Cyclicality, Performance Measurement, and Cash Flow Liquidity in Private Equity *

David T. Robinson
Duke University and NBER

Berk A. Sensoy
Ohio State University

September 20, 2013

Abstract

This paper takes a new approach towards understanding the risk/return tradeoff that investors to private equity face when they invest in private equity partnerships. We study the sensitivity of private equity cash flows to business cycle and market conditions using a new large dataset of cash flows to 837 buyout and venture capital funds from 1984-2010. Buyout has outperformed the S&P 500 by 18% on average over the life of the fund, while venture capital has underperformed since at least the late 1990s. Most cash flow variation at a point in time is diversifiable – either idiosyncratic to a given fund or explained by the fund's age. Both capital calls and distributions also have a systematic component that is procyclical on average. Distributions are more sensitive than calls, implying procyclical aggregate net cash flows. A consequence is that the well-known finding that funds raised in hot markets underperform in absolute terms is sharply attenuated when comparing to public equities. Consistent with a liquidity premium for calling capital in bad times, we find that funds with a relatively high propensity to do so perform better in both absolute and relative terms. Venture capital cash flows and performance are considerably more cyclical than buyout, and the links between cyclical cash flows and performance are likewise stronger.

*For helpful comments on an earlier draft, we thank Harry DeAngelo, Tim Jenkinson, Steve Kaplan, Josh Lerner, Andrew Metrick, Oguzhan Ozbas, Ludovic Phalippou, Antoinette Schoar, Morten Sørensen, Per Strömberg, René Stulz, Mike Weisbach, and seminar and conference participants at Baylor University, Erasmus University Rotterdam, London School of Economics, Tilburg University, University of California at San Diego, the EFA 2011 Annual Meeting, the NBER Entrepreneurship Summer Institute, and the third annual LBS Private Equity Symposium for helpful comments and discussions. An earlier draft of this paper previously circulated under the title "Private Equity in the 21st Century: Cash flows, Performance and Contract terms from 1984-2010." Contact information: davidr@duke.edu; sensoy_4@fisher.osu.edu.

I. Introduction

Understanding the risk/return tradeoff that investors experience when they invest in private equity partnerships continues to be a challenge for financial economists, despite the prevalence and importance of the private equity industry in the modern economy. A number of existing papers have quite naturally attempted to measure risks to private equity by measuring the betas of the underlying companies in which private equity funds invest.[1] Motivated in part by recent advances in asset pricing that provide the theoretical foundations for cash-flow based performance measures in private equity (Korteweg and Nagel, 2013), this paper departs from previous work and studies this problem from a fresh perspective.

In particular, we study how the cash flows that private equity investors receive (rather than the underlying investments that the private equity managers hold) vary with macroeconomic conditions. This allows us to study a set of closely related questions. First, what is the risk-adjusted performance of private equity? Second, by how much can the cash-flow volatility of private equity investments be lowered by diversifying over time and across private equity funds? Third, does the co-movement of private equity cash flows with business cycle and market conditions support the widely held view that it should command a substantial liquidity premium? Finally, what are the implications of such cash flow risk for fund performance?

Our approach is motivated by the fact that private equity funds are contractually obligated to provide capital to the fund when it is called by the fund managers (up to a total commitment), and in return receive distributions when the fund exits its investments. These cash flows reflect not only the characteristics of the underlying investments made by the fund, but also the fund manager's decisions about the timing and magnitude of investments and exits. It is these managed cash flow streams, not the underlying investments of the funds *per se*, that determine both the returns investors ultimately receive and the liquidity demand or supply they face at any point in time.

We use a proprietary database of quarterly cash flows for 837 buyout and venture capital funds from 1984 to 2010, representing almost $600 billion in total committed capital. The

[1] For instance, Driessen et al. (2012) report a beta of 1.3 for buyout and 2.5 for venture capital.

dataset is the first available for academic research to include cash flow information for a large sample of private equity funds raised after the pre-1995 period first studied by Kaplan and Schoar (2005).

We begin by reporting cash-flow based statistics on the average performance of private equity funds in the post-Kaplan and Schoar (2005) sample period. Our results show that the average buyout fund outperformed the S&P 500 index by 18% net of fees over the life of the fund (i.e., had an average Kaplan-Schoar (2005) public market equivalent (PME) of 1.18).[2] Recent work by Korteweg and Nagel (2013) shows that, under appropriate conditions on investor preferences, the PME incorporates all necessary adjustments for the fund's market risk. Thus, this 18% can be interpreted as the private equity alpha with respect to market risk earned over the life a typical fund. The question then becomes whether this excess return is sufficient to compensate investors for the liquidity risk associated with investing in private equity partnerships.

We focus on a particular type of liquidity risk that investors in private equity face: cash flow risk. This cash flow risk stems from the particular institutional features of the industry.[3] Namely, private equity commitments are not fully funded up front; they are instead drawn down over time as capital is called by the general partner. Because investors in private equity are contractually obligated to meet these capital calls when they occur—or else face potentially draconian provisions, such as forfeiting invested capital—a natural concern is that investors may be asked to provide cash to the private equity fund when it is difficult to obtain cash.[4]

The first step in understanding this cash flow risk is assessing the magnitude of variation in private equity cash flows and the extent to which this variation is diversifiable and/or predictable. In particular, because the opportunity cost of capital called in bad times is

[2]Our findings have been confirmed in recent work subsequent to ours, suggesting that our data are of similar quality and representativeness as other recent cash flow datasets. See, in particular, Harris, Jenkinson, and Kaplan (forthcoming). We discuss selection issues in Section II below.

[3]Cash flow risk is related to, but distinct from, the rebalancing risk that has been the focus of other studies: viz, that because private equity commitments are long-dated, they are potentially difficult to hedge. See Sorensen, Wang and Yang (2012). As we show in this paper, understanding cash flow risk over the business cycle is important for assessing the likely importance of rebalancing risk.

[4]The salience of this risk in investors' minds is illustrated by many news accounts of the behavior of many famous institutional limited partners who, during the financial crisis urged general partners *not* to call capital (Financial Times, 2008).

high and the relative value of distributions received in good times is low, the co-movement of calls and distributions with broader market conditions is fundamentally important to evaluating private equity as an asset class. If, for instance, the undiversifiable component of capital calls tends to be countercyclical, then private equity investments have a relatively high opportunity cost and the liquidity premium investors demand, in terms of a required return above and beyond that of public equities, should be high as well.[5]

The analyses of cash flow cyclicality also lead to predictions about the links between such cyclical cash flow risk and fund performance. The second main goal of this paper is to evaluate these predictions. In particular, we predict that investors in funds with countercyclical capital calls should earn a liquidity premium to compensate for the opportunity cost of providing capital for illiquid investments made in bad times, and provide estimates of the magnitude of this premium.

Our analysis of cash flows reveals that net cash flows (distributions minus calls), distributions, and calls at the fund level are all procyclical. Distributions are more sensitive to market conditions than calls. The market price-dividend ratio, which is used extensively in asset pricing studies as a predictor of public equity returns, is an economically significant predictor of private equity cash flows. All else equal, a 10% increase in public equity valuations is associated with an 11% increase in quarterly net cash flows to buyout funds, and a 53% increase for venture capital funds. The price-dividend ratio combines with the Baa-Aaa yield spread to capture essentially all of the predictive power for private equity cash flows of a broader set of variables relating to market cycles, including IPO and M&A activity and buyout and venture capital industry fundraising. The fact that calls are procyclical on the margin suggests that the average liquidity premium associated with private equity as an asset class is likely to be relatively low – calls made in good times carry a relatively low opportunity cost. This is consistent with the average performance statistics noted above: a PME of 1.18 implies outperformance of public equities by about 3% per year, given a typical five or six year holding period for underlying investments.

At the same time, most variation in fund-level cash flows is purely idiosyncratic across funds of a given age at a given point in time, or associated with lifecycle effects whereby funds

[5]See Brunnermeier and Pedersen (2008) for theory predicting a countercyclical liquidity premium.

call capital when they are young and distribute it as they age. These results suggest that from an investor's perspective, liquidity shocks arising from uncertain calls and distributions from private equity investments can be significantly mitigated by holding a portfolio of investments diversified both across different funds of the same age and across funds of different ages. For example, for buyout funds the standard deviation of quarterly net cash flows averages 11.57% of committed capital, and this standard deviation shrinks to 4.54% in a portfolio of all buyout funds in the sample. Yet, even within such a portfolio, the systematic cyclical component of cash flows remains and has important implications for fund performance, both in the aggregate over time and in the cross-section of funds.

One implication of our results on cash flow liquidity is that times when public market valuations are low are also times when private equity net cash flows are low. This in turn suggests that the well-known underperformance (in absolute terms) of private equity funds raised in hot fundraising markets[6] has a simple interpretation grounded in the co-cyclicality of public and private equity markets. To the extent that private equity fundraising booms forecast both broader market downturns and low private equity cash flows, cyclicality in absolute private equity performance is likely to be attenuated when measuring performance relative to public markets. Consistent with this, using PMEs we find that the underperformance of funds raised in hot markets vanishes altogether for buyout funds, and is reduced in magnitude by about two-thirds for venture capital funds. In short, because private equity cash flows are linked to broader market conditions, aggregate performance over time is much less volatile on a relative basis than it is on an absolute basis.

The cyclicality of cash flow liquidity is also related to the cross-section of fund performance. Because expected returns on alternative investments, such as public equities, vary across the business cycle, capital calls made when economic conditions are weak entail a higher opportunity cost than capital called when economic conditions are improving. This logic suggests that there should be a return premium associated with providing liquidity to fund managers in bad times when the opportunity cost is high. That is, funds with less procyclical capital calls – those more likely to call capital in down markets – should perform

[6] Kaplan and Strömberg (2009) document this relation for buyout funds. We confirm this finding in our data, and find similar results for venture capital funds.

better. We find exactly this. Funds with below-median procyclical capital calls perform about 35% better over the life of the fund in absolute terms, and about 15% better in terms of PME. These numbers translate to annualized rates of about 6% and 3%, respectively, given a typical five-year investment holding period. Based on the logic provided by Korteweg and Nagel (2013), the 15% PME premium associated with calling capital in market downturns carries the interpretation of a liquidity premium to compensate for the opportunity cost of providing capital for illiquid investments made in bad times.

Throughout these analyses, we find strong differences in cyclicality between buyout and venture capital funds. Venture capital calls, distributions, net cash flows, and performance over fundraising cycles all exhibit substantially more cyclicality than in buyout, and the liquidity premium for calling capital in bad times is larger.[7] These facts are consistent with Berk, Green, and Naik (2004), whose theory emphasizes that the real option properties of venture companies can generate substantial cyclicality.

In a final step, we investigate cash flow liquidity and fund performance in the 2007-2009 financial crisis. Anecdotally, the crisis had a clear effect on private equity activity. Exit, investment, and financing opportunities dried up, and the industry ground to a near halt. Yet we know of no prior systematic investigation of private equity cash flows in the crisis. Consistent with a liquidity crunch, net cash flows (holding fund age constant) fell significantly during the crisis, primarily due to lower distributions. However, these lower distributions are explained by the same business-cycle variables that help explain cash flow behavior in normal times. From this perspective, the events of the crisis were not unusual.

Our work is related to several branches of prior literature. Perhaps most closely related is work using earlier data on private equity cash flows. Kaplan and Schoar (2005) and Phalippou and Gottschalg (2009) use cash flow data from Venture Economics to provide early estimates of private equity performance. Jones and Rhodes-Kropf (2003) use the same data to investigate how private equity returns relate to idiosyncratic risk. Ljungqvist and Richardson (2003) and Ljungqvist, Richardson, and Wolfenzon (2007) use a different sample

[7]These findings are consistent with but not implied by prior work finding a higher beta of venture capital portfolio companies compared to buyout (Driessen et al. 2011). Higher beta suggests a greater sensitivity of distributions to market conditions for a given investment, but might, a priori, be offset in a net cash flow sense by an even larger sensitivity of capital calls to market conditions.

of buyout funds for which they have data on cash flows for the full LP-GP-portfolio company chain. They focus on understanding how the types of portfolio companies and the timing of investments vary across funds and over a fund's lifecycle. In all of these papers, the cash flow data ends by 2003, and is limited to funds with vintage years prior to 1995.

Our work also contributes to the literature studying aspects of cyclicality in private equity (cf., in addition to the works cited above, Gompers et al. (2008), Axelson et al. (2009), and Axelson et al. (2012)). No prior work investigates cyclicality in fund-level cash flows and its implications for fund performance. In its broadest goals, our paper adds to this literature by taking early steps toward integrating private equity into the broad research stream in economics and finance that seeks to understand the impact of business cycles on asset returns and the predictability of payoffs to risky assets (e.g. Fama and French, 1989). The fundamental illiquidity of private equity investments makes private equity a unique and challenging setting for investigating these central questions in asset pricing.

The remainder of the paper proceeds as follows. Section II describes the data and discusses representativeness. Section III presents summary performance statistics. Section IV investigates the determinants and cyclical behavior of cash flows. Section V relates the cash flow results to fund performance. Section VI investigates cash flows in the crisis and subsequent performance. Section VII discusses the implications of this work and concludes.

II. Data and Sample

A. Coverage, Variables, and Summary Statistics

Our analysis uses a confidential, proprietary data set obtained from a large, institutional limited partner with extensive investments in private equity. The dataset provided to us includes 990 unique private equity funds, including buyout, venture capital, real estate, debt (including distressed and mezzanine), and fund-of-funds. In this paper, we focus on the 837 buyout and venture capital funds, the two most important and widely-studied forms of private equity. Of this total, over 85% are U.S. funds, with the remainder mostly European. The funds collectively represent almost $600 billion in committed capital spanning vintage years (fund start dates) from 1984 to 2009.

For each fund, the data contain capital calls, distributions, and estimated market values at the quarterly frequency extending to the second quarter of 2010, comprising over 34,000 time-series observations. Capital calls are payments from investors (called limited partners, LPs) to fund managers (called general partners, GPs); these payments draw down the balance of committed, as-yet-unfunded capital and are used to fund the investments that GPs make in portfolio companies. Distributions occur when GPs exit investments; the proceeds net of the GP's carried interest profit share are returned to the LPs. We also have data on fund sequence number and fund size, and we know whether any two funds belong to the same partnership. The data were anonymized before they were provided to us, therefore we do not know the identity of the GPs or the names of the funds.[8]

The characteristics of funds in our sample are presented in Table 1. We have 542 buyout funds, for a total capitalization of $535 billion. Our U.S. buyout funds represent 56% of the total capital committed to U.S. buyout funds over the same period (data from Venture Economics, VE). Our coverage is significantly stronger for buyout than for venture capital. Our data include 295 venture capital funds representing $61 billion in committed capital, or around 16% of the VE universe of U.S. committed capital. Overall, we have about 40% of the VE universe of committed capital.

Because many of the funds in our sample have recent vintage years and are still active, we also present summary statistics for the sample of funds that had vintage years 2005 or earlier and were either officially liquidated by end of the sample period (6/30/2010) or had no cash flow activity for the last six quarters of the sample. This sample includes about two-thirds of all funds in the total sample, and represents about half of the total committed capital in the full sample. The two samples are broadly similar except that average fund size is smaller in the liquidated sample, reflecting the growing prevalence of large buyout funds in the post-2005 vintage portion of the sample. We stress that none of our performance assessments are sensitive to the inclusion of non-liquidated funds. In general, we find no evidence to suggest that stated pre-liquidation market values are a biased estimate of the realized market value of the fund.

[8]The data also contain information on the terms of the GP-LP management contract, including the fees charged and the GP's ownership in the fund, which we analyze in Robinson and Sensoy (2012).

B. Representativeness and Comparison to Commercial Databases

As noted above, our data comprise a sizable fraction of the universe of private equity funds. In addition, they are at least partially randomly selected. The data provider's overall private equity portfolio was assembled over time through a series of mergers of previously independent businesses that occurred for reasons unrelated to each company's private equity portfolio.[9] The representativeness of the sample is nevertheless a natural concern.

Assessing representativeness is inherently difficult because the universe of private equity funds (and portfolio investments) is not available, making representativeness a concern that applies to all research in private equity. The commercially available databases most often used in academic research and for performance benchmarking in the industry are VE, Preqin, and Cambridge Associates (CA). Unfortunately, these sources provide inconsistent accounts of private equity performance, and potentially suffer from reporting and survivorship biases (Harris, Jenkinson and Stucke, 2010). Our data come directly from the limited partner's internal accounting system and are not subject to these biases. Despite the issues with commercially available data, comparisons to such data are one way to gauge the representativeness of our sample.

The performance data available from these commercial sources are primarily fund-level IRRs or value multiples. Table A-1 in the Appendix compares coverage and fund-level IRRs to commercial databases. All comparisons are based on U.S. funds, the focus of Harris, Jenkinson, and Stucke (2010), our source for information on commercial coverage. As the table illustrates, our data contain over 80% as many buyout funds as the number for which fund-level IRR information is available on VE, Preqin, or CA over the same time period. Hence our coverage of buyout funds compares well to commercial sources. Our coverage of VC funds is less comprehensive; our data comprise about one-fifth to one-third of the number of VC funds for which the commercial sources have fund-level IRR information.

Coverage, particularly of buyout funds, is especially good for funds raised in the 1994-2001 period, after which coverage falls. The fall reflects a shift away from private equity

[9] On occasion, multiple formerly independent business units had invested in the same private equity fund. These cases are clearly indicated in the data, which allows us to avoid double-counting these funds. In addition, all co-investments alongside a GP are clearly labeled in the data. We exclude these from our sample. Neither business-unit duplicates nor co-investments are included in the fund counts presented above.

investments after the technology crash, and not any change in investment strategy or access to funds within the private equity sphere. Such cohort effects are not an issue for our cash flow analyses; the fund age fixed effects in those analyses control for cohort effects. Cohort effects in the data could in principle influence our analysis of performance over time as it relates to fundraising conditions; however those results are not driven by differences in the 1994-2001 period and the rest of the sample.

Because we do not know the sampling variation of the commercial data sources, it is difficult to construct reasonable test statistics for differences in average performance numbers. Ignoring this, we can compute naïve test statistics by treating each vendor's point estimate as a population mean with zero sampling variance, thereby understating the standard error of the difference. In terms of the time series presented in Table A-1, there is no significant difference between the time-series mean of the cross-sectional means of IRRs from our data and those from VE or Preqin (nor, for buyout, CA). A cross-sectional analysis, which has more power, suggests that our sample of VC funds have lower IRRs than those in either VE or Preqin, but there remain no significant differences for buyout funds. If instead we were to assume that commercial data had a sampling variation equal to that of our data, we would fail to reject the null of performance equality in all tests for differences.

While these results are generally reassuring, they do suggest it is possible that our data underrepresent the top performing VC funds. This would be consistent with Lerner, Schoar, and Wongsunwai (2007) as well as Sensoy, Wang, and Weisbach (2013), both of whom show that such access to the top venture groups in the 1990s was essentially limited to one class of investor, university endowments, who in turn experienced unusually good investment performance that is not representative of the typical private equity investor. Moreover, our main conclusions rely on correlations, and we believe it is unlikely that any lack of top groups would bias our conclusions. We discuss these issues as we present our results in the text.

Further consistent with this discussion, work subsequent and complementary to ours by Harris, Jenkinson, and Kaplan (2012), focusing on average performance a different recent sample of private equity funds, finds very similar buyout performance to ours. In fact, they find the exact same average buyout PME of 1.18 (defined in the next section) as we do (please see Table 2). Our venture capital PMEs are somewhat below theirs on average, which is driven by very high performance of venture funds in their sample in the late 1990s. Our venture capital PMEs are close to theirs for other periods.

Ultimately, however, the universe of private equity funds is not available, and summary statistics from VE, Preqin, and CA differ systematically from one another (Harris, Jenkinson and Stucke, 2010). Consequently, it is impossible to know whether any differences are a function of sample selection, self-reporting, and survivorship biases that creep into commercially available data sources, whether they reflect characteristics of the LP/GP matching process in private equity, or whether they are evidence of sample selection bias in our data. Our results should be interpreted with these caveats in mind.

III. Performance Measures and Summary Statistics

Before turning to our main analyses, we discuss the measures of performance used in the remainder of the paper and present summary statistics for these measures.

A. Performance Measures

Most private equity research and industry practitioners express the performance of private equity funds in terms of IRR or TVPI (total value to paid-in capital, the undiscounted ratio of total distributions to total capital calls). As purely absolute measures of performance, IRR and TVPI make no attempt to account for the opportunity cost of private equity investments.

In light of this deficiency, Kaplan and Schoar (2005) develop the public market equivalent (PME) performance measure, which is defined as the ratio of the sum of discounted distributions to the sum of discounted calls. The PME uses the realized total return on the S&P 500 from the fund's inception (or any arbitrary reference date) to the date of the cash flow as the discount rate. For concreteness, the PME is:

$$\text{PME} = \sum_{t=0}^{T} \frac{D_t}{\prod_{\tau=0}^{t}(1+r_\tau)} \Bigg/ \sum_{t=0}^{T} \frac{C_t}{\prod_{\tau=0}^{t}(1+r_\tau)}. \qquad (1)$$

In this expression, D_t and C_t are, respectively, distributions and calls occurring at time t, and r_τ is the (time-varying) realized return on the S&P 500.

Intuitively, one can think of the PME as reflecting the funding surplus/gap associated with a zero-cost position in private equity formed by shorting a public index to meet capital commitments and then using the subsequent distributions to close out the short positions when the distributions occur. (Indeed, anecdotally many pension fund managers indicate that they commonly meet capital calls in their private equity portfolios by selling positions in liquid indexes.) More concretely, the PME equals the net present value of fund cash flows scaled by the present value of calls (plus one), where the realized S&P return is used as the discount rate in the NPV computation. Korteweg and Nagel (2013) outline the conditions on investor preferences that, if true, imply that the PME embeds all necessary adjustments for the market risk of the fund.

B. Performance Summary Statistics

Table 2 reports cross-sectional statistics on IRR, TVPI, and PME for both the liquidated and full samples of funds. We (not our data provider) calculate each of these performance measures from quarterly net-of-fee fund cash flows and ending NAVs.[10]

Table 2 shows that liquidated buyout funds have an average IRR of 9%, TVPI of 1.57, and PME of 1.18. These estimates are higher than those of Kaplan and Schoar (2005) for the pre-1995 period, and indicate that the average buyout fund in our sample has outperformed the S&P 500 by 18% over the life of the fund, or about 3% per year at an investment holding period of about five years.

Venture capital performance is lower, with an average IRR of 9%, TVPI of 1.44, and PME of 1.03. These figures are lower than those reported by Kaplan and Schoar (2005), though we find PMEs similar to theirs when considering only their sample period. Table A-2 in the Appendix reports performance statistics by vintage year and shows that the difference is driven primarily by the poor performance of funds raised in the technology boom of the late 1990s.

Median values of performance are somewhat less than the averages, indicating that the distribution is right-skewed, especially for venture capital funds. The standard deviations

[10] We treat ending NAVs as true values, as do Kaplan and Schoar (2005). Phalippou and Gottschalg (2009) recommend writing ending NAVs for liquidated funds down to zero, but we find this has only a very slight impact on our estimates of performance. Most liquidated funds have zero reported final NAV.

and interquartile ranges of all performance measures indicate wide dispersion in the returns to individual funds, with venture capital displaying considerably more dispersion than buyout. Finally, performance statistics for the full and liquidated samples are almost identical. This suggests that pre-liquidation market values, although self-reported by GPs, are not a biased estimate of the realized market value of the fund.

The Appendix provides further performance estimates using alternative benchmark indexes and levering the S&P index to account for beta different from one, and shows that reasonable such choices have little effect on PME estimates. The Appendix also revisits the some of the key cross-sectional results of Kaplan and Schoar (2005), and shows that their results of an increasing and concave relation between fund size and performance, as well as persistence in the performance of sequential funds of the same partnership, continue to hold.

IV. Cash Flows, Liquidity, and Market Conditions

In this section we present our main analyses on the determinants of cash flows between private equity funds and their investors. While these managed cash flow streams are of course influenced by the risk and return of the underlying investments of private equity funds, it is the cash flows, not the underlying investments *per se* that determine the returns investors receive and the liquidity demand or supply they face. The managed cash flow streams reflect the GPs' active decisions regarding the timing and magnitude of investments and exits.

Our main conclusions are as follows. We find that both distributions and calls at the fund level are procyclical, with distributions more sensitive than calls, so net cash flows (distributions minus calls) are also procyclical. The market price-dividend ratio, which is used extensively in asset pricing studies as a predictor of public equity returns, combines with the Baa-Aaa high yield spread to capture essentially all of the predictive power for private equity cash flows of a broader set of variables relating to market cycles, including IPO and M&A activity and buyout and venture capital industry fundraising. Venture capital cash flows are considerably more cyclical than buyout.

At the same time, most variation in fund-level cash flows is purely idiosyncratic across funds of a given age at a given point in time, or associated with lifecycle effects whereby funds call capital when they are young and distribute it as they age. We show that the reduction in cash flow volatility from such diversifying these cash flows is substantial, and show that even within a diversified portfolio of private equity funds, the systematic cyclical component of cash flows remains. Thus, private equity funds are on average liquidity providers when market conditions are good, and sinks when conditions are poor.

We discuss and empirically examine the implications of these cyclicality results for fund performance in Section V.

A. Fund-Level Cash Flows

Table 3 presents our analyses of fund-level cash flows. Our main focus is on assessing the impact of broader market conditions on private equity cash flows. To isolate the role of market conditions, we control for two important cash flow determinants arising from institutional details specific to private equity. First, the age of the fund. Private equity funds, unlike mutual funds or hedge funds, have contractually specified, finite lives. Typically, the lifespan is 10 years with an option to extend for 1-3 more. As a result, funds tend to call capital early in their lives to make investments, and distribute capital later after those investments have been realized. All else equal, these considerations suggest a lifecycle pattern of negative net cash flow early in a fund's life, turning positive later. Second, the fund's remaining uncalled capital. Investors in private equity funds are contractually obligated to provide capital to the fund when it is called, but only up to a total commitment. All else equal, the more "dry powder" a fund has, the more likely it is to call capital.

We capture these two effects empirically using fixed effects. Because our data are at the quarterly frequency, we create fixed effects for fund age measured in calendar quarters. A fund's uncalled capital is a continuous variable, but including it as such in our estimates requires an assumption as to functional form. To avoid this, we create fixed effects from bins of uncalled capital as a percentage of committed capital. We choose cutoffs to take into account that behavior is especially likely to be affected when capital is fully called or totally uncalled. The cutoffs are 0%, greater than or equal to 0% but less than 1%, greater than or equal to 1% but less than 5%, analogous increments of 5 percentage points up to 95%, greater than or equal to 95% but less than 100%, and 100%. The resulting fixed effects constitute a nonparametric control for uncalled capital at the cost of suppressing variation in uncalled capital within each bin.[11]

A.1. Net Cash Flows

Panel A of Table 3 focuses on net cash flows as the dependent variable, equal to distributions minus calls, expressed as a percentage of committed capital. The unit of observation is a fund-calendar quarter. Estimates are OLS, and standard errors are clustered by calendar quarter. Clustering by fund or by both fund and calendar quarter yield generally lower standard errors.

Models (1) and (6) assess the explanatory power of fund age and uncalled capital fixed effects for buyout and venture capital funds, respectively. The adjusted R^2 values indicate that these variables explain 8.7% and 5.3%, respectively, of the total variation in quarterly fund-level net cash flows.[12]

Models (2) and (7) add time period (calendar quarter) fixed effects, and the adjusted R^2 values rise to 9.4% and 8.5%, respectively. The R^2 values from these models give us a non-parametric theoretical upper bound on the explanatory power that we could hope to obtain from a model including fund age and uncalled capital fixed effects plus *any* set of variables capturing quarterly fluctuations in market conditions, the macroeconomy, or any other systematic time-series effect. That these R^2 values are low, and the increment in R^2 when time fixed effects are added lower still, tells us that most of the variation in fund-level net cash flows is unrelated to observed or unobserved market conditions, and therefore is in principle diversifiable.

These observations in no way imply that the impact of market conditions on cash flows is economically unimportant. An analogy to stock returns is helpful. Typically, a CAPM or Fama-French 3-factor regression of returns to an individual stock on returns to common

[11] Our results are unaffected by including a direct control for the natural logarithm of uncalled capital instead. Our results on disaggregated capital calls and distributions are likewise unaffected by restricting the sample to only those observations in which, respectively, some capital remains uncalled or some capital has previously been called. The former restriction is not as obvious as it might appear; capital calls do sometimes occur by mutual agreement after all previously committed capital has been called.

[12] Examining the coefficients on the fund age fixed effects bears out the conventional wisdom for lifecycle effects in net cash flows outlined above. The coefficients start off negative, cross zero between 3 and 4 years of age, and monotonically increase to about 8 years of age, remaining roughly flat thereafter.

factors produces a low R^2, because most stock return variation is idiosyncratic. This does not mean the factors are unimportant for understanding average stock returns.

Models (3) and (7) begin our assessment of the impact of observable market conditions by dropping the time fixed effects and instead using a single forecasting variable related to market conditions, the natural logarithm of the price-dividend ratio of the S&P 500 index, ln(P/D), obtained from Robert Shiller's website. In these models ln(P/D) is measured on the last day of the prior calendar quarter, so these are predictive regressions.

The estimates show that, holding fund age fixed, net cash flows to investors are positively related to ln(P/D). That is, they are procyclical. The coefficient estimates are 1.00 for buyout funds and 3.85 for venture capital funds. These coefficients imply that all else equal a 10% increase in P/D is associated with a 0.095 (=ln(1.100)) percentage point increase in net cash flows for buyout funds and a 0.326 (=ln(1.385)) percentage point increase for venture capital funds. These effects are large relative to the unconditional mean quarterly net cash flow, which is 0.85% of committed capital for buyout funds and 0.61% for venture capital funds. The effects are 11.2% and 53.1%, respectively, of these unconditional means.

Models (4) and (9) add to the specifications the natural logarithm of Moody's Baa-Aaa yield spread, measured at the end of the prior calendar quarter.[13] The yield spread is a direct measure of debt market conditions that are likely to be related to financing and exit opportunities for private equity investments. Of course, public equity and debt markets conditions are (negatively) correlated; the yield spread typically widens when times are bad and public equity valuations are low and narrows when times and equity valuations improve. To ensure that we attribute only incremental information to the yield spread, we orthogonalize it with respect to ln(P/D). Models (4) and (9) reveal that net cash flows for both buyout and venture capital funds are negatively related to the independent information in the yield spread, reinforcing the conclusion that they are procyclical.

Finally, we investigate whether these results on cyclicality are somehow special to the price-dividend ratio and yield spread variables by considering a broader set of variables related to market cycles, including private equity cycles. In addition to the price-dividend

[13] We obtain this variable from the FRED website. The Baa-Aaa spread is a broad measure of liquidity in the corporate bond market. Results are similar using other yield spread variables, in particular the Merrill high yield spread used in some prior work.

ratio and the yield spread, we consider the natural logarithms of the following four quarterly variables: the number of IPOs (from Jay Ritter's website); the number of M&A transactions (from SDC); and the dollar amounts (in millions) of buyout and venture capital fundraising (from Venture Economics).

Of course, any set of variables intended to capture market conditions or the state of the macroeconomy at a point in time are likely to be highly correlated with one another and contain relatively little independent variation. Table A-4 in the Appendix presents a correlation matrix. All six variables are highly correlated with one another (the yield spread negatively so). Table A-4 also presents a principal component analysis. The first two principal components capture 82% of the total variation of all six variables, and are the only two with eigenvalues greater than one, the typical cutoff for "significant" components. The first principal component loads highly positively on the price-dividend ratio, M&A activity, and buyout and venture capital fundraising. This component is therefore highly procyclical. The second principal component loads highly positively on the yield spread and highly negatively on IPO activity, so this component is countercyclical.

In Models (5) and (10), we replace the price-dividend and yield spread variables with these two principal components, similarly lagged one quarter. As expected from our results in the previous models, net cash flows are positively related to the first principal component and negatively related to the second. The R^2 values are virtually unchanged from Models (4) and (9), indicating that these principal components do not have incremental explanatory power for private equity cash flows relative to the price-dividend ratio and the yield spread.

Thus, the market price-dividend ratio combines with the Baa-Aaa yield spread to capture essentially all of the predictive power for private equity cash flows of this broader set of variables relating to market cycles. For this reason, we rely on the price-dividend and yield spread variables in subsequent tables. By emphasizing the market price-dividend ratio in this way, we are in keeping with the large literature in asset pricing that focuses on this ratio as a predictive variable for stock and bond returns (see Cochrane, 2011, for a summary). Moreover, using financial market variables associated with business cycle variation to forecast private equity cash flows follows a tradition in asset pricing and macroeconomics that uses financial variables to capture business-cycle variation in the expected returns to financial assets (e.g. Fama and French, 1988, 1989). In addition to being forward looking, such variables are more volatile and therefore have more potential for predictive power than slower moving measures of real economic activity such as GDP growth or unemployment. We experimented with such real variables and find that they have essentially no incremental predictive power for private equity cash flows.

A.2. Disaggregated Distributions and Capital Calls

Panels B and C of Table 3 conduct the same analyses separately for distributions and capital calls, respectively. The dependent variables are, respectively, the natural logarithm of (one plus distributed capital as a percentage of committed capital) and the natural logarithm of (one plus called capital as a percentage of committed capital). Estimation is Tobit because these variables are bounded below by zero.

These Panels show that the conclusions from the analysis of net cash flows hold for both distributions and calls individually. The most important new insight is that both distributions and capital calls are procyclical, and the procyclicality of net cash flows arises because distributions are more sensitive than calls.[14] An additional insight, one that also emerges from the net cash flow models from Panel A, is that venture capital cash flows are considerably more cyclical than is the case for buyout funds, displaying significantly larger loadings on the market conditions variables.[15]

The procyclicality of capital calls that we find is consistent with Ljungqvist et al. (2007), who find that buyout funds that experience low yield spreads in their early years are quicker to reach thresholds of capital invested (e.g., quicker to become 70% invested). Our analysis in Table 3 differs from theirs in several respects. First, we investigate distributions and

[14]The distribution coefficient for buyout funds on ln(P/D) is lower than that for capital calls (Model (3)). However, these coefficients are elasticities because these are log-log specifications. Because distributions are much larger on average than calls, distributions actually have a much higher sensitivity to P/D than calls even though they have a lower elasticity.

[15]Although as discussed in Section II, our sample probably omits some of the top-performing venture capital partnerships, it is likely that they would only strengthen our conclusions. Gompers et al. (2008) show that the top venture capitalists alter their investments more in response to public market signals compared to other venture capitalists. Further, high returns to the top venture capital funds are primarily generated by IPOs, which as Table A-4 in the Appendix shows are highly negatively correlated with the yield spread and have a large influence on the second principal component used in Models (5) and (10). Thus, it is likely that the calls and distributions of the top venture capital funds are more cyclical than average.

net cash flows in addition to capital calls. In addition, our focus is not on measuring first passage times to capital thresholds as a measure of the speed of capital deployment, but rather on understanding the impact of market conditions and the extent of predictable versus idiosyncratic variation, both at the level of individual flows.

B. Cash Flow Liquidity with Diversification Across Funds

The analysis reported in Table 3 has two key implications from the perspective of an investor concerned with predicting the liquidity demand and supply from a portfolio of private equity funds. The first is that given the amount of variation that is either related to lifecycle effects or is purely idiosyncratic, there are likely to be substantial gains from diversification across funds in terms of reducing the volatility of quarterly cash flows. The second is that even with such diversification, the cyclical, systematic component of private equity cash flows implies that a certain amount of the liquidity risk associated with uncertain cash flows is undiversifiable.

Table 4 provides direct evidence supporting both of these implications. Panel A presents summary statistics on the volatility (standard deviation) of quarterly net cash flows as a percentage of committed capital to illustrate how this volatility changes with different levels of diversification. The first row presents cross-sectional means of the time-series standard deviations of net cash flows to each fund. The volatility of net cash flows averages 11.57% of committed capital per quarter for buyout funds and 11.99% for venture capital funds. This is the volatility that an LP who invests in just one fund would experience on average. The second row illustrates the effects of diversifying across funds of a given age. At each point in time, we collapse the cross-section of funds of a given age by taking the average (either equal-weighted or value-weighted by fund size) of the fund-level net cash flows. The second row reports the cross-sectional mean of the time-series standard deviation of the resulting net cash flows to each of these age portfolios. The volatility of cash flows averages 8.46% and 8.91% for the equal-weight and value-weight combinations of buyout funds, and 9.11% and 9.39% for venture capital funds. These figures represent the average volatility an LP would experience by holding a portfolio of all sample funds of a given age. Finally, the third row of Panel A illustrates the effects of full diversification across our sample funds by reporting the standard deviation of the time series of net cash flows that result from collapsing the cross-section at each point in time by averaging net cash flows across all funds. Quarterly cash flow volatility shrinks to 4.54% and 3.38% for the equal-weight and value-weight combinations of buyout funds, and 4.09% and 3.36% for venture capital funds.

Clearly, diversifying across funds results in significant reductions in cash flow volatility. Part of the remaining volatility is due to the fact that we have a finite sample of funds so idiosyncratic volatility cannot be fully diversified in sample. However, part is also due to the common cyclical, systematic component of cash flows.

Panel B of Table 4 confirms these points. The Panel presents regressions analogous to those in Columns (4) and (9) of Panel A of Table 3 but in which the dependent variable is the quarterly net cash flow to the portfolios of funds whose volatilities are reported in Panel A. Models (1), (2), (5), and (6) present results for the equal-weight and value-weight age portfolios of buyout funds and venture capital funds, respectively. Here, it remains possible to include fund age fixed effects but not uncalled capital fixed effects. We therefore replace these fixed effects with the mean (analogously either equal-weight or value-weight) uncalled capital of the funds in each portfolio. There are two main takeaways from these models. First, the cyclical component of cash flows remains economically and statistically significant.[16] Second, the adjusted R^2 values are higher than those in Table 3, consistent with diversifying idiosyncratic variation. Models (3), (4), (7), and (8) present results for the portfolios that result from full diversification across all sample funds at a point in time. Once again, the cyclical component of cash flows remains and the R^2 rises.

The results reported in Table 4 extend the analogy to stock returns mentioned in Section IV.A.1. Typically, when stocks are grouped into portfolios, the variance of returns declines, the R^2 values from factor model regressions increase, and the systematic component of returns remains evident in the loadings on common factors. Our analysis shows that private equity cash flows behave in a similar way.

[16]The coefficients can and do differ from those in Table 3 because we have an unbalanced panel and because of the weighting method.

V. Implications for Fund Performance

Our analysis of cash flow cyclicality in the prior section has important implications for fund performance. In this section, we develop and present evidence consistent with these implications. We find that the aggregate underperformance in absolute terms of private equity funds raised in boom fundraising periods is sharply attenuated when performance is measured relative to public markets using the PME. At the individual fund level, we find that funds with the least procyclical capital calls – those that impose the greatest cost of providing liquidity on their investors – outperform in both absolute and relative terms.

A. Cash Flow Cyclicality and Aggregate Performance over Time

The cyclicality of cash flows implies that private equity cash flows are low precisely when broader market conditions are weak, and in particular when public equity valuations are low. This finding sheds new light on what is known about variation in aggregate private equity performance over time. Specifically, Kaplan and Strömberg (2009) find that the absolute performance of buyout funds raised in boom fundraising years is significantly worse than that of funds raised in bust periods. This finding is frequently interpreted as symptomatic of idiosyncratic overheating in private equity markets. Our cash flow results suggest a different interpretation. They imply that if private equity fundraising negatively forecasts private equity cash flows, then they also forecast low public equity valuations.[17] This means that cycles in absolute performance are likely to be attenuated when performance is compared to public markets.

Table 5 presents consistent evidence. We relate a fund's ultimate performance to fundraising conditions when the fund is raised, using TVPI for absolute performance and PME for relative performance. We use TVPI instead of IRR in the table because TVPI and PME are both performance multiples and can be easily compared, but we obtain similar results with IRR. Following Kaplan and Strömberg (2009), our measure of fundraising conditions ("Flows") is the total capital committed to all funds of the same type in the same vintage year (data from VE), expressed as a percentage of total U.S. stock market capitalization at

[17] In an untabulated test, we confirm directly that private equity fundraising and future market returns are negatively correlated.

the end of the vintage year (data from CRSP).

Panel A focuses on the liquidated sample. Models (1) and (5) show that there is a strongly negative relation between absolute performance and industry fundraising. These results echo prior work for buyout funds and show that the impact is even greater for venture capital funds.

Models (2) and (6) show that the picture changes markedly using PMEs. The underperformance of funds raised in hot markets vanishes altogether for buyout funds. For venture capital funds, the coefficient remains significantly negative, but is reduced in magnitude by about three-quarters. These results suggest that like the underlying cash flows, the ultimate performance of venture capital funds is more cyclical than that of buyout funds.

We next consider how these conclusions vary with fund size. Though our cash flow analyses do not offer a clear prediction, concerns about idiosyncratic overheating are typically focused on the large size of funds raised in boom periods. If such funds perform worse, we should see especially poor performance among the largest funds raised in boom periods. It is also possible that boom fundraising times permit the entry of relatively unskilled GPs, but do not allow them to raise as large funds as their more proven counterparts, in which case poor performance should be concentrated in the smaller funds raised in boom times. In either case, our cash flow analyses suggest that such patterns are likely to be sharply reduced if not eliminated when switching from TVPI to PME. To investigate these ideas, Models (3), (4), (7) and (8) repeat the analysis with Flows interacted with fund type-specific size tercile indicator variables. The level effects of these indicators are estimated in the models but not reported in the table. Models (3) and (7) show that the negative fundraising/TVPI relation is driven by the larger two terciles for buyout, but the smaller two terciles for venture capital. Models (4) and (8) show that these interaction largely vanish when we switch to PME.

Panel B of Table 5 repeats the analysis for the full sample of funds. The results are very similar to those discussed above. There is some evidence that the largest buyout funds raised in boom years underperform somewhat in PME terms.[18]

[18]In unreported robustness tests, we ensure that the results in Table 5 are not driven solely by the 1994-2001 period in which, as discussed in Section II.B., our sample coverage is greatest. Also, any bias resulting from a lack of the top venture capital partnerships would likely cause us to understate the attenuation in the performance-fundraising relation using PME. The top partnerships are likely to be those whose relative performance is least sensitive to the fundraising environment.

Finally, Table A-5 in the Appendix provides further evidence of the cash flow fundamentals underlying the patterns in performance over time discussed in this section. There, we show that capital calls display their highest sensitivity to market conditions early in the life of the fund, especially for venture capital funds. A fund that is one year old when market conditions are good is more likely to make large capital calls than a fund that is one year old when market conditions are weak. This gap narrows and eventually disappears as funds age. The implication is that compared to funds raised in bust periods, funds raised in boom times invest capital more quickly and so have a greater proportion of their invested capital subject to subsequent market fluctuations. Because fundraising booms generally presage broader market downturns, these patterns in capital calls help explain why funds that are raised in boom times underperform in absolute terms, and why this is especially true for venture capital funds.

B. Cash Flow Cyclicality and the Cross-Section of Fund Performance

As noted above, the returns that private equity investors receive are determined by the timing and magnitude of the capital calls they face and the distributions they receive, not by the underlying investments associated with these cash flows *per se*. Because expected returns on alternative investments, such as public equities, vary across the business cycle, capital calls made when economic conditions are weak entail a higher opportunity cost than capital called when economic conditions are improving. This logic suggests that there should be a return premium associated with providing liquidity to fund managers in bad times when the opportunity cost is high. That is, funds with less procyclical capital calls – indicating a greater propensity to call capital in bad times – should perform better.

Table 6 presents evidence consistent with this idea. The table reports results of a two-stage estimation procedure. In the first stage, we perform a panel regression of capital calls on fund age fixed effects (Panel A) or fund age and vintage year fixed effects (Panel B). We do this separately for buyout and venture capital funds. The residuals measure the deviation of each capital call from what is predicted given the fund's type, age and, in Panel B, vintage year. This first stage ensures that the results are not confounded by lifecycle or vintage year effects in capital calls. In the second stage, we perform fund-level regressions of these residuals on ln(P/D), lagged one quarter as in Table 3. We focus on P/D because it is the market conditions variable that is both most strongly related to capital calls and most directly measures the performance of alternative investments (i.e. public equities) and therefore most directly relates to changes in investors' opportunity costs over time.

Our hypothesis is that funds with less procyclical capital calls perform better. To test this, we sort funds into two groups based on the loadings on ln(P/D) from the second stage. Funds in the "High Propensity" group have below-median loadings on ln(P/D) compared to other funds of their type, indicating s a relatively higher propensity to call capital when economic conditions are weak. The reverse is true for funds in the "Low Propensity" group. We then perform a means comparison test for differences in ultimate fund performance across the two groups of funds.

The results presented in Table 6 support the hypothesis that "High Propensity" funds provide higher returns. Panel A shows that for buyout funds, the average IRR for "High Propensity" funds is 9% higher than that for "Low Propensity" funds. The average TVPI is 0.36 higher, and the average PME is 0.15 higher. All of these results are statistically significant. The results for PME are particularly noteworthy because they indicate that such funds perform better even in a market-adjusted sense. The estimates for venture capital funds are 9%, 0.39, and 0.31 for IRR, TVPI, and PME, respectively. Though these point estimates are similar to those for buyout funds, statistical significance is reduced as a consequence of the greater variability of venture capital returns and the smaller sample of funds. Panel B adds vintage year effects in the first stage to eliminate variation in investment opportunities across funds of different vintage years. The results are virtually identical results to those in Panel A, with somewhat improved statistical significance for venture capital funds.

Thus, funds with below-median procyclical capital calls perform about 35% better over the life of the fund in absolute terms, and about 15% better in terms of PME. These numbers translate to annualized rates of about 6% and 3%, respectively, given a typical five-year investment holding period. Again, this 15% PME premium associated with calling capital in market downturns carries the interpretation of a liquidity premium to compensate for the opportunity cost of providing capital for illiquid investments made in bad times.

VI. Cash Flows and the 2007-2009 Financial Crisis

In a final step, we investigate private equity in the recent financial crisis. Anecdotally, the crisis had a clear effect on private equity activity. Exit, investment, and financing opportunities dried up, and with them the industry ground to a near halt. Yet, we know of no prior systematic investigation of private equity in the crisis. This gap is particularly important given that the crisis was, at least in the beginning, a crisis of liquidity that might be expected to have a profound impact on an inherently illiquid asset class such as private equity. An important open question is just what happened to private equity cash flows during the crisis, whether these events were in fact unusual from a historical perspective, and how cash flow behavior in the crisis relates to ultimate fund performance.

Panel A of Table 7 investigates cash flows in the crisis. In essence, the Panel adds a "Crisis" indicator variable to some of the specifications from Table 3. This variable equals one for calendar quarters 2007:Q3 to 2009:Q1, inclusive, and zero for other time periods. The dependent variables and the other explanatory variables are exactly as described for Table 3. Specificaitons (1)-(6) focus on buyout funds, with the first two columns examining net cash flows, the next two distributions, and the final two capital calls. Specifications (7)-(12) analogously focus on venture capital funds.

The results in the odd-numbered columns show that controlling for fund age and the amount of uncalled capital, net cash flows, distributions, and, for buyout, capital calls all declined in the crisis relative to other times. These results are consistent with the anecdotal evidence. The even-numbered columns in Panel A add the P/D and yield spread variables introduced in Table 3 to assess whether these patterns in average cash flow activity are abnormal, or instead reflect changes in the same underlying market conditions variables that help explain cash flow behavior in normal times. During the crisis, market valuations dropped and the yield spread rose. Both of these are normally associated with lower net cash flows and distributions.

When we add these market conditions variables, the coefficient on the crisis indicator becomes insignificant in all specifications except it is significantly positive for venture capital calls. Thus, for the most part, the crisis appears to have been a non-event from the perspective of private equity cash flows in the sense that changes in cash flow behavior during the crisis are explained by changes in the same underlying fundamentals that explain cash flow behavior in normal times.

The increased capital call activity for venture capital funds, however, raises a more general concern that even if capital calls in the crisis were not unusual from a historical perspective, they might not have been deployed optimally from an investor's perspective, if for example they were used to prop up underperforming investments. The crisis was so extraordinary that even though our earlier results show that countercyclical capital calls are typically associated with better fund performance, this general pattern might not hold in the crisis.

To investigate this possibility, Panel B of Table 7 compares the ultimate performance of funds with abnormally high capital calls in the crisis to those with abnormally low calls. To account for the fact that funds that are young during the crisis are more likely to call capital than funds that are old due to normal lifecycle effects, we compute abnormal calls using the following procedure, separately for buyout and venture capital funds. We first regress capital calls over the full sample period on indicator variables for fund age (in calendar quarters). We then calculate the average of the resulting residual capital calls during the crisis for each fund that is active during the crisis. We define funds with above-median average residual capital calls in the crisis as "High Crisis Capital Calls" funds.

The point estimates reported in Panel B suggest that funds with abnormally high capital calls in the crisis have worse ultimate performance. These results are only suggestive, however, because they are not statistically significant and because we can only measure ultimate performance up to the end of our sample period, June 2010. While the point estimates are consistent with concerns about the wisdom of the deployment of capital calls in the crisis, it is also possible that exit conditions had not improved enough by the end of our sample for investments made in the crisis to have come to fruition.

VII. Conclusion

Private equity plays a central role in the economy as a vehicle for capital reallocation. And while the pro-cyclicality of capital reallocation (in broad terms) is well documented in a variety of settings, our understanding of capital reallocation in private equity is complicated by the specific institutional features of the sector. In particular, the limited partners who are the ultimate suppliers of capital to private equity derive their returns not from the underlying assets of the partnership *per se*, but from the managed cash flow stream generated by the general partners' choice to call capital and exit investments as a function of perceived market conditions. Thus, the implications of the potential comovement between private equity and broader market conditions is not well understood.

This paper represents a first attempt to examine the comovement of public and private capital markets and to study the implications of this comovement for the performance of private equity as an asset class. We demonstrate the pro-cyclicality of private equity capital calls and distributions and show that a parsimonious predictive model can explain a great deal of the time-series variation in average cash flow activity. The fact that most of the variation in private equity cash flows is cross-sectional, however, means that most of the volatility in private equity cash flows can be diversified. This has important implications for fund performance, and for our understanding of the connection between aggregate inflows of capital to the industry and subsequent performance.

Ultimately, our analysis raises questions about liquidity that go beyond the scope of this paper. Buyout and venture capital funds, after all, are not consumers of liquidity, they are financial intermediaries who pull liquidity from limited partners and distribute it to portfolio companies in the form of specifically structured investments. The general equilibrium properties of the liquidity redistribution that occurs from limited partners to the corporate sector through the private equity channel is an important topic for future research.

References

[1] Axelson, Ulf, Tim Jenkinson, Per Strömberg, and Michael S. Weisbach, 2011. Borrow Cheap, Buy High? The Determinants of Leverage and Pricing in Buyouts. *Journal of Finance*, forthcoming.

[2] Axelson, Ulf, Per Strömberg, and Michael S. Weisbach, 2009. Why are Buyouts Levered? The Financial Structure of Private Equity Funds. *Journal of Finance* 64:1549-1582.

[3] Berk, Jonathan, Richard Green, and Vasant Naik, 2004. Valuation and Return Dynamics of New Ventures. *Review of Financial Studies* 17:1-35.

[4] Brunnermeier, Markus and Lasse Pederson, 2009. Market Liquidity and Funding Liquidity. *Review of Financial Studies*, 22(6):2201-2238.

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

[6] Cochrane, John, 2011. Discount Rates. *Journal of Finance* 66:1047-1108.

[7] Driessen, J., T.-C. Lin, and L. Phalippou, 2011. A New Method to Estimate Risk and Return of Non-Traded Assets from Cash Flows: The Case of Private Equity Funds. forthcoming, *Journal of Financial and Quantitative Analysis*.

[8] Fama, Eugene F. and Kenneth R. French, 1989. Business Conditions and Expected Returns on Stocks and Bonds. *Journal of Financial Economics* 25:23-49.

[9] Fama, Eugene F. and Kenneth R. French, 1992. The Cross-Section of Expected Stock Returns. *Journal of Finance* 47:427-465.

[10] Financial Times, 2008 "Market Havoc Forces Urgent Rebalancing," November 23, 2008, Deborah Brewster.

[11] Gompers, Paul, Anna Kovner, Josh Lerner, and David Scharfstein, 2008. Venture Capital Investment Cycles: The Impact of Public Markets, *Journal of Financial Economics* 87:1-23.

[12] Harris, Robert S., Tim Jenkinson, and Rudiger Stucke, 2010. A White Paper on Private Equity Data and Research. UAI Foundation Consortium Working Paper.

[13] Harris, Robert S., Tim Jenkinson, and Steven N. Kaplan, forthcoming. Private Equity Performance: What do we Know? *Journal of Finance*.

[14] Jegadeesh, Narasimhan, Roman Kraussl, and Josh Pollet. Risk and Expected Returns of Private Equity Investments: Evidence Based on Market Prices. Working Paper, Emory University, University of Amsterdam, and Michigan State University.

[15] Jones, Charles and Matthew Rhodes-Kropf, 2003. The Price of Diversifiable Risk in Venture Capital and Private Equity. Working Paper, Columbia University.

[16] Kaplan, Steven N. and Antoinette Schoar, 2005. Private Equity Performance: Returns, Persistence, and Capital Flows, *Journal of Finance* 60:1791-1823.

[17] Kaplan, Steven N. and Per Strömberg, 2009. Leveraged Buyouts and Private Equity. *Journal of Economic Perspectives* 23:121-46.

[18] Korteweg, Arthur and Stefan Nagel, 2013. Risk-Adjusting the Returns to Venture Capital. Working Paper, Stanford University.

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

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

[21] Ljungqvist, Alexander, Matthew Richardson, and Daniel Wolfenzon, 2007. The Investment Behavior of Buyout Funds: Theory and Evidence. Working Paper, NYU Stern School of Business

[22] Peng, Liang, 2001. Building a Venture Capital Index. Working Paper, Yale School of Management.

[23] Phalippou, Ludovic and Oliver Gottschalg, 2009. The Performance of Private Equity Funds, *Review of Financial Studies* 22:1747-1776.

[24] Robinson, David T. and Berk A. Sensoy, forthcoming. Do Private Equity Fund Managers Earn their Fees? Compensation, Ownership and Cash Flow Performance. *Review of Financial Studies*.

[25] Sensoy, Berk A., Yingdi Wang, and Michael S. Weisbach, 2013. Limited Partner Performance and the Maturing of the Private Equity Industry. Working Paper, California State University at Fullerton and Ohio State University.

[26] Woodward, Susan, and Robert Hall, 2003. Benchmarking the Returns to Venture. Working Paper, Stanford University.

Table 1: Sample Summary

This table presents summary statistics for the venture capital (VC) and buyout (BO) private equity funds in our sample. Fraction of 1st, 2nd, and 3rd funds indicates the fraction of sample funds of that sequence number (position in a partnership's sequence of funds). Total Committed Capital is the aggregate amount of capital committed to our sample funds (i.e. the sum of the sizes of all sample funds). Total LP Capital and Total GP Capital indicate, respectively, the contributions of limited partners and general partners to this total. The % of VE universe is the total committed capital of the sample funds of a given fund type expressed as a percentage of the total committed capital to all funds of the same type reported on Venture Economics over the entire 1984-2009 sample period. The % of VE U.S. universe includes only U.S. funds. Fund Size is the committed capital of the fund. All dollar amounts are in millions of US dollars. The full sample includes all funds. Funds in the liquidated sample are those that had vintage years prior to 2006 and either were officially liquidated as of 6/30/2010 or had no cash flow activity for the last six quarters of the sample.

	All Funds	Buyout	Venture Capital
Full Sample:			
Number of Funds	837	542	295
Fraction of 1st Funds	0.30	0.32	0.25
Fraction of 2nd Funds	0.24	0.23	0.26
Fraction of 3rd Funds	0.16	0.16	0.15
Total Committed Capital	$596,843	$535,485	$61,358
Total LP Capital	$585,745	$525,276	$60,469
Total GP Capital	$11,088	$10,209	$879
% of VE universe	26.5%	41.6%	10.8%
% of VE U.S. universe	34.4%	55.7%	15.9%
Mean Fund Size ($M)	713.06	987.98	207.96
Median Fund Size ($M)	204.34	312.91	106.12
St. Dev. Fund Size ($M)	1887.61	2291.21	276.26
Liquidated Sample:			
Number of Funds	560	368	192
Fraction of 1st Funds	0.33	0.35	0.28
Fraction of 2nd Funds	0.23	0.23	0.23
Fraction of 3rd Funds	0.16	0.15	0.18
Total Committed Capital	$308,309	$271,183	$37,126
Total LP Capital	$302,165	$265,556	$36,609
Total GP Capital	$6,144	$5,627	$517
Mean Fund Size ($M)	550.55	736.91	193.37
Median Fund Size ($M)	172.90	266.72	83.46
St. Dev. Fund Size ($M)	1228.38	1467.87	284.51

Table 2: Summary Statistics on Cash Flow Performance

We calculate IRRs, TVPIs, and public market equivalents (PMEs) using actual fund cash flows. TVPI (total value to paid in capital) is the ratio of the undiscounted sum of distributions to the undiscounted sum of capital calls. S&P PME, following Kaplan and Schoar (2005), is the ratio of the discounted sum of distributions to the discounted sum of capital calls, where the discount rate is the return on the S&P 500 index. The table reports equal-weight cross-sectional statistics of fund-level final realized performance. The full sample includes all funds, with ending NAV treated as a liquidating cash flow for non-liquidated funds. The liquidated sample includes funds with pre-2006 vintage years that were either liquidated by 06/30/2010 or have no cash flow activity for the last six quarters of the sample.

	Buyout Funds		Venture Capital Funds	
Sample:	Full (N=542)	Liquidated (N=368)	Full (N=295)	Liquidated (N=192)
IRR:				
Mean	0.09	0.12	0.08	0.09
Median	0.09	0.10	0.01	0.02
St. Dev.	0.26	0.28	0.43	0.47
25^{th} %ile	-0.02	-0.01	-0.09	-0.08
75^{th} %ile	0.19	0.22	0.13	0.16
TVPI:				
Mean	1.51	1.57	1.38	1.44
Median	1.36	1.45	1.03	1.05
St. Dev.	0.86	0.80	1.45	1.33
25^{th} %ile	0.95	0.99	0.68	0.72
75^{th} %ile	1.84	1.90	1.51	1.65
S&P PME:				
Mean	1.19	1.18	1.06	1.03
Median	1.09	1.09	0.84	0.82
St. Dev.	0.61	0.56	1.15	0.95
25^{th} %ile	0.82	0.82	0.55	0.52
75^{th} %ile	1.46	1.46	1.21	1.13

Table 3: Cash Flows, Fund Age, and Market Conditions

This table presents estimates of the determinants of net cash flows (distributions minus calls), distributions, and capital calls, all expressed as a percentage of the fund's committed capital. The determinants are the age of the fund, the fund's uncalled capital (dry powder), and macroeconomic conditions. The unit of observation is a fund-calendar quarter. ln(P/D) is the natural logarithm of the price/dividend ratio of the S&P 500. ln(Yield Spread) is the natural logarithm of the Baa-Aaa yield spread.. Princ. Comp. 1 is the first principal component of six macroeconomic variables: ln(P/D), ln(Yield Spread), ln(# of IPOs), the natural logarithm of the number of IPOs (from Jay Ritter's website); ln(# of M&A), the natural logarithm of the number of M&A transactions (from SDC); ln($ Buyout Industry Fundraising), the natural logarithm of the dollar amount (in millions) of buyout fundraising (from Venture Economics); and ln($ Venture Capital Industry Fundraising), the natural logarithm of the dollar amount (in millions) of venture capital fundraising (from Venture Economics). Princ. Comp. 2 is the second principal component of these variables. See Appendix Table A-4 for a correlation matrix and principal component loadings. All of these variables are measured at the end of the previous calendar quarter. Fund age (measured in quarters), uncalled capital, and calendar quarter fixed effects are included as indicated below. Uncalled capital fixed effects are based on the following bins of uncalled capital (as a percentage of committed capital): 0%, greater than or equal to 0% but less than 1%, greater than or equal to 1% but less than 5%, analogous increments of 5 percentage points up to 95%, greater than or equal to 95% but less than 100%, and 100%. In each Panel, specifications (1)-(5) use only the sample of buyout funds, while specifications (6)-(10) use only the sample of VC funds. In specifications (4) and (9), ln(Yield Spread) is orthogonalized with respect to ln(P/D). Estimation is OLS in Panel A, and Tobit in Panels B and C. Standard errors (in parentheses) are robust to heteroskedasticity and clustered by calendar quarter. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

		Columns (1)-(5): Buyout Funds				Columns (6)-(10):Venture Capital Funds				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Dependent variable is net cash flow as percentage of committed capital										
ln(P/D)			1.00**	0.92**				3.85**	3.74**	
			(0.44)	(0.43)				(1.62)	(1.60)	
ln(Yield Spread)				-0.60***					-0.74**	
				(0.10)					(0.29)	
Princ. Comp. 1					0.27**					0.83**
					(0.10)					(0.38)
Princ. Comp. 2					-0.41***					-0.63***
					(0.08)					(0.20)
Fund Age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Uncalled Capital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	Yes	No	No	No	No	Yes	No	No	No
Observations	21,687	21,687	21,684	21,684	21,684	13,032	13,032	13,029	13,029	13,029
Adjusted R^2	0.087	0.094	0.087	0.089	0.089	0.053	0.085	0.057	0.058	0.060

Table 3 continued next page

Table 3 continued from previous page

	Columns (1)-(5): Buyout Funds					Columns (6)-(10):Venture Capital Funds				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel B: Dependent variable is ln(distributions as a percentage of committed capital + 1)										
ln(P/D)			0.29**	0.29**				1.25***	1.25***	
			(0.14)	(0.12)				(0.32)	(0.33)	
ln(Yield Spread)				-0.30***					-0.61***	
				(0.04)					(0.12)	
Princ. Comp. 1					0.14***					0.29***
					(0.04)					(0.06)
Princ. Comp. 2					-0.16***					-0.44***
					(0.03)					(0.08)
Fund Age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Uncalled Capital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	Yes	No	No	No	No	Yes	No	No	No
Observations	21,687	21,687	21,684	21,684	21,684	13,032	13,032	13,029	13,029	13,029
Pseudo R^2	0.046	0.062	0.047	0.052	0.052	0.029	0.073	0.034	0.045	0.048
Panel C: Dependent variable is ln(capital calls as a percentage of committed capital + 1)										
ln(P/D)			0.39***	0.41***				0.92***	1.05***	
			(0.09)	(0.09)				(0.18)	(0.20)	
ln(Yield Spread)				-0.09***					-0.28***	
				(0.03)					(0.11)	
Princ. Comp. 1					0.11***					0.31***
					(0.02)					(0.03)
Princ. Comp. 2					-0.05**					-0.11
					(0.02)					(0.08)
Fund Age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Uncalled Capital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	Yes	No	No	No	No	Yes	No	No	No
Observations	21,687	21,687	21,684	21,684	21,684	13,032	13,032	13,029	13,029	13,029
Pseudo R^2	0.145	0.155	0.147	0.148	0.149	0.173	0.215	0.178	0.181	0.186

Table 4: Cash Flows with Diversification Across Funds

This table presents estimates of the effects of diversification across funds on the properties of overall cash flows. Panel A presents statistics on the standard deviation of quarterly net cash flows (as a percentage of committed capital). The first row presents the cross-sectional mean of the time-series standard deviation of net cash flows to each fund. The second row illustrates the effects of diversification across funds of a given age at a point in time (without diversifying across funds of different ages). Specifically, at each point in time the average net cash flow for funds of each age is calculated; i.e. we collapse the cross-section for funds of a given age at a given point in time. The second row reports the cross-sectional mean of the time-series standard deviation of the resulting net cash flows to each of these age portfolios. The third row illustrates the effects of full diversification by reporting the standard deviation of the time series of net cash flows that result from collapsing the cross-section at each point in time by averaging net cash flows across all funds. For the second and third rows, the cross-sectional averages at a point in time are computed on both an equal-weight (EW) and value-weight (VW, by fund size) basis. Panel B reports regression results analogous to those in Table 3. The dependent variable is the average (equal-weight or value-weight) net cash flow to a group of funds at a point in time. In specifications (1), (2), (5), and (6), the averages are taken over all funds of a given age of a given type at each point in time (i.e., the cross-section is collapsed within fund type and age). In the remaining specifications the averages are taken over all funds of a given type at each point in time. Mean Uncalled is the average of the natural logarithm of uncalled capital as a percentage of committed capital for each grouping of funds, with the average analogously either equal-weight or value-weight. Mean Age is the average of the natural logarithm of fund age for each grouping of funds, similarly either equal or value-weighted, and is relevant only for the specifications in which the averages are taken across funds of different ages. All other variables are defined in Table 3. A constant is estimated in each specification but not reported. Standard errors (in parentheses) are robust to heteroskedasticity and clustered by calendar quarter. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Cross-sectional means of time-series standard deviations of net cash flows (Percent of committed capital per quarter)

	Buyout Funds		Venture Capital Funds	
	EW	VW	EW	VW
No diversification	11.57	N/A	11.99	N/A
Diversification across funds of a given age	8.46	8.91	9.11	9.39
Full diversification	4.54	3.38	4.09	3.36

Panel B: Dependent variable is average net cash flow as percentage of committed capital

	Columns (1)-(4): Buyout Funds				Columns (5)-(8):Venture Capital Funds			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(P/D)	1.95***	1.55**	1.56***	1.29***	5.00***	5.27***	1.73***	0.71**
	(0.57)	(0.60)	(0.45)	(0.27)	(1.88)	(1.86)	(0.41)	(0.28)
ln(Yield Spread)	-0.65***	-0.76***	0.03	-0.35**	-0.78**	-0.81**	-0.77***	-0.79***
	(0.16)	(0.17)	(0.30)	(0.17)	(0.31)	(0.33)	(0.20)	(0.17)
Mean Uncalled	-1.34***	-1.40***	-1.80***	-1.99***	-1.59***	-1.51***	-1.67***	-1.94***
	(0.20)	(0.18)	(0.47)	(0.22)	(0.27)	(0.28)	(0.38)	(0.25)
Mean Age			-0.09	-0.22			-0.07	0.42*
			(0.56)	(0.26)			(0.34)	(0.25)
Observations	3,376	3,376	105	105	2,825	2,825	105	105
Adjusted R^2	0.159	0.151	0.249	0.498	0.149	0.142	0.371	0.449
Average taken over	Age	Age	All	All	Age	Age	All	All
Averaging method	EW	VW	EW	VW	EW	VW	EW	VW
Fund Age FE	Yes	Yes	N/A	N/A	Yes	Yes	N/A	N/A

Table 5: Fund Performance and Market Conditions

This table presents fund-level OLS estimates of the relations between final fund performance and market conditions at time of fundraising. The main independent variable, "Flows", is equal to the total capital committed to all funds of the same type raised in the fund's vintage year (data from Venture Economics), expressed as a percentage of total U.S. stock market capitalization at the end of the vintage year (data from CRSP). Size Q1-3 are indicator variables for whether the fund's size falls into the bottom, second, or top tercile of the size distribution of all funds of the same type. Panel A reports results for the liquidated sample and Panel B for the full sample. In odd-numbered columns, the dependent variable is fund TVPI (undiscounted ratio of total distributions to total calls). In even-numbered columns, the dependent variable is fund PME with respect to the S&P 500. A constant is estimated in all specifications but not reported. Size Q indicator variables (level effects) are estimated in specifications (3), (4), (7), and (8), but not reported for brevity. Standard errors (in parentheses) are robust to heteroskedasticity and clustered by vintage year. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Liquidated Sample

	Columns (1)-(4): Buyout Funds				Columns (5)-(8): Venture Capital Funds			
	TVPI	PME	TVPI	PME	TVPI	PME	TVPI	PME
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Flows	-1.26***	0.25			-1.68***	-0.55***		
	(0.27)	(0.16)			(0.29)	(0.17)		
Flows×Size Q1			-0.62	0.74**			-1.47***	0.06
			(0.55)	(0.28)			(0.35)	(0.55)
Flows×Size Q2			-1.74***	0.17			-1.98***	-0.48
			(0.37)	(0.21)			(0.47)	(0.28)
Flows×Size Q3			-1.48***	-0.20			-0.98	-0.69
			(0.51)	(0.27)			(0.72)	(0.51)
Observations	368	368	368	368	192	192	192	192
Adjusted R^2	0.06	0.01	0.06	0.02	0.10	0.02	0.11	0.04

Panel B: Full Sample

	Columns (1)-(4): Buyout Funds				Columns (5)-(8): Venture Capital Funds			
	TVPI	PME	TVPI	PME	TVPI	PME	TVPI	PME
Flows	-0.66***	-0.11			-1.65***	-0.70***		
	(0.13)	(0.07)			(0.28)	(0.19)		
Flows×Size Q1			-0.43	0.69**			-1.89***	-0.55
			(0.30)	(0.25)			(0.34)	(0.43)
Flows×Size Q2			-1.01***	-0.08			-1.66***	-0.55**
			(0.27)	(0.11)			(0.34)	(0.21)
Flows×Size Q3			-0.52***	-0.19***			-0.83	-0.57
			(0.14)	(0.04)			(0.56)	(0.40)
Observations	542	542	542	542	295	295	295	295
Adjusted R^2	0.06	0.00	0.07	0.03	0.09	0.03	0.10	0.03

Table 6: Fund Performance and the Propensity to Call Capital in Bad Times

This table presents estimates of the relation between final fund performance and the fund's propensity to call capital in bad times. The estimates result from a two-stage procedure. In the first stage panel regression, the natural logarithm of each fund's quarterly capital calls as a percentage of committed capital plus one is regressed on fund age (in quarters) indicator variables. The residuals measure the deviation of capital calls from what is expected given the fund's age. In the second stage fund-level regressions, these residuals are regressed on ln(P/D) (lagged one quarter) to estimate the fund's propensity to call capital in response to market conditions above and beyond normal lifecycle effects. Funds are sorted into two groups: "High" if the fund's coefficient from the second stage is below the median, indicating a high propensity to call capital in bad times, and "Low" otherwise. Panel A displays the mean and standard error of the mean of measures of fund performance for these two groups. Panel B displays analogous statistics that result when vintage year fixed effects are also included in the first stage. All estimates are performed separately for buyout and venture capital funds. Standard errors (in parentheses) are robust to heteroskedasticity and clustered by vintage year. *, **, and *** indicate statistically significant differences at the 10%, 5%, and 1% levels, respectively.

Panel A: First stage does not include vintage year effects

	Buyout Funds			Venture Capital Funds		
	IRR	TVPI	PME	IRR	TVPI	PME
High Propensity	0.14	1.72	1.27	0.13	1.58	1.21
	(0.02)	(0.07)	(0.04)	(0.07)	(0.29)	(0.18)
Low Propensity	0.05	1.36	1.12	0.03	1.19	0.90
	(0.02)	(0.06)	(0.03)	(0.06)	(0.17)	(0.13)
Difference	0.09***	0.36***	0.15***	0.09	0.39*	0.31*
	(0.03)	(0.10)	(0.05)	(0.06)	(0.22)	(0.15)

Panel B: First stage includes vintage year effects

	Buyout Funds			Venture Capital Funds		
	IRR	TVPI	PME	IRR	TVPI	PME
High Propensity	0.14	1.73	1.26	0.12	1.56	1.18
	(0.02)	(0.07)	(0.04)	(0.04)	(0.15)	(0.12)
Low Propensity	0.05	1.35	1.12	0.04	1.20	0.93
	(0.01)	(0.04)	(0.03)	(0.06)	(0.07)	(0.05)
Difference	0.09***	0.38***	0.14***	0.07	0.36**	0.25**
	(0.02)	(0.08)	(0.05)	(0.05)	(0.17)	(0.13)

Table 7: Cash Flows, Performance, and the 2007-2009 Crisis

Panel A presents estimates of the determinants of net cash flows (distributions minus calls), distributions, and capital calls, all expressed as a percentage of the fund's committed capital. The unit of observation is a fund-calendar quarter. "Crisis Indicator" is equal to one for calendar quarters 2007:Q3-2009:Q1 (inclusive) and zero otherwise. All other variables are defined in previous tables. In each Panel, specifications (1)-(6) use only the sample of buyout funds, while specifications (7)-(12) use only the sample of venture capital funds. The dependent variable in columns (1), (2), (7), and (8) is the net cash flow as a percentage of committed capital. The dependent variable in columns (3), (4), (9), and (10) is the natural logarithm of one plus distributions expressed as a percentage of committed capital. The dependent variable in columns (5), (6), (11), and (12) is the natural logarithm of one plus capital calls expressed as a percentage of committed capital. All specifications include a constant and fixed effects for fund age in calendar quarters and for the fund's uncalled capital (unreported). Estimation is OLS in columns (1), (2), (7), and (8) and Tobit in all other columns. R^2 values are adjusted R^2 in columns (1), (2), (7), and (8) and and pseudo R^2 in all other columns. Standard errors (in parentheses) are robust to heteroskedasticity and clustered by calendar quarter. Panel B presents estimates of the relation between final fund performance (measured by IRR, TVPI, and S&P PME) and whether the fund calls higher than predicted amounts of capital in the crisis. The predicted capital calls are obtained from a panel regression of ln(one plus capital calls as a percentage of committed capital) on indicator variables for fund age (in calendar quarter). For each fund active during the crisis, the fund-level average of the residual capital calls is computed. Funds with average residual capital calls above the median are "High Crisis Capital Calls" funds. All specifications include fund vintage year fixed effects. Standard errors (in parentheses) are robust to heteroskedasticity and clustered by vintage year. In each Panel, *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Cash Flows in the Crisis

	Specifications (1)-(6): Buyout Funds						Specifications (7)-(12): Venture Capital Funds					
	Net cash		Distributions		Calls		Net cash		Distributions		Calls	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Crisis Indicator	-1.17***	-0.42	-0.34**	0.02	-0.09**	0.09	-0.83**	0.37	-0.77***	-0.02	0.19	0.54**
	(0.37)	(0.32)	(0.16)	(0.13)	(0.05)	(0.09)	(0.39)	(0.74)	(0.22)	(0.22)	(0.19)	(0.23)
ln(P/D)		0.87**		0.29**		0.43***		3.76**		1.25***		1.08***
		(0.44)		(0.12)		(0.09)		(1.63)		(0.34)		(0.20)
ln(Yield Spread)		-0.56***		-0.30***		-0.10***		-0.77**		-0.61***		-0.31***
		(0.11)		(0.04)		(0.03)		(0.32)		(0.12)		(0.10)
	All specifications include fund age and uncalled capital fixed effects											
Observations	21,687	21,684	21,687	21,684	21,687	21,684	13,032	13,029	13,032	13,029	13,032	13,029
R^2	0.087	0.089	0.047	0.052	0.145	0.148	0.053	0.058	0.031	0.045	0.173	0.182

Panel B: Capital Calls in the Crisis and Fund Performance

	Buyout Funds			Venture Capital Funds		
	IRR	TVPI	PME	IRR	TVPI	PME
High Crisis Capital Calls Indicator	-0.04	-0.16	-0.15	-0.07	-0.24	-0.23
	(0.03)	(0.12)	(0.10)	(0.05)	(0.26)	(0.23)
	All specifications include vintage year fixed effects					
Observations	298	298	298	191	191	191
Adjusted R^2	0.047	0.040	-0.020	0.129	0.171	0.101

Appendix

This Appendix contains the supplementary tables, figures, and analysis discussed in the main text.

A. Comparison to Commercial Databases

Table A-1 compares coverage and performance statistics for our sample to the samples available from publicly-available commercial databases Venture Economics (VE), Preqin, and Cambridge Associates. Our source for information on the coverage of these databases is Harris, Jenkinson, and Stucke (2010), Tables 9 and 12. Table A-1 displays coverage and IRR statistics by vintage year. See Section II of the main text for a discussion of these comparisons.

B. Tailored PME

Panel A of Table A-2 reports summary statistics, analogous to Table 2, for fund-level PMEs computed using alternative benchmarks. Rather than use the S&P 500 as the standard PME does, these "Tailored PMEs" use the Nasdaq 2000 index for venture capital funds and the Fama-French size tercile indexes for buyout funds according to whether the fund is self-described as a small-cap, mid-cap, or large-cap buyout fund. The tailored PMEs for buyout funds are somewhat smaller than the regular PMEs reported in Table 2, mostly because the small tercile portfolio outperformed the S&P 500 over much of the sample.

C. Performance by Vintage Year

Panel B of Table A-2 reports size-weighted average fund performance by vintage year for our sample of liquidated funds. Performance is measured four ways: IRR, TVPI, S&P PME, and Tailored PME.

D. Levered PME

As discussed in Section III, we assess the robustness of the average PME statistics reported in Table 2 to levering the S&P 500 index to account for beta different from one. We introduce the "Levered PME" performance measure, defined as follows:

$$\text{Levered PME } (\beta) = \sum_{t=0}^{T} \frac{D_t}{\prod_{\tau=0}^{t} (1+\beta r_\tau)} \Bigg/ \sum_{t=0}^{T} \frac{C_t}{\prod_{\tau=0}^{t} (1+\beta r_\tau)}. \qquad \text{(A-1)}$$

In this expression, D_t and C_t are, respectively, distributions and calls occurring at time t, and r_τ is the (time-varying) realized return on the S&P 500. The levered PMEs nest as special cases both the standard PME ($\beta = 1$) and the TVPI ($\beta = 0$).[1]

We are particularly interested in the sensitivity to β of assessments of final fund performance using Levered PME around the ranges of β that have been estimated in the literature. We acknowledge, however, that with the exception of Jegadeesh et al. (2010), the literature offers estimates of the β associated with portfolio investments, not the β experienced by an LP investing in a portfolio of funds. Recent buyout β estimates range from a low of about 0.7 to 1.0 (Jegadeesh et al., 2010) to a high of 1.3 (Driessen et al., 2011). Recent venture capital β estimates are around 2.5 (Korteweg and Sorensen, 2010; Driessen et al., 2011).

Figure A-1 displays the cross-sectional mean Levered PME and 95% confidence intervals for β ranging from zero to three. The figure shows that while moving from β=0 to β=1 has a major impact, further increases in beta have strongly diminishing effects on inferences. The Levered PME-beta relation is convex. Performance inferences are remarkably insensitive to β in the ranges described above. Moving β from 1.0 to 1.5 for buyout funds moves average Levered PME from 1.18 to 1.12. The minimal value of Levered PME is achieved at β about 2.2. Only in this extreme range does the lower bound of the buyout 95% confidence interval drop below one. For β above 2.2, average levered PME begins to increase again, as the early calls of funds started in rising markets get increasingly discounted. This basic pattern holds for venture capital as well, for which the relation is even flatter. Average levered PMEs are close to flat for β in the range of 1.5 to 3.

The convexity is a consequence of the arithmetic of multiperiod discounting combined with the fact that distributions occur later in a fund's life than calls. To see why, consider

[1] An alternative would be to use the realized return $r_{f\tau} + \beta(r_\tau - r_{f\tau})$, where $r_{f\tau}$ is the riskfree rate, in place of βr_τ. The patterns discussed below are not affected by this alternative.

a t-period discount factor of the form:

$$\text{DF}\,(\beta) = \frac{1}{(1+\beta r)^t}. \tag{A-2}$$

The derivative with respect to β shows how the discount factor changes with β:

$$\frac{\partial \text{DF}\,(\beta)}{\partial \beta} = \frac{-tr}{(1+\beta r)^{t+1}}. \tag{A-3}$$

For positive r, this derivative is negative, so the discount factor is decreasing in β: a higher β results in a lower discounted cash flow.

The second derivative with respect to β shows how the sensitivity of the discount factor to β itself changes with β:

$$\frac{\partial^2 \text{DF}\,(\beta)}{\partial \beta^2} = \frac{(t+1)tr^2}{(1+\beta r)^{t+2}}. \tag{A-4}$$

This second derivative is positive, implying that the discount factor is a convex function of β, for all $\beta > 0$ and $r > 0$. Thus, when β is small, an incremental increase in β has a larger effect on the discount factor than when β is large. For this reason, both discounted distributions and discounted capital calls will be relatively less affected by an increase in β when β is large; there is convexity in the discounted cash flow-β relation for both distributions and capital calls.

To generate convexity in the ratio of the two, it must be that discounted distributions fall with β faster than discounted calls when β is low, and this gap narrows at higher β. This too is implied by Equation A-3 because distributions occur later in a fund's life than calls, so distributions are affected by discount factors with larger t values..

To see this, consider the derivative of Equation A-3 with respect to t:

$$\frac{\partial^2 \text{DF}\,(\beta)}{\partial \beta \partial t} = \frac{r(t\ln(1+\beta r)-1)}{(1+\beta r)^{t+1}}. \tag{A-5}$$

When β is small, this cross-derivative is negative – an increase in β has a larger (more negative) effect on the discount factor when t is large. As β grows, this effect becomes smaller.

Another way to see this is by direct inspection of the first derivative in Equation A-3. When β is equal to zero, the derivative is equal to $-tr$, so its magnitude is strongly increasing in t. At higher β, the denominator in Equation A-3 also increases with t, so the magnitude of the overall derivative does not increase as strongly with t. Putting it all together, when β is low, an incremental increase in β has a stronger effect on the discounted value of cash flows that occur further out in time (distributions) than those that occur sooner (calls). When β is larger, an incremental increase in β has a more uniform effect on distributions and calls.[2]

This logic also explains why the Levered PME-β relation is flatter for venture capital funds than for buyout funds. Compared to buyout, large venture capital distributions tend to occur later in the fund's life, and so are already relatively heavily discounted even with modest β.

E. Fund Size, Performance, and Perisistence

Table A-3 provides evidence on the relation between fund size and performance and performance persistence, first documented by Kaplan and Schoar (2005) using an earlier sample. Columns (1) and (6) reveal no significant linear relation between PME and (log) fund size. Columns (2) and (7) indicate, however, that the relation is in fact increasing and concave, consistent with Kaplan and Schoar's (2005). Comparing their coefficients to these suggests that the relation has become more concave since their sample period. Columns (3) and (8) add fund family fixed effects to examine the relation between within-family variation in fund size and fund performance. Like Kaplan and Schoar (2005), we find a statistically significant negative coefficient for venture funds and a negative, but statistically insignificant coefficient for buyout funds.

Turning to persistence, Columns (4) and (9) show that performance persistence has persisted since Kaplan and Schoar (2005). A fund's PME is positively related to the PME of the prior fund raised by the same partnership. Columns (5) and (10) show that the effect is stronger when we drop vintage year fixed effects to allow persistence estimates to

[2]In fact, if βr and t are large enough, the magnitude of the overall derivative can actually decrease with t; the denominator can increase in magnitude by more than the numerator. In this case an increase in β can have a relatively stronger effect on calls (low t) than on distributions. This explains why it is possible for the Levered PME - β relations to turn slightly positive at large β.

be influenced by the possibility that the endogenous choice to launch a follow-on fund based on past performance will be stronger in good years.

F. Market Conditions Variables

Panel A of Table A-4 present a correlation matrix for the six market conditions variables whose principal components are used in Table 3 of the main text and discussed in Section IV.A.1. Panel A shows that the variables are strongly correlated with one another, the yield spread negatively so. Panel B shows that the first two principal components capture 82% of the total variation of all six variables. The first principal component captures much of the variation associated with the market price-dividend ratio, M&A activity, and private equity fundraising, and is positively related to these variables. The second principal component is most strongly related to the yield spread (positively) and IPO activity (negatively).

G. Sensitivity of Capital Calls to Market Conditions by Fund Age

Table A-5 breaks out the sensitivity of capital calls to market conditions by fund age. The specifications are analogous to those in Panel C of Table 3 in the main text, but also interact the market conditions variables with indicator variables for fund age. Table A-5 shows that, controlling for fund age and uncalled capital fixed effects, young funds have the greatest sensitivity of capital calls to market conditions, and this diminishes as funds age.

Table A-1: Comparison to Public Databases

This table presents comparisons of our sample coverage of U.S. buyout and venture capital funds to those of publicly-available commercial databases produced by Venture Economics (VE), Preqin, and Cambridge Associates (CA). The number of funds in our sample by vintage year are given for the full sample and for U.S. funds only; comparisons use only the U.S. funds. Our source for the coverage of these databases is Harris, Jenkinson, and Stucke (2010), Tables 9 and 12. Ave. IRR is the simple average IRR of all funds in a given vintage year (in percent). The exception is the CA average IRR for VC funds, which is a pooled IRR created by combining the cash flows from all funds within a vintage year. Wtd. Ave. IRR is the size-weighted average IRR by vintage year (in percent). Panel A compares buyout funds and Panel B compares venture capital funds. CA does not provide weighted-average IRRs. In Panel A, comparisons begin in 1986 and end in 2008, the interval for which Harris et al. report the needed data. In Panel B, comparisons end in 2007 because we have no VC funds raised after 2007.

	Number of funds					Average IRR				Weighted Average IRR		
	Our Sample											
Vintage	Full	U.S.	VE	Preqin	CA	Our Sample	VE	Preqin	CA	Our Sample	VE	Preqin
Panel A: Buyout funds												
1984	3	3										
1985	5	5										
1986	1	1	10	6	7	13.2	18.0	18.3	15.4	13.2	20.9	21.7
1987	9	8	25	6	10	15.7	9.8	24.6	15.9	20.6	13.4	24.3
1988	14	14	14	8	11	9.3	8.7	14.6	10.8	8.7	9.7	14.0
1989	16	16	23	10	14	14.8	13.8	35.0	21.5	19.4	25.6	31.3
1990	7	7	9	10	4	21.5	5.0	21.9	16.7	27.6	11.3	22.4
1991	2	2	5	7	7	6.3	13.7	29.4	31.8	15.8	13.2	25.9
1992	4	4	15	13	6	30.5	20.0	15.3	34.4	37.3	23.9	22.1
1993	9	9	22	16	18	40.2	18.9	22.1	21.0	36.4	21.1	20.8
1994	25	24	26	21	13	22.8	14.0	22.1	13.3	25.7	15.9	24.1
1995	28	24	24	18	22	16.2	9.3	20.4	13.5	19.4	10.1	15.8
1996	49	41	26	22	25	10.2	8.3	12.2	9.1	8.3	6.6	8.2
1997	49	40	41	28	37	5.4	6.0	8.1	4.8	10.7	8.8	8.4
1998	78	59	55	44	38	4.8	5.5	6.0	7.7	3.9	1.3	2.2
1999	69	59	41	29	41	2.1	4.2	6.0	11.6	-4.1	7.7	6.6
2000	83	68	48	43	52	6.6	10.6	15.4	14.1	6.8	11.1	16.2
2001	33	26	27	18	12	12.0	11.3	22.0	25.5	3.6	11.1	25.8
2002	7	5	15	21	24	17.9	9.9	12.4	17.2	25.1	12.4	16.3
2003	8	8	11	20	19	37.5	9.1	15.7	13.1	48.2	17.3	26.7
2004	4	3	19	26	49	18.8	14.2	12.9	6.3	18.9	10.7	12.3
2005	2	2	20	50	44	-1.1	0.4	4.1	-0.8	-0.6	-3.9	4.8
2006	8	8	26	43	41	-18.3	-7.1	-6.3	-5.6	-4.6	-9.6	-7.8
2007	7	6	19	47	45	-17.6	-2.9	-5.5	-9.0	-14.6	-8.2	-7.4
2008	15	12	14	34	22	-17.7	-7.7	-7.0	-22.2	-30.3	-19.9	-8.5
2009	7	7										
Total (86-08)		446	535	540	561							
Panel B: Venture capital funds												
1984	6	6	64	14	32	10.6	5.0	13.7	8.6	10.2	6.1	12.4
1985	5	5	46	17	25	11.4	8.2	14.5	12.9	12.2	9.2	13
1986	3	3	43	16	31	-27.7	7.0	11.0	14.6	-10.1	10.2	12.8
1987	6	6	63	18	34	3.8	7.6	14.2	18.3	5.8	13.5	13.9
1988	9	9	44	21	27	12.0	12.3	22.7	21.1	15.3	19.8	24.9
1989	10	10	54	28	37	13.5	12.3	23.7	19.2	18.4	16.2	28.5
1990	1	1	22	15	15	14.9	17.5	18.9	35.2	14.9	24.4	23.3
1991	-	-	-	-	-	-	-	-	-	-	-	-
1992	4	4	28	19	24	6.8	25.2	27.3	34.8	8.5	29.1	30.7
1993	5	5	40	23	38	24.5	22.0	32.6	47.1	35.5	28.7	42.1
1994	8	7	39	23	42	61.8	25.2	32.3	55.6	62.5	32.8	48.9
1995	13	13	48	23	34	26.9	45.4	65.3	88.0	27.1	57.0	66.4
1996	14	13	36	21	41	22.7	74.1	39.1	99.3	24.2	59.2	32.3
1997	22	19	62	37	75	31.6	49.1	45.7	85.1	36.8	45.7	55.5
1998	43	36	76	32	81	12.4	25.0	24.8	12.4	18.9	23.0	26.4
1999	44	40	110	59	114	-10.1	-4.9	-5.3	-2.1	-22.6	-6.7	-6.2
2000	68	55	125	76	161	-6.6	-2.0	-1.2	-1.3	-9.4	-0.1	-1.2
2001	21	18	57	51	53	-8.8	0.8	-2.2	0.8	-10.4	0.8	0.8
2002	10	7	20	29	33	37.0	-0.6	-2.4	-0.3	7.5	-0.5	-0.1
2003	-	-	-	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-	-	-
2005	1	1	23	32	57	-5.9	0.8	-2.6	-0.9	-5.9	1.6	-0.5
2006	-	-	-	-	-	-	-	-	-	-	-	-
2007	2	2	23	41	52	-8.9	-4.2	-5.2	-4.2	-6.4	-5.8	-8.7
Total (84-07)		260	1023	595	1006							

Table A-2: Tailored PME and Performance by Vintage Year

Tailored PME is calculated in the same way as S&P PME, but use different benchmarks. For venture capital, we use the Nasdaq index. For buyout, we use the Fama-French size tercile index according to whether the fund is self-described a small-cap, mid-cap, or large-cap buyout fund. Panel A reports equal-weight cross-sectional statistics of fund-level final realized tailored PMEs, analogous to Table 2 in the text. Panel B reports size-weighted average final fund performance, measured by IRR, TVPI, S&P PME, and Tailored PME, by vintage year using only the sample of liquidated funds.

Panel A: Summary Statistics on Tailored PMEs

	Buyout Funds		Venture Capital Funds	
Sample:	Full (N=542)	Liquidated (N=368)	Full (N=295)	Liquidated (N=192)
Tailored PME:				
Mean	1.08	1.10	1.09	1.06
Median	0.96	1.00	0.85	0.83
St. Dev.	0.64	0.65	1.16	0.94
25^{th} %ile	0.74	0.77	0.56	0.54
75^{th} %ile	1.30	1.37	1.28	1.18

Panel B: Performance by Vintage Year

	Buyout Funds					Venture Capital Funds				
Vintage Year	# Funds	IRR	TVPI	S&P PME	Tailored PME	# Funds	IRR	TVPI	S&P PME	Tailored PME
1984	3	0.38	3.23	1.56	1.60	6	0.10	1.48	0.78	0.85
1985	5	0.24	2.62	1.27	1.31	5	0.12	2.05	0.92	1.03
1986	1	0.13	2.05	0.93	0.96	3	-0.10	1.40	0.78	0.79
1987	9	0.20	2.66	1.28	1.32	6	0.06	1.78	0.73	0.69
1988	14	0.09	1.57	0.77	0.78	9	0.15	1.80	1.02	0.97
1989	15	0.20	2.42	1.15	1.15	10	0.18	2.13	1.17	1.09
1990	7	0.28	2.64	1.35	1.36	1	0.15	1.43	1.01	0.96
1991	2	0.16	1.92	0.84	0.83	-	-	-	-	-
1992	4	0.37	2.30	1.31	1.40	3	0.06	1.27	0.84	0.79
1993	6	0.44	2.74	1.49	1.56	5	0.36	1.96	1.19	1.17
1994	22	0.28	2.14	1.28	1.37	6	0.52	3.31	1.87	1.69
1995	24	0.18	2.09	1.33	1.37	11	0.21	1.89	1.22	1.17
1996	36	0.09	1.43	1.07	1.01	6	0.27	1.99	1.27	1.10
1997	30	0.13	1.67	1.41	1.35	16	0.42	2.26	1.80	1.58
1998	54	0.06	1.39	1.25	1.10	26	0.30	1.67	1.54	1.54
1999	37	-0.03	1.36	1.20	1.07	30	-0.27	0.64	0.61	0.75
2000	60	0.06	1.31	1.14	1.06	34	-0.11	0.83	0.71	1.00
2001	22	0.04	1.26	1.03	0.97	8	-0.22	0.82	0.67	0.64
2002	6	0.27	1.53	1.25	1.24	6	0.03	1.05	0.85	0.85
2003	7	0.50	1.60	1.43	1.41	-	-	-	-	-
2004	2	0.17	1.23	1.04	1.03	-	-	-	-	-
2005	2	0.14	1.19	1.04	1.03	1	-0.06	0.93	0.80	0.79

Table A-3: Fund Performance, Size, and Persistence

This table presents cross-sectional fund-level OLS estimates of the relations between final fund performance and fund characteristics, including fund size, sequence number, and the performance of the partnership's previous fund. The sample includes only liquidated funds, though we obtain similar results using the full sample of funds. The dependent variable is the PME with respect to the S&P 500. The first five specifications include only buyout funds, the next five only venture capital funds. A constant is estimated in each specification but not reported. Standard errors (in parentheses) are robust to heteroskedasticity and clustered at the partnership level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable = PME									
	Specifications (1)-(5): Buyout Funds					Specifications (6)-(10):Venture Capital Funds				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln(Fund Size)	0.03	0.26**	-0.04			0.05	0.81**	-0.61**		
	(0.02)	(0.13)	(0.16)			(0.05)	(0.31)	(0.24)		
ln(Fund Size)^2		-0.02*					-0.09***			
		(0.01)					(0.03)			
ln(Fund No.)		-0.01	-0.13				0.17	0.85**		
		(0.06)	(0.38)				(0.12)	(0.37)		
Previous PME				0.22***	0.23***				0.17*	0.32***
				(0.06)	(0.06)				(0.10)	(0.10)
Vintage Year FE?	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Fund Family FE?	No	No	Yes	No	No	No	No	Yes	No	No
Observations	368	368	368	152	152	192	192	192	73	73
R-squared	0.08	0.09	0.73	0.18	0.13	0.17	0.19	0.59	0.36	0.12

Table A-4: Market Conditions Variables: Correlations and Principal Components

Panel A presents a correlation matrix for the six market conditions variables used to construct the principal components used in Table 3 of the main text. Panel B presents the eigenvalues and eigenvectors of the principal components of these variables. Proportion is the proportion of the total variance of the six variables that is explained by each eigenvector. Cumulative is the total proportion explained by the current and previous eigenvectors. The six variables are: ln(P/D), the natural logarithm of the price/dividend ratio of the S&P 500; ln(Yield Spread), the natural logarithm of the Baa-Aaa yield spread; ln(# IPO), the natural logarithm of the number of IPOs (from Jay Ritter's website); ln(# M&A), the natural logarithm of the number of M&A transactions (from SDC); ln($ BO Fund.), the natural logarithm of the dollar amount (in millions) of buyout industry fundraising (from Venture Economics); and ln($ VC Fund.), the natural logarithm of the dollar amount (in millions) of venture capital industry fundraising (from Venture Economics). All variables are measured quarterly.

Panel A: Correlation Matrix

	ln(P/D)	ln(High Yield)	ln(# IPO)	ln(# M&A)	ln(BO Fund.)	ln(VC Fund.)
ln(P/D)	1.00					
ln(High Yield)	-0.44	1.00				
ln(# IPO)	0.10	-0.66	1.00			
ln(# M&A)	0.80	-0.48	0.06	1.00		
ln(BO Fund.)	0.76	-0.17	-0.17	0.81	1.00	
ln(VC Fund.)	0.59	-0.25	0.01	0.58	0.66	1.00

Panel B: Principal Component Eigenvalues and Eigenvectors

	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5	Comp. 6
ln(P/D)	0.50	0.03	-0.24	0.32	-0.77	0.06
ln(High Yield)	-0.30	0.59	0.13	0.63	0.08	0.36
ln(# IPO)	0.09	-0.73	0.20	0.60	0.22	0.09
ln(# M&A)	0.50	0.05	-0.34	-0.16	0.42	0.65
ln(BO Fund.)	0.47	0.31	-0.11	0.28	0.42	-0.65
ln(VC Fund.)	0.42	0.14	0.87	-0.17	-0.06	0.12
Eigenvalue	3.33	1.60	0.49	0.26	0.21	0.11
Proportion	0.55	0.27	0.08	0.04	0.03	0.02
Cumulative	0.55	0.82	0.90	0.95	0.98	1.00

Table A-5: Sensitivity of Capital Calls to Market Conditions by Fund Age

This table presents estimates of how the sensitivity of capital calls to macroeconomic conditions vary with fund age. The dependent variable is the natural logarithm of the fund's capital calls as a percentage of committed capital plus one. The unit of observation is a fund-calendar quarter. Years 4-6 is an indicator variable for whether the fund is in the fourth through sixth years of its life. Years 7-9 is an indicator variable for whether the fund is in the seventh through ninth years of its life.. Years 10+ is an indicator variable for whether the fund is in the tenth or greater year of its life. The omitted category is whether the fund is in the first three years of its life. All other variables are defined in Table 3. All specifications include fund age (in calendar quarters) and uncalled capital fixed effects. Estimation is Tobit. Standard errors (in parentheses) are robust to heteroskedasticity and clustered by calendar quarter. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Buyout Funds	Venture Capital Funds
	(1)	(2)
Dependent variable is ln(capital calls as percentage of committed capital + 1)		
ln(P/D)	0.39***	0.61***
	(0.08)	(0.10)
ln(P/D) × Years 4-6	-0.14	-0.11
	(0.09)	(0.10)
ln(P/D) × Years 7-9	-0.40***	-0.62***
	(0.09)	(0.11)
ln(P/D) × Year 10+	-0.38***	-0.67***
	(0.09)	(0.12)
ln(Yield Spread)	-0.10***	-0.23***
	(0.02)	(0.04)
ln(Yield Spread) × Years 4-6	-0.01	0.04
	(0.03)	(0.04)
ln(Yield Spread) × Years 7-9	0.10***	0.23***
	(0.03)	(0.03)
ln(Yield Spread) × Year 10+	0.10***	0.21***
	(0.02)	(0.03)
All specifications include fund age and uncalled capital fixed effects		
Observations	21,684	13,029
Adjusted R^2	0.295	0.321

Figure A-1: Levered PME-β Sensitivity

This figure displays cross-sectional means of Levered PME and 95% confidence intervals for the mean as the beta used in the Levered PME calculation varies from 0 to 3. The calculations are performed on the sample of liquidated funds.