Liquidity Shocks and Private Equity Investment*

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Abstract

This paper demonstrates that investor composition shapes private equity (PE) investment dynamics in response to liquidity shocks. Investors' different liability structures lead to heterogeneous costs of financing illiquid investments. During large natural disasters, PE funds with more committed capital from property and casualty insurers invest less than other near-identical funds. This investment distortion reduces the productivity of private companies. However, the shock transmission is attenuated ex-post when funds can adjust their investor base or enforce drawdowns more effectively. To mitigate liquidity shocks ex-ante, funds exposed to shock-prone investors accelerate drawdowns, leading to inefficient investment. Overall, the growing interconnectedness between PE and other financial markets can have implications for financial stability and capital allocation.

Keywords: Nonbanks, Financial Institutions, Insurers, Private Equity, Liquidity Shocks, Capital Allocation

JEL Classification: E22, G11, G22, G23, G24

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1 Introduction

Non-bank financial intermediaries have been playing a growing role in transforming household and corporate savings into capital investments, a trend exemplified by the rapid expansion of the private equity (PE) market. This trillion-dollar market has been financing an increasing share of the real economy (Figure 1) and is dominated by a *wide array* of institutional investors, including pension funds, endowments, and insurance companies, each with different sensitivity to shocks because of their distinct liability structures as highlighted in recent literature (e.g., Vayanos and Vila, 2021; Bretscher, Schmid, Sen, and Sharma, 2024; Darmouni, Siani, and Xiao, 2024). These investors typically rely on PE funds to intermediate their investments. Unlike mutual funds or hedge funds, PE funds are closed-end and funded through capital commitments rather than upfront contributions. PE funds draw down ("call") capital from their investors over time who contractually commit to providing cash *on demand* based on the pro rata share of committed capital. On the one hand, this unique feature allows fund managers to raise larger funds ex-ante by offering investors various benefits. On the other hand, the fund design introduces uncertainty in the amount of capital available for investment ex-post due to investors' heterogeneous costs of meeting capital calls for illiquid investments particularly during liquidity shocks.

This paper investigates how investor base composition affects PE investment dynamics and capital allocation in response to liquidity shocks. Despite the PE market's interconnection with various financial institutions, investors' institutional differences have largely been considered irrelevant after capital commitments. In a frictionless capital market, investor heterogeneity should note affect real outcomes as long as investment opportunities stay constant. However, when market frictions make alternative financing costly, the cross-sectional distribution of investor base becomes important as heterogeneous financial institutions can transmit different liquidity shocks, potentially leading to inefficient PE investment.

I motivate the research question by presenting novel stylized facts about PE funds' investment patterns based on Preqin data. First, whereas most PE funds spend all their capital raised at fund inception, many funds invest less than the committed amount, which may be attributed to capital supply frictions (Figure 2). Second, PE funds on average call capital quickly with a monotonically declining pace instead of spreading out the capital contribution evenly over several years (Figure 3a). This pattern aligns with the theoretical prediction of Maurin, Robinson, and Strömberg (2022) that PE funds have incentives to mitigate funding shocks through acceleration of drawdowns. Third, there is *large heterogeneity* in investment pace across funds, especially in the early life cycle (Figure 3b). The variation could reflect PE funds' heterogeneous hedging incentives, driven by their exposure to investors susceptible to liquidity shocks.

However, the observed drawdowns are an equilibrium outcome of capital supply and demand. Lower drawdowns might result from narrower sets of investment opportunities for PE funds rather than reduced availability of capital from their investors. Moreover, while liquidity shocks are common and manifest in various forms, events like financial crises are systematic and usually coincide with business cycles that affect capital demand.

To overcome these challenges, I use large natural disasters as exogenous liquidity shocks to test whether investor base affects PE investment dynamics. Investors face heterogeneous costs of financing illiquid investments in different states of the economy due to their distinct contractual liabilities. Unlike pension funds or endowments, property and casualty (P&C) insurers are sensitive to large natural disasters, whose timing and damage are difficult to predict. These events can trigger sudden spikes in short-term claims that P&C insurers are obligated to pay, thus increasing their preference for liquid assets over private equity. In contrast, other investors are less affected by natural catastrophes, as their contractual liabilities remain stable following such events. Specifically, I document a heavily right-skewed distribution of quarterly insured losses from natural disasters and classify losses above the 90th percentile as abnormal. Calendar quarters with these abnormal losses represent liquidity shocks to P&C insurers, which is supported by within-insurer estimates indicating that P&C insurers experience substantially greater underwriting losses during these periods.

The natural experiment generates plausibly exogenous temporal and cross-sectional variation in liquidity shocks to investors at the PE fund level, based on a largely fixed characteristic—these close-end funds' exposure to P&C insurers. By tightly controlling for the calendar quarter, fund age, and fund manager fixed effects interacted with dummy variables for fund characteristics (fund type and size), my empirical design fully absorbs any confounding variation of investor base fixed at the fund manager level or explained by observable fund characteristics. Therefore, it mitigates concerns about endogenous matching between investors and fund managers (Lerner and Schoar, 2004). The residual variation in funds' exposure to P&C insurers is *sizable* and mainly driven by *idiosyncratic* factors across different fund vintage years—such as investors' demand for private equity as well as search and matching frictions—that are uncorrelated with funds' investment opportunities.

I establish causal evidence that investor base transmits liquidity shocks reducing PE funds' investment across several proxies.[1] Funds with high exposure to P&C insurers invest 19% less during quarters with abnormal insured losses from natural disasters. The transmission of liquidity shocks from investors to PE funds persists for two quarters without differential pre-trends in investment. Furthermore, high-exposure funds do not invest more in the following periods, indicating a potential loss of investment opportunities. The results are unlikely driven by capital demand and are robust to various subsamples, including subsets of funds with largely *limited choices* of investor base. Moreover, liquidity shocks ultimately reduce private companies' productivity measured by the number of highly cited patent applications. Overall, PE funds cannot fully insulate themselves from costly funding shocks arising from their investor base. These findings support the theory of Maurin, Robinson, and Strömberg (2022) and provide micro-level evidence consistent with the procyclicality of aggregate capital calls with market liquidity documented by Robinson and Sensoy (2016).

To further highlight the importance of investor base, I demonstrate that PE funds with high exposure to various non-P&C investors do not experience any investment declines when natural disasters cause abnormal insured losses in the economy. Among others, these investors include life insurers, endowments and foundations (henceforth endowments), and public pension funds, whose contractual liabilities exhibit weak sensitivity to large natural disasters. The result provides additional causal evidence for the shock transmission and suggests that variation in investor base can lead to different state-dependent capital supply.

Moreover, triple-diff estimations suggest that the distortion in PE investment following liquidity shocks is attenuated when the demand for fund shares improves in the secondary

[1] The reduced investment can be i) fund managers' concession - they may slow down capital calls during periods of elevated costs of capital for investors due to the relationship business nature, or ii) LP defaults, in which investors, also known as limited partners (LPs), fail to fulfill fund managers' capital calls on demand (see Section 5.4). Section 2.2 discusses frictions in arranging non-pro-rata capital calls.

market, as it facilitates adjustment of PE funds' investor base. Due to the illiquidity of their underlying investments, PE funds are typically structured as closed-end vehicles with fixed investor base throughout their life cycle. As a market response to this friction, a secondary market has emerged for trading fund shares enhancing the transferability of PE investments (e.g., Albuquerque, Cassel, Phalippou, and Schroth, 2018; Nadauld, Sensoy, Vorkink, and Weisbach, 2019). After the transaction, buyers replace sellers who are existing investors in a fund and assume all future fund cash flows based on their pro rata equity contribution.

A key challenge in PE funds' investment decisions arises from incomplete contracting. Capital calls cannot be contracted on liquidity shocks because such states are difficult to specify ex-ante and verify ex-post.[2] To address investors' limited commitment, fund managers write covenants that allow them to penalize investors who default on capital calls. The most punitive and commonly used provision is forfeiture of fund investments for defaulting investors—even the threat of such penalties strengthens managers' bargaining power during renegotiations (Litvak, 2004). I show that investors' limited commitment is mitigated when more capital has been called because early investments serve as collateral that investors may risk losing if they fail to meet capital calls (Maurin, Robinson, and Strömberg, 2022).

Lastly, I examine whether investor base can have any ex-ante implications on investment dynamics across PE funds. Although P&C insurers are sensitive to large natural disasters, they are not inherently more vulnerable to liquidity shocks ex-ante than other PE investors, such as life insurers or pension funds, since sensitivity to shocks vary across investors and these shocks occur with different probabilities. However, these "*debt-financed*" investors have formal contractual liabilities such as insurance claims and pension benefits, whereas endowments are "*equity-financed*" by donations and have flexible dividend-like payouts (Brown, Dimmock, Kang, and Weisbenner, 2014). This fundamental difference in funding structures implies that endowments are arguably the least susceptible to liquidity shocks. By exploiting variation in investor base across *nearly identical* funds raised by the same manager—including subsamples of funds with *limited choices* of investor base—I demonstrate that funds with a lower share of endowments tend to invest earlier. By accelerating drawdowns,

[2] Although the occurrence of natural disasters is publicly observable, the losses they inflict on individual insurers are not and thus unverifiable. Consequently, contracting on natural disasters remains challenging.

PE funds reduce the amount of uncalled capital at the risk of not being provided during liquidity shocks and build up the collateral to punish non-complying investors (Maurin, Robinson, and Strömberg, 2022). However, the acceleration is costly because it distorts PE funds' investment schedule leading to suboptimal selection of portfolio companies. Within-fund estimation confirms this prediction and suggests that investments in the early stage of a fund's life tend to have a lower chance of successful exits, especially among funds with a lower share of endowments.

Overall, this paper documents novel evidence that investor base is an important determinant of PE investment dynamics and capital allocation in response to liquidity shocks. PE investors have distinct contractual liabilities that result in heterogeneous sensitivity to liquidity shocks, such as natural disasters for P&C insurers, pandemics for life insurers, and interest rate changes for pension funds. While the growing participation of these non-bank intermediaries has fueled PE market expansion, this trend has also amplified the interconnectedness of different financial markets and potentially reduced financial stability by transmitting shocks within the economy.[3]

Related Literature. This paper contributes to three strands of literature. First of all, it adds to the emerging literature on the role of institutional investor heterogeneity in financial markets. Recent studies have examined its implications on asset prices (e.g., Koijen and Yogo, 2019; Bretscher, Schmid, Sen, and Sharma, 2024; Coppola, 2024; Darmouni, Siani, and Xiao, 2024), term structure (Vayanos and Vila, 2021), costs of capital (Siani, 2024), and contracting (Chernenko, Lerner, and Zeng, 2021). This paper establishes causal evidence that investors' distinct liability structures shape their ability to supply capital across different states of the world and influence capital allocation in PE markets. It connects this body of work to the literature on PE return persistence (e.g., Kaplan and Schoar, 2005; Braun, Jenkinson, and Stoff, 2017). While differences in institutional investors' skills and objectives affect their fund selection and investment performance in private equity (Lerner, Schoar, and

[3] Bernstein, Lerner, and Mezzanotti (2019) and Johnston-Ross, Ma, and Puri (2025) document that PE funds increase financial stability by providing timely financing to distressed companies and failed banks during crises. Therefore, abrupt disruptions in PE funds' investment activities could amplify crises. My findings highlight the importance of investor base since PE funds will have limited ability to provide timely financing if their investor base face correlated shocks with distressed companies and banks.

Wongsunwai, 2007; Hochberg and Rauh, 2013; Andonov, Hochberg, and Rauh, 2018), my findings support the theory that investors' varying illiquidity tolerance is another source of return persistence at both the investor and fund levels by affecting fund investment outcomes (Maurin, Robinson, and Strömberg, 2022).

Second, the paper contributes to the financial intermediation literature on funding shocks, an under-explored topic in the PE context.[4] This paper presents the first empirical evidence that investors' liquidity mismatch can create funding shocks to PE funds after capital commitments. Existing work on funding shocks to mutual funds and hedge funds usually focuses on asset prices and trading, influenced by redemption of fund shares, and investigates topics such as fire sales and financial fragility (e.g., Coval and Stafford, 2007; Chen, Goldstein, and Jiang, 2010; Ben-David, Franzoni, and Moussawi, 2012; Goldstein, Jiang, and Ng, 2017; Darmouni, Siani, and Xiao, 2024). In sharp contrast, PE funds, being closed-end and backed by commitments, mainly focus on primary markets. My work emphasizes the importance of funding shocks in affecting the *quantity of investments* made by PE funds, both ex-post and ex-ante. More broadly, the paper is the first to highlight investor base as a key determinant of funding shocks to pooled investment vehicles—a relationship previously obscured by the lack of granular investor data in mutual funds and hedge funds.

Moreover, my setting features a high level of interconnectedness among non-bank financial intermediaries and with PE markets, which distinguishes it from the extensive literature on the transmission of liquidity shocks in banking (e.g., Khwaja and Mian, 2008; Ivashina and Scharfstein, 2010; Schnabl, 2012; Chodorow-Reich, 2014). These non-bank intermediaries differ significantly from banks in funding structures and have heterogeneous sensitivity to shocks. This paper adds to the growing body of work on the impact of non-bank intermediaries on financial stability in the context of the ongoing structural shift from a bank-centric financial system towards non-bank financial intermediation (e.g., Davydiuk, Marchuk, and Rosen, 2024; Darmouni, Siani, and Xiao, 2024; Bhardwaj, Ge, and Mukherjee, 2025).

Third, my paper is closely related to the vast literature on illiquidity and its economic

[4] In previous studies, PE funds are considered as facing little funding shocks because investors are often implicitly assumed to follow one of the two approaches: either they invest all their committed capital immediately into illiquid assets (e.g., Sorensen, Wang, and Yang, 2014), or they consistently fulfill sequential capital calls due to the substantial costs of non-compliance (Giommetti and Sorensen, 2024; Gourier, Phalippou, and Westerfield, 2024).

impacts (e.g., Shleifer and Vishny, 1992; Amihud, Mendelson, and Pedersen, 2006; Tirole, 2011). Specifically, my work complements research that studies the implications of illiquidity in PE markets covering areas such as illiquidity premium (e.g., Harris, Jenkinson, and Kaplan, 2014; Robinson and Sensoy, 2016), asset allocation (Giommetti and Sorensen, 2024; Gourier, Phalippou, and Westerfield, 2024), risk-adjusted returns (e.g., Korteweg, 2019; Gupta and Van Nieuwerburgh, 2021) and investor screening (Lerner and Schoar, 2004). A novelty of this paper is its emphasis on illiquidity as an important friction faced by PE funds when intermediating the capital of investors, who have heterogeneous costs of financing illiquid investments in different states of the economy. Moreover, my work contributes to the small but growing body of research on the secondary market for PE fund shares, by examining how it alleviates this friction (e.g., Albuquerque, Cassel, Phalippou, and Schroth, 2018; Nadauld, Sensoy, Vorkink, and Weisbach, 2019).

2 Institutional Background

2.1 Private Equity Investors and Their Liability Structures

Pension funds, endowments, and insurers are the major PE investors in the US (Figure B1). These investors have distinct contractual liabilities and susceptibility to liquidity shocks:

Insurance Companies. Insurance companies are funded by premiums paid by policyholders and, in return, are contractually obligated to compensate them for covered losses or policy events. To ensure they can meet these obligations, regulators typically require insurers to maintain a certain level of liquid assets. These reserves, set aside to cover these contractual claims, constitute the primary liability for insurers. Based on the types of risks they insure, insurance companies are broadly categorized into two main types: property & casualty (P&C) insurers and life insurers.

P&C insurers issue short-term contracts and face significant variability in claim outcomes. While premiums are typically calculated based on historical data and paid by policyholders in advance, the actual cost of claims remains uncertain until the policy matures. Much of this variability arises from claims related to large natural disasters, the timing and damage of which are highly unpredictable. Natural disasters have been documented to affect the product pricing and portfolio rebalancing decisions of P&C insurers (Girardi, Hanley, Nikolova, Pelizzon, and Sherman, 2021; Ge and Weisbach, 2021; Ge, 2022).

In contrast, life insurers issue long-term policies, such as annuities, with pre-specified claim amounts or guaranteed interest rates. Their liability structure makes them vulnerable to unexpected changes in mortality rates and falling interest rates which increase liabilities by reducing the discount rate used to calculate the present value of future claims.

Pension Funds. Pension funds are primarily funded by contributions from employers and employees and pay retirement benefits determined by pre-defined contractual terms. Most public pension funds in the US offer defined benefit plans, while private pension funds have been gradually shifting towards defined contribution plans over the past three decades. For defined benefit pension plans, managers are obligated to provide guaranteed pension benefits. Liquidity shocks can occur if payout liabilities exceed liquid assets, which may result from financial market declines or reduced pension contributions during economic downturns.[5] In contrast, defined contribution plans transfer investment risk to pension contributors. However, pension funds may still need to hold more liquid assets to accommodate large withdrawals if their beneficiaries take early retirement or opt for lump-sum payments.

Endowments. Funded by donations, endowments aim to preserve the real value of their principal amounts while using the investment income to finance university operations and philanthropic programs. Endowments' payouts are similar to dividends, typically following a *smoothed* multi-year moving average of endowment values. However, endowments maintain flexibility by actively reducing payouts below stated targets when facing negative shocks (Brown, Dimmock, Kang, and Weisbenner, 2014). Therefore, endowments *lack contractual liabilities* that must be paid, arguably making them resilient to liquidity shocks.[6]

Overall, the differences in PE investors' liability structures give rise to heterogeneous opportunity costs of financing illiquid investments like private equity. Both insurance companies and pension funds are more vulnerable to liquidity shocks due to their contractual liabilities and regulatory restrictions on maintaining reserves for such obligations. In contrast, endowments operate free from such constraints.

[5] Although pension funds can hedge their liability risk, interest rate hedging has been documented to create liquidity shocks due to margin calls (Jansen, Klingler, Ranaldo, and Duijm, 2024).

[6] During my sample period, U.S. endowments are typically tax-exempt, provided they meet certain regulatory requirements, such as maintaining a minimum annual distribution of 5%.

2.2 Committed Capital and Capital Calls

PE funds are structured with committed capital and capital calls. Investors only need to *contractually commit* to providing capital *on demand* up to the total committed amount set at fund inception, known as the committed capital. A capital call occurs when the fund requests its investors to contribute their *pro rata* share, typically with a two-week notice, to finance new investments or cover fees.[7] This ex-ante financing structure facilitates fundraising by mitigating agency frictions faced by fund managers in a deal-by-deal fundraising structure (Axelson, Strömberg, and Weisbach, 2009; Maurin, Robinson, and Strömberg, 2022).

Pro rata capital calls are legally binding contracts and offer two key benefits. First, they ensure that all investors maintain proportional stakes in each fund investment, preventing fund managers from favoring certain investors in the timing or amount of contributions. Second, pro rata capital calls reduce compliance costs and administrative burden, for example, in PE fees calculation. While non-pro-rata capital calls can address liquidity shocks faced by some investors, they require majority consent, which may cause delays and coordination challenges. Additionally, other investors may lack the resources to cover extra contributions. The prospect of ex-post renegotiation can also distort incentives ex-ante, as investors anticipating renegotiation may engage in suboptimal behaviors, such as taking excessive risks in their portfolios. Overall, pro rata capital calls can amplify liquidity shocks, creating *negative externalities* on compliant LPs and the fund's investment when a subset of investors experience liquidity issues.

2.3 Contracting and Enforcement of Capital Calls

The contractual design of committed capital potentially introduces uncertainty in the funds available for investment ex-post due to investors' limited commitment. Capital calls are largely unpredictable in timing and amount, as investment opportunities arise randomly. Investors may be unwilling to or even unable to meet drawdowns if they are hit by liquidity shocks, causing delays or reductions in investment.

The fundamental issue stems from incomplete contracting. It is challenging to write state-contingent contracts for capital calls, because liquidity shocks are difficult to specify

[7] The total amount of called capital can sometimes exceed the committed capital because of the recycling provisions, allowing fund managers to reinvest exit proceeds, rather than distribute them back to investors, under certain conditions. See stylized facts in Section 4.

ex-ante and verify ex-post. This challenge is compounded by numerous unforeseen contingencies that can emerge during a PE fund's long lifespan, which often exceeds 10 years. Consequently, fund contracts do not specify the amount of drawdowns under different circumstances. Instead, these contracts rely on default penalties and, occasionally, escrow accounts to enforce capital calls. Next, I discuss these contracts in detail below.

Default Penalties. In limited partnership agreements (LPAs), fund managers establish various penalties for investors, also known as limited partners (LPs), who fail to meet their capital contribution obligations. If an LP does not fulfill part of their commitment, the fund manager typically issues a written notice of default and the investor is classified as a defaulting LP. The most severe provision commonly available is the forfeiture of a portion of the fund interest (Litvak, 2004).[8] For example, the 2020 version of the LPA template drafted by the Institutional Limited Partners Association (ILPA) includes:

> *"The General Partner in its sole discretion pursue and enforce any and all rights and remedies the Fund, the General Partner or the Fund Manager may have against such Defaulting Partner at law, in equity or pursuant to the Partnership Agreement, including forfeiting up to 100% of its Interest in the Fund without payment or other consideration."*

The incomplete contract nature of capital calls implies room for renegotiation between the fund manager and investors. Even if the forfeiture provision is not always used, its presence enhances the fund manager's bargaining power during renegotiations with investors regarding drawdowns. The availability of such a penalty can effectively serve as a deterrent, increasing the enforceability of capital calls (Litvak, 2004).

Escrow Accounts. A PE fund can address investors' limited commitment by holding their promised contribution in an escrow account. In this arrangement, investors make a single upfront payment, and any unutilized contributions are invested in liquid securities, with the interest accruing to the investors.

[8] Among others, penalties may include withholding distribution of fund returns, charging high interest on the uncontributed amount, and forcing secondary sales of the fund interest. See Litvak (2004) for detailed examples of penalty terms ranked by severity of punishment.

However, escrow accounts are not widely in fundraising used for several reasons. First, staged capital contributions can boost a fund's internal rate of return (IRR). If a fund receives an excess amount of capital that it cannot immediately invest and instead holds the capital in the fund's bank account, the IRR will become lower making the fund performance less impressive. Second, PE funds do not specialize in managing multi-asset portfolios—if PE funds allocate uncalled capital to liquid assets, investors can usually find superior investment alternatives, making escrow accounts unattractive. Third, some investors might lack the necessary cash for upfront contributions in PE funds and face financial constraints due to regulatory restrictions or high borrowing costs. Maurin, Robinson, and Strömberg (2022) shows that the escrow account cannot fully solve the investors' limited commitment problem unless borrowing is costless.

2.4 The Secondary Market for Private Equity Fund Shares

Unlike mutual funds and hedge funds, PE funds primarily invest in private companies, aiming to improve their performance over an extended period and realize returns upon exits such as M&As or IPOs. These investments are inherently illiquid, in contrast to publicly traded securities held by mutual funds or hedge funds, which can usually be sold readily upon investors' redemption requests.

Therefore, PE funds are structured as closed-end vehicles, allowing them to invest without the liquidity constraints imposed by investor redemptions. However, the illiquidity of PE investments does not necessarily imply that PE fund shares have to be illiquid. In fact, a secondary market has evolved in which buyers, such as specialized intermediaries known as secondary funds, provide liquidity to sellers by purchasing their stakes in PE funds. Following the transaction, the buyer as the new fund investor will assume all future cash flow on a pro rata basis of their equity contribution. Therefore, secondary sales enable PE funds to adjust their investor base.

Liquidity is one of the most important reasons to sell fund shares in the secondary market (Nadauld, Sensoy, Vorkink, and Weisbach, 2019). During liquidity shocks, PE fund investors may need to increase their precautionary cash holdings to meet liabilities or to adjust balance sheets due to regulatory requirements and investment mandates.[9] By selling

[9]Other reasons include portfolio rebalancing, PE investment strategy shift, sale of tail-end funds, GP-led

their PE fund shares, investors can partially reduce their illiquid investments.

The secondary market remains illiquid due to information frictions faced by buyers in valuing PE funds' underlying assets as well as search and matching frictions. In fact, most transactions still occur at a considerable discount to the net asset value (NAV) (Nadauld, Sensoy, Vorkink, and Weisbach, 2019). However, the liquidity of the secondary market has been growing over time, driven in part by rising demand for liquidity.

3 Data and Summary Statistics

3.1 Measures of Private Equity Fund Investment

My main analysis uses Preqin's comprehensive cash flow data to measure PE funds' investment: *Capital Called (%)*, the quarterly amount of capital called by a PE fund as a percentage of its committed capital, or *Number of Investments*, the number of investments made by a fund in a calendar quarter. I consider each capital call as an investment and exclude capital calls with amounts below the quarterly amortized amount of management fees, since capital calls typically commingle investments with private equity fees. My results are robust to including these capital calls to create *Number of Investments*.

Preqin's cash flow data has three unique features. First, it presents the cash flow from the perspective of a hypothetical investor with a 10 MIL commitment to the fund. As a result, I do not observe more granular cash flow data at the investor-fund level. However, such a level of granularity is unnecessary for this study because capital is usually drawn down based on the pro rata contribution of investors' committed capital. Therefore, both the hypothetical and actual investors contribute in the same way, relative to their commitments when their capital is called.

Second, although Preqin records capital calls as negative cash flows, there are occasionally positive values for capital calls, likely representing fee rebates (Begenau, Robles-Garcia, Siriwardane, and Wang, 2020). Since I am interested in studying PE investment dynamics, I exclude capital calls recorded as positive cash flow in Preqin when constructing *Capital Called (%)* and *Number of Investments*. Including these positive capital calls does not impact the robustness of my results.

Third, PE funds can also borrow debt to finance their investments, as seen in leveraged

secondaries. See Nadauld, Sensoy, Vorkink, and Weisbach (2019) for more details.

buyouts and capital call facilities (e.g., Kaplan and Strömberg, 2009; Axelson, Jenkinson, Strömberg, and Weisbach, 2013; Albertus and Denes, 2024). However, Preqin's cash flow data solely accounts for the equity committed to the fund, and it excludes any debt used to finance investment. Therefore, my cash-flow-based outcome variables capture the fund investors' equity contribution to their PE funds' investment. In Section 5.7.2, I use alternative proxies for investment based on PE deals that can be matched to each PE fund. These outcome variables measure both the equity and debt contribution to PE funds' investment. My results remain quantitatively and qualitatively similar.

3.2 Summary Statistics

My main sample consists of US PE funds covered by Preqin's fund cash flow database, spanning from 1990 to 2020. Due to the nature of my analysis, the sample excludes PE funds without cash flow or investor data.[10] There are 1,715 unique PE funds managed by 636 fund managers and 53,154 fund-quarters in my sample. The total amount of capital raised by my sample funds is 1.81 trillion USD, accounting for approximately 60% of the aggregate fundraising in the Preqin universe during the period of 1990-2020 in the US.[11] Appendix A.1 details the data sources used in this study.

Panel A of Table 1 reports the summary statistics for the sample of fund-quarters. On average, 2.87% of committed capital is called in each quarter and 0.46 investments are made. However, more than half of the funds do not draw down any capital in a quarter. The sporadic nature implies that investment opportunities arrive randomly. Moreover, there is large *cross-sectional variation* in PE funds' investor base (Figure 5a)—while the unconditional mean of *P&C Insurer Share* is 3.40%, the average value is 9.42%/20.20% conditional on having any/high exposure to P&C insurer LPs.

For the analysis of the ex-ante impacts of investors' liquidity shocks on investment outcomes, I use the cross-sectional data by pairing PE funds with their portfolio companies. The summary statistics are shown in Panel B of Table 1. On average, around 10% of the companies invested by my sample funds have gone public, and 48% of these companies are

[10]The investor composition can be observed for over 97% of the funds with cash flow data.

[11]Preqin is widely used in the literature that studies cash flows of PE funds. An incomplete list of relevant papers includes Harris, Jenkinson, and Kaplan (2014), Korteweg and Nagel (2016), Korteweg and Sorensen (2017), Ang, Chen, Goetzmann, and Phalippou (2018), Gupta and Van Nieuwerburgh (2021), and Begenau and Siriwardane (2024).

invested within the first year after the fund vintage year.

4 Stylized Facts of Capital Calls

Without claiming causality, this section provides novel stylized facts about PE fund investment patterns that align with investor composition as a potential driver of investment dynamics in response to liquidity shocks. These patterns are robust to various subsamples by fund types, size, and sequence, presented in Appendix B.

Uninvested Capital Commitments. Figure 2 shows the cross-sectional distribution of total drawdowns as a percentage of fund size at the end of the fund lifespan. Fund size is the amount of capital committed by the investors at fund inception. The sample consists of PE funds raised between 1990 and 2005, ensuring that each fund has at least 15 years to call capital by 2020. While most funds call capital amounts close to their fund size, a large portion of funds either draw down substantially more or less than the committed amount. Some funds' total drawdowns exceed their committed capital due to recycling provisions, which permit reinvestment of exit proceeds rather than distributing them to investors under certain conditions.[12] Conversely, some funds underinvest, potentially reflecting capital supply constraints from liquidity shocks to their investors.[13] However, lower drawdowns may also result from a limited set of investment opportunities available to the fund manager, rather than reduced investor contributions.

Declining Investment Pace. Figure 3a presents capital calls as a percentage of the committed capital by fund age. Instead of spending capital contributions evenly over several years, PE funds on average call capital quickly. On average, around 20% of committed capital is invested in the fund inception year, and the investment pace declines monotonically with fund age. The PE investment dynamic aligns with the idea that fund managers have incentives to hedge against funding shocks by accelerating drawdowns, as theoretically formalized by Maurin, Robinson, and Strömberg (2022).[14]

[12] In a recent survey study by law firm Paul, Weiss, Rifkind, Wharton & Garrison LLP, all PE funds surveyed allow recycling of capital, with 60% of funds permitting recycling when capital is returned within 2 years of investment.

[13] Fund managers may raise more capital than needed as a buffer due to expected liquidity shocks to LPs.

[14] Although PE fund managers' compensation contracts could also lead to a declining investment pace, these contracts are quite homogeneous across funds and thus unlikely to generate the substantial cross-sectional variation of investment pace (Metrick and Yasuda, 2010; Robinson and Sensoy, 2013).

Heterogeneous Investment Pace. Figure 3a also reveals substantial cross-sectional variation in investment pace—some funds invest almost 50% of their entire committed capital in the first year of inception, while others only spend less than 5%. This heterogeneity is particularly pronounced in the early stage of the fund life and gradually diminishes as the fund ages. This pattern likely reflects funds' varying hedging incentives, which stem from differential exposure to investors with liability structures that make them inherently more vulnerable to liquidity shocks. A similar pattern of heterogeneity appears in cumulative drawdowns, as demonstrated in Figure 3b. Funds at the 25th percentile have invested approximately 25% of the committed capital at age 2, whereas funds at the 95th percentile have nearly completed all of their investments by the same point.

5 Ex-Post Impacts of Investor Base

5.1 Identification Strategy

Liquidity shocks are common and take many forms. However, events such as financial crises are systematic and usually coincide with business cycles that affect capital demand. To isolate causal effects, my empirical setting focuses on natural disasters—whose timing and severity are plausibly exogenous—to examine how investor composition shapes PE investment dynamics.

5.1.1 Large Natural Disasters as Exogenous Liquidity Shocks

Figure 4a shows the quarterly insured losses caused by natural disasters in the US during 1990-2020. The horizontal red dashed line indicates the historical 90th percentile value (13.5 USD BIL). Insured losses greater than this value are considered abnormal, representing liquidity shocks to P&C insurers due to their severity and unpredictability.

The focus on large natural disasters is motivated by two key considerations. First, P&C insurers specialize in assuming and managing catastrophic risk in return for premiums. Liquidity challenges should emerge only when claim volumes experience substantial, unexpected surges. Second, as Figure 4a demonstrates, insured losses from natural disasters tend to be relatively stable for most quarters, suggesting that these losses are anticipated. Given the opportunity costs of excessive liquidity buffers, P&C insurers rationally maintain minimum cash reserves in normal times while managing their cash flows in times of large payout. In fact, NAIC filings indicate that P&C insurers typically allocate a median of 6% (mean of

11%) of total assets to cash, cash equivalents, and short-term investments.

Table B1 ranks the calendar quarters of the liquidity shocks in descending order based on the quarterly insured loss. 2005Q3 stands out as the period with the largest insured loss, exceeding USD 100 billion, primarily due to Hurricane Katrina and Hurricane Rita. While hurricanes account for most of the most costly natural disasters, other events such as droughts, earthquakes, and wildfires have also caused significant insured losses over the past three decades.[15] Large natural disasters are arguably unpredictable—the Durbin-Watson statistics for the quarterly time series of the liquidity shocks is 1.89, failing to reject the null hypothesis of no serial correlation. Furthermore, Figure B5b shows no significant partial autocorrelation with lags extending up to five years.

To provide direct evidence that large natural disasters are liquidity shocks to P&C insurers, I collect the financial data from their statutory reports, obtained from the NAIC, and estimate the following within-insurer regression for P&C insurers during 2001-2020:[16]

$$\textit{Net Underwriting Gain (\%)}_{it} = \beta \times \textit{Liquidity Shock}_t + \boldsymbol{\delta_i} + \boldsymbol{\tau_{q(t)}} + \epsilon_{it} \tag{1}$$

in which i and t denote an insurer and a calendar quarter. The regressions are estimated at the insurer group level and give similar findings at the firm level. *Net Underwriting Gain (%)* is the net underwriting gain as a percentage of lagged total assets. The variable is winsorized at the 1st/99th percentile, with an unconditional mean of -0.135 (median = -0.003) and interquartile range values of -0.790 (25th percentile) and 0.734 (75th percentile).[17] Net underwriting gain reflects the profits and losses generated from a P&C insurer's core underwriting activities. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. $\boldsymbol{\delta_i}$ and $\boldsymbol{\tau_{q(t)}}$ are insurer and quarter fixed effects. The

[15] Although the occurrence of certain disasters like hurricanes is largely predictable, forecasting their damage remains far more challenging.

[16] The NAIC P&C insurers' quarterly financial statements are available starting from 2001. Life insurers report their income statements differently and do not include net underwriting gain as an accounting item, because their business model is fundamentally different from P&C insurers and they follow different accounting rules based on accruals. Life insurance focuses on long-term policies, actuarial assumptions, and investment income.

[17] My finding remain robust to winsorizing the scaled net underwriting gain at 5th/95th percentiles, which mitigates the potential concern of outliers driving my results.

coefficient of interest β measures the average difference in the deseasonalized net underwriting gain between periods with and without large natural disasters within the same P&C insurer. Standard errors are two-way clustered at the insurer and calendar quarter levels.

Figure 4b displays the histogram showing the within-insurer estimation of the beta coefficient from Equation (1), derived from 1,000 trials of a placebo test that randomly selects 10% of the calendar quarters in the sample period as pseudo liquidity shocks to P&C insurers. The vertical dashed line represents the coefficient estimate of -0.225 (around 15% of the interquartile range),[18] based on true liquidity shocks linked to insured losses caused by natural disasters. Notably, over 97% of the distribution falls to the right of this vertical dashed line. Table B2 reports the estimates based on the true liquidity shocks and uses an alternative measure of P&C losses as the outcome variable (Ge and Weisbach, 2021; Ge, 2022). Overall, these findings suggest that large natural disasters are liquidity shocks to P&C insurers leading to substantial underwriting losses.

5.1.2 The Importance of Insurers for Private Equity Markets

As shown by Lerner, Schoar, and Wongsunwai (2007), insurers are an important source of capital for private equity. Recent NAIC filings reveal that US insurers reported holding 187.33 USD BIL private equity in book/adjusted carrying value (BACV) as of 2022.[19] BACV focuses on the actual invested capital and represents the value of those investments as reported by the fund after necessary adjustment following NAIC's guidelines. Therefore, the reported value is an underestimate of the actual dollar amount of insurers' PE investments because BACV incorporates illiquidity discounts (typically 10%-30%) to the fund's net asset value (NAV) and does not reflect uncalled capital commitments, fees or expenses paid to PE fund managers. Meanwhile, PE funds in the US raised around 3.38 trillion USD between 2013 and 2022 according to Preqin, excluding funds of funds and secondary funds to avoid double counting capital supply for private companies. Relatedly, Preqin (2012) reports that insurers constitute 8% of all LPs and provide 9% of capital invested in private equity as of June 2011, while Figure B1 confirms that insurers rank as the fourth-largest institutional investor class in PE funds based on fund-level LP data. Combined together, these data

[18] The reduction represents around 13% of the average return on assets (1.79%) for P&C insurers in a year.
[19] Growth in U.S. Insurers' Schedule BA Assets Slows at Year-End 2022, NAIC

points suggest that insurers contribute a significant amount of capital to PE markets, with their reported holdings representing only the lower bound of actual economic exposure.

5.1.3 Empirical Design

I use large natural disasters as exogenous liquidity shocks to test whether investor base affects PE investment dynamics. Besides the temporal variation stemming from occurrences of large natural disasters, my empirical design features substantial *cross-sectional variation* in the share of P&C insurers at the fund level (Figure 5). While more than 60% of funds do not have P&C insurers, 10% of funds have more than 12% of their investors being P&C insurers. I estimate various forms of the following difference-in-differences (DiD) model:

$$y_{it} = \beta \times \textit{Investor Base}_i + \gamma \times \textit{Investor Base}_i \times \textit{Liquidity Shock}_t + \boldsymbol{FEs} + \epsilon_{it} \tag{2}$$

in which the subscript i and t denote a PE fund and a calendar quarter.[20] The outcome variable y is either *Capital Called (%)* or *Number of Investments* in the corresponding quarter. *Investor Base* is various measures of the fund's exposure to a specific category of investors. For example, *Investor Base* can be *P&C Insurer Exposure*, an indicator variable equal to one if the fund's exposure to P&C insurer is greater than the 90th percentile value and zero otherwise, or *P&C Insurer Share*, the percentage of investors that are P&C insurers within a fund. Standard errors ϵ are two-way clustered at the fund and calendar quarter levels.

In the baseline regression, I include year-quarter and fund age fixed effects to control for macro shocks and the lifecycle of PE funds' investment (Robinson and Sensoy, 2016). Then I gradually add fund manager fixed effects and, in the tightest specification, saturate fund manager fixed effects by interacting them with fund size dummies, based on the fund's size quintile, and a fund type dummy, based on whether the fund is a venture capital or buyout fund. Such inclusion of fixed effects in Equation (2) helps to address the concern that matching between fund managers and investors is not random (Lerner and Schoar, 2004; Lerner, Schoar, and Wongsunwai, 2007). The interacted fixed effects allow me to compare investment activities of *nearly identical* funds raised in different vintage years but managed by the *same*

[20] Ideally, the identification can be further sharpened by using fund-investor-quarter cash flow data and estimating the fixed effect model as in Khwaja and Mian (2008). Such data is unavailable in standard databases of PE fund cash flows. However, my data structure is unlikely to be a concern, because investors provide cash based on their *pro rata* portion of their committed capital when PE funds make capital calls.

fund manager, by removing confounding cross-sectional variation in fund ownership. The remaining variation in a fund's exposure to P&C insurers primarily arises from *idiosyncratic* factors, such as match and search frictions as well as investors' demand for private equity during fundraising. These factors are unlikely to be correlated with a fund's subsequent investment opportunities. Figure 5b shows that these *idiosyncratic* factors generate *sizable* residual variation in P&C insurer shares across PE funds. Table B3 Panel A further supports the idiosyncratic variation by indicating balanced fund characteristics between funds with high and low residual P&C insurer shares.

To test the parallel trend assumption and highlight the dynamic effects of investors' liquidity shocks, I estimate the following event-study regression with a four-quarter window around liquidity shocks caused by large natural disasters:[21]

$$y_{it} = \beta \times \textit{Investor Base}_i + \sum_{n=-4}^{4} \gamma_n \times \textit{Investor Base}_i \times \textit{Liquidity Shock}_{t+n} + \boldsymbol{FEs} + \epsilon_{it} \quad (3)$$

in which $\textit{Liquidity Shock}_{t+n}$ is an indicator variable equal to one for a calendar quarter if it is n quarters before/after a calendar quarter with abnormal insured losses when n is negative/positive, and zero otherwise. The coefficient γ_{-1} is normalized to zero. The specification includes the same set of fixed effects in Equation (2) and uses standard errors two-way clustered at the fund and calendar quarter levels. As an additional robust check, I estimate alternative event study designs including the specification used in Dessaint and Matray (2017) and a stacked version that duplicates data around each event. My results are robust to these alternative specifications.

5.2 Reduced Investment

Table 2 presents difference-in-differences (DiD) estimates from Equation (2), examining how investor base affects the amount of drawdowns during liquidity shocks. Columns 1-3 use the indicator variable *P&C Insurer Exposure* to assign funds to treatment and control groups. Funds above the 90th percentile (12.5%) in P&C insurer share constitute the treatment

[21]This procedure is recommended by Sandler and Sandler (2014) for empirical settings with multiple events across each cross-sectional unit. The authors conduct Monte Carlo simulations to demonstrate that alternative methods of handling multiple events, such as disregarding subsequent events or duplicating observations around events, can introduce trends in the outcome variable before and after an event, resulting in biased estimates.

group and the rest are the control group. Across all columns, the DiD coefficient estimates of *P&C Insurer Exposure* × *Liquidity Shock* are negative and statistically significant at the 1% level. For example, the saturated specification in Column 3 includes year-quarter, fund age, and fund manager fixed effects interacted with dummies of fund characteristics, and the DiD estimate suggests that treated funds call 0.56 percentage points (approximately 19% of the unconditional mean) less capital during calendar quarters with large natural disasters. Columns 4–6 demonstrate robustness using the continuous *P&C Insurer Share* measure. For example, Column 6 suggests that a one-standard-deviation increase in P&C insurer share reduces the amount of quarterly capital calls by 0.19 percentage points (around 6% of the unconditional mean) when natural disasters result in abnormal insured losses.

Table 3 investigates implications of investor base on the extensive margin of PE investment dynamics during liquidity shocks. The results demonstrate economically and statistically significant reductions across all specifications. Column 3's estimate for *P&C Insurer Exposure* × *Liquidity Shock* suggests that high-exposure funds complete 0.06 fewer investments per quarter (13% of the unconditional mean) following large natural disasters. This finding implies that liquidity shocks not only reduce investment amounts but also force private equity funds to forgo potential deals entirely.[22]

Figure 6a and 6b plot the event study estimates in Equation (3) and the associated two-tailed 95% confidence intervals for *Capital Called (%)* and *Number of Investments* respectively. There are no pre-trends before the event and significant investment declines among treated funds following large natural disasters. While the decline lasts for two quarters, investment does not rebound afterward in terms of size or number of investments indicating a potential loss of investment opportunities.

Overall, the reduced investment is consistent with PE funds facing important frictions in substituting adversely shocked investors with other investors. For example, funds typically face coordination challenges and agency conflicts if they arrange non-pro-rata capital calls, as discussed in Section 2.2. Meanwhile, investor base cannot be easily adjusted due to PE

[22] If PE fund cannot draw down capital as planned, it can result in significant costs for them. First, PE funds may need to pass on investment opportunities. Second, PE funds pay upfront costs from deal selection and due diligence before calling capital from investors. Third, if PE funds have to retract from deals that were already agreed upon, they would face significant reputational damage and incur various costs associated with the broken deals.

funds' close-end nature and the illiquidity of the secondary market to transfer fund shares (see Section 5.6.1). My findings support the theory of Maurin, Robinson, and Strömberg (2022) and suggest that the *cross-sectional distribution* of investor base is an important determinant of the procyclicality of aggregate capital calls with public market liquidity documented by Robinson and Sensoy (2016).

5.3 Heterogeneous Illiquidity Costs across Investors

To highlight the importance of investor base, Table 4 shows that funds with high exposure to life insurers maintain normal investment levels during natural disasters. This contrasts sharply with the P&C insurer results, reflecting life insurers' more predictable liabilities, based on mortality tables, and limited natural disaster exposure. Both Panels A and B show economically small and statistically insignificant DiD estimates—markedly different from the significant effects found for P&C insurers in Tables 2 and 3. Figure B6 further confirms this null result, revealing no divergence in investment patterns between high- and low-exposure funds during disaster periods.

Figure 7 plots the DiD coefficients in Equation (2) and the associated two-tailed 95% confidence intervals estimated separately for different measures of fund-level exposure to various types of investors. These investors include life insurers, endowments and foundations, public/private pension funds, and fund of funds managers. None of the DiD estimates, except the baseline estimate based on P&C insurers, are statistically significant. This result can be attributed to the fact that natural disasters pose a unique liquidity shock solely to P&C insurers. P&C insurers' liabilities increase significantly after large natural disasters, creating substantial liquidity mismatches between their liabilities and assets.[23] This finding provides evidence that investors have heterogeneous costs of financing illiquid investments, such as private equity, due to their distinct contractual liabilities in different economic conditions. Therefore, variation in investor base composition can result in different state-dependent PE financing for private companies.

A potential concern is that, while natural disasters are plausibly exogenous, their eco-

[23] Figure B7a shows that the total death toll from natural disasters is generally small, except for 2005Q3 when Hurricane Katrina occurred. The life insurance claims resulting from the death are likely small in dollars compared to the P&C insured losses and are unlikely to be liquidity shocks to life insurers. Table C4 shows that my results are robust to excluding 2005Q3.

nomic impact may correlate with broader financial conditions affecting other PE investors beyond P&C insurers. For example, large natural disasters might disrupt the economy, impacting stock and bond markets and consequently affecting pension funds and life insurers. However, besides the insignificant coefficient estimates presented in Figure 7, Figure B7b further reveals no discernible co-movement between quarterly natural disaster losses and S&P 500 returns (correlation = -0.04), term spread (correlation = 0.00), or credit spread (correlation = -0.03)—all with correlations statistically insignificant at the 10% level.

5.4 Mechanism of the Shock Transmission

The reduced investment by PE funds following liquidity shocks does not solely result from LP defaults, in which investors fail to fully fund capital calls.[24] In many cases, fund managers face pressure to slow down drawdowns when their investors' costs of capital are high.[25] Consequently, the pro rata rule of capital calls can generate *negative externalities*, as liquidity-constrained investors impose spillover effects on unaffected LPs. This mechanism amplifies funding disruptions—consistent with the substantial reduction in investment documented in Section 5.2. While data limitations prevent me from fully disentangling fund concessions from LP defaults, Appendix B.1 presents suggestive evidence that the reduced investment primarily reflects delayed capital calls—particularly in my setting characterized by idiosyncratic rather than systematic liquidity shocks. Importantly, this potential limitation does not affect the main implication of this paper that investor base influences the investment dynamics of PE funds.

There are several reasons why investors want to delay capital calls during liquidity shocks. First, Liquidity shocks can lead to the so-called "*denominator effect*" - selling liquid assets causes over-exposure to private equity, due to investment mandates and capital reg-

[24]There is no comprehensive data on actual LP defaults because of confidentiality agreements and the private nature of these transactions. Nonetheless, ample anecdotal evidence suggests that LPs sometimes face difficulties meeting capital calls during periods of market stress, with some even defaulting on their commitments. See Griffith (2009) and Lynn (2020). For example, Silicon Valley Bank defaulted on capital calls of some PE funds after its collapse (PitchBook, 2023).

[25]For example, TPG Partners VI, L.P., a global PE fund, offered to cut its investors' capital commitments by 10% and promised not to call more than 30% of the total commitments in 2009 in response to the financial crisis. See the case study by Chaplinsky, Loutskina, and Walsh (2011) for more details. Fund managers may offer investors concessions to maintain a mutually beneficial relationship because they usually need to return to their existing investors for fundraising in the future. This need arises due to information asymmetry and search frictions, which give investors significant bargaining power in PE markets (Hochberg, Ljungqvist, and Vissing-Jørgensen, 2014; Begenau and Siriwardane, 2024).

ulations that impose restrictions on the portfolio allocation to different asset classes. Such constraints reflect investors' liquidity and diversification concerns based on their liability structures. Second, investors often face higher external financing costs and asset price declines due to selling pressure (Ellul, Jotikasthira, and Lundblad, 2011). These factors strain their balance sheets, prompting greater reliance on internal funds. Third, investors might also become more risk averse because the portfolio manager potentially face a higher chance of losing jobs if their institutions become insolvent. Overall, these factors increase investors' preferences for liquidity while raising their opportunity costs of holding illiquid assets. Consistent with this idea, Ge and Weisbach (2021) documents that P&C insurers rebalance their portfolio towards safer and more liquid assets in response to liquidity shocks.[26]

Moreover, the closed-end structure of PE funds creates unique liquidity challenges. Unlike mutual funds or hedge funds, PE fund investors cannot cash out by redeeming PE fund shares and instead rely primarily on distributions—cash generated after the sale of portfolio companies through IPOs or M&As. However, compared to capital calls, cash distributions offer far less flexibility, as PE funds must wait for favorable market conditions to execute profitable exits, if there is any (Gompers, Gornall, Kaplan, and Strebulaev, 2020). Rushed or forced asset sales to meet investors' distribution requests can result in large price discounts due to illiquidity.[27] Consequently, investors usually resort to reducing capital calls to preserve cash during liquidity shocks, especially if they cannot easily unload their PE investments through secondary transactions. Appendix B.2 indicates that PE funds do not increase cash distributions to their P&C insurer investors after large natural disasters.

5.5 Real Effects - Reduced Productivity of Private Companies

Private companies' real outcomes may suffer if investor base transmits liquidity shocks though PE funds. I examine firm productivity, measured by patenting activities, across

[26] Relatedly, the corporate finance literature suggests that firms adapt their capital structures and financial policies to preserve flexibility during economic downturns. For example, Gorbenko and Strebulaev (2010) demonstrates that companies facing temporary shocks tend to maintain higher liquidity buffers and operate with lower leverage ratios. These adjustments reflect financial constraints that limit external financing options, prompting firms to both accumulate cash reserves and secure revolving credit facilities as precautionary liquidity measures (Bates, Kahle, and Stulz, 2009).

[27] Moreover, PE funds usually have to negotiate with other shareholders in the portfolio company to determine the exit route and timing (Cumming, 2008; Bian, Li, and Nigro, 2024).

companies with different investor base during liquidity shocks.[28] The empirical design pools these events, large natural disasters indicated in Table B1, and regresses the first difference in a company's patenting outcomes in the year after and before each event on measures of fund investor base and a set of fixed effects:[29]

$$\Delta y_{ije} = \beta \times \textit{Investor Base}_i + \boldsymbol{FEs} + \epsilon_{ije} \tag{4}$$

in which i, j, and e denote a PE fund, a private company, and an event, respectively. Only pre-existing company-fund pairs are included for each event. Moreover, the sample excludes funds that invested in the company more than five years ago, since these funds are less likely to have significant uncalled capital to provide additional financing. y is the number of (eventually granted) highly cited patents applied for in a year. Highly cited patents are defined as those with the top tercile numbers of citations among patents granted in the same year. I also use the top quintile group as an alternative cut-off to define highly cited patents. Standard errors are two-way clustered at the fund and company levels.

Panel A of Table 5 suggests that private companies become less productive after large natural disasters if their PE funds have higher exposure to P&C insurers. For example, the coefficient estimate in Column 3 implies that companies with a one-standard deviation higher share of P&C insurers on average have 21.9% (= -0.007 × 10.468 / -0.334) greater reduction in the number of highly cited patents. The economic magnitude rises to 29.1% (= -0.007 × 10.468/ -0.251) when we use the top quintile group to define highly cited patents in Column 6, and the estimates are statistically significant at the 5% level. The result is consistent with private companies facing significant frictions in establishing new financing relationships due to asymmetric information as well as match and search frictions.

To further highlight the importance of investor base, Panel B reports results of regressions based on *Life Insurer Share*. Across all columns, the coefficient estimates are statistically insignificant and economically small. Overall, the findings in of Table 5 suggest that investor base is an important determinant of private company financing and subse-

[28]Patent activities have been widely used to study the productivity of VC-backed startups and companies acquired in leveraged buyouts (e.g., Lerner, Sorensen, and Strömberg, 2011; Bernstein, Giroud, and Townsend, 2016).

[29]Similar first-differenced estimation methods are used in Khwaja and Mian (2008) and Schnabl (2012).

quently real outcomes due to investors' heterogeneous illiquidity costs in different states of the economy.

5.6 Mitigation of Liquidity Shock Transmission

The previous section documents that liquidity shocks can negatively affect real outcomes. In this section, I investigate the role of capital markets and contracts in mitigating the transmission of liquidity shocks through investor base.

5.6.1 Investor Base and the Secondary Market for Fund Shares

The illiquidity of private equity is a key friction in the shock transmission when investors experience liquidity shocks. However, the illiquidity of PE funds' underlying assets does not necessarily imply PE fund shares are equally illiquid. Improved secondary market conditions (e.g. increased demand for fund shares) can alleviate the illiquidity friction by improving the transferability of investors' PE investments and allowing funds to adjust investor base more easily following liquidity shocks.

Table 6 reports the results of a triple-diff estimation design that exploits variation in the secondary market condition in a fund's lifespan. Specifically, *High Secondary Dry Powder* is an indicator variable equal to one for a fund-quarter if the total dry powder of secondary funds at the beginning of the quarter is in the top quintile group within a fund's lifespan, and zero otherwise. Secondary funds specialize in purchase existing shares or assets from primary PE fund investors. Dry powder refers to the unallocated capital commitments available for deployment when attractive opportunities arise. Higher dry powder signals greater potential demand, enhancing secondary market liquidity. The coefficient of interest is the slope of *P&C Insurer Share* × *Liquidity Shock* × *High Secondary Dry Powder*, which captures how the effect of liquidity shocks on PE investment varies with secondary market conditions, conditional on a fund's exposure to P&C insurers. From Columns 1-4, the estimates are all positive and statistically significant, indicating that the presence of a relatively liquid secondary market attenuates the shock transmission.

Overall, the finding aligns with the theoretical prediction in Maurin, Robinson, and Strömberg (2022). It demonstrates that the secondary market helps to address *idiosyncratic* liquidity shocks, such as large natural disasters. However, the secondary market is presumably less effective in absorbing systematic liquidity shocks, such as financial crises, which simultaneously raise cash preferences across most investors.

5.6.2 Contracting and the Collateral Value of Early Investments

The fundamental issue behind the reduced investment is incomplete contracting. A state-contingent contract for capital calls cannot be written based on investors' liquidity shocks, since they are hard to specify ex-ante and challenging to verify ex-post. Therefore, incomplete contracting theory suggests that the fund manager's bargaining power plays an important role when renegotiating with the investors on capital calls during liquidity shocks. Then a natural question is how effective the forfeiture provision, the most punitive and commonly used penalty as discussed in Section 2.3, can be in enforcing capital calls. Since LP investors stand to lose their contributed capital and future cash flow rights if they cannot meet capital calls, early investments act as collateral against LP defaults (Maurin, Robinson, and Strömberg, 2022; Gourier, Phalippou, and Westerfield, 2024).

Table 7 reports triple-diff estimates that support this prediction. *Cumulative Drawdown* is the share of committed capital that has been drawn down cumulatively at the beginning of each period. Across Columns 1-3, the coefficient estimates of *P&C Share* $\times$ *Liquidity Shock* $\times$ *Cumulative Drawdown* are positive and significant, suggesting that a greater amount of cumulative drawdowns attenuates the transmission of investors' liquidity shocks to PE funds. For instance, Column 3 indicates that the shock transmission is 21% ($= 0.25 \times 0.049/0.058$) weaker for a fund that has drawn down 50% of its committed capital compared to a near-identical fund that has called 25%. This finding implies that investors' limited commitment problem is mitigated when the fund manager can more effectively enforce capital calls.

5.7 Additional Results & Robustness Checks

5.7.1 Funds with Limited Choices of Investor Base

My identification strategy exploits large cross-sectional variation in investor base conditional on a tight set of fixed effects, which allow me to address potential confounding factors related to the investor base that remain constant across fund managers or can be explained by observable fund attributes. To further mitigate the concern about endogenous matching between investors and funds, I re-estimate the baseline regressions using two subsets of funds with plausibly constrained choices of investor base.

First, my results remain robust when examining undersubscribed funds—those failing to meet their fundraising target size—as shown in Table B6 Panel A. These funds arguably have limited investor selectivity because managers' compensation contracts strongly incentivize achieving target fund size (Metrick and Yasuda, 2010; Robinson and Sensoy, 2013). Second, Table B6 Panel B demonstrates quantitatively and qualitatively similar findings when restricting the sample to funds raised during bust periods (2001, 2002 and 2009 as in Figure 1a). During such periods, funds face approximately 25 percentage point higher probabilities of being undersubscribed compared to boom periods (Figure B8), suggesting substantially higher opportunity costs of investor selection. Importantly, fundraising conditions are driven by the macro environment and are plausibly exogenous to individual fund managers.

5.7.2 Debt Financing and Deal-based Investment Measures

Besides debt used in leverage buyouts, the recent rise of capital call facilities enables PE fund managers to borrow debt against uncalled capital commitments and actively manage the timing of capital calls from investors (Albertus and Denes, 2024; Albertus, Denes, and Li, 2024). However, Preqin's cash flow data only captures investors' equity contributions, excluding debt financing from lenders (see Section 3.1). Therefore, it raises a potential concern that observed reductions in investor drawdowns may not reflect decreased PE investment activity, as funds can compensate through borrowing when investors face liquidity shocks.

Two pieces of evidence mitigate this issue. First, my findings are robust to alternative measures of investment based on PE deals, as reported in Table B8. These investment measures capture both the equity and debt financing to private companies. The DiD coefficient estimates are all negative, while some are not statistically significant due to noise in the data and a lack of statistical power.[30] For example, Column 3 in Panel A suggests that funds with high exposure to P&C insurers invest 17% less (= 0.251/1.495) compared to the unconditional mean. The attenuated effect sizes compared to baseline results (19% less) suggest capital call facilities may partially offset liquidity shocks. Second, the maturity of capital call facilities ranges from several months to several years. The short-term nature and associated debt costs imply that PE funds have incentives to call capital in the next few

[30] Data on deal-level investment is much noisier than the fund cash flow in Preqin. 43% of PE deals do not report any fund investors and 36% of deals have missing deal size. Therefore, I exclude funds that are matched to fewer than 3 deals for the regressions. Since the investment amount of each fund is not reported, I estimate this value by splitting the investment size by the number of observed investors in each deal.

quarters to pay off the debt. Yet Figure 6 shows investment reductions persist beyond one quarter without subsequent increase in capital calls, indicating limited debt financing.

While allowing PE funds to manage cash flows, capital call facilities also introduce costs. First, they introduce agency concerns by enabling fund managers to manipulate reported returns, reducing performance comparability across funds (Albertus and Denes, 2024). Second, these facilities generate additional interest expenses and fees, particularly burdensome in high-interest rate environments, while simultaneously increasing liquidity risk if delayed capital calls prevent timely debt repayment. Third, they create complex clawback obligations and tax complications (Preqin, 2019). Due to these costs, many limited partnership agreements (LPAs) either prohibit capital call facilities entirely or restrict their use through covenants limiting the debt-to-unfunded-commitments ratio.

5.7.3 Capital Demand

Natural disasters are real shocks which potentially reduce investment opportunities. It is possible that PE funds with a higher share of P&C insurers are more likely to be located in areas with a greater risk of natural disasters, which can disrupt fund operations and thus reduce funds' demand for capital. I rule out this explanation by excluding fund-quarters of managers located in states impacted by natural disasters. Table B7 Panel A suggests that this story is unsatisfactory.

Another possibility is that P&C insurers might hedge their liquidity risk from catastrophes by choosing PE funds that specialize in industries with potentially lower capital demand during periods of natural disasters, such as manufacturing, infrastructure, and agriculture industries. In Table B7 Panel B, I only keep funds that focus on industries (IT, internet, information services, media, software, and gaming) where production is arguably not vulnerable to the impacts of natural disasters. The DiD coefficient estimates remain quantitatively and qualitatively similar to the baseline results.

5.7.4 Robustness Checks

Besides my baseline findings, I have demonstrated a lack of pre-trends, introduced subsample results, and outlined treatment heterogeneity that indicates that the observed effects are causally driven by liquidity shocks. Appendix B.3 presents placebo tests based on pseudo liquidity shocks. Nevertheless, I further support my findings by checking the robustness of my results, for example, by restricting to funds with more than ten observed investors. Appendix C discusses the motivation for each robustness check and shows that my results are robust to various modifications of the sample and regression specifications.

6 Ex-Ante Impacts of Investor Base

The results in Section 5 demonstrate that investor composition exposes PE funds to costly liquidity shocks. Building on these ex-post effects and their associated costs, I now investigate whether investor base influences fund behavior ex-ante, particularly in investment pace and capital allocation.

6.1 Investor Base and Ex-Ante Exposure to Liquidity Shocks

As discussed in Section 2.1, the fundamental difference in funding structures between endowments and other major PE investors implies that endowments are less susceptible to liquidity shocks ex-ante. Endowments are "*equity-financed*" by donations and have largely flexible dividend-like payouts.[31] In sharp contrast, pension funds and insurance companies are "*debt-financed*" and must generate sufficient investment returns to meet their contractual liabilities—pension benefits and insurance claims. Due to these obligations, pension funds and insurance companies can face liquidity shocks from either the asset or liability side of their balance sheets, compounded by regulatory constraints on their asset management.

Motivated by these structural differences, I test whether fund-level endowment share drives the cross-sectional variation in investment pace shown in Figure 3 and influences capital allocation. Conceptually, funds with higher share of endowments are exposed to lower funding risk, which should manifest in distinct investment dynamics compared to funds dominated by liability-driven investors.

6.2 Accelerated Capital Calls

There are at least two economic motives for PE funds to invest early rather than spending the committed capital evenly in the first few years. First, PE funds can decrease the amount of uncalled capital at the risk of not being available for future drawdowns when investors are hit by liquidity shocks. Second, early investments act as collateral that that strengthens capital call enforceability and mitigates investor default risk, as demonstrated by my empirical

[31] Risk diversification is arguably a more significant factor than liquidity concerns when endowments allocate capital to private equity.

finding in Section 5.6.2 and the theoretical work of Maurin, Robinson, and Strömberg (2022).

I estimate the following regression to investigate whether PE funds with lower share of endowments accelerate capital calls more:

$$
\begin{aligned}
y_{it} = & \beta \times \textit{Endowment Share}_i + \kappa \times \textit{Log(Fund Age)}_t \\
& + \gamma \times \textit{Endowment Share}_i \times \textit{Log(Fund Age)}_t + \boldsymbol{FEs} + \epsilon_{it}
\end{aligned} \tag{5}
$$

in which i and t denote a PE fund and a calendar quarter. y can be either *Capital Called* or *Number of Investments*. *Endowment Share* is the percentage of investors that are endowments or foundations within a fund. The identification assumption is that the matching between investors and funds is not correlated with investment pace conditional on the same set of fixed effects in Equation (2).[32] Detailed variable definitions are provided in Appendix A.2. Standard errors are clustered at the fund level.

Table 8 reports the coefficient estimates of Equation (5). *Log(Fund Age)* has a statistically negative slope across all columns, suggesting that PE funds tend to front-load their capital calls, which is consistent with the aggregate patterns in Figure 3a. However, this tendency is attenuated for funds with greater share of endowments, as evidenced by the positive and statistically significant interaction terms *Log(Fund Age)* $\times$ *Endowment Share*. For example the estimates in Column 3 suggests that a 10% decrease in fund age will approximately increase capital call by 5.77% ($= 0.1 \times 1.655/2.87$) and a standard deviation increase in the share of endowments will mitigate this effect by 5% ($= 16.58 \times 0.005/1.655$). These findings remain quantitatively and qualitatively similar when restricting the sample to undersubscribed funds and those raised during fundraising burst—subgroups with arguably limited choice of investor base—mirroring the findings in Section 5.7.1.

Although alternative explanations exist for the early investment behavior, including the higher present value of compensation due to earlier exits and agency frictions arising from the compensation contract (Robinson and Sensoy, 2013), these factors arguably cannot account for the systematic relationship between investment pace and investor composition

[32]Figure B10b shows that these idiosyncratic factors generate sizable residual variation in endowment share across funds. Table B3 Panel B shows the balance of fund characteristics between funds with high and low residual endowment shares.

documented in Table 8. The cross-sectional variation by investor base suggests distinct funding risk considerations beyond pure compensation motives.

6.3 Distorted Investment Schedules

If accelerating drawdowns can preemptively mitigate funding shocks, why don't all PE funds do so? First, expecting the fund manager's incentives to front-load capital calls, typically impose contractual restrictions: approximately 50% of fund agreements include annual contribution caps (typically 25-60% of committed capital), while all fund agreements incorporate "call-to-invest" provisions mandating the fund manager to call only as much capital as they can promptly invest (Litvak, 2004).[33] Second, accelerating drawdowns implies that fund managers may need to deviate from their optimal investment schedules and forgo the real option value of waiting (Brennan and Schwartz, 1985; McDonald and Siegel, 1986; Dixit and Pindyck, 1994). This temporal distortion of investment schedules may ultimately depress fund returns.[34]

To examine potential suboptimal selection of portfolio companies resulting from accelerated capital calls, I estimate the following cross-sectional regression using matched fund-portfolio-company data:

$$\begin{aligned} y_{ij} = &\beta \times \textit{Early Investment}_{ij} + \gamma \times \textit{Early Investment}_{ij} \times \textit{Endowment Share}_i \\ &+ \boldsymbol{\delta_i} + \boldsymbol{\lambda_t} + \boldsymbol{\phi_{industry}} + \boldsymbol{\zeta_{state}} + \epsilon_{ij} \end{aligned} \tag{6}$$

in which i and j denote a PE fund and a portfolio company, respectively. y is a measure of the company's exit outcomes measured by *IPO*, an indicator variable equal to one if the company goes public, and zero otherwise, or *Successful Exit*, an indicator variable equal to one if the company goes public or is acquired with a valuation greater than 2.5 (the sample median) to the total amount of capital raised by the company. *Early Investment*, an indicator variable equal to one if the company is invested within the first year after the fund vintage, and zero otherwise. $\boldsymbol{\delta_i}$, $\boldsymbol{\lambda_t}$, $\boldsymbol{\phi_{industry}}$ and $\boldsymbol{\zeta_{state}}$ are fund, first investment year, company

[33] Unfortunately, the limited partnership agreements signed between fund managers and investors are not publicly available. As a result, I cannot provide an analysis of contracting.

[34] Under the adverse selection framework of Axelson, Strömberg, and Weisbach (2009), funding shocks can exacerbate fund managers' incentives to finance bad projects leading to worse investment performance.

industry, and company state fixed effects. Standard errors are two-way clustered at the fund and company levels.

Table 9 provides empirical support for this prediction by analyzing differential investment outcomes across funds with varying endowment investor exposure. The results reveal two key patterns: First, early investments consistently underperform later investments within the same fund, as evidenced by negative and statistically significant coefficients of *Early Investment*. Second, this distortion attenuates significantly for funds with a greater share of endowment investors. For example, Column 4 suggests that while an early investment has around 0.016 percentage points (8.7% of the unconditional mean) lower chance of successful exits, this performance gap is narrowed by 43% (= $0.041 \times 16.58/1.566$) by a one standard deviation increase in *Endowment Share*. These findings collectively demonstrate that accelerated drawdowns compromise investment quality, but liquidity-resilient LPs help preserve selection standards.

Overall, the results imply that the heterogeneous illiquidity costs across investors can be another source of return persistence at both the fund and investor levels. Funds with a larger share of investors susceptible to liquidity shocks experience greater distortion in their investment and achieve inferior performance. Conversely, investors that are less shock-prone, such as endowments, provide "premium" capital to funds and are in turn compensated by higher net returns (Maurin, Robinson, and Strömberg, 2022). In terms of external validity, my findings align with higher PE returns earned by endowments compared to other investors, as documented by Lerner, Schoar, and Wongsunwai (2007). While the authors attribute the return persistence to endowments' access to better PE funds, my findings suggest that endowments' illiquidity tolerance due to their lack of contractual liabilities can also contribute to their outperformance in private equity.

7 Conclusion

This paper shows that investor base composition shapes PE investment dynamics and capital allocation outcomes in response to liquidity shocks. Investor base transmits liquidity shocks which reduce PE funds' investment ex-post and distort their investment schedules ex-ante, leading to inefficient capital allocation. Specifically, I use natural disasters as exogenous liquidity shocks and provide causal evidence of the reduced investment following liquidity shocks. The transmission of shocks is mitigated by a relatively liquid secondary market, which facilitates PE funds to adjust their investor base, and contracting on capital call defaults, which helps to enforce capital calls. Moreover, I demonstrate that funds with less capital from endowments experience more distortion in investment schedules. This is attributed to these funds' higher funding risks, leading to stronger incentives to accelerate capital calls.

As an integral part of the broader financial system, PE markets provide various non-bank financial intermediaries with alternatives to transform the economy's savings into capital investments. Liquidity shocks to these intermediaries can disrupt funding for private companies, affect economic development, and spill over to other financial markets potentially affecting financial stability. By studying the transmission of these shocks, policymakers can identify systemic vulnerabilities and implement targeted measures—such as monitoring PE investor composition, developing centralized secondary market trading platforms and PE fund financing sectors—to enhance financial stability. At the macroeconomic level, my research challenges conventional wisdom about the availability of uncalled capital. Even when substantial committed capital exists, liquidity shocks to investors can trigger abrupt funding scarcity—a crucial consideration for policymakers assessing the resilience of financial system.

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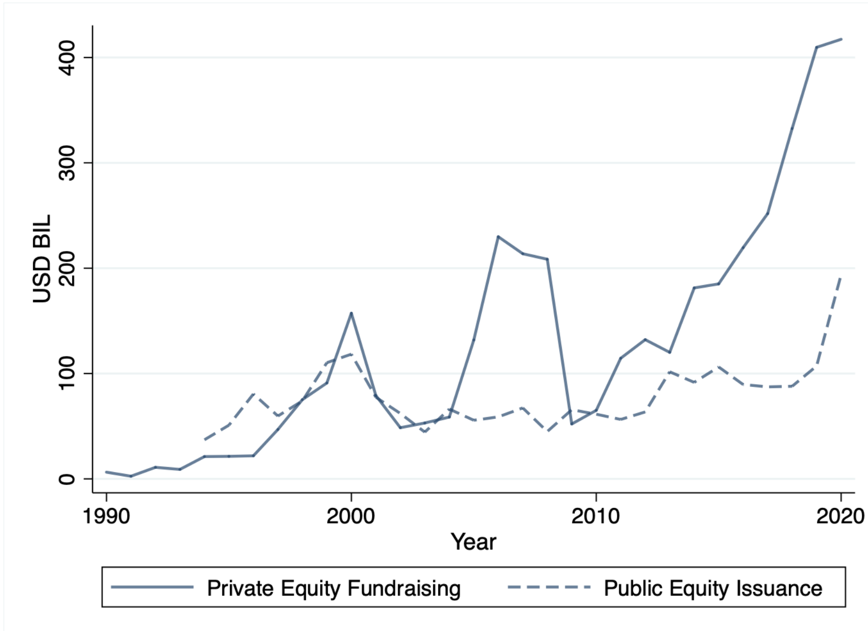
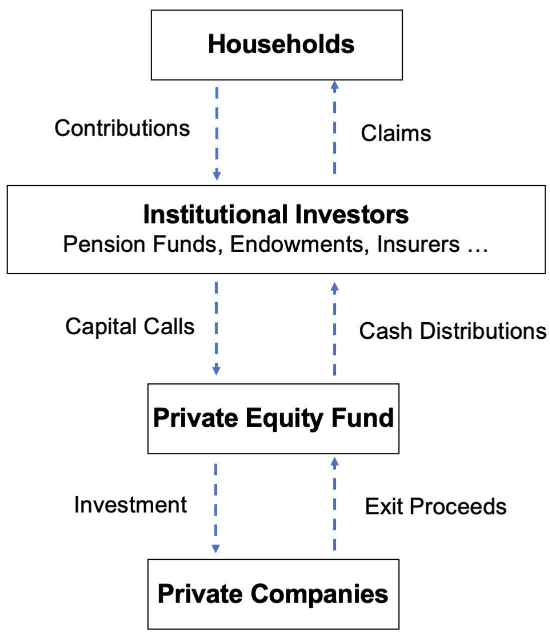


(a) Expansion of Private Equity Markets



(b) Financial Intermediation in Private Equity Markets

Figure 1: Private Equity Market Size and Capital Flows

Figure 1a illustrates the amount of capital raised by PE funds in the US during 1990-2020. Buyout funds and venture capital funds are included, while funds such as secondary funds and funds of funds are excluded to avoid double counting of capital provided to PE markets. As a benchmark, the dashed line shows the equity issuance of initial public offerings and seasoned equity offerings in the same period. The fundraising data is collected from Preqin and the equity issuance data is sourced from the Federal Reserve Board. Figure 1b shows the capital flow from households to private companies in the economy through multi-layer financial intermediation - households allocate capital to institutions with different contractual liabilities, and then institutions allocate capital through private equity funds.

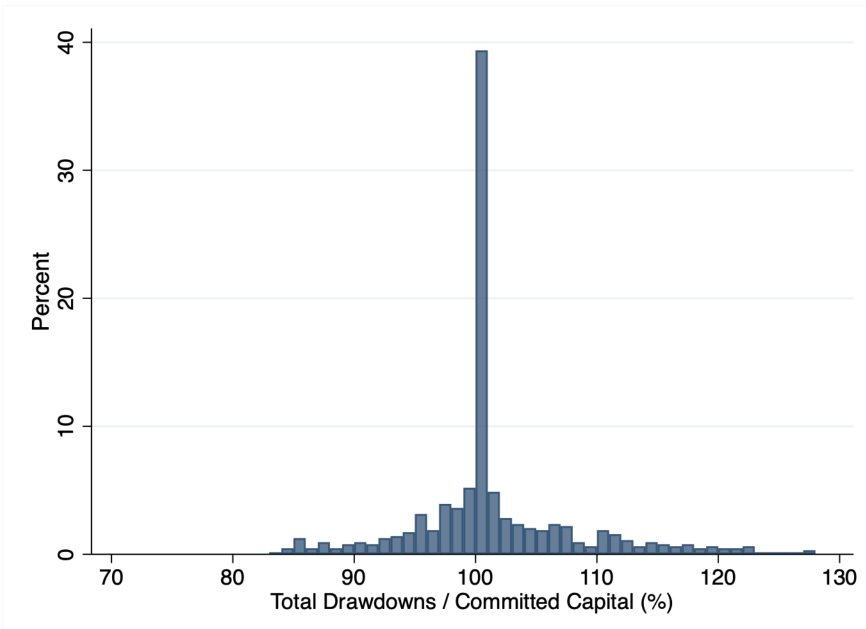
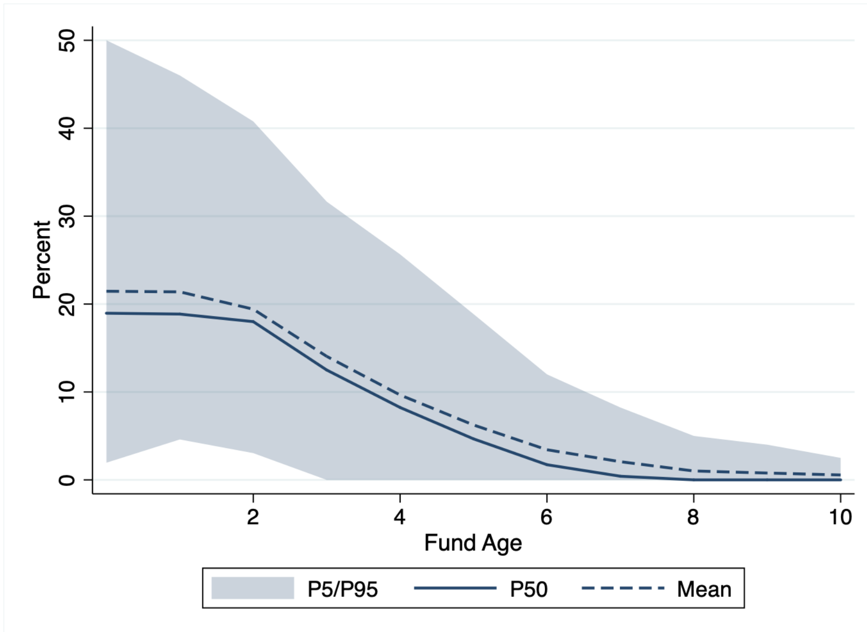
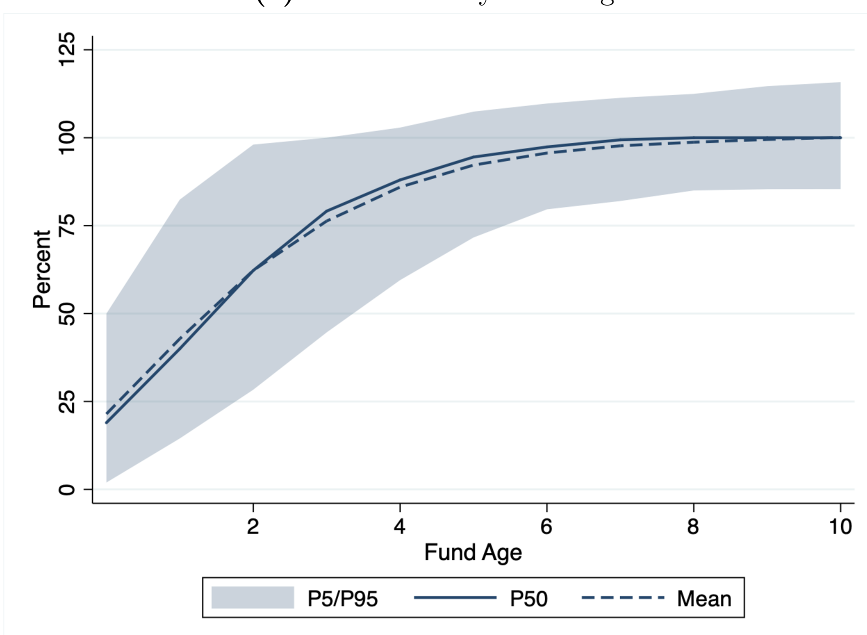


Figure 2: Cross-sectional Distribution of Total Investment Amount

This figure displays the cross-sectional distribution of the total amount of drawdowns as a percentage of committed capital. The sample consists of US PE funds raised between 1990 and 2005, ensuring that each fund has at least 15 years to call capital by 2020. Some funds have called more than 100% of committed capital due to recycling provisions that allow fund managers to reinvest exit proceeds rather than distribute them to investors, subject to specific contractual terms. Most funds ultimately call capital amounting to nearly their full committed fund size. Figure B2 shows that the patterns are robust to subsamples by fund type, fund size, and fund sequence.



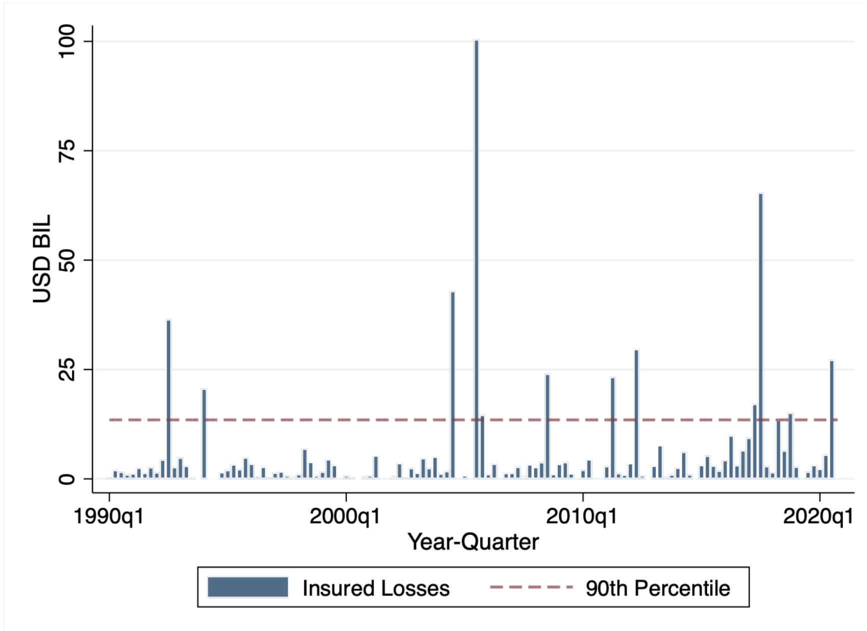
(a) Drawdowns by Fund Age



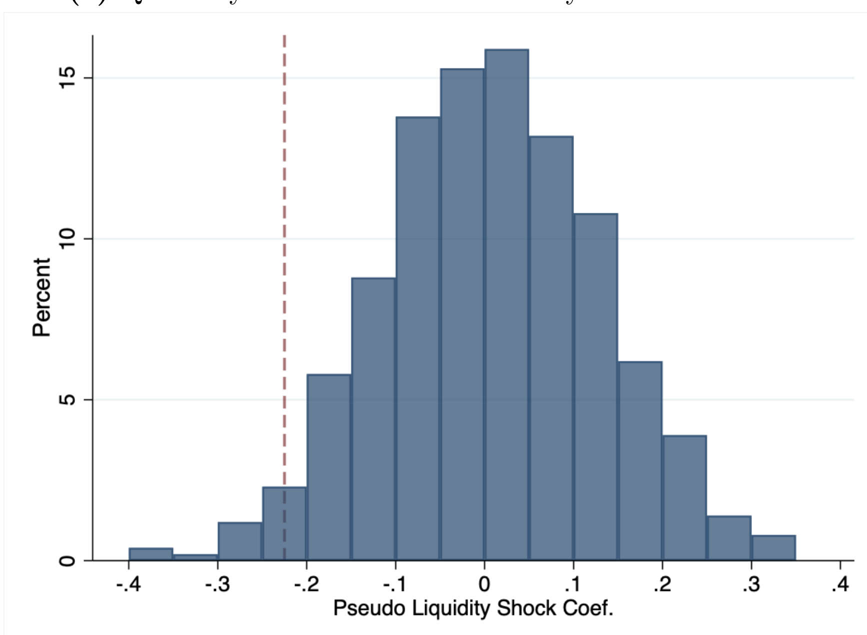
(b) Cumulative Drawdowns by Fund Age

Figure 3: Investment Pace of Private Equity Funds

Figure 3a presents the distribution of capital calls as a percentage of total committed capital across fund ages, showing the mean, median, and tails. The sample consists of US PE funds raised between 1990 and 2005, ensuring that each fund has at least 15 years to draw down cash from investors by 2020. The dash and solid lines represent the mean and median values. The shaded area illustrates the range between the 5th percentile and the 95th percentile. Figure 3b plots the distribution of cumulative capital calls over the fund life cycle. Figure B3 and B4 show that the patterns are robust to subsamples by fund type, fund size, and fund sequence.



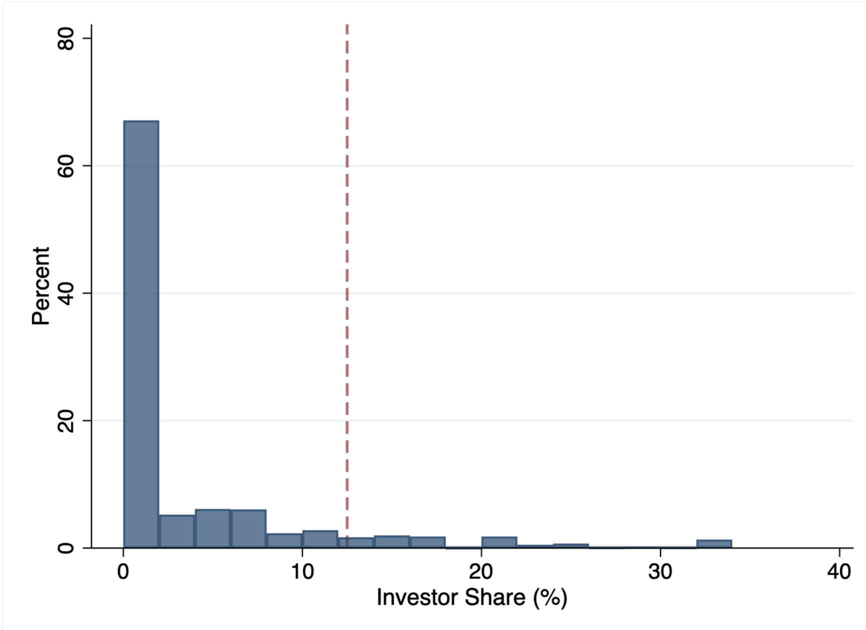
(a) Quarterly Insured Losses Caused by Natural Disasters



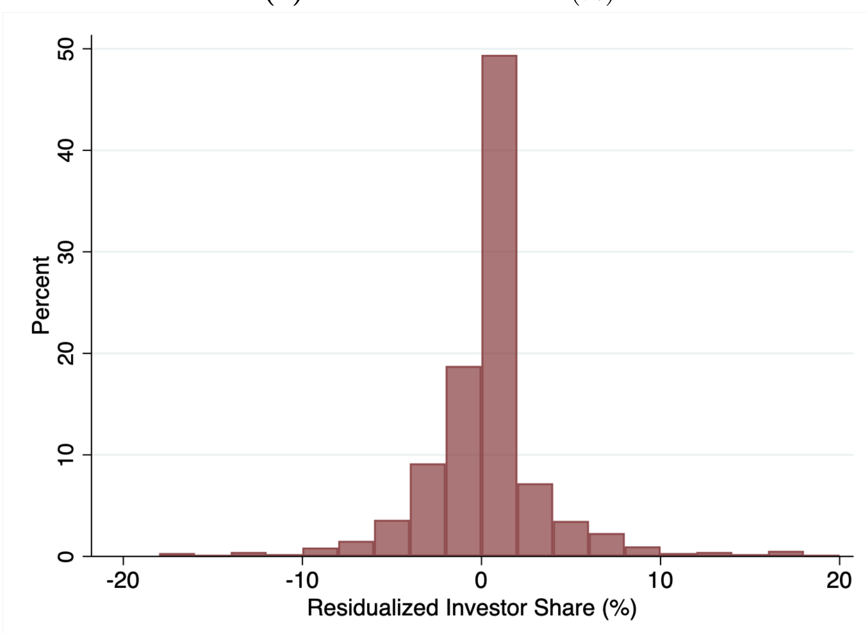
(b) Change in Net Underwriting Gain—True vs. Pseudo Shocks

Figure 4: Liquidity Shocks - Abnormal Insured Losses Caused by Natural Disasters

Figure 4a shows the quarterly insured losses resulting from natural disasters in the US during 1990-2020. The horizontal red dashed line indicates the 90th percentile value (13.5 USD BIL). Periods with insured losses greater than this value are considered as having abnormal insured losses caused by natural disasters, and are liquidity shocks to property & casualty (P&C) insurers. Figure 4b plots the histogram of the β coefficient estimates for Equation (1) from 1,000 trials of a placebo test that randomly chooses 10% of the calendar quarters as pseudo liquidity shocks. The outcome variable is a P&C insurer's net underwriting gain as a percentage of lagged total assets. The vertical dashed line indicates the estimate (= -0.225 in Column 2 Table B2) based on the true liquidity shocks defined in Figure 4a. More than 97% of the mass is on the right side of this line suggesting that P&C insurers experience greater losses during large natural disasters.



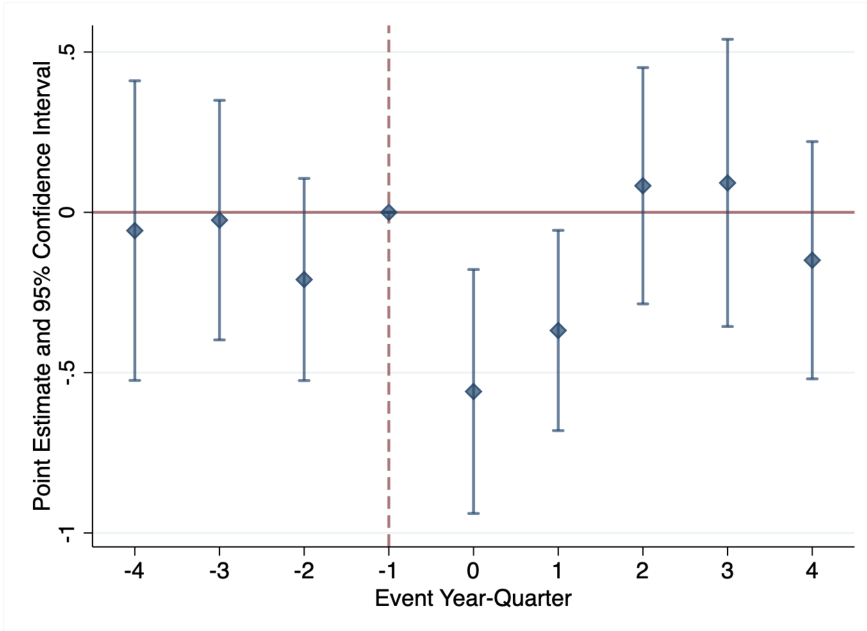
(a) P&C Insurer Share (%)



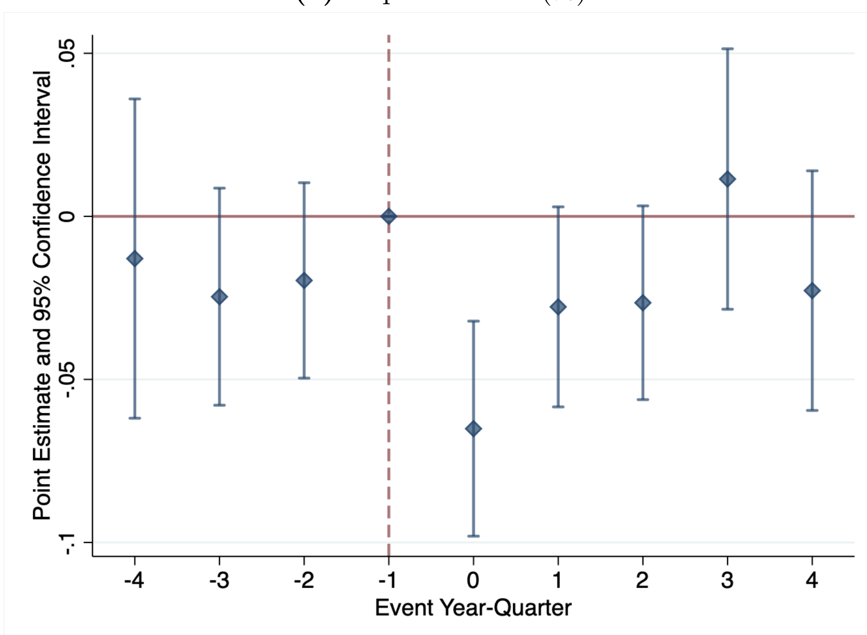
(b) Residual P&C Insurer Share (%)

Figure 5: Share of Property & Casualty Insurers at the Private Equity Fund Level

Figure 5a documents large cross-sectional distributions of the property & casualty insurer share at the PE fund level. The sample consists of PE funds raised in the US between 1990 and 2020. The red vertical dashed line indicates the 90th percentile value (12.5%). Figure 5b shows sizable cross-sectional distribution of the residual property & casualty insurer share at the PE fund level. The residual is obtained by regressing the unconditional value on fund manager × fund type × fund size dummies. The adjusted R^2 is 0.47, indicating sizable variation in the residual P&C insurer share across near-identical funds managed by the same manager. Table B3 reports the balance of fund characteristics based on residual P&C insurer share.



(a) Capital Called (%)



(b) Number of Investments

Figure 6: P&C Insurer Exposure and Investment Dynamics around Large Natural Disasters

This figure plots the coefficient estimates of *P&C Insurer Exposure* $\times$ *Liquidity Shock*$_{t+n}$ in Equation (3) and the associated two-tailed 95% confidence intervals. The red vertical dashed line marks the quarter before liquidity shocks, with the coefficient normalized to zero. *P&C Insurer Exposure* is an indicator variable equal to one if the share of P&C insurers within a fund is greater than the 90th percentile value, and zero otherwise. *Liquidity Shock*$_{t+n}$ is an indicator variable equal to one for a calendar quarter if it is n quarters before/after a calendar quarter with abnormal insured loss when n is negative/positive, and zero otherwise. The outcome variables are indicated in subcaptions. The regressions include year-quarter, fund age, fund manager $\times$ fund type $\times$ fund size fixed effects and use standard errors two-way clustered at the fund and calendar quarter levels. Detailed variable definitions are provided in Appendix A.2.

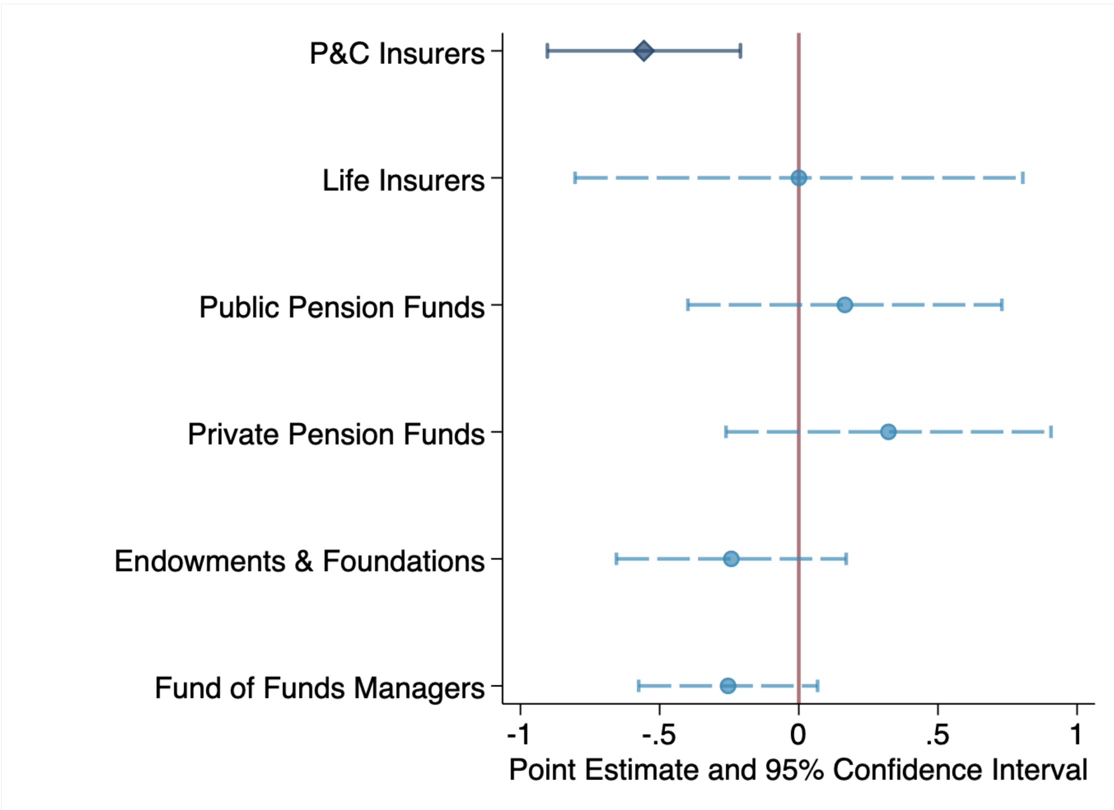


Figure 7: DiD Estimates Based on Exposure to Different Investor Types

For *Capital Called (%)*, this figure plots the difference-in-differences (DiD) coefficients in Equation (2) and the associated two-tailed 95% confidence intervals estimated separately based on PE funds' exposure to different types of investors. The exposure measures are defined similarly to *P&C Insurer Exposure*, an indicator variable equal to one if the share of P&C insurers within a fund is greater than the 90th percentile value, and zero otherwise. Each row corresponds to the estimated coefficient of an alternative measure. The top row shows the estimate for *P&C Insurer Exposure* × *Liquidity Shock*. The regressions include year-quarter, fund age, fund manager × fund type × fund size fixed effects and use standard errors two-way clustered at the fund and calendar quarter levels. Figure B7b presents evidence that natural disasters do not systematically correlate with broader financial conditions that might affect other PE investors beyond P&C insurers.

Table 1: Summary Statistics

This table reports the summary statistics for the main variables used in the analysis. The sample consists of PE funds raised in the US between 1990 and 2020. In Panel A, a unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *Number of Investments* is the number of investments made by a fund in a calendar quarter. *Cash Distributed (%)* is the quarterly amount of capital returned to the investors by a PE fund as a percentage of its committed capital. *P&C Insurer Exposure* is an indicator variable equal to one if the share of P&C insurers within a fund is greater than the 90th percentile value, and zero otherwise. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Life Insurer Exposure* and *Life Insurer Share* are defined similarly for life insurers. *Endowment Share* is the percentage of investors that are endowments or foundations within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. *Fund Age* is the fund age in calendar quarters. In Panel B, the sample consists of PE funds and their portfolio companies financed during the period 1990-2015. The sample ensures that these companies have sufficient time for an exit event. A unit of observation is a fund-company pair. *IPO* is an indicator variable equal to one if the company goes public, and zero otherwise. *Successful Exit* is an indicator variable equal to one if the company goes public or is acquired with a valuation greater than 2.5 (the median value of acquisition multiple) to the total amount of capital raised by the company. *Early Investment* is an indicator variable equal to one if the company is invested within the first year after the fund vintage, and zero otherwise. Detailed variable definitions are provided in Appendix A.2.

	Mean	Std.	p10	p25	p50	p75	p90	N
Panel A: Fund-Quarter Level								
Capital Called (%)	2.87	5.17	0.00	0.00	0.11	4.07	9.40	53,154
Number of Investments	0.46	0.53	0.00	0.00	0.00	1.00	1.00	53,154
P&C Insurer Exposure	0.08	0.27	0.00	0.00	0.00	0.00	0.00	53,154
P&C Insurer Share (%)	3.40	6.20	0.00	0.00	0.00	5.26	11.11	53,154
Liquidity Shock	0.13	0.34	0.00	0.00	0.00	0.00	1.00	53,154
Life Insurer Exposure	0.08	0.27	0.00	0.00	0.00	0.00	0.00	53,154
Life Insurer Share (%)	6.28	9.20	0.00	0.00	0.00	10.00	19.05	53,154
High Secondary Dry Powder	0.18	0.39	0.00	0.00	0.00	0.00	1.00	52,884
Cumulative Drawdown	0.65	0.36	0.09	0.32	0.75	0.96	1.01	53,154
Endowment Share (%)	16.99	16.58	0.00	0.00	13.33	25.00	40.00	53,154
Fund Age	17.26	11.31	3.00	7.00	16.00	27.00	34.00	53,154
Panel B: Fund-Company Pair Level								
IPO	0.10	0.30	0.00	0.00	0.00	0.00	1.00	37,358
Successful Exit	0.18	0.39	0.00	0.00	0.00	0.00	1.00	37,358
Early Investment	0.48	0.50	0.00	0.00	0.00	1.00	1.00	37,358

Table 2: Investor Base and Amount of Drawdowns during Liquidity Shocks

This table presents difference-in-differences estimates of Equation (2) examining how a PE fund's investor base affects the amount of drawdowns during liquidity shocks. The sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *P&C Insurer Exposure* is an indicator variable equal to one if the share of P&C insurers within a fund is greater than the 90th percentile value, and zero otherwise. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

	Capital Called (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Exposure	-0.083	-0.091**	0.009			
	[0.054]	[0.040]	[0.150]			
P&C Insurer Exposure × Liquidity Shock	-0.614***	-0.564***	-0.556***			
	[0.187]	[0.182]	[0.177]			
P&C Insurer Share				0.001	-0.002	0.001
				[0.003]	[0.005]	[0.011]
P&C Insurer Share × Liquidity Shock				-0.034***	-0.031***	-0.030***
				[0.009]	[0.009]	[0.008]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	53,154	53,154	52,152	53,154	53,154	52,152
Adjusted R^2	0.152	0.151	0.148	0.152	0.151	0.148

Table 3: Investor Base and Number of Investments during Liquidity Shocks

This table presents difference-in-differences estimates of Equation (2) examining how a PE fund's investor base affects its number of investments made during liquidity shocks. The sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Number of Investments* is the number of investments made by a fund in a calendar quarter. *P&C Insurer Exposure* is an indicator variable equal to one if the share of P&C insurers within a fund is greater than the 90th percentile value, and zero otherwise. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

	Number of Investments					
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Exposure	-0.035*	-0.027	0.001			
	[0.018]	[0.017]	[0.016]			
P&C Insurer Exposure × Liquidity Shock	-0.073***	-0.061***	-0.060***			
	[0.021]	[0.016]	[0.016]			
P&C Insurer Share				-0.001	0.001	0.001
				[0.001]	[0.001]	[0.001]
P&C Insurer Share × Liquidity Shock				-0.004***	-0.003***	-0.003***
				[0.001]	[0.001]	[0.001]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	53,154	53,154	52,152	53,154	53,154	52,152
Adjusted R^2	0.165	0.215	0.227	0.164	0.214	0.227

Table 4: PE Investment Dynamics - Life Insurers and Large Natural Disasters

This table highlights the importance of investor base by demonstrating that a PE fund's life insurer share does not affects its investment dynamics during large natural disasters. The sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *Number of Investments* is the number of investments made by a fund in a calendar quarter. *Life Insurer Exposure* is an indicator variable equal to one if the share of life insurers within a fund is greater than the 90th percentile value, and zero otherwise. *Life Insurer Share* is the percentage of investors that are life insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

Panel A: Amount of Drawdowns

	Capital Called (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
Life Insurer Exposure × Liquidity Shock	0.006	0.031	0.001			
	[0.404]	[0.403]	[0.410]			
Life Insurer Share × Liquidity Shock				0.001	0.002	0.001
				[0.010]	[0.010]	[0.010]
Life Insurer Variable	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	53,154	53,154	52,152	53,154	53,154	52,152
Adjusted R^2	0.152	0.151	0.148	0.152	0.151	0.148

Panel B: Number of Investments

	Number of Investments					
	(1)	(2)	(3)	(4)	(5)	(6)
Life Insurer Exposure × Liquidity Shock	-0.036	-0.024	-0.021			
	[0.022]	[0.019]	[0.021]			
Life Insurer Share × Liquidity Shock				-0.001	-0.001	-0.001
				[0.001]	[0.001]	[0.001]
Life Insurer Variable	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	53,154	53,154	52,152	53,154	53,154	52,152
Adjusted R^2	0.164	0.215	0.227	0.164	0.214	0.227

Table 5: Investor Base and Private Company Productivity during Liquidity Shocks

This table presents estimates of Equation (4) examining how a PE fund's investor base affects private company productivity during liquidity shocks. A unit observation is a fund-company pair across different years affected by liquidity shocks as indicated in Table B1. Δ*Number of Highly Cited Patents* is the first difference in the number of (eventually granted) highly cited patents applied for in the year after and before liquidity shocks. Highly cited patents are defined as those with the top tercile/quintile numbers of citations among patents granted in the same year, as indicated in the column names. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Life Insurer Share* is the percentage of investors that are life insurers within a fund. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and company levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

Panel A: Fund Exposure to P&C Insurers

	ΔNumber of Highly Cited Patents					
	Top Tercile			Top Quintile		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share	-0.001	-0.005*	-0.007*	-0.001	-0.004**	-0.007*
	[0.002]	[0.002]	[0.004]	[0.001]	[0.002]	[0.004]
Year FE	✓	✓	✓	✓	✓	✓
Company FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	123,175	123,119	118,095	123,175	123,119	118,095
Adjusted R^2	0.259	0.253	0.242	0.243	0.237	0.227

Panel B: Fund Exposure to Life Insurers

	ΔNumber of Highly Cited Patents					
	Top Tercile			Top Quintile		
	(1)	(2)	(3)	(4)	(5)	(6)
Life Insurer Share	0.000	-0.001	0.001	-0.000	-0.001	0.000
	[0.001]	[0.001]	[0.002]	[0.001]	[0.001]	[0.002]
Year FE	✓	✓	✓	✓	✓	✓
Company FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	123,175	123,119	118,095	123,175	123,119	118,095
Adjusted R^2	0.259	0.253	0.242	0.243	0.237	0.227

Table 6: Secondary Market Conditions and Investor Base

This table reports the results from triple-diff estimations examining whether improved secondary market demand for fund shares attenuates transmission of liquidity shocks from investor base to PE funds. Greater demand allows PE funds to adjust their investor base more easily due to the increased transferability of PE investments. The sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *Number of Investments* is the number of investments made by a fund in a calendar quarter. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. *High Secondary Dry Powder* is an indicator variable equal to one for a fund-quarter if the total dry powder of secondary funds at the beginning of the quarter is in the top quintile group within a fund's lifespan, and zero otherwise. Secondary funds specialize in purchase existing shares or assets from primary PE fund investors. Dry powder refers to the unallocated capital commitments available for deployment when attractive opportunities arise. Control variables including the stand-alone and other two-way interaction terms are suppressed in the table. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share × Liquidity Shock	-0.040***	-0.037***	-0.035***	-0.004***	-0.004***	-0.003***
	[0.010]	[0.010]	[0.010]	[0.001]	[0.001]	[0.001]
P&C Insurer Share × Liquidity Shock × High Secondary Dry Powder	0.030**	0.027**	0.026**	0.003**	0.003	0.002
	[0.012]	[0.013]	[0.013]	[0.002]	[0.002]	[0.002]
Control Variables	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	52,884	52,884	51,907	52,884	52,884	51,907
Adjusted R^2	0.153	0.152	0.149	0.165	0.216	0.228

Table 7: Cumulative Drawdowns and Enforceability of Capital Calls

This table reports the results from triple-diff estimations examining whether increased cumulative drawdowns mitigate transmission of liquidity shocks from investor base to PE funds. Early investments act as collateral against capital call defaults due to the forfeiture provision - investors risk losing their contributed capital if they cannot meet capital calls. The sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *Number of Investments* is the number of investments made by a fund in a calendar quarter. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. *Cumulative Drawdown* is the share of committed capital that has been drawn down cumulatively at the beginning of each period. Control variables including the stand-alone and other two-way interaction terms are suppressed in the table. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share × Liquidity Shock	-0.065***	-0.059**	-0.058***	-0.004*	-0.004	-0.003
	[0.023]	[0.023]	[0.021]	[0.002]	[0.002]	[0.002]
P&C Insurer Share × Liquidity Shock × Cumulative Drawdown	0.050*	0.047*	0.049**	0.001	0.001	0.001
	[0.026]	[0.026]	[0.024]	[0.003]	[0.003]	[0.003]
Control Variables	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	53,154	53,154	52,152	53,154	53,154	52,152
Adjusted R^2	0.160	0.174	0.182	0.170	0.224	0.238

Table 8: Investor Base and Accelerated Capital Calls

This table reports the estimates of the panel regression in Equation (5) investigating the relationship between a PE fund's investor base and investment pace in response to liquidity shock risk. The sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Endowment Share* is the percentage of investors that are endowments or foundations within a fund. *Log(Fund Age)* is the natural logarithm of one plus the fund age in calendar quarters. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are clustered at the fund level and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
Endowment Share	-0.017***	-0.012**	-0.012*	-0.002***	-0.001**	-0.001
	[0.006]	[0.006]	[0.006]	[0.001]	[0.001]	[0.001]
Log(1 + Fund Age)	-1.880***	-1.818***	-1.655***	-0.177***	-0.172***	-0.134***
	[0.051]	[0.054]	[0.060]	[0.005]	[0.006]	[0.006]
Log(1 + Fund Age) × Endowment Share	0.006***	0.005**	0.005**	0.001***	0.001**	0.000
	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	53,154	53,154	52,152	53,154	53,154	52,152
Adjusted R^2	0.116	0.114	0.111	0.093	0.140	0.160

Table 9: Investor Base and Suboptimal Selection of Portfolio Companies

This table reports the results from cross-sectional regressions in Equation (6) examining how a PE fund's investor base distorts its investment schedule through accelerated capital calls. The sample consists of fund-company pairs for portfolio companies financed between 1990 and 2015. The sample ensures that these companies have sufficient time for an exit event. A unit of observation is a fund-company pair. *IPO* is an indicator variable equal to one if the company goes public, and zero otherwise. *Successful Exit* is an indicator variable equal to one if the company goes public or is acquired with a valuation greater than 2.5 (the median value of acquisition multiple) to the total amount of capital raised by the company. *Early Investment* is an indicator variable equal to one if the company is invested within the first year after the fund vintage, and zero otherwise. *Endowment Share* is the percentage of investors that are endowments or foundations within a fund. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and company levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels. The coefficient estimates and standard errors are scaled by 100.

	IPO		Successful Exit	
	(1)	(2)	(3)	(4)
Early Investment	-1.495**	-1.400**	-1.593*	-1.566*
	[0.647]	[0.647]	[0.813]	[0.826]
Early Investment × Endowment Ratio	0.033*	0.049***	0.025	0.041*
	[0.017]	[0.017]	[0.024]	[0.025]
Fund FE	✓	✓	✓	✓
First Investment Year FE	✓		✓	
Company Industry FE	✓		✓	
Company State FE	✓		✓	
Company Industry × Investment Year FE		✓		✓
Company State × Investment Year FE		✓		✓
Observations	37,939	37,777	37,939	37,777
Adjusted R^2	0.130	0.141	0.140	0.148

Internet Appendix for
"Liquidity Shocks and Private Equity Investment"

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City University of Hong Kong

May 2025

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A Data Sources & Variable Definitions

A.1 Data Sources

Preqin. This database provides detailed information on the timing and amount of each capital call made by a PE fund. Additionally, Preqin contains other rich fund-level data including details on investor composition, fund size, and vintage, as well as information about fund managers and investors. I specifically focus on buyout and venture capital funds, which are the two most important and widely studied types of PE funds. I exclude other funds such as secondary funds and funds of funds.

NAIC. Preqin does not differentiate between insurance companies with and without P&C divisions. To identify P&C insurers, I manually check insurer names in the P&C insurance market share reports issued by the National Association of Insurance Commissioners (NAIC). I also cross-validate the data by searching the insurance company's websites and using PitchBook, which provides the major line of business for each PE fund investor.[1] Moreover, NAIC also provides detailed financial data such as total assets and net underwriting gain for P&C insurers. The data comes from periodical statutory reports filed by insurance companies to the NAIC. I use the financial data to show that P&C insurers suffer substantially more underwriting losses when large natural disasters happen.

EM-DAT. The database was initially created with support from the World Health Organisation and the Belgian Government to serve humanitarian actions against disasters. EM-DAT compiles data from various sources, such as United Nations agencies, the International Federation of Red Cross, insurance companies, and research institutes, and has comprehensive global coverage of disasters. I extract all natural disasters in the US and aggregate insured damages by calendar quarter to identify time periods with abnormal insured loss.[2] Besides insured losses, EM-DAT also provides information such as affected areas and death toll caused by natural catastrophes.

PatentsView. Supported by the United States Patent and Trademark Office (USPTO),

[1] I categorize P&C/life reinsurers as P&C/life insurers, respectively.

[2] For the purpose of my empirical design, an important advantage of the EM-DAT dataset is that it distinguishes insured losses from total economic losses, while databases such as the Spatial Hazard Events and Losses Database for the US (SHELDUS) only provide data on economic losses and insured crop losses caused by natural disasters.

PatentsView provides comprehensive patent data such as the assignee name, grant year, and citations of published patent applications. The granular data allows me to assess the real impacts of liquidity shocks on private companies' productivity, measured by their patenting outcomes.

SDC Platinum. For my analysis of the capital allocation implications of investors' liquidity shocks, I augment the Preqin private equity exit database with SDC Platinum to construct outcome variables related to IPOs and acquisitions. I merge these two datasets using a combination of fuzzy name matching, along with manual checks after standardizing spellings and removing legal suffixes of company names.

Federal Reserve Board. I supplement my analysis with time-series data, such as the amount of public equity issuance, credit and term spreads, collected from the Federal Reserve Board.

CRSP. I collect S&P 500 returns and show that natural disasters do not correlate with the stock market performance.

A.2 Variable Definitions

Variable Name	Definition
Panel A: Fund-Quarter Level	
Capital Called (%)	Quarterly amount of capital called by a PE fund as a percentage of its committed capital.
Number of Investments	Number of investments made by the fund in a calendar quarter.
Investment Amount / Fund Size (%)	Quarterly total deal size as a percentage of the fund size.
Number of Deals	number of deals invested by a fund in a calendar quarter.
Cash Distributed (%)	Quarterly amount of capital returned to the investors by a PE fund as a percentage of its committed capital.
P&C Insurer Exposure	An indicator variable equal to one if the share of P&C insurers within a fund is greater than the 90th percentile value, and zero otherwise.
P&C Insurer Share	The percentage of investors that are P&C insurers within a fund.
Liquidity Shock	An indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise.
Liquidity Shock$_{t+n}$	An indicator variable equal to one for a calendar quarter if it is n quarters before/after a calendar quarter with abnormal insured losses when n is negative/positive, and zero otherwise.

Life Insurer Exposure	An indicator variable equal to one if the share of life insurers within a fund is greater than the 90th percentile value, and zero otherwise.
Life Insurer Share	The percentage of investors that are life insurers within a fund.
Endowment Share	The percentage of investors that are endowments or foundations within a fund. Both endowments and foundations are included.
High Secondary Dry Powder	An indicator variable equal to one for a fund-quarter if the total dry powder of secondary funds at the beginning of the quarter is in the top quintile group within a fund's lifespan, and zero otherwise. Dry powder is the cash reserves that fund managers hold for investment when they identify attractive opportunities.
Cumulative Drawdown	Share of committed capital that has been drawn down cumulatively at the beginning of each period. For example, a value of 0.5 means 50% of the committed capital that has been called.
Log(Fund Age)	Natural logarithm of one plus the fund age in calendar quarters.
Panel C: Fund-Company-Event Level	
Δ*Number of Highly Cited Patents*	The first difference in the number of (eventually granted) highly cited patents applied for in the year after and before liquidity shocks. Highly cited patents are defined as those with the top tercile/quintile numbers of citations among patents granted in the same year.
Panel D: Fund-Company Level	
IPO	An indicator variable equal to one if the company goes public, and zero otherwise.
Successful Exit	An indicator variable equal to one if the company goes public or is acquired with a valuation greater than 2.5 to the total amount of capital raised by the company.
Early Investment	An indicator variable equal to one if the company is invested within the first year after the fund vintage, and zero otherwise.
Endowment Share	The percentage of investors that are endowments or foundations within a fund.
Panel E: P&C Insurer Level	
Net Underwriting Gain (%)	Net underwriting gain as a percentage of lagged total assets. Net underwriting gain is the calculated as premiums earned minus losses incurred and related expenses.
P&C Loss	Equal to the negative of the net underwriting gain as a percentage of lagged asset if the net underwriting gain is negative, and set to zero if the net underwriting gain is positive

B Additional Results

B.1 Mechanism - LP Defaults vs. Delayed Capital Calls

Although the data limitation makes it challenging to distinguish LP defaults from delayed capital calls in a given calendar quarter (see Section 5.4), a fund's lifetime cumulative capital calls can offer meaningful insights. In LP defaults, the defaulting LP investors usually cease subsequent capital contributions—reducing the effective fund size and resulting in total drawdowns that often fall short of committed capital.

To provide suggestive evidence, I estimate the following cross-sectional regression using PE funds raised between 1990 and 2010. The sample ensures that these funds have sufficient time to fully draw down their committed capital as of 2020:

$$y_i = \beta \times \textit{P\&C Share}_i + \gamma \times \textit{P\&C Share}_i \times \textit{Shock Vintage}_t + \boldsymbol{FEs} + \epsilon_j \quad (7)$$

in which i and t denote a PE fund and a vintage year. The outcome variable y is either *Cumulative Drawdown (%)*, the percentage of committed capital that has been drawn down cumulatively, or *Underinvest*, an indicator variable equal to one for a fund if its total amount of capital calls is less than the committed capital, and zero otherwise.[3] *Shock Vintage* is an indicator variable equal to one for a fund if natural disasters lead to abnormal insured losses in the next 4 quarters after its vintage year, and zero otherwise. The construction of this variable is motivated by the monotonically declining investment pace as funds age (Figure 3a), suggesting greater sensitivity to investor liquidity shocks during a fund's early years. The standalone *Shock Vintage* is absorbed by the vintage year fixed effects. Standard errors are clustered at the fund manager level. *Shock Vintage* is plausibly random because the fund completed its fundraising before significant natural disasters occurred, and the timing of these events is difficult to anticipate. The identification assumption is that the matching between investors and PE funds is orthogonal to capital calls conditional on the time-invariant characteristics of fund managers and observable characteristics of the funds they manage.

[3] My results remain robust to using different cutoffs, such as 90% and 95% of committed capital, to define *Underinvest*.

Table B4 suggests that the reduced investment documented in Section 5.2 is likely delayed capital calls, at least in my empirical setting featured with *idiosyncratic* instead of systematic liquidity shocks. The coefficient estimates of *P&C Share* × *Shock Vintage* are small in magnitude and highly insignificant across all columns - suggesting a lack of meaningful difference in total capital calls between funds with high and low shares of P&C insurers raised shortly before large natural disasters.

B.2 Amount of Cash Distributions

Table B5 shows that PE funds do not increase cash distributions to their P&C insurer investors after large natural disasters. *Cash Distributed (%)* is the quarterly amount of capital returned to investors by a PE fund as a percentage of its committed capital. From Columns 1 to 6, the coefficient estimates of the DiD term are small in magnitude and highly insignificant, indicating no differences in cash distributions between funds with a higher and lower share of P&C insurers during quarters of large natural disasters. The findings can be considered as placebo tests that further support the causality in my main results.

As discussed in Section 5.4, there is much less flexibility in distributions compared to capital calls because PE funds must wait for favorable market conditions for profitable exits if there is any (Gompers, Gornall, Kaplan, and Strebulaev, 2020). Rushed or forced asset sales to meet investors' distribution requests can result in large price discounts due to illiquidity.

B.3 Pseudo Liquidity Shocks

I conduct a placebo test by re-estimating the regressions 1,000 times using pseudo liquidity shocks constructed from randomly selected 10% calendar quarters during 1990-2020. Figure B9 shows the distribution of the DiD coefficient estimates, which is centered around zero. More than 98% of the mass is to the right of the estimates reported in Column 3 of Tables 2 and 3, suggesting that such reduced investment is a low-probability event under pseudo liquidity shocks. Therefore, my results are unlikely to be driven by unobservable differences across funds. The finding also provides additional support that large natural disasters are liquidity shocks to P&C insurers.

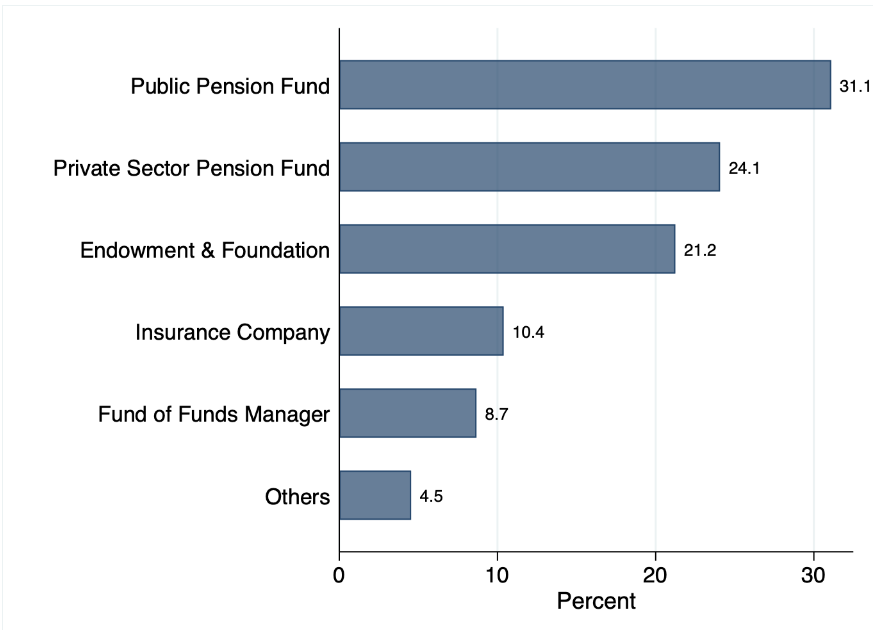
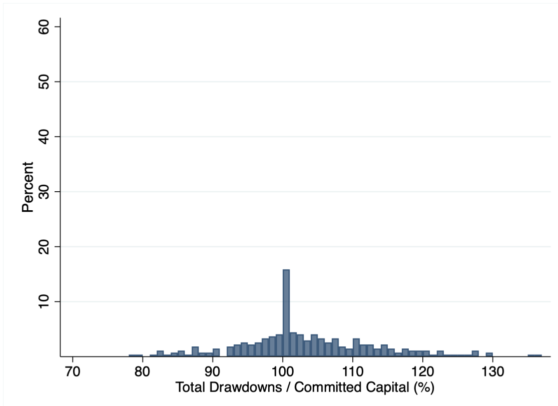
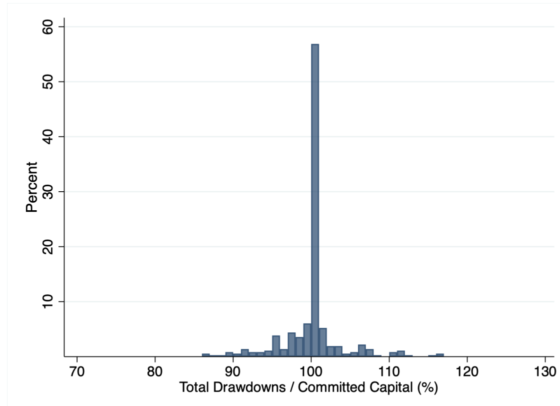


Figure B1: Private Equity Investors by Institutional Type

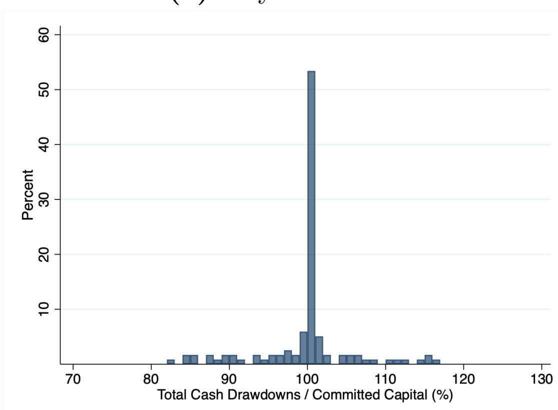
This figure ranks different types of institutional investors based on the number of their PE fund investments. The sample consists of investors in US PE funds raised between 1990 and 2020. Investors such as family offices, sovereign wealth funds, corporate investors, banks, government agencies, and asset managers are categorized into Others. Public pension funds and public endowments are likely overrepresented in the data, since Preqin collects fund-level LP composition information through Freedom of Information Act (FOIA) requests.



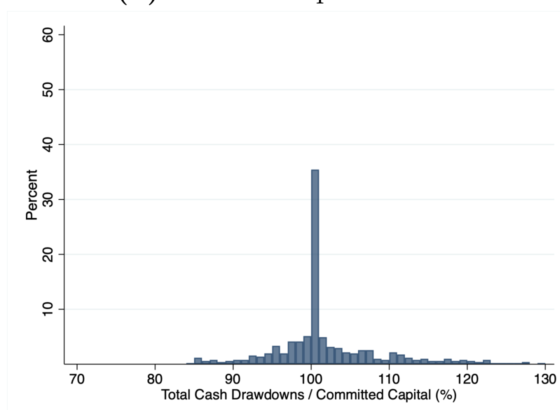
(a) Buyout Funds



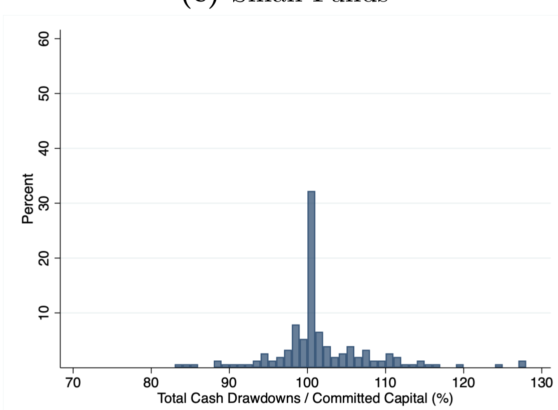
(b) Venture Capital Funds



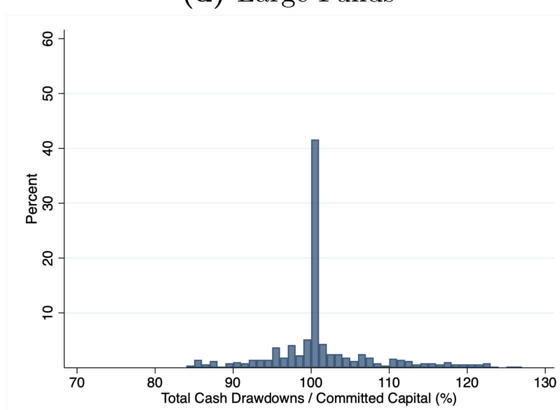
(c) Small Funds



(d) Large Funds



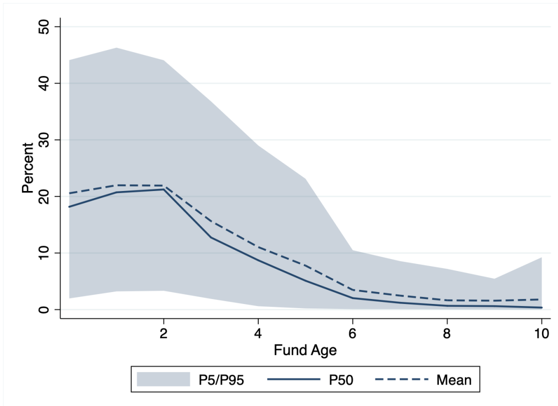
(e) First Funds



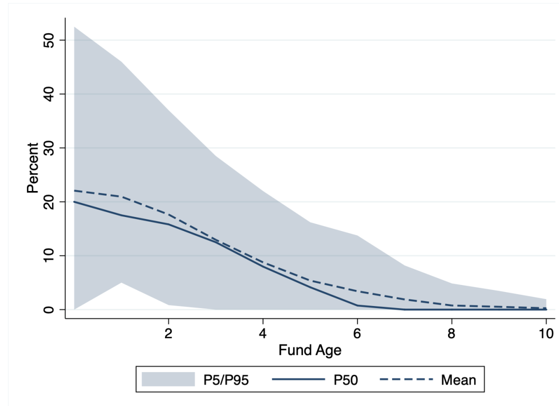
(f) Non-First Funds

Figure B2: Cross-sectional Distribution of Total Investment Amount - Subsamples

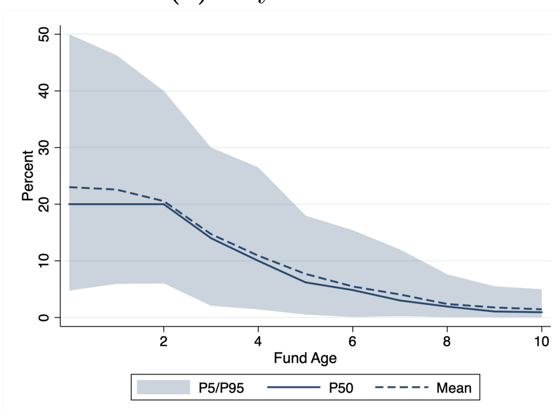
For each subsample indicated in subcaptions, this figure displays the cross-sectional distribution of the total amount of drawdowns as a percentage of committed capital. The sample consists of US PE funds raised between 1990 and 2005, ensuring that each fund has at least 15 years to call capital by 2020. The figure with the full sample is presented in Figure 2.



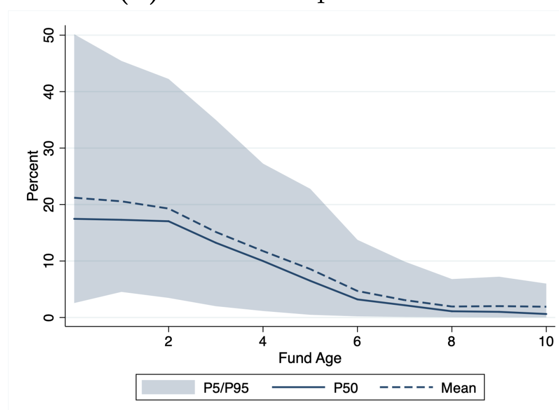
(a) Buyout Funds



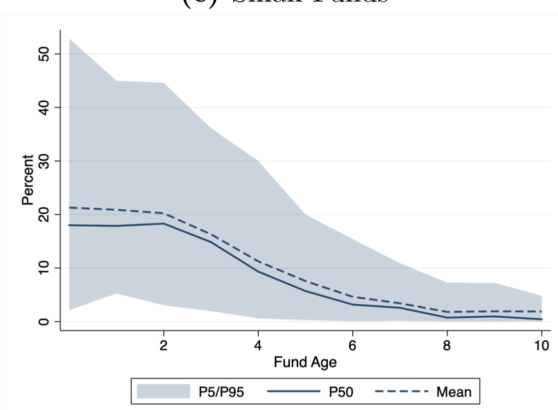
(b) Venture Capital Funds



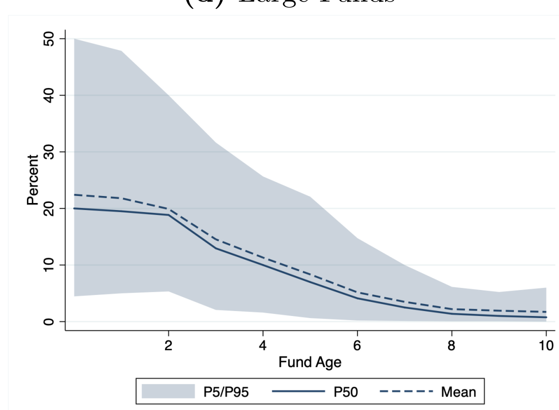
(c) Small Funds



(d) Large Funds



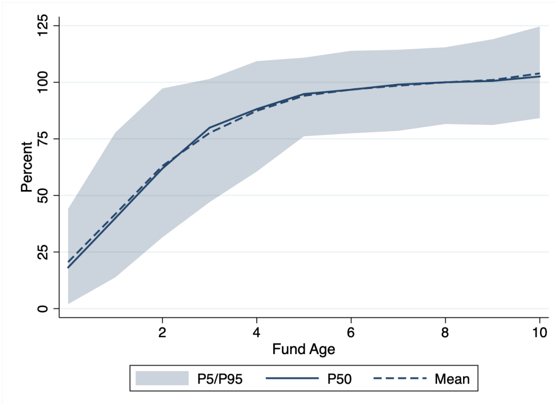
(e) First Funds



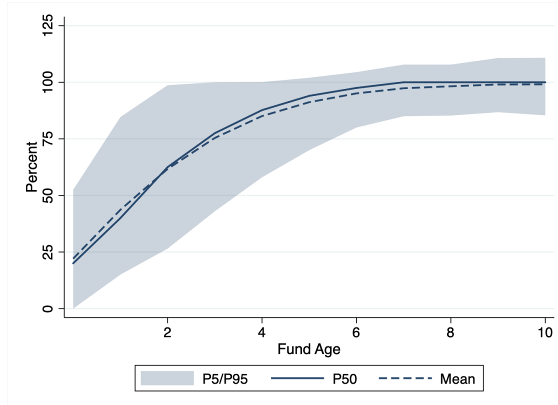
(f) Non-First Funds

Figure B3: Drawdowns by Fund Age - Subsamples

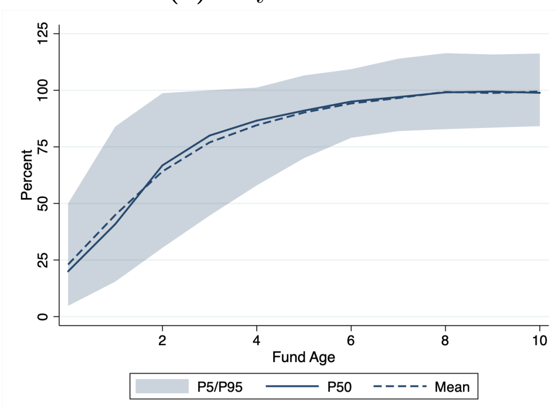
For each subsample indicated in subcaptions, this figure presents the distribution of capital calls as a percentage of total committed capital across fund ages, showing the mean, median, and tails. The sample consists of US PE funds raised between 1990 and 2005, ensuring that each fund has at least 15 years to draw down cash from investors by 2020. The dash and solid lines represent the mean and median values. The shaded area illustrates the range between the 5th percentile and the 95th percentile. The figure with the full sample is presented in Figure 3a.



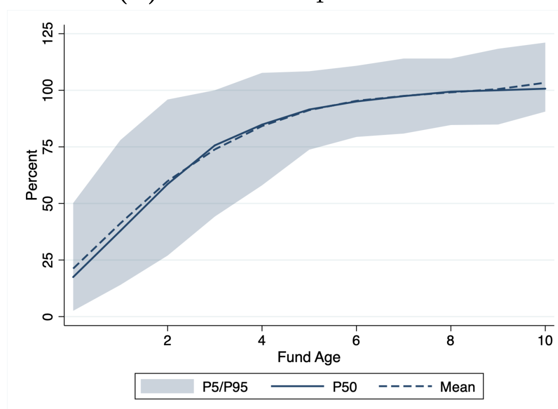
(a) Buyout Funds



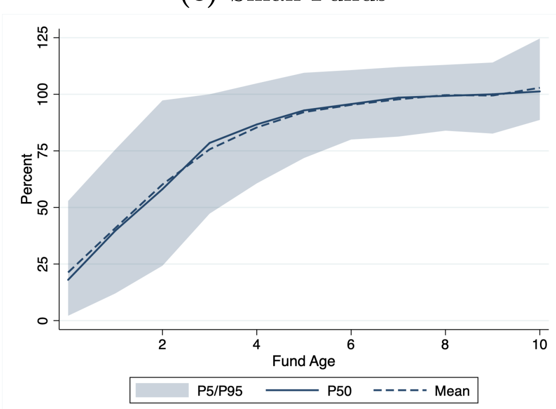
(b) Venture Capital Funds



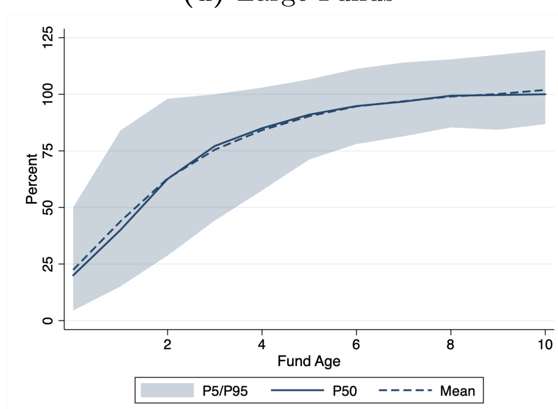
(c) Small Funds



(d) Large Funds



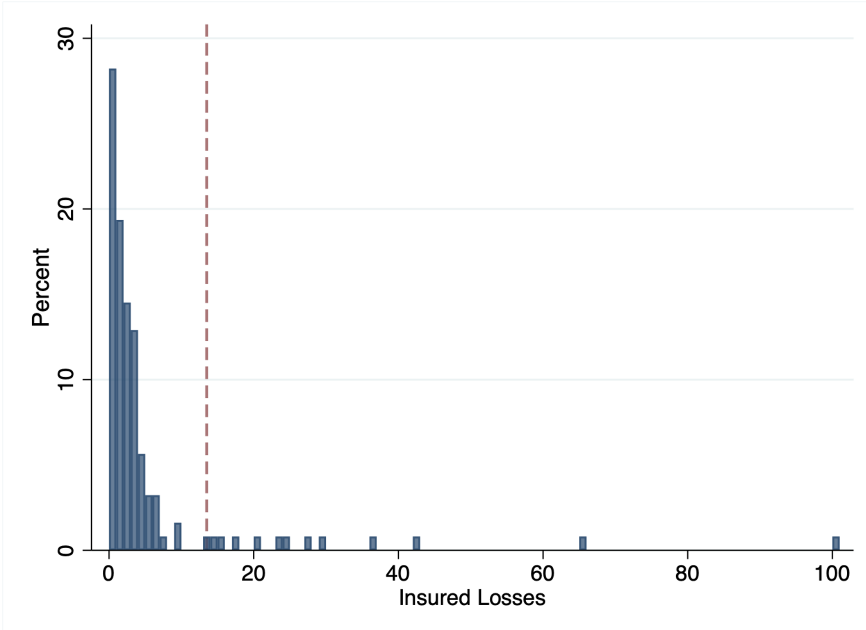
(e) First Funds



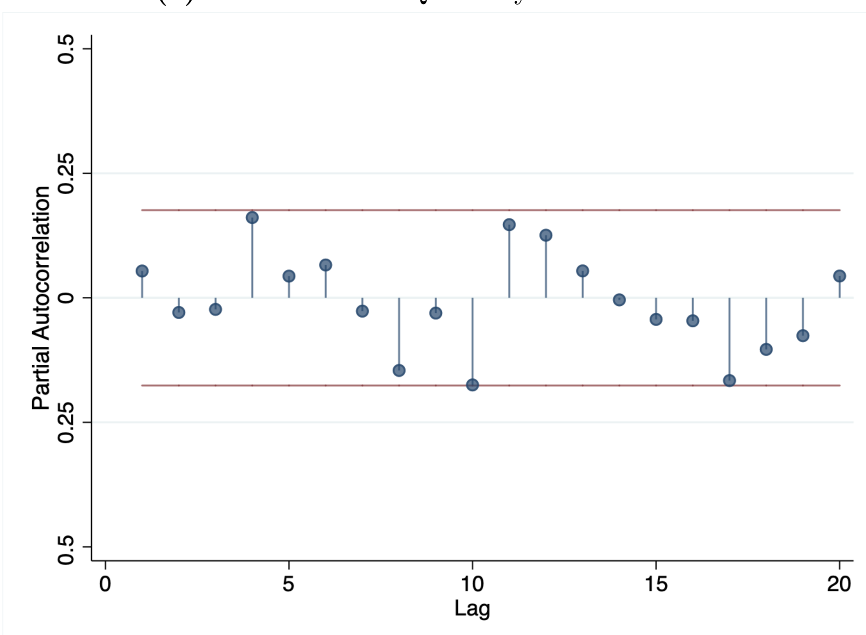
(f) Non-First Funds

Figure B4: Cumulative Drawdowns by Fund Age - Subsamples

For each subsample indicated in subcaptions, this figure presents the distribution of cumulative capital calls as a percentage of total committed capital across fund ages, showing the mean, median, and tails. The sample consists of US PE funds raised between 1990 and 2005, ensuring that each fund has at least 15 years to draw down cash from investors by 2020. The dash and solid lines represent the mean and median values. The shaded area illustrates the range between the 5th percentile and the 95th percentile. The figure with the full sample is presented in Figure 3b.



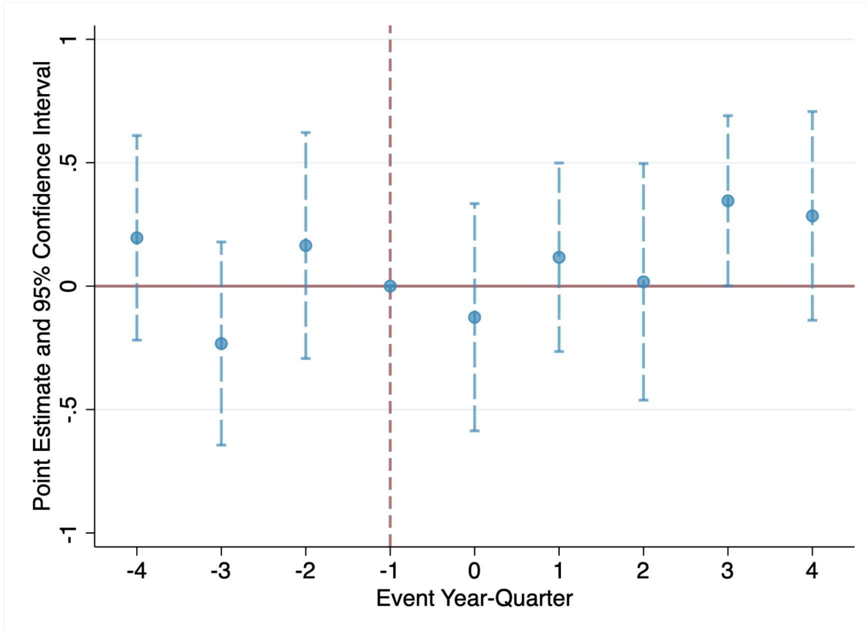
(a) Distribution of Quarterly Insured Losses



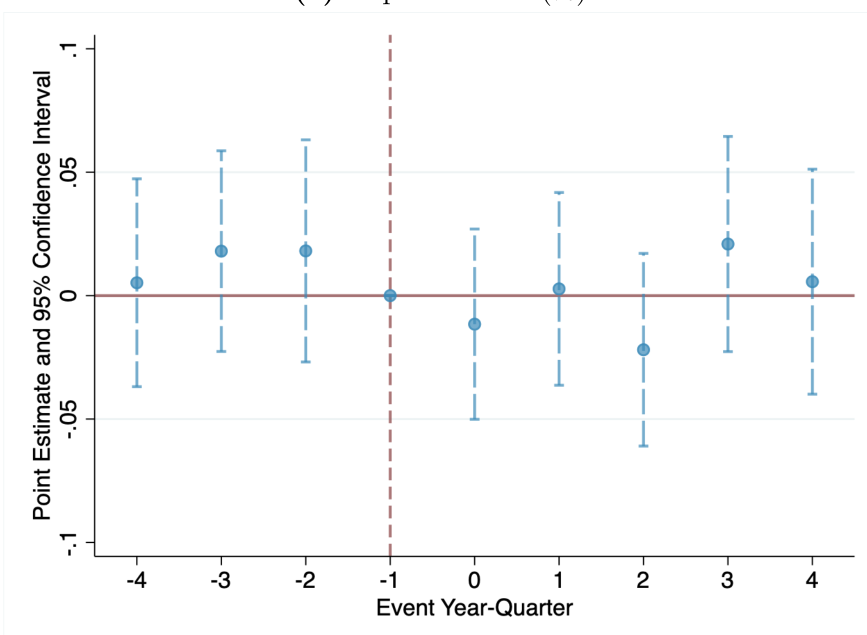
(b) Partial Autocorrelation of *Liquidity Shocks*

Figure B5: Large Natural Disasters as Liquidity Shocks - Size and Timing

Figure B5a plots the empirical distribution of the quarterly insured losses caused by natural disasters in the US during 1990-2020. The distribution is highly right-skewed and calendar quarters with insured losses greater than the 90th percentile value (12.5 USD BIL), indicated by the vertical dashed line, are liquidity shocks to P&C insurers since the insured losses are much larger than other periods. Figure B5b shows the partial autocorrelation of the time series of the indicator variable *Liquidity Shock*, an indicator variable equal to one for a calendar quarter when large natural disasters, indicated in Table B1, happen and lead to abnormal insured losses. The red horizontal lines indicate the 95% confidence intervals. The Durbin-Watson statistics for the time series is 1.89, which cannot reject the null hypothesis of no serial correlation. These tests suggest that liquidity shocks resulting from large natural disasters are unpredictable for P&C insurers.



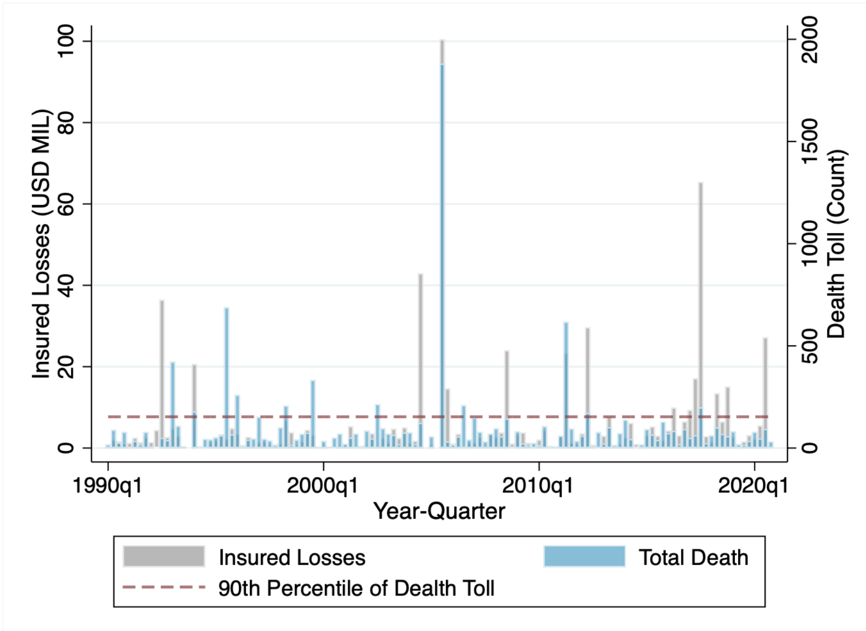
(a) Capital Called (%)



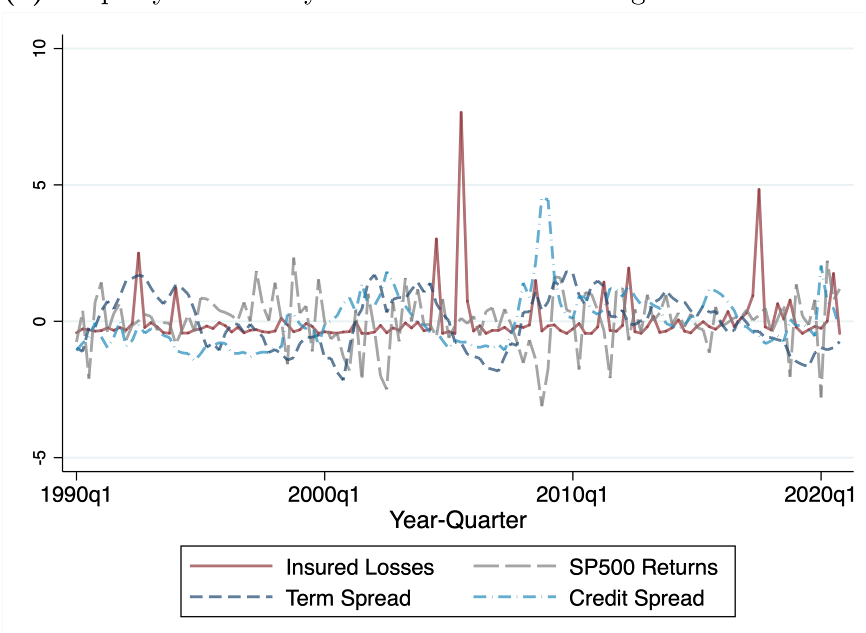
(b) Number of Investments

Figure B6: Life Insurer Exposure and Investment Dynamics around Large Disasters

This figure plots the coefficient estimates of *Life Insurer Exposure* $\times$ *Liquidity Shock*$_{t+n}$ in Equation (3) and the associated two-tailed 95% confidence intervals. The red vertical dashed line marks the quarter before liquidity shocks, with the coefficient normalized to zero. *Life Insurer Exposure* is an indicator variable equal to one if the share of life insurers within a fund is greater than the 90th percentile value, and zero otherwise. *Liquidity Shock*$_{t+n}$ is an indicator variable equal to one for a calendar quarter if it is n quarters before/after a calendar quarter with abnormal insured loss when n is negative/positive, and zero otherwise. The outcome variables are indicated in subcaptions. The regressions include year-quarter, fund age, fund manager $\times$ fund type $\times$ fund size fixed effects and use standard errors two-way clustered at the fund and calendar quarter levels. Detailed variable definitions are provided in Appendix A.2.



(a) Property & Casualty vs. Life Insurance during Natural Disasters



(b) Natural Disasters and Broader Financial Conditions

Figure B7: Natural Disasters and Shocks to Different Investors

Figure B7a shows the quarterly insured losses and total death resulting from natural disasters in the US during 1990-2020. The horizontal red dashed line indicates the 90th percentile value of the quarterly death toll (153 counts), while the 90th percentile value of quarterly insured losses is 13.5 USD BIL. The life insurance claims resulting from natural disasters are small in dollars compared to the P&C insured losses and are unlikely to be liquidity shocks to life insurers. Table C4 reports rebostness checks excluding 2005Q3. Figure B7b shows the quarterly time series of insured damages caused by natural disasters, S&P 500 returns, term spread, and credit spread. All variables are standardized. The correlations of insured damages with S&P 500 returns, term spread, and credit spread are -0.04, 0.00, and -0.03, all statistically insignificant at the 10% level.

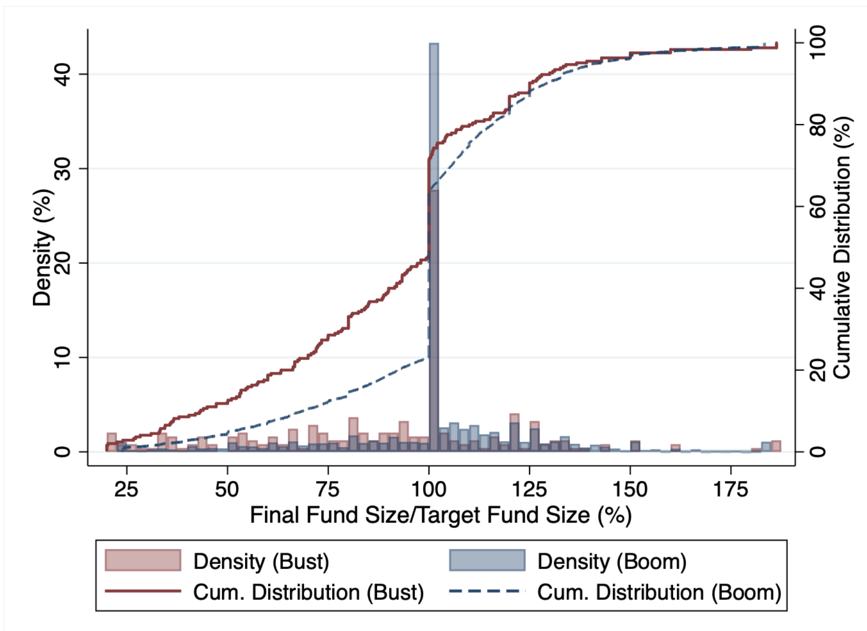
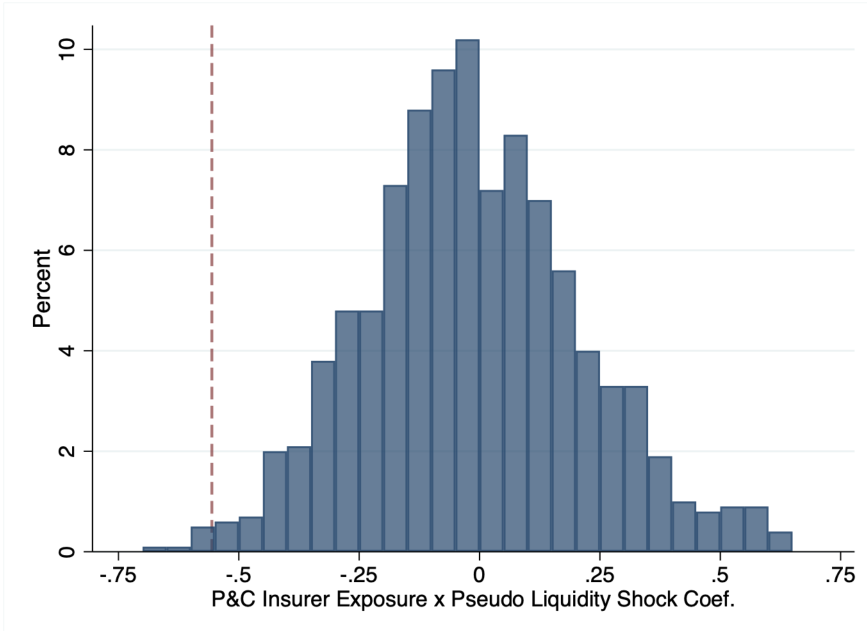
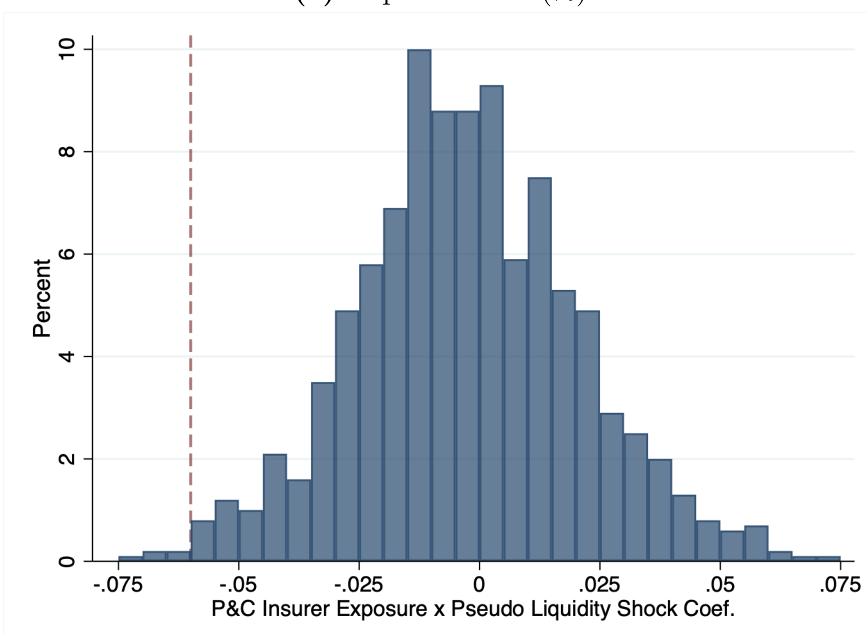


Figure B8: Subscription Ratio during Fundraising Boom and Burst Periods

This figure shows the (cumulative) distribution of PE fund subscription ratio during by fundraising boom and burst periods. The subscription ratio is defined as the ratio of the final fund size to the target fund size. Burst periods are 2001-2002 and 2009 (see Figure 1a), while the rest are considered boom periods. Around 48% of funds can not reach their target size during the burst period, while only 23% of funds are undersubscribed during the boom period. Funds raised in burst periods have more limited choices of their investor base than those raised in boom periods.



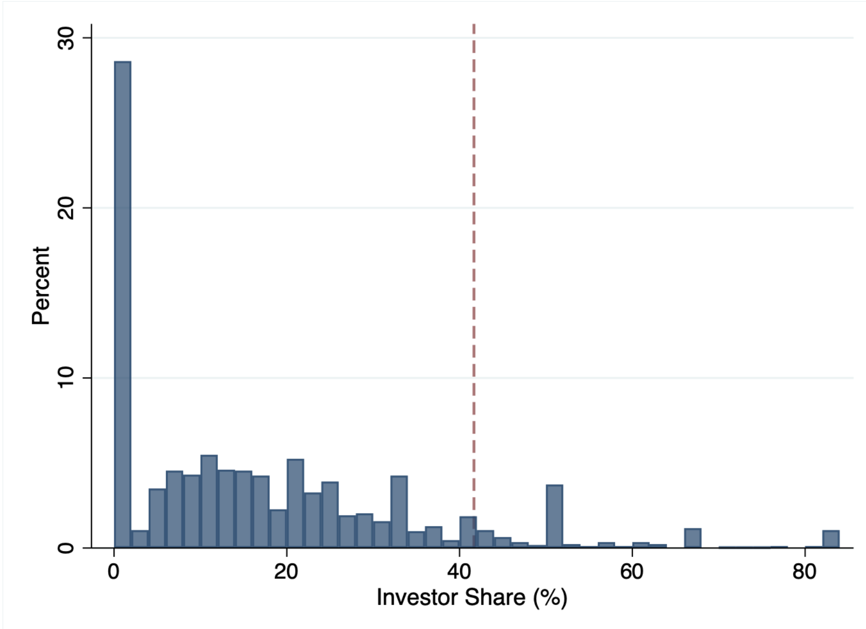
(a) Capital Called (%)



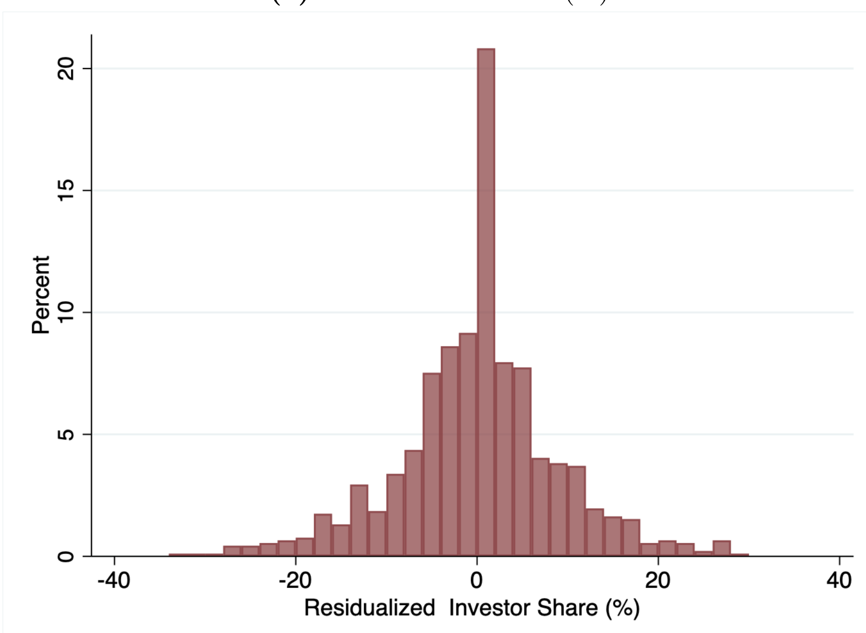
(b) Number of Investments

Figure B9: DiD Coefficients Estimated With Pseudo Liquidity Shocks

This figure plots the histogram of estimated DiD coefficients from 1,000 trials of a placebo test that randomly chooses 10% of the calendar quarters during 1990-2020 as those with pseudo liquidity shocks to P&C insurers. The DiD coefficient of *P&C Insurer* × *Pseudo Liquidity Shock* is estimated using the specification in Column 3 of Tables 2 and 3, with the outcome variables indicated in subcaptions. The vertical dashed line in each figure indicates the corresponding coefficient estimates based on true liquidity shocks. More than 99% of the mass in Panels (a) and (b) is on the right side of the vertical dashed line.



(a) Endowment Share (%)



(b) Residual Endowment Share (%)

Figure B10: Share of Endowments at the Private Equity Fund Level

Figure B10a shows the cross-sectional distributions of the endowment share at the PE fund level. Both endowments and foundations are included. The sample consists of PE funds raised in the US between 1990 and 2020. The red vertical dashed line represents the 90th percentile value (41.7%). Figure B10b shows the cross-sectional distribution of the residual endowment share at the PE fund level. The residual is obtained by regressing the unconditional value on fund manager × fund type × fund size dummies. The adjusted R^2 is 0.52, indicating sizable variation in the residual P&C insurer share. Table B3 reports the balance of fund characteristics based on residual endowment share.

Table B1: Periods with Abnormal Insured Losses Caused by Natural Disasters

This table shows the calendar quarter in which natural disasters lead to abnormal insured losses to insurance companies. Abnormal insured losses are defined as those greater than the 90th percentile value of quarterly losses during 1990 and 2020. The table includes details such as insured loss amounts, total losses, and the names of major disasters. The calendar quarters are ranked by total insured loss in descending order. Figure B5b provides evidence that there is no significant autocorrelation in the occurrence of these large natural disasters.

Ranking	Year-Quarter	Insured Loss (USD BIL)	Total Loss (USD BIL)	Major Disasters
1	2005Q3	100.48	198.73	Hurricane Katrina & Hurricane Rita
2	2017Q3	65.44	168.25	Hurricane Maria & Hurricane Irma
3	2004Q3	42.94	76.84	Hurricane Ivan & Hurricane Charley
4	1992Q3	36.48	61.17	Hurricane Andrew
5	2012Q2	29.69	46.66	Draught
6	2020Q3	27.22	45.02	Hurricane Laura
7	2008Q3	24.04	48.50	Hurricane Ike
8	2011Q2	23.31	45.15	Storms
9	1994Q1	20.65	54.84	Northridge Earthquake
10	2017Q2	17.13	23.44	Tubbs, Atlas, Nuns Fires
11	2018Q4	15.11	23.47	Hurricane Michael
12	2005Q4	14.64	20.32	Hurricane Wilma
13	2018Q2	13.49	21.58	Camp Fire

Table B2: Large Natural Disasters as Liquidity Shocks to P&C Insurers

This table reports deseasonalized within-insurer estimates of Equation (1), suggesting that P&C insurers suffer substantial underwriting losses when large natural disasters happen. *Net Underwriting Gain (%)* is the net underwriting gain as a percentage of lagged total assets. Following Ge and Weisbach (2021) and Ge (2022), *P&C Loss* is equal to the negative of the net underwriting gain as a percentage of lagged asset if the net underwriting gain is negative, and set to zero if the net underwriting gain is positive. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered at the insurer and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

	Underwriting Gain		P&C Losses	
	(1)	(2)	(3)	(4)
Liquidity Shock	-0.288**	-0.225*	0.209**	0.177**
	[0.140]	[0.125]	[0.081]	[0.088]
Insurer FE	✓	✓	✓	✓
Quarter FE		✓		✓
Observations	32,406	32,406	32,406	32,406
Adjusted R^2	0.204	0.208	0.214	0.217
$\bar{y}$	-0.135	-0.135	0.725	0.725

Table B3: Balance of Fund Characteristics

This table presents PE fund characteristics for funds in the first and last deciles based on the residual share of P&C insurers (Panel A) and endowments (Panel B). The residual is obtained by regressing the unconditional value on fund manager × fund type × fund size dummies. The examined PE funds are buyout and venture capital funds raised between 1990 and 2020, excluding funds of funds, secondary funds, and co-investment funds. *Buyout Fund* is an indicator variable equal to one for a buyout fund, and zero for a venture capital fund. *Target Size* is the target amount of capital to be raised by the PE fund. *Fund Size* is the amount of capital raised by a PE fund at the end of fundraising. *Fund Sequence* is the order in which a fund is raised by a private equity firm. *CA* is an indicator variable equal to one if the fund manager is located in California. *NY*, *MA*, *IL*, and *TX* are defined similarly based on whether the fund manager is located in New York (NY), Massachusetts (MA), Illinois (IL), or Texas (TX). *Number of Investors* is the number of investors providing capital to the PE fund. Detailed variable definitions are provided in Appendix A.2. ***, **, and * indicate 1%, 5%, and 10% significance levels.

Panel A: Residualized P&C Insurer Share

	First Decile Mean	Last Decile Mean	Difference	t-stats
Buyout Fund	0.61	0.59	0.03	0.39
Target Size ($ MIL)	1453.54	1546.39	-92.85	-0.27
Fund Size ($ MIL)	1368.18	1436.61	-68.43	-0.22
Fund Sequence	4.47	4.69	-0.22	-0.59
Number of Investors	15.60	14.86	0.74	0.46
CA	0.34	0.27	0.08	1.16
NY	0.25	0.30	-0.05	-0.77
MA	0.12	0.12	0.00	0.03
IL	0.10	0.11	-0.01	-0.22
TX	0.02	0.03	-0.01	-0.44

Panel B: Residualized Endowment Share

	First Decile Mean	Last Decile Mean	Difference	t-stats
Buyout Fund	0.42	0.42	0.00	0.00
Target Size ($ MIL)	1321.10	1478.86	-157.75	-0.39
Fund Size ($ MIL)	1247.38	1423.56	-176.18	-0.55
Fund Sequence	4.59	4.77	-0.18	-0.42
Number of Investors	11.17	20.37	-9.20	-3.09***
CA	0.33	0.29	0.03	0.48
NY	0.16	0.18	-0.02	-0.39
MA	0.25	0.27	-0.02	-0.33
IL	0.03	0.02	0.01	0.45
TX	0.03	0.04	-0.01	-0.38

Table B4: Liquidity Shocks and Cumulative Capital Calls

This table presents cross-sectional regression results from Equation (7), offering suggestive evidence that the investment reduction documented in Section 5.2 primarily reflects fund concessions. The sample consists of PE funds raised in the US between 1990 and 2010. The sample ensures that these funds have sufficient time to fully draw down their committed capital as of 2020. A unit of observation is a fund. *Cumulative Drawdown (%)* is the percentage of committed capital that has been drawn down cumulatively. The value can be greater than 100% due to the recycling provision. *Underinvest* is an indicator variable equal to one for a fund if its total amount of capital calls is less than the committed capital, and zero otherwise. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Shock Vintage* is an indicator variable equal to one for a fund if natural disasters lead to abnormal insured losses in the next 4 quarters after its vintage year, and zero otherwise. The specifications in Columns 1 and 4 include vintage year and fund manager fixed effects. Columns 2 and 5 absorb the fund manager fixed effects with fund manager by fund type fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. The standalone *Shock Vintage* is absorbed by the vintage year fixed effects. The standalone *Shock Vintage* is absorbed by the vintage year fixed effects. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund manager and vintage year levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

	Cumulative Drawdown (%)			Underinvest		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share	-0.016	-0.236**	-0.219	0.002	0.012***	0.010*
	[0.091]	[0.088]	[0.172]	[0.002]	[0.004]	[0.005]
P&C Insurer Share × Shock Vintage	-0.045	0.122	-0.050	-0.001	-0.007	-0.002
	[0.102]	[0.141]	[0.170]	[0.005]	[0.007]	[0.010]
Vintage Year FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	1,178	887	497	1,178	887	497
Adjusted R^2	0.002	0.347	0.325	0.007	0.224	0.215
$\bar{y}$	102.09	102.09	102.09	0.35	0.35	0.35

Table B5: Investor Base and Cash Distributions during Liquidity Shocks

This table reports the difference-in-differences estimates of the regression in Equation (2) suggesting that PE funds do not provide liquidity to investors through cash distributions when investors face liquidity shocks. Cash distributions represent capital returned to investors upon fund managers' exit from portfolio companies, typically through IPOs or M&As. The sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Cash Distributed (%)* is the quarterly amount of capital returned to the investors by a PE fund as a percentage of its committed capital. *P&C Insurer Exposure* is an indicator variable equal to one if the share of P&C insurers within a fund is greater than the 90th percentile value, and zero otherwise. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

	Cash Distributed (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Exposure	0.043	0.352	1.122			
	[0.337]	[0.510]	[1.052]			
P&C Insurer Exposure × Liquidity Shock	-0.396	-0.341	-0.442			
	[0.512]	[0.493]	[0.510]			
P&C Insurer Share				0.009	0.019	0.067*
				[0.013]	[0.021]	[0.039]
P&C Insurer Share × Liquidity Shock				-0.015	-0.012	-0.016
				[0.019]	[0.017]	[0.018]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	53,154	53,154	52,152	53,154	53,154	52,152
Adjusted R^2	0.043	0.056	0.071	0.043	0.056	0.071

Table B6: Reduced Investment - Funds with Limited Choices of Investor Base

This table examines how a PE fund's investor base affects the amount of drawdowns during liquidity shocks, based on subsamples of funds with limited choices of investor base. In Panel A, the subsample consists of undersubscribed funds. In Panel B, the sample is restricted to funds raised during fundraising burst periods (2001, 2002 and 2009 as indicated in Figure 1a). A unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *Number of Investments* is the number of investments made by a fund in a calendar quarter. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels. In Panel B Columns 3 and 6, *P&C Insurer Share* is absorbed by the fixed effects due to a lack of within-firm variation given the restricted fund sample.

Panel A: Undersubscribed Funds

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share	0.008	-0.061	0.055	-0.002	-0.003	0.016
	[0.011]	[0.076]	[0.152]	[0.002]	[0.011]	[0.019]
P&C Insurer Share × Liquidity Shock	-0.044*	-0.054**	-0.052*	-0.004**	-0.005***	-0.005***
	[0.025]	[0.026]	[0.027]	[0.002]	[0.002]	[0.002]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	7,324	7,324	7,324	7,324	7,324	7,324
Adjusted R^2	0.030	0.076	0.093	0.046	0.134	0.160

Panel B: Funds Raised during Fundraising Burst Periods

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share	-0.013	-0.004	0.000	-0.003	-0.013*	0.000
	[0.013]	[0.023]	[.]	[0.003]	[0.008]	[.]
P&C Insurer Share × Liquidity Shock	-0.061***	-0.062***	-0.060**	-0.005***	-0.005***	-0.005***
	[0.016]	[0.021]	[0.023]	[0.002]	[0.002]	[0.002]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	4,729	4,729	4,649	4,729	4,729	4,649
Adjusted R^2	0.076	0.102	0.083	0.097	0.188	0.170

Table B7: Rule Out Alternative Explanations - Reduced Capital Demand

This table reports regression results that rule out reduced capital demand as an alternative explanation. In Panel A, fund-quarters in states affected by natural disasters are excluded from the sample. In Panel B, the sample is restricted to funds specializing in industries (IT, internet, information services, media, software, and gaming) that are less likely to be affected by natural disasters. The full sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *Number of Investments* is the number of investments made by a fund in a calendar quarter. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

Panel A: Exclude Fund-Quarters in States Affected by Natural Disasters

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share	-0.002	-0.001	-0.002	-0.001	0.000	0.001
	[0.005]	[0.006]	[0.013]	[0.001]	[0.001]	[0.001]
P&C Insurer Share × Liquidity Shock	-0.040***	-0.036***	-0.034***	-0.004***	-0.003***	-0.003***
	[0.010]	[0.010]	[0.010]	[0.001]	[0.001]	[0.001]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	25,893	25,890	25,389	25,893	25,890	25,389
Adjusted R^2	0.151	0.152	0.150	0.163	0.220	0.233

Panel B: Restrict to Funds in Unaffected Industries

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share	0.004	0.002	0.011	0.001	0.002	0.002
	[0.003]	[0.006]	[0.008]	[0.001]	[0.001]	[0.002]
P&C Insurer Share × Liquidity Shock	-0.046***	-0.044***	-0.039***	-0.005***	-0.004***	-0.004***
	[0.010]	[0.010]	[0.010]	[0.002]	[0.001]	[0.001]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	30,043	30,042	29,503	30,043	30,042	29,503
Adjusted R^2	0.180	0.179	0.176	0.187	0.240	0.250

Table B8: Ex-Post Impacts Based on Deal-based Outcome Measures

This table uses deal-based investment measures to examine how a PE fund's investor base affects PE fund investment dynamics during liquidity shocks. The regression is restricted to PE funds that can be matched to at least 3 deals. The full sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Investment Amount / Fund Size (%)* is the quarterly total deal size as a percentage of the fund size. *Number of Deals* is the number of deals invested by a fund in a calendar quarter. *P&C Insurer Exposure* is an indicator variable equal to one if the share of P&C insurers within a fund is greater than the 90th percentile value, and zero otherwise. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

Panel A: Investment Amount / Fund Size (%)

	Investment Amount / Fund Size (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Exposure × Liquidity Shock	-0.449**	-0.298**	-0.251*			
	[0.214]	[0.137]	[0.144]			
P&C Insurer Share × Liquidity Shock				-0.023*	-0.013**	-0.010
				[0.011]	[0.006]	[0.006]
P&C Insurer Variable	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	42,715	42,715	42,715	42,715	42,715	42,715
Adjusted R^2	0.050	0.094	0.108	0.050	0.095	0.108

Panel B: Number of Deals

	Number of Deals					
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Exposure × Liquidity Shock	-0.116*	-0.072	-0.049			
	[0.070]	[0.058]	[0.054]			
P&C Insurer Share × Liquidity Shock				-0.007*	-0.003	-0.002
				[0.004]	[0.002]	[0.002]
P&C Insurer Variable	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	43,406	43,406	42,715	43,406	43,406	42,715
Adjusted R^2	0.135	0.310	0.360	0.134	0.310	0.360

Table B9: Acceleration of Investment - Funds with Limited Choices of Investor Base

This table investigates the relationship between a PE fund's investor base and investment pace in response to liquidity shock risk, based on subsamples of funds with limited choices of investor base. In Panel A, the subsample consists of undersubscribed funds. In Panel B, the sample is restricted to funds raised during fundraising burst periods (2001, 2002 and 2009 as indicated in Figure 1a). A unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *Number of Investments* is the number of investments made by a fund in a calendar quarter. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are clustered at the fund level and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels. In Panel B Columns 3 and 6, *Endowment Share* is absorbed by the fixed effects due to a lack of within-firm variation given the restricted fund sample.

Panel A: Undersubscribed Funds

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
Endowment Share	-0.035***	-0.034**	-0.028	-0.000	0.001	0.003
	[0.012]	[0.016]	[0.023]	[0.001]	[0.002]	[0.003]
Log(1 + Fund Age)	-2.181***	-1.985***	-1.853***	-0.144***	-0.120***	-0.072***
	[0.138]	[0.188]	[0.241]	[0.011]	[0.016]	[0.024]
Log(1 + Fund Age) × Endowment Share	0.012**	0.014***	0.014***	0.000	0.000	0.000
	[0.005]	[0.005]	[0.005]	[0.000]	[0.001]	[0.001]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	7,324	7,324	7,324	7,324	7,324	7,324
Adjusted R^2	0.122	0.116	0.116	0.094	0.153	0.164

Panel B: Funds Raised during Fundraising Burst Periods

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
Endowment Share	-0.042*	-0.075**	0.000	-0.002	-0.017***	0.000
	[0.024]	[0.029]	[.]	[0.002]	[0.004]	[.]
Log(1 + Fund Age)	-2.038***	-1.400***	-0.856	-0.179***	0.033	0.092***
	[0.210]	[0.397]	[0.548]	[0.022]	[0.033]	[0.034]
Log(1 + Fund Age) × Endowment Share	0.013	0.013	0.018**	0.001	0.001*	0.001*
	[0.009]	[0.009]	[0.008]	[0.001]	[0.001]	[0.001]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	4,729	4,729	4,649	4,729	4,729	4,649
Adjusted R^2	0.122	0.108	0.085	0.127	0.191	0.173

C Robustness Checks

C.1 Alternative Specifications

More Granular Fixed Effects. The fund manager × fund type × fund size fixed effects allows me to compare nearly identical funds managed by the same fund manager and arguably addresses the concern that the cross-sectional variation in investor base might be correlated with confounding factors that affect a fund's investment dynamics. As a robustness check, I absorb all unobservable time-invariant characteristics across funds by re-estimating Equation (2) with fund fixed effects. These differences include the investor base and fund contractual terms. Table C1 indicates that my results are robust to the within-fund estimation design.

C.2 Alternative Samples

Restrict to the First Five Years of a Fund's Life. Figure 3 suggests that the first five years are the most active phase for investments during a fund's life cycle, which is consistent with the industry practice that many PE funds have a 5-year investment period (Metrick and Yasuda, 2010; Robinson and Sensoy, 2013). Instead of using the first ten years of a fund in my main analysis, I re-estimate the equations excluding fund-quarters after the first five years. The DiD coefficient estimates reported Table C2 are larger in magnitude compared to the baseline estimates and statistically significant, which suggests greater impacts of investor base in transmitting liquidity shocks in the early stage of a fund life cycle.

Exclude Funds with a Small Number of Observed Investors. In my main analyses, I exclude PE funds with only one observed investor. The average (median) number of investors in my sample funds is 16 (11). To further mitigate potential measurement errors arising from investor disclosure at the fund level, I restrict the regressions to funds with more than ten investors. The results, reported in Table C3, remain quantitatively and qualitatively similar to my baseline findings.

Exclude the Hurricane Katrina Quarter. Table C4 presents regression results from the subsample that excludes the Hurricane Katrina quarter. Although the coefficients of *P&C Insurer Exposure* × *Liquidity Shock* are smaller in magnitude compared to the baseline estimates, they remain both statistically significant and economically meaningful. Therefore, my results are not driven by Hurricane Katrina, by far the largest natural disaster in recent US history (see Table B1).

Table C1: More Granular Fixed Effects

This table reports robustness checks using more granular fixed effects. The sample consists of PE funds raised in the US between 2002 and 2020. A unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *Number of Investments* is the number of investments made by a fund in a calendar quarter. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. *Endowment Share* is the percentage of investors that are endowments or foundations within a fund. *Log(Fund Age)* is the natural logarithm of one plus the fund age in calendar quarters. Detailed variable definitions are provided in Appendix A.2. Standard errors are clustered at the fund and calendar quarter levels (fund level) in Panel A (B) and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

Panel A: Ex-Post Effects

	Capital Called (%) (1)	Number of Investments (2)
P&C Insurer Share × Liquidity Shock	-0.031***	-0.003***
	[0.009]	[0.001]
Year-Quarter FE	✓	✓
Fund Age FE	✓	✓
Fund FE	✓	✓
Observations	53,149	53,149
Adjusted R^2	0.146	0.243

Panel B: Ex-Ante Effects

	Capital Called (%) (1)	Number of Investments (2)
Log(1 + Fund Age)	0.301***	0.170***
	[0.106]	[0.009]
Log(1 + Fund Age) × Endowment Share	0.004*	0.000**
	[0.002]	[0.000]
Year-Quarter FE	✓	✓
Fund FE	✓	✓
Observations	53,149	53,149
Adjusted R^2	0.135	0.238

Table C2: Restrict to First Five Years

This table reports robustness checks excluding fund-quarters that occur after 5 years from fund inception. The full sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are clustered at the fund and calendar quarter levels (fund level) in Panel A (B) and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

Panel A: Ex-Post Effects

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share	-0.002	-0.007	-0.004	-0.002*	-0.000	0.002
	[0.005]	[0.007]	[0.014]	[0.001]	[0.001]	[0.001]
P&C Insurer Share × Liquidity Shock	-0.044***	-0.039***	-0.038***	-0.004***	-0.003**	-0.003**
	[0.013]	[0.013]	[0.013]	[0.002]	[0.001]	[0.002]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	31,124	31,124	30,426	31,124	31,124	30,426
Adjusted R^2	0.052	0.049	0.041	0.040	0.114	0.123

Panel B: Ex-Ante Effects

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
Endowment Share	-0.018**	-0.014*	-0.014*	-0.002***	-0.002***	-0.002***
	[0.007]	[0.008]	[0.008]	[0.001]	[0.001]	[0.001]
Log(1 + Fund Age)	-0.873***	-0.846***	-0.742***	-0.021***	-0.021***	-0.003
	[0.086]	[0.088]	[0.093]	[0.007]	[0.007]	[0.007]
Log(1 + Fund Age) × Endowment Share	0.005	0.005	0.005	0.001***	0.001**	0.001**
	[0.003]	[0.003]	[0.004]	[0.000]	[0.000]	[0.000]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	31,124	31,124	30,426	31,124	31,124	30,426
Adjusted R^2	0.038	0.034	0.025	0.026	0.099	0.109

Table C3: Exclude Funds with a Small Number of Observed Investors

This table reports robustness checks excluding PE funds with fewer than ten observed investors. The full sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are clustered at the fund and calendar quarter levels (fund level) in Panel A (B) and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

Panel A: Ex-Post Effects

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share	0.005	0.010	0.020	-0.000	0.003**	0.003*
	[0.005]	[0.009]	[0.014]	[0.001]	[0.001]	[0.002]
P&C Insurer Share × Liquidity Shock	-0.053***	-0.051***	-0.049**	-0.005***	-0.005***	-0.004***
	[0.020]	[0.019]	[0.020]	[0.002]	[0.002]	[0.002]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	32,489	32,489	32,145	32,489	32,489	32,145
Adjusted R^2	0.167	0.164	0.160	0.175	0.217	0.230

Panel B: Ex-Ante Effects

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
Endowment Share	-0.019**	-0.016*	-0.017*	-0.003***	-0.001	-0.002
	[0.009]	[0.009]	[0.010]	[0.001]	[0.001]	[0.001]
Log(1 + Fund Age)	-1.878***	-1.818***	-1.595***	-0.185***	-0.178***	-0.134***
	[0.068]	[0.072]	[0.081]	[0.008]	[0.008]	[0.009]
Log(1 + Fund Age) × Endowment Share	0.006**	0.007**	0.005	0.001***	0.001**	0.001*
	[0.003]	[0.003]	[0.003]	[0.000]	[0.000]	[0.000]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	32,489	32,489	32,145	32,489	32,489	32,145
Adjusted R^2	0.120	0.116	0.114	0.091	0.130	0.153

Table C4: Exclude the Hurricane Katrina Quarter (2005Q3)

This table reports robustness checks excluding the period when Hurricane Katrina happened (2005Q3). The full sample consists of PE funds raised in the US between 1990 and 2020. A unit of observation is a fund-quarter. *Capital Called (%)* is the quarterly amount of capital called by a PE fund as a percentage of its committed capital. *Number of Investments* is the number of investments made by a fund in a calendar quarter. *P&C Insurer Exposure* is an indicator variable equal to one if the share of P&C insurers within a fund is greater than the 90th percentile value, and zero otherwise. *P&C Insurer Share* is the percentage of investors that are P&C insurers within a fund. *Liquidity Shock* is an indicator variable equal to one for a calendar quarter if the insured loss caused by natural disasters in this period is greater than the historical 90th percentile, and zero otherwise. The specification in Columns 1 and 4 includes fund age and year-quarter fixed effects. Columns 2 and 5 add fund manager fixed effects. Columns 3 and 6 use the saturated specification by interacting the fund manager fixed effects with the fund type dummy, based on whether the fund is a venture capital or buyout fund, and fund size dummies, based on the fund's size quintile. Detailed variable definitions are provided in Appendix A.2. Standard errors are two-way clustered, at the fund and calendar quarter levels, and reported in brackets. ***, **, and * indicate 1%, 5%, and 10% significance levels.

	Capital Called (%)			Number of Investments		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Insurer Share	0.001	-0.003	0.001	-0.001	0.001	0.001
	[0.003]	[0.005]	[0.011]	[0.001]	[0.001]	[0.001]
P&C Insurer Share × Liquidity Shock	-0.036***	-0.033***	-0.031***	-0.004***	-0.003***	-0.003***
	[0.009]	[0.009]	[0.009]	[0.001]	[0.001]	[0.001]
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Fund Age FE	✓	✓	✓	✓	✓	✓
Fund Manager FE		✓			✓	
Fund Manager × Fund Type × Fund Size FE			✓			✓
Observations	52,641	52,641	51,641	52,641	52,641	51,641
Adjusted R^2	0.152	0.151	0.148	0.164	0.215	0.227