	*2.550*	*0.430*	*1.430*
HML	0.712	0.766		0.569	0.578	-0.689	0.181
	1.180	*1.260*		*1.130*	*1.090*	*-1.070*	*0.350*
SMB	-0.019	-0.020		0.028	-0.062	-0.922	-0.190
	-0.040	*-0.040*		*0.050*	*-0.120*	*-1.560*	*-0.360*
Constant	-0.015	-0.015	-0.026	-0.012	-0.013	-0.007	-0.009
	-2.620	*-2.560*	*-4.850*	*-2.100*	*-1.640*	*-1.300*	*-1.560*
N_obs	2270	2270	2270	2270	2270	2270	2270
Adj. R-square	0.016	0.016	0.031	0.018	0.016	0.028	0.026

Table 10: Alternative performance measures

This table shows the result of OLS pooled panel regression. Standard errors are based on a three dimensional clustering (month/year of the investment, fund country and investment industry); corresponding t-statistics are reported below each coefficient in italics. Dependent variables include the usual three asset pricing factor and either of the seven liquidity measures used in Tables 4 and 5. Each dependent variable is the time-series average during the investment's life of the corresponding variable. In panel A, performance is in local currency; in panel B, performance is Modified IRR with S&P 500 as re-investment rate; in panel C, performance is Modified IRR with a flat 8% as re-investment rate.

Panel A: IRR in local currency

	Dependent variable: IRR in local currency						
Liquidity variable is:	IML_ew_PS	IML_vw_PS	IML_Liu	PS_LIQ	AP_LIQ	Sadka_tf	Sadka_pv
Liquidity	0.724	0.528	1.256	0.895	0.132	16.209	7.669
	2.300	*1.470*	*3.980*	*3.420*	*1.810*	*1.880*	*1.900*
Rm-Rf	2.297	2.271	2.348	1.559	2.047	1.728	1.924
	5.370	*5.340*	*8.330*	*3.070*	*4.400*	*3.520*	*4.120*
HML	1.468	1.083		0.643	0.574	0.116	0.516
	2.930	*2.200*		*1.530*	*1.290*	*0.230*	*1.200*
SMB	0.499	0.288		0.356	0.185	-0.167	0.160
	1.140	*0.660*		*0.840*	*0.420*	*-0.360*	*0.360*
Constant	-0.022	-0.020	-0.026	-0.014	-0.012	-0.015	-0.015
	-4.580	*-4.160*	*-5.960*	*-2.960*	*-1.830*	*-3.250*	*-3.180*
N_obs	3421	3421	3421	3421	3421	3421	3421
Adj. R-square	0.042	0.040	0.053	0.047	0.040	0.041	0.041

Panel B: Modified IRR; S&P 500 as re-investment rate

	Dependent variable: Modified IRR; S&P 500 as re-investment rate						
Liquidity variable is:	IML_ew_PS	IML_vw_PS	IML_Liu	PS_LIQ	AP_LIQ	Sadka_tf	Sadka_pv
Liquidity	0.672	0.445	1.179	0.799	0.159	11.086	7.118
	2.660	*1.500*	*4.620*	*3.790*	*2.670*	*1.570*	*2.160*
Rm-Rf	2.125	2.100	2.231	1.464	1.834	1.726	1.778
	5.980	*5.940*	*9.900*	*3.460*	*4.700*	*4.250*	*4.580*
HML	1.360	0.973		0.598	0.488	0.255	0.477
	3.320	*2.380*		*1.720*	*1.320*	*0.610*	*1.350*
SMB	0.316	0.116		0.179	0.011	-0.204	0.001
	0.880	*0.320*		*0.520*	*0.030*	*-0.540*	*0.000*
Constant	-0.022	-0.020	-0.026	-0.015	-0.011	-0.016	-0.016
	-5.490	*-4.950*	*-7.390*	*-3.670*	*-1.940*	*-4.230*	*-3.910*
N_obs	3421	3421	3421	3421	3421	3421	3421
Adj. R-square	0.062	0.058	0.076	0.068	0.062	0.058	0.060

Panel C: Modified IRR; 8% as re-investment rate

	Dependent variable: Modified IRR; 8% as re-investment rate						
Liquidity variable is:	IML_ew_PS	IML_vw_PS	IML_Liu	PS_LIQ	AP_LIQ	Sadka_tf	Sadka_pv
Liquidity	0.621	0.421	1.111	0.751	0.131	12.767	6.510
	2.450	*1.430*	*4.350*	*3.570*	*2.220*	*1.810*	*1.990*
Rm-Rf	1.932	1.909	1.987	1.312	1.688	1.481	1.615
	5.480	*5.440*	*8.740*	*3.130*	*4.370*	*3.670*	*4.190*
HML	1.294	0.942		0.588	0.506	0.177	0.479
	3.170	*2.330*		*1.700*	*1.380*	*0.430*	*1.360*
SMB	0.382	0.198		0.257	0.106	-0.161	0.092
	1.070	*0.560*		*0.750*	*0.300*	*-0.430*	*0.260*
Constant	-0.023	-0.021	-0.027	-0.016	-0.013	-0.017	-0.017
	-5.780	*-5.290*	*-7.470*	*-4.070*	*-2.470*	*-4.500*	*-4.320*
N_obs	3421	3421	3421	3421	3421	3421	3421
Adj. R-square	0.048	0.045	0.061	0.053	0.046	0.046	0.046

Figure 2: Distribution of Performance Measures

Figure 2A: winsorized US dollar IRR

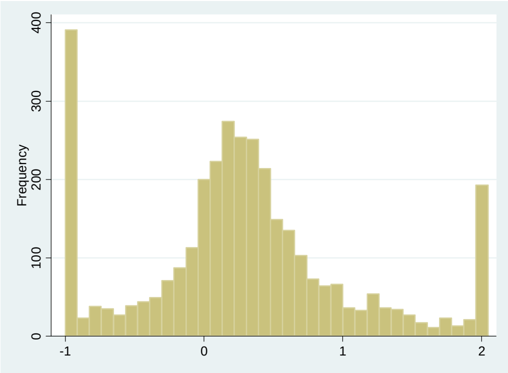

Figure 2B: winsorized local currency MIRR_8%

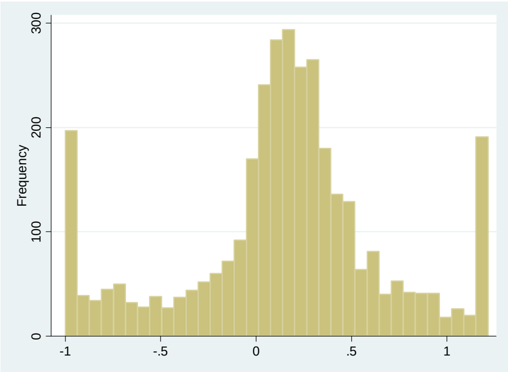

Figure 2C: winsorized US dollar MIRR_S&P