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Fund ownership, wealth, and risk-taking: Evidence on private equity managers☆

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ABSTRACT

Private equity (PE) managers are required to invest their own money in the funds they manage. We examine the incentive effects of this ownership on the delegated acquisition decision. A simple model shows that PE managers select less risky firms and use more debt, the higher their ownership. We test these predictions for a sample of Norwegian PE funds, using managers' wealth to capture their relative risk aversion. As predicted, the target company's cash-flow risk decreases and leverage increases with the manager's ownership scaled by wealth. Moreover, the overall portfolio risk decreases with ownership, mitigating widespread concerns about excessive risk-taking.

1. Introduction

Private equity (PE) funds are raised and managed by the investment professionals of a general partner (GP), also known as a PE firm. The GP is typically compensated through an annual management fee of two percent of the fund's capital and a twenty percent carried interest on the returns above a certain threshold (Metrick and Yasuda, 2010).[1] This carry has an option-like payoff and incentivizes the GP to generate high absolute returns. Since the performance of the fund, in addition, affects the success of subsequent fundraising efforts—and, hence, the ability to earn future fees—the GP's incentive to take risk is even stronger than that provided by the carry alone (Chung et al., 2012).

Neither the management fee nor the carry (or the option to raise future funds) implies any downside risk for the fund manager, causing widespread concerns that GPs over-lever their portfolio companies in an attempt to generate high absolute returns and enrich themselves. The concern that too much risk-taking might harm the financial stability of the banking system, which is a major provider of debt, prompted the European Parliament to propose limitations on the leverage of PE-owned firms in 2011.[2] Moreover, the massive wealth

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[1] Many GPs charge transaction fees and monitoring fees to their portfolio companies. Phalippou (2009) and Phalippou et al. (2018b) estimate that the total fees average 6%–7% of invested capital.

[2] Directive 2011/61/EU of the European Parliament and of the Council of 8 June 2011 on Alternative Investment Fund Managers (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011L0061).

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accumulation of GPs collecting large performance fees is controversial and has fueled fears of reckless risk-taking.[3]

To align interests, the Limited Partners (LPs) contributing the capital require the GP to invest her own money in the fund.[4] This fund ownership effectively imposes a penalty on the GP if the investment fails, mitigating her risk-taking incentives. Robinson and Sensoy (2013) report that GPs of US buyout funds, on average, contribute 2.4 percent (median 1.0 percent) of the capital. However, they do not find a relationship between the dollar amount or percent of GP ownership and the fund performance net of fees—as if the GP's ownership does not systematically affect her choice of risk.

In this paper, we provide novel and more direct evidence on the incentive effect of the GP's fund ownership on the delegated investment decision. Specifically, we study how GP ownership affects the choice of portfolio company risk and leverage. Moreover, we exploit the commonly accepted notion that risk aversion is declining in wealth (Holt and Laury, 2002; Becker, 2006; Eckbo et al., 2021), by using a unique sample of PE investments in Norway, where personal wealth data are publicly available. Importantly, we are the first to document that the overall PE fund portfolio risk is declining in the GP ownership scaled by wealth. Our evidence indicates that LPs can effectively mitigate excessive risk-taking incentives by designing contracts that account for the GP's risk preferences.

We start by developing a simple theoretical model in which the GP simultaneously selects a target firm and decides how much debt to use in the acquisition, contributing the equity from the fund. The GP can choose between firms with different risks, where high-risk firms have relatively high expected cash flow and probability of default compared to low-risk firms. The GP invests a fraction β of the equity and receives a performance-based carried interest α of the cash flow above a threshold. Because debt increases the payoff to equity in good states, managers use more debt the higher the carry α.

We assume that the GP is risk-averse and derives negative utility from downside risk. It follows that the GP's ownership directly affects the portfolio company choice. In particular, the GP selects the target firm by trading off the expected cash flow against the downside risk. *Ceteris paribus*, managers with a relatively high ownership fraction β invest in less risky firms. Since lower-risk firms have greater debt capacity, GP ownership also indirectly affects leverage. For a given carry α, the GP uses more debt to finance the firm, the higher the ownership. Moreover, allowing risk aversion to be declining in wealth, the effect of the GP ownership on the choice of firm risk and leverage decreases with the GP's personal wealth.

We take these model predictions to the data, using a sample of 62 firms acquired by 20 Nordic PE funds between 2000 and 2010. We limit the analysis to Norway, where information on the investment professionals' taxable wealth is publicly available, as are the portfolio companies' financial statements after going private. Using hand-collected wealth data, we estimate the incentive effects of GP ownership, not only in dollars and percent of the fund value but also as a proportion of the GP's wealth. This is an important empirical contribution of our paper. As we show below, the effect of GP ownership on portfolio company risk and leverage is significant largely only after scaling by wealth.

The GP ownership varies substantially across the PE funds in our sample, with an average of 3.7% (median 1.5%), ranging from zero to 15% of the fund's capital.[5] In contrast, there is little, if any, variation in the carry across funds, so we can safely attribute differences in risk-taking incentives to the cross-sectional variation in GP ownership. Importantly, we show that PE professionals in Norway are required to invest a large fraction of their wealth in the funds they manage. In our sample, the PE partners' ownership in the fund averages as much as 93% (median 48%) of their taxable wealth.[6]

Our empirical tests confirm the model predictions. We show that funds with higher GP ownership tend to acquire target firms with lower asset beta and return volatility, i.e., firms with relatively low cash-flow risk. Moreover, these funds typically use more debt to finance their acquisitions. The implied negative association between cash-flow risk and leverage is consistent with Colla et al. (2012)'s finding of an inverse relationship between buyout leverage and the firm's cash-flow volatility. Furthermore, our evidence that portfolio company leverage increases with GP ownership adds to Axelson et al. (2013), who document that economy-wide credit conditions determine debt levels in buyouts.

Although our model is silent on the overall effect of GP ownership on portfolio risk, this relationship is interesting since it informs about the LPs' ability to mitigate the GP's risk-taking incentives. The data shows that the PE fund's overall risk decreases with the GP's ownership. First, the target firm's equity beta is declining in GP ownership, suggesting that the reduction in cash-flow risk dominates the increased default risk from higher leverage. Second, we introduce "ticket size", defined as the ratio of the fund's equity investment in the firm to its total capital, as an alternative measure of portfolio risk. The lower this ratio, the higher the number of portfolio companies and the more diversified is the PE fund. Consistent with the negative impact on the target firm equity beta, we document that ticket size is decreasing in GP ownership. Thus, our evidence suggests that the incentive effect of the GP's ownership goes beyond the choice of individual target firm characteristics and has a broader impact on the overall design of the fund's portfolio.

Importantly, the effect of GP ownership on target firm risk and leverage is significant primarily when scaling the former by wealth. Neither the GP ownership in percent of fund value nor the dollar amount invested is related to portfolio company systematic risk and leverage. This result is consistent with Robinson and Sensoy (2013), who fail to find an association between GP percent or dollar ownership and fund returns net of fees. We argue that differences in risk preferences may conceal the effect of GP ownership on risk-taking in their data. Thus, a contribution of this paper is to show the importance of controlling for the investment professionals' wealth to assess the incentive effect of GP ownership properly. Our findings complement the evidence in Pool et al. (2019) that mutual fund managers experiencing a wealth shock from declining housing prices reduce the risk in their delegated funds and Faccio et al. (2011) that shareholder portfolio concentration affects corporate risk-taking.[7]

In our model, the GP's ownership is exogenously determined upfront, whereas the target company is selected later. We thus posit that GP ownership has a causal effect on the subsequent choice of portfolio company risk and leverage. Empirically, a nice feature of the PE setting is that the GP ownership is determined *ex-ante* when raising the fund, whereas the acquisition decisions are made *ex-post* as the committed capital is drawn down over the subsequent investment period—typically the first five years of the fund's life. This sequencing mitigates endogeneity concerns and is similar to the approach of Shue

[3] Phalippou (2020) estimates that GPs collected a total carry of $370 billion from PE funds raised in 2006–2015, despite returns similar to that of public equity indexes.

[4] Institutional Limited Partner Association (ILPA) recommends that the GP commitment should be "substantial" and ideally paid in cash (https://ilpa.org/wp-content/uploads/2019/06/ILPA-Principles-3.0_2019.pdf).

[5] GP commitments are generally substantial. In 2019, one-third of US PE funds required a GP ownership of 3% or more (MJ Hudson research, https://mjhudson.com/news/fund-terms-research-sixth/).

[6] SoftBank asked their executives to take on large personal loans, sometimes exceeding ten times their base salary, to invest in its $97bn Vision Fund (Financial Times, 09/24/2019).

[7] For effects of incentive-based pay, see also Guay (1999), Knopf et al. (2002), Rajgopal and Shevlin (2002), and Coles et al. (2006) on corporate investment policy, Tchistyi et al. (2011) on corporate financial policies, Fahlenbrach and Stulz (2011) on the stock-return volatility of banks, and Driessen et al. (2009) on the performance of equity mutual funds.

and Townsend (2017).[8] We further scale the GP ownership with the manager's wealth at the time of investment, which is likely to have changed since fund inception.

While we do not have a direct identification strategy, the data are inconsistent with equilibria caused by endogeneity and reverse causality. First, since LPs often negotiate the partnership agreements and influence the terms (Robinson and Sensoy, 2013), GP ownership can be an optimal contract designed by LPs to resolve moral hazard problems. Specifically, if LPs know the GP's risk preferences *ex-ante*, they may select a GP ownership that *ex-post* counteracts her personal risk preferences. For example, LPs may require high ownership from a risk-loving GP to mitigate her appetite for risk and low ownership from a risk-averse GP to encourage further risk-taking. Therefore, in an equilibrium where LPs set GP ownership to counteract her risk preferences, there should be no systematic relation between GP ownership and portfolio company risk—something our data rejects.

Second, GPs may use the ownership stake to signal their risk aversion to LPs. In a signaling equilibrium, a risk-loving GP would choose high fund ownership to separate herself from a risk-averse GP, selecting low ownership. Hence, GP ownership and target company risk would be positively correlated. The same relationship obtains if unobservable fund-manager characteristics, such as risk preference and ability, generate a spurious correlation between GP ownership and target firm risk. For example, a risk-averse GP could select lower fund ownership and less risky target firms. Our empirical analysis instead shows that GP ownership is negatively related to risk-taking, rejecting the notion of a signaling equilibrium.

Overall, our evidence suggests that LPs effectively reduce PE fund managers' risk-taking incentives by requiring them to invest in the fund. An important implication of this result is that regulatory attempts to limit PE firms' leverage may be unnecessary and premature since LPs can address excessive risk-taking concerns by requiring the GP to invest a sufficiently large fraction of her wealth in the fund. That notwithstanding, LPs ultimately care for the risk-adjusted return net of fees. Whether a reduction in the GP's risk appetite from fund ownership is optimal or not goes beyond the scope of this paper and an issue we leave for future research.[9]

The paper proceeds as follows. Section 2 sets up and discusses our theoretical model and its predictions. Section 3 describes the data, while Section 4 presents the empirical results. Section 5 concludes.

2. Model

In this section, we develop a simple model showing how the GP's fund ownership and wealth affect her choice of target company risk and leverage. Our model relies on an exogenous GP compensation scheme, similar to that observed in PE funds, and investigates the comparative statics of GP ownership on the delegated risk-taking. We build on the rationale of Axelson et al. (2009) for the use of leverage in buyout transactions and complement the theoretical work of Maurin et al. (2020), who derive the level of GP ownership in an optimal contract between the GP and the LP.

[8] Shue and Townsend (2017) study the effects of CEO option grants that vest over several years. See Chava and Purnanandam (2010) and Coles et al. (2012) for other approaches to address similar endogeneity concerns.

[9] Gupta and Sachdeva (2019) and Ibert (2023) find that hedge funds and mutual funds with more inside investment outperform other funds. For evidence on PE fund returns, see, e.g., Kaplan and Schoar (2005), Phalipou and Gottschalg (2009), Groh and Gottschalg (2011), Driessen et al. (2012), Harris et al. (2014), Higson and Stucke (2012), Phalippou (2014), Braun et al. (2017), and Phalippou et al. (2018a). We do not have data on investment returns.

2.1. Basic set-up

Agents and timing. The model has three agents: a GP raising and managing a PE fund, risk-neutral investors (LPs) contributing capital to the fund, and a risk-neutral bank providing debt via a competitive lending market. At time $t = 0$, the GP selects risk through the choice of a target company and the amount of debt financing. At time $t = 1$, the target firm realizes a cash flow that is shared by the bank, investors, and the GP. The firm's realized cash flow x is $R+\Delta$ (high), R (medium), or $R-\rho$ (low) with probability $0.5q$, $1-q$, and $0.5q$, respectively. Firms vary in the likelihood of the tail outcomes and hence in the risk q of their cash flows. We assume $\Delta > \rho$ and zero discount rate, so the expected value of the firm $V(q) = R + 0.5q(\Delta - \rho)$ is increasing in q.

Bank lending. After selecting a firm with a certain project risk q, the GP approaches the bank for debt financing. The GP finances the purchase price I by borrowing D against the firm's cash flow, using equity from the PE fund for the remaining amount of $I - D$. The bank charges an interest rate r and receives $D(1+r)$ at $t = 1$ as long as the realized cash flow $x > D(1+r)$. We let $R > D(1+r) > R-\rho$, so the firm defaults and goes bankrupt in the low state. We assume zero monetary bankruptcy costs, so the bank receives $R-\rho$ and investors zero in the low state. In the high and medium state, the cash flow is sufficient to pay back the bank debt with interest. We let cash flow risk be verifiable and the bank sets the loan rate r accounting for q. To simplify notation we assume the bank's refinancing costs to be zero. With a competitive loan market, the bank will require a rate r that allows it to break even:

$$0.5qD(1+r) + (1-q)D(1+r) + 0.5q(R-\rho) = D. \quad (1)$$

The cash flow to equity left after the bank is paid off is shared between LPs and the GP. For tractability, we ignore potential benefits from leverage, such as tax shield of debt (Modigliani and Miller, 1958) and reduced agency costs (Jensen, 1986), and let firm value $V(q)$ be independent of leverage.

2.2. The GP's compensation scheme and objective function

The GP is compensated through a performance-based carried interest $\alpha > 0$ received at $t = 1$. In practice, GPs also charge a management fee, expressed as a fixed percentage of the fund's capital. However, in our setting, the management fee has no effect on the GP's investment decision and, for tractability, we ignore it in the analysis below. The carry pays the GP a fraction of the cash flow to equity exceeding the hurdle rate e. We assume that this hurdle rate e is a non-risk-adjusted exogenous rate. This maps industry practice, where the hurdle rate is set when the fund is raised, well before the fund manager selects target companies.

The carry α is zero in the low state and, hence, an option-like payoff with no downside risk. To give the GP skin in the game and a possible downside, investors require the GP to invest in the fund. So the GP contributes a fraction $\beta \in (0,1)$ of the fund's equity investment at $t = 0$ and receives β of the realized cash flow to equity at $t = 1$. In the following, we refer to this fraction as the GP's ownership fraction. It allows her a share of the cash flow to equity, net of investment, V^E, which in expectation amounts to:

$$V^E(q, D) = 0.5q[R + \Delta - D(1+r)] + (1-q)[R - D(1+r)] - (I - D). \quad (2)$$

Hence, the GP's monetary payoff V_m^{GP} is her fraction of the cash flow to equity βV^E plus the carried interest of $\alpha(x - C) > 0$, where C is the threshold consisting of the debt payments to the bank $D(1+r)$ and the hurdle amount paid to the LPs $(I-D)(1+e)$ in outcomes where the cash flow x exceeds C. Therefore, we get $V_m^{GP} = \beta V^E + \alpha(x - C)$. We assume that $R > I(1+e)$, so the GP receives carry in the medium outcome (where the cash flow is $x = R$) for an all-equity financed firm.

By plugging the bank's participation constraint from Eq. (1) into the equity value of the leveraged firm, V^E in Eq. (2), and by replacing x with the expected cash flows in the medium and high state, we get the GP's monetary payoff as:

$$V_m^{GP}(q, D) = \beta(0.5q(R+\Delta) + (1-q)R + 0.5q(R-\rho) - I) + \alpha[0.5q(R+\Delta-C) + (1-q)(R-C)]. \quad (3)$$

We can express the threshold C formally as:

$$C(D) = D(1+r) + (I-D)(1+e) = I(1+e) - D(e-r). \quad (4)$$

We further assume that $e > r$, implying that the hurdle rate exceeds the loan interest rate, which fits well with industry standards (Metrick and Yasuda, 2010). Hence, taking Eq. (4) into account, Eq. (3) shows that the GP's monetary payoff V_m^{GP} is strictly increasing in the debt level D. Intuitively, the GP benefits from debt because it increases the expected payoff from the carry. The GP's monetary payoff is also increasing in the firm risk q. This can be seen by using Eq. (1) to rewrite Eq. (4) for the threshold:

$$C(D) = I(1+e) - De + \frac{0.5qD}{1-0.5q} - \frac{0.5q(R-\rho)}{1-0.5q}. \quad (5)$$

Plugging Eq. (5) into Eq. (3) reveals that the GP's monetary payoff also increases with the firm's risk level q.

To find an interior solution for the choice of project risk and debt financing, we next consider the GP's non-monetary costs of leverage and firm risk.

Non-monetary costs of debt. In the case of default, which in our model occurs in the low state, the GP incurs a reputational cost due to adverse effects on future fundraising efforts. We let the GP's reputational cost of default B be increasing in the bank's loss and convex in D.[10] We further assume that the failure of a low-risk firm imposes a greater reputational cost than that of a high-risk firm, i.e., that B decreases with q. This assumption reflects the notion that LPs view the failure of a low-risk company as a more negative signal of the GP's monitoring abilities since low-risk firms inherently have a relatively low default probability.[11] Hence, we let $B(q, D) = \lambda D^2/q$, where $\lambda > 0$. Because default occurs only in the low outcome, the cost B occurs with probability $0.5q$.

Non-monetary costs of project risk. We further assume that the GP is risk-averse and an expected utility maximizer. We translate this into the notion that the GP's negative utility from risk-taking is greater the more likely are the extreme (the low and the high) outcomes, i.e., the higher is the level of risk, q. To derive an interior solution in a tractable manner we depict the negative utility expression to be quadratic in q. We let the difference in payoff in the two states be reflected in a parameter $c = \tilde{c}(\Delta + \rho)$ with $\tilde{c}$ being a positive constant. Hence, we depict the negative utility expression as $k(q) = 0.5cq^2$. Since the GP is exposed to downside risk through her ownership in the firm, we let this cost be proportional to the ownership fraction β (see Bolton et al. (2011) for a related approach). We further let the parameter c be decreasing in the GP's personal wealth w (i.e., $c(w)$ with $\partial c/\partial w < 0$), implying that wealthier GPs are less risk-averse (Rabin, 2000b; Holt and Laury, 2002). Technically speaking, we assume decreasing absolute risk aversion (see, e.g., Kroll et al. (1995)).

[10] A more precise way of modeling this mechanism is to let these costs be convex in the bank's loss $(D-(R-\rho))$. However, to reduce the computational complexity, we drop the exogenous part $(R-\rho)$.

[11] Dropping this assumption complicates our analysis but leaves the results qualitatively unchanged.

GP objective function. The objective function of the GP can, hence, be written by adding the non-monetary costs to the monetary payoff in Eq. (3) as:[12]

$$V^{GP}(q, D) = \beta(0.5q(R+\Delta) + (1-q)R + 0.5q(R-\rho) - 0.5cq^2 - I) + \alpha[0.5q(R+\Delta-C) + (1-q)(R-C)] - 0.5\lambda D^2. \quad (6)$$

2.3. GP ownership and risk-taking

When choosing the level of project risk q and debt financing D, the GP faces two opposing effects that she must trade off against each other. Higher firm risk q is associated with, on the one hand, larger expected cash flows and, on the other hand, greater negative utility k related to risk aversion. Similarly, higher debt D is accompanied by higher expected carry, but also greater expected (reputational) default costs B.

Taking Eq. (5) into account in Eq. (6), the first-order condition for the GP's choice of risk is:

$$\frac{dV^{GP}}{dq} = \beta(0.5(\Delta-\rho) - cq) + 0.5\alpha(\Delta - \rho + I(1+e) - D(1+e)) = 0 \quad (7)$$

and the first-order condition for her choice of debt is:

$$\frac{dV^{GP}}{dD} = -\lambda D + \alpha((1-0.5q)e - 0.5q) = 0. \quad (8)$$

Solving these two equations yields:

$$q(D, \beta, \alpha) = \frac{(\Delta-\rho)}{2c} + \frac{\alpha(\Delta - \rho + I(1+e) - D(1+e))}{2c\beta} \quad (9)$$

and

$$D(q, \alpha) = \frac{\alpha((1-0.5q)e - 0.5q)}{\lambda}. \quad (10)$$

Project risk q is a function of debt D in Eq. (9) and D is a function of q in Eq. (10). Note that the two dimensions of risk, q and D, operate in opposite directions. Higher project risk leads the GP to optimally choose lower leverage and vice versa.[13] Our two choice variables are in this sense risk substitutes. This tradeoff between project risk and leverage, which can be seen in the first-order conditions, is a key mechanism in our model.

An important consequence of this substitutability is that exogenous parameters may affect the choice of risk and leverage directly, via the respective first-order condition, as well as indirectly, through the other choice variable. For example, the carry α affects both q and D directly, and therefore also indirectly. In contrast, the GP's equity ownership β has a direct effect on project risk q only and, hence, only an indirect effect on the leverage choice.

We derive the comparative static effects of the GP's ownership by totally differentiating the first-order conditions. From Eqs. (7) and (8), we get:

$$\frac{dq}{d\beta} = \frac{-\lambda(cq - 0.5(\Delta-\rho))}{\Gamma} < 0 \quad (11)$$

and

$$\frac{dD}{d\beta} = \frac{(cq - 0.5(\Delta-\rho))(0.5\alpha(1+e))}{\Gamma} > 0, \quad (12)$$

where $\Gamma > 0$ is the determinant of the Hessian matrix of the two endogenous variables.[14]

[12] For tractability, we ignore the portion of the carry that the GP has to pay from the ownership stake β in the target firm. With $\alpha = 0.20$ and $\beta = 0.01$, this portion will be small in comparison with the other components of the GP's payoff and can safely be ignored without altering the results.

[13] This follows from $\frac{dD}{dq} = -\frac{\alpha(e+1)}{2\lambda} < 0$ and $\frac{dq}{dD} = -\frac{\alpha(1+e)}{2c\beta} < 0$.

[14] Γ is the determinant of the D-q matrix of the second derivatives stemming from Eqs. (9) and (10). Since the direct second-order conditions are negative, a positive Γ is a necessary and sufficient condition for the Hessian matrix to be negative definite, implying that the optimal solution D^* and q^* resulting from Eqs. (11) and (12) are maxima.

From Eq. (7) and since $I > D$, the optimal project risk q implies that $cq > 0.5(\Delta - \rho)$. Consequently, the effect of an increase in the ownership fraction β on the marginal value of risk is negative from the GP's point of view. That is, the negative effect of a higher ownership fraction on the GP's marginal non-monetary costs of q exceeds the positive effect on the marginal monetary benefits of q. Hence, a larger ownership (higher β) induces the risk-averse GP to select a less risky firm (lower q). This leads to a lower probability of the low state and, thus, reduces the firm's bankruptcy risk. The ownership fraction has no direct effect on the marginal value of debt to the GP. However, since the two risk drivers are substitutes, the reduction in project risk induces the GP to increase leverage (higher D).

Proposition 1 summarizes the effect of the GP's equity ownership on her choice of project risk and leverage.

Proposition 1. *The GP selects a less risky firm and uses more debt financing the higher is her ownership β*

The impact of the GP's personal wealth on the incentive effect of her equity ownership is summarized in our second proposition.

Proposition 2. *Higher GP wealth w (i) increases the GP's incentive to invest in riskier firms and use less leverage and (ii) decreases the marginal effect of the GP's ownership fraction β on firm risk and leverage*

To see (i), we totally differentiate Eqs. (7) and (8) with respect to the two dimensions of risk (q and D), taking the negative relation between risk aversion and wealth (c and w) into account:

$$\frac{dq}{dw} = \frac{-\beta q \lambda(\partial c/\partial w)}{\Gamma} > 0 \tag{13}$$

and

$$\frac{dD}{dw} = \frac{0.5\beta q(1+e)\alpha(\partial c/\partial w)}{\Gamma} < 0. \tag{14}$$

An increase in wealth, hence, has opposite effects on the two risk measures. Wealthier GPs are less risk-averse (technically speaking, their non-monetary costs of riskier projects $k(q)$ are lower) and, therefore, select riskier firms (Eq. (13)), which they finance with less debt (Eq. (14)).

The second part of Proposition 2 can be seen by investigating Eq. (7). An increase in wealth reduces the non-monetary costs of taking risks ($\partial c/\partial w$) making a wealthier GP react less to a given increase in the ownership fraction β.

In sum, our model generates two testable predictions. First, as stated in Proposition 1, the GP's incentive to select risky portfolio companies is declining in her ownership β. Second, the choice of a less risky firm induces the GP to use more debt financing, generating a negative relationship between her ownership β and debt.[15] Furthermore, as stated in Proposition 2, since GP wealth lowers the negative utility associated with firm risk, it reduces the incentive effects of the GP's ownership on cash flow risk and leverage. We account for this effect empirically by scaling the GP's fund ownership with the wealth of the investment professionals and partners.

3. Sample selection and description

3.1. Sample selection and data sources

We start with a list of all buyout transactions in Norway between 1991 and 2010, provided by the Argentum Centre for Private Equity at the Norwegian School of Economics (NHH). Comparing this list with the web pages of Nordic PE funds, we can identify 142 acquisitions of 134 unique Norwegian firms. By manually matching on company name and year, we find 113 of the target firms in the Brønnøysund Register Centre database, provided by Mjøs et al. (2016). We retrieve these firms' financial statements and ownership data for the period 1997–2012.

Norwegian corporate law prevents acquirers from servicing acquisition debt with the target firm's cash flow.[16] To circumvent this rule, buyout transactions are typically executed in two steps. First, the PE fund raises debt against an empty holding company used to acquire the target. Second, about a year later, the holding company merges with the portfolio company. To account for this practice, we consolidate the debt of the target firm and its Norwegian holding companies in the year of the acquisition.[17]

Information on the GP's ownership in the fund is typically confidential. However, we are able to get this information for 20 PE funds from a large LP that wants to remain anonymous. The 20 funds, which are raised by 11 Nordic GPs, acquire 62 of the 113 target firms between 2000 and 2010. These 62 portfolio firms are our final sample. Most of the firm and fund characteristics are similar across the 62 sample firms and the 51 firms with missing GP ownership information. The exceptions are that the sample firms, on average, are acquired somewhat more recently (in the year 2007 vs. 2004) and by higher sequence number funds (3.6 vs. 2.7), where the sequence number indicates the order in which the GP raised the fund.[18]

To retrieve data on wealth, we first identify all investment professionals from the PE firms' web sites. We drop professionals who join after the fund's investment phase and search the web for professionals that have left. Since our wealth data is limited to Norwegian tax subjects, we eliminate 123 professionals living outside of Norway and restrict the analysis to 120 investment professionals in Norway.

We obtain the history of tax records for these 120 professionals from the Norwegian tax authorities. The tax records disclose the GP's taxable wealth, used below to scale the GP's ownership in the fund. The caveat with this wealth data is that they underestimate the true wealth and the discount varies across asset classes. For example, listed securities are valued at 75 percent of their market value, whereas real estate is valued at 25 percent of its assessed value. Moreover, investments in private firms are recorded at or below book value and debt is listed at face value. However, while the taxable wealth generally underestimates the true wealth, it provides a coarse measure of the differences in wealth across investment professionals and, hence, can serve as a proxy for their relative risk aversion.[19]

3.2. Sample description

Panel A of Table 1 presents summary statistics for the 20 PE funds in the sample. The average fund has a committed capital of $942 million (median $325 million) and is number 3.6 (median 3) in sequence. Moreover, our sample includes 3.1 (median 3) of the fund's portfolio companies. The average GP is 10 (median 8) years old when the fund acquires its first sample firm. It has 16.6 (median 10) investment professionals in Norway, of which 8.4 (median 7) are partners.

For a subset of funds, we have information on the management fee (14 funds), carry (11 funds), and equity hurdle rate (12 funds).[20] The average fund has a management fee of 2.0% (median 2.0%), carry of 18% (median 20%), and hurdle rate of 8.0% (median 8.0%). The terms are similar to those reported by Metrick and Yasuda (2010) for the US.

[15] These comparative statics hold also if β is determined endogenously in an optimal contract.

[16] "Aksjeloven §8–10. Kreditt til erverv av aksjer mv".

[17] For tax reasons, it is attractive to domicile holding companies in Norway. In our sample, only 32% of the firms are owned directly by the PE fund.

[18] See the Internet Appendix for a detailed comparison of the two samples.

[19] Facing the same issue, Becker (2006) states "while tax wealth is clearly a noisy measure of economic wealth, it probably contains a lot of information nonetheless, given that tax authorities do a scrupulous job of collecting data on many types of wealth and valuing it relatively close to market value".

[20] The fee information is from the LP providing the GP ownership data.

Table 1
Summary statistics.

Variable	Num. (1)	Mean (2)	Median (3)	Std. Dev. (4)	Min (5)	Max (6)
A: GP and fund characteristics						
Fund size ($ million)	20	942	325	1700	53	5883
Fund sequence number	20	3.65	3	2.35	1	8
# of sample firms in portfolio	20	3.1	3	1.619	1	7
GP age at first acquisition in sample	20	9.65	8.5	6.53	1	20
# of professionals in Norway	20	16.6	10	17.95	4	83
# of partners in Norway	20	8.45	7	4.25	3	21
Management fee	14	0.020	0.020	0.000	0.013	0.023
Carry	11	0.180	0.200	0.050	0.020	0.200
Hurdle rate	12	0.080	0.080	0.000	0.070	0.080
B: Firm characteristics						
Total assets ($ million)	62	119.7	67	223	2.10	1717
Sales ($ million)	62	100	54	116	0	628
Leverage	62	0.618	0.641	0.276	0.02	1.325
ROA	62	0.030	0.072	0.243	−1.66	0.315
Tangibility	62	0.080	0.004	0.149	0	0.554
Asset beta	62	0.473	0.459	0.298	−0.29	1.237
Equity beta	62	0.691	0.586	0.538	−0.47	2.747
Volatility	62	0.030	0.031	0.016	0.011	0.078
Ticket size	62	0.106	0.055	0.153	0	0.796
C: GP wealth and fund ownership						
GP age	62	9.903	8	5.955	1	21
Wealth professionals ($ million), year 0	62	2.17	1.32	2.27	0.02	10.20
– ” – , year −1	62	2.00	1.16	2.28	0	11.88
– ” – , year −2	62	1.90	0.69	2.68	0	12.20
Wealth partners ($ million), year 0	62	3.22	1.77	3.42	0.03	17.33
– ” – , year −1	62	2.70	1.51	3.27	0	17.00
– ” – , year −2	62	2.23	0.94	3.08	0	12.47
Ownership in %	62	3.7	1.5	4.9	0	15.0
Ownership in $ million	62	13.02	5.90	20.67	0	88.33
Relative ownership all	62	0.893	0.427	1.32	0	5.00
Relative ownership partners	62	0.932	0.476	1.33	0	5.00

The table shows summary statistics for the sample of 20 PE funds (Panel A) and 62 portfolio companies (Panel B), as well as the GPs' wealth and fund ownership (Panel C). All firm characteristics are from year 0, in which the sample firm is acquired by the PE fund. The table uses an exchange ratio of 6 NOK/USD (the time-series average across the sample period). In Panel A, the wealth is averaged across years −2 through 0 in event time.

Since there is almost no variation in these fees across our sample funds, we ignore them in the empirical analysis below. It is worth noting that Nordic PE funds do not charge transaction and management fees from their portfolio companies, unlike US funds. Moreover, the GP typically receives no carry until the total invested capital and hurdle returns have been paid out to the LPs.

In Panel B, we report summary statistics for the 62 portfolio companies in the sample. At the end of the fiscal year of the acquisition, the average firm has total assets of $120 million (median $67 million), sales of $100 million (median $54 million), and book leverage, defined as total liabilities/total assets, of 62% (median 64%). The return on assets (ROA, defined as EBITDA/total assets) averages 3% (median 7%), and asset tangibility (property, plant, and equipment/total asset) averages 8% (median 0.4%). Most of the sample firms are in the services (42%), transportation (24%), and retail and wholesale (16%) industries, as defined by the European Nomenclature of Economic Activities (NACE) codes 70–75, 62–65, and 51–52, respectively.

An empirical test of our model requires a measure of firm risk. Since the target firms are private, we only have their annual financial statements, which are inadequate for estimating the cash-flow risk. We, therefore, follow Acharya et al. (2013) and estimate the portfolio company asset betas using a matched sample of public firms. Specifically, we run a propensity score estimator that finds the best fit among the approximately 250 firms listed on the Oslo Stock Exchange (OSE) in a given year. Similar to Drucker and Puri (2005), the estimator matches on industry, total assets, sales, ROA, and asset tangibility. We use the nearest neighbor matching with replacement and assign five matches to each sample firm.[21] The matched firms are, on average, larger (in total assets and sales) but do not differ significantly in terms of ROA and asset tangibility.

For each matched firm, we first estimate its equity beta over a 24-month rolling window against the Oslo Main Index, ending in the month of the acquisition and using monthly stock return data from NHH's "Børsprosjektet".[22] We then delever the matched firm's equity beta to obtain its asset beta, assuming a debt beta of zero. A sample firm's asset beta is the average asset beta of the five public matches. We compute the sample firms' equity beta by relevering this asset beta at the target company's actual post-transaction book leverage. Because the book value of assets is restated in connection with the acquisition under Norwegian Generally Accepted Accounting Principles (GAAP), book leverage is a close approximation of the market leverage. As shown in Panel B, the average sample firm has an asset beta of 0.47 (median 0.46) and an equity beta of 0.69 (median 0.59). These betas are consistent with the relatively low betas estimated by Driessen et al. (2012) for portfolio companies in US buyout funds.

We estimate the return volatility for the five matched firms as an alternative risk measure. Specifically, $Volatility$ is the standard deviation of the daily stock return over the eight months preceding the acquisition, averaged across the five matched firms. The average firm in our sample has a return volatility of 0.030, with a median of 0.031. The last row of the panel shows *Ticket size*, defined as the sample firm's book value of equity (winsorized at zero) divided by the fund's committed capital. As discussed above, because asset values are typically written up to reflect the purchase price, the book equity provides a fair approximation of the fund's investment in the target company. We use this variable as a proxy for fund diversification. The

[21] Each sample firm has five unique matched listed firms, whereas a listed firm may be a matched firm for more than one sample firm.

[22] https://www.nhh.no/forskning/borsprosjektet/

larger the ticket size, the greater proportion of the fund's capital is invested in a single firm and the more concentrated the fund's portfolio. In our sample, the average ticket size is 0.10, with a median of 0.05.[23]

Finally, Panel C of Table 1 presents summary statistics on the GP wealth and fund ownership for the 62 sample firms. The average investment professional has a taxable wealth of $2.7 million in the acquisition year (year 0), up from $2.0 in year -1 and $1.9 in year -2. For the average partner, the corresponding wealth is slightly higher: $3.2 million in year 0, $2.7 in year -1, and $2.3 in year -2.

Many of the PE firms in our sample invest in several Nordic countries. While we cannot identify the exact deal team, discussions with LPs and GPs indicate that local investment professionals are responsible for local deals. We, therefore, assume that a GP's Norwegian investment professionals are jointly responsible for the fund's investments in Norway.[24] As a group, the GP's investment professionals are required to contribute 3.7% (median 1.5%) of the fund's capital from their own wealth, ranging from a low of zero to a high of 15%. This GP ownership is somewhat higher than the average of 2.4% (median 1.0%) reported for US buyout funds (Robinson and Sensoy, 2013).

Since our wealth data is limited to Norwegian GPs, we need an estimate of the fund capital committed to investments in Norway. We, therefore, assume that the proportion of the fund committed to Norway equals the fraction of the GP's professionals in Norway. Hence, we estimate the value of the fund's Norwegian capital as the total fund capital times the fraction of its investment professionals residing in Norway. We then calculate the dollar value of the Norwegian investment professionals' contribution to the fund as the fund's capital committed to investments in Norway times the GP's percentage ownership. As shown in Panel C, the fund ownership of the GP's investment professional (as a group) averages $13.0 million (median $5.9 million).

The relative ownership is the ratio of the GP's dollar ownership in the fund to the taxable wealth of the GP's investment professionals or partners in Norway, averaged over the three years ending with the acquisition (year 0). We use the ratio of GP ownership to wealth to accommodate a concave relationship between utility and wealth.[25] Moreover, we smooth wealth over three years to avoid large variations in the wealth estimate from year to year and aggregate the wealth across all professionals within the GP since we do not know the exact deal team.[26] Furthermore, as the GP's risk aversion is determined by the total amount at risk, we use the GP's ownership in the fund—and not in the individual target firm—in the empirical analysis below.

We use two different wealth measures to address heterogeneity in wealth across the PE firm's investment professionals. The first is the wealth of all investment professionals, including junior professionals that have not yet made partners. As shown in Panel C, the GP professionals invest on average 89% (median 43%) of their taxable wealth in the fund. The second measure is the wealth of the partners, who are likely to be more affluent and have a greater say in the fund's investment strategy. It is possible that the requirement to invest is limited to the PE firm's partners. Restricting the investment in the fund to the partners, the average GP ownership is 93% (median 48%) of their wealth. In the empirical analysis below, we scale the GP ownership with the taxable wealth of all investment professionals and the partners.[27]

One might argue that if the management fees are sufficiently large, the investment professionals could finance their equity contribution by waiving the fee income, rendering their wealth largely irrelevant. To address this concern, we compare the median fund's management fee with its estimated office and staff costs. Assuming that the fund employs the median number of partners and staff, there is no surplus left of the management fee after salaries and other expenses have been paid.[28] Since the estimated management fee net of costs falls substantially short of the GP's required equity investment, we do not view the management fee as a substitute for wealth with respect to the GP commitment.

4. Empirical analysis

In this section, we perform cross-sectional tests of our model predictions, examining the impact of GP ownership on portfolio company cash flow risk and leverage. While our model is silent on the effect of GP ownership on overall risk-taking, we next resolve this issue empirically by examining how the ownership affects portfolio company equity beta and fund diversification. Finally, we end with robustness tests giving more weight to GPs with a larger number of investment professionals.

4.1. GP ownership and target firm cash-flow risk

According to Proposition 1, the incentive to invest in risky firms is decreasing in GP ownership. We first use the target firm's asset beta as a proxy for the portfolio company's cash flow risk. Table 2 shows the coefficient estimates from ordinary least squares (OLS) regressions for asset beta. Standard errors are clustered by GP to account for the correlation in risk-taking within a GP. While not tabulated, using robust standard errors yields similar inferences (the results are available upon request).

The regressions control for fund and firm characteristics that may capture past success and influence the risk-taking incentives. The fund characteristics are *GP_age* (number of years since the GP was founded when the firm is acquired), *Fund_size* (log of the fund's committed capital) and *Fund_sequence*. Moreover, the firm characteristics are (log of) total sales, *Tangibility*, and *ROA*. The even-numbered columns of Table 2 include dummies for the three largest industry groups (services, transportation, and retail and wholesale), examining GP risk-taking within a given target industry. In contrast, the odd-numbered columns do not, allowing the GP to select portfolio company risk also through the industry choice. All regression models include year dummies to control for time-varying economy-wide conditions, such as the credit market spread.

As shown in the table, of the control variables, *Fund_sequence* and *GP_age* generate significant coefficients. Specifically, portfolio company asset beta increases with fund sequence and decreases with GP age. A possible explanation is that fund sequence and age are correlated with prior success and—to the extent successful GPs tend to be wealthier—capture wealth effects beyond GP ownership. The rationale is twofold. First, GPs with past success are more likely to raise new funds, so higher-sequence funds are associated with more successful GPs. Second, more successful GPs can raise new funds faster. Thus, for a given fund sequence, a younger GP is generally more successful. Since younger GPs raising higher-sequence funds are likely to have wealthier investment

[23] This suggests that our sample firms make up one-third of the average PE fund's portfolio. We set the ticket size to zero for three firms with negative book equity.

[24] Although this assumption introduces noise in the GP wealth estimate, it works against us finding any results and is, therefore, of little concern.

[25] According to Rabin (2000a) and Rabin and Thaler (2001), it is reasonable to assume risk-aversion based on concave utility-of-wealth functions when the stakes (the fund ownership) are substantial and measured relative to lifetime income (wealth), as in our data. We winsorize two observations with a ratio above five.

[26] Because GP wealth largely depends on the success of earlier funds, there is likely a high correlation in wealth between a GP's investment professionals.

[27] The ownership in European funds is split more evenly across senior and junior partners than in US funds, where the senior partners tend to have larger shares (Ivashina and Lerner, 2019).

[28] In our sample, the median fund size is 350 MUSD, and the yearly management fee is 2%. The average industry salary is estimated at 0.5 MUSD and 0.1 MUSD for partners and staff, respectively. With these assumptions, the estimated costs exceed the management fee by 0.3 MUSD per year for the median fund.

Table 2
Cross-sectional determinants of cash flow risk.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GP ownership:								
%_ownership	−0.041	−0.001						
	(1.041)	(1.072)						
$_ownership			0.084	−0.047				
			(0.402)	(0.448)				
Rel_ownership_all					−0.044**	−0.043**		
					(0.019)	(0.017)		
Rel_ownership_partners							−0.040*	−0.040**
							(0.021)	(0.018)
Fund characteristics:								
GP_age	−0.026**	−0.028***	−0.026***	−0.027***	−0.023**	−0.025**	−0.023**	−0.025**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)
Fund_size	−0.033	−0.039	−0.040	−0.035	−0.019	−0.025	−0.019	−0.025
	(0.030)	(0.032)	(0.048)	(0.058)	(0.027)	(0.028)	(0.027)	(0.028)
Fund_sequence	0.072**	0.076**	0.071**	0.077**	0.076**	0.081**	0.076**	0.081**
	(0.033)	(0.035)	(0.032)	(0.033)	(0.029)	(0.033)	(0.030)	(0.033)
Firm characteristics:								
Sales	−0.007	0.000	−0.007	0.000	−0.001	0.007	−0.002	0.006
	(0.010)	(0.010)	(0.011)	(0.011)	(0.010)	(0.010)	(0.009)	(0.010)
Tangibility	0.236	0.148	0.234	0.147	0.245	0.168	0.246	0.167
	(0.397)	(0.384)	(0.392)	(0.369)	(0.399)	(0.376)	(0.398)	(0.376)
ROA	−0.180	−0.197	−0.173	−0.199	−0.247	−0.267	−0.239	−0.259
	(0.205)	(0.183)	(0.228)	(0.209)	(0.219)	(0.215)	(0.219)	(0.214)
Constant	1.051	1.141	1.186	1.055	0.656	0.742	0.672	0.757
	(0.628)	(0.688)	(0.946)	(1.163)	(0.511)	(0.583)	(0.507)	(0.583)
Industry dummies	No	Yes	No	Yes	No	Yes	No	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	62	62	62	62	62	62	62	62
R-squared	0.311	0.354	0.312	0.354	0.336	0.376	0.331	0.372

The table shows coefficient estimates from ordinary least squares (OLS) regressions of portfolio company asset beta, estimated from five matched public firms. *Rel_ownership* is the GP's ownership in the fund scaled by the wealth of either all its investment professionals or its partners only. The sample is 62 Norwegian firms acquired by 20 Nordic PE funds between 2000 and 2010. Fund and firm characteristics are from the year of the acquisition. Standard errors are clustered by GP and shown in parenthesis. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

professionals, fund sequence and age may capture the positive influence of wealth on risk-taking.

Our main variable of interest is the GP's fund ownership. The regressions include the ownership in percent of the fund's capital (columns 1–2) and the invested dollar amount (columns 3–4). As reported in the table, the coefficient estimates for *%_ownership* and *$_ownership* are insignificantly different from zero. So neither the GP's ownership in percent nor the GP's investment in absolute dollar amount explains the choice of portfolio company cash flow risk.

The last four columns of Table 2 instead contain the GP's ownership scaled by wealth. Importantly, the coefficient estimates for *Rel_ownership_all*, which adjusts for the wealth of all investment professionals, are negative and significant at the 5% level (columns 5–6). GPs with a relatively high proportion of their wealth invested in the fund tend to select less risky firms, as predicted by our model. The coefficient for *Rel_ownership_partners*, which adjusts for only the partners' wealth, is significant at the 5% level when including industry dummies (column 8) and otherwise at the 10% level (column 7). Thus, if anything, the selection of lower systematic cash flow risk is more pronounced within the target firm's industry. To gauge the economic impact, we note that the average asset beta is 0.47 with a standard deviation of 0.298 (Table 1). The coefficient estimate for *Rel_ownership_all* of −0.043 (column 6) implies that a one standard deviation increase in the relative GP ownership in the fund reduces the target company asset beta by 13%, from 0.47 to 0.41. While statistically significant, however, the economic significance of this effect appears relatively small.

We next use return volatility to measure the firm's idiosyncratic cash flow risk. PE funds have a finite number of firms in their portfolios and may not be able to diversify the idiosyncratic risk fully. Table 3 reports the coefficient estimates from OLS regressions of *Volatility*, using the same control variables as in Table 2 and clustering standard errors by GP. As shown in columns (1)-(4), *%_ownership* and *$_ownership* now generate negative and highly significant coefficients (p-value <0.01). The higher the GP's percentage and dollar ownership in the fund, the lower the return volatility of the acquired firm, consistent with Proposition 1. However, there is no discernible effect of GP ownership when scaled with wealth, whether that of all investment professionals (columns 5–6) or partners (columns 7–8). The lack of significance of the relative GP ownership is somewhat surprising. However, the positive effect of wealth on the GP's incentives to take volatility risk may be large enough to offset the negative effect of the GP's fund ownership. In other words, the insignificant impact of the relative GP ownership may conceal the two counteracting forces stemming from GP ownership and wealth in the data.

Overall, the evidence in Tables 2 and 3 indicates that GPs tend to choose portfolio companies with less risky cash flows the higher their ownership in the PE fund. These predictions hold for asset beta after scaling GP ownership with wealth (Table 2), consistent with Proposition 2, while they hold for stock-return volatility in the GP's percentage and dollar fund ownership (Table 3), lending support to Proposition 1.

4.2. GP ownership and target firm leverage

The second implication of Proposition 1 is that the GP's incentive to finance acquisitions with debt is increasing in her fund ownership. To test this prediction, Table 4 reports the coefficient estimates from OLS regressions for the portfolio company leverage. Starting with the control variables, there is some evidence that leverage is decreasing in firm profitability and increasing in asset tangibility, consistent with, e.g., Titman and Wessels (1988) and Rajan and Zingales (1995).

Turning to GP ownership, the coefficient estimates of *%_ownership* and *$_ownership* are again insignificant (columns 1–4). That is, there is no evidence that the percentage or the dollar amount of fund ownership affects the GP's choice of portfolio company leverage. More importantly, *Rel_ownership_all* and *Rel_ownership_partners* both generate positive coefficients, significant at the 5% level (column 6) and 1% level (column 8), respectively, when including industry dummies. Consistent

Table 3
Cross-sectional determinants of return volatility.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GP ownership:								
%_ownership	−0.044***	−0.046***						
	(0.013)	(0.013)						
$_*ownership*			−0.075***	−0.075***				
			(0.025)	(0.026)				
Rel_ownership_all					−0.000	0.000		
					(0.001)	(0.001)		
Rel_ownership_partners							0.000	0.000
							(0.001)	(0.001)
Fund characteristics:								
GP_age	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Fund_size	0.004**	0.004**	−0.002	−0.002	−0.000	−0.000	−0.000	−0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fund_sequence	−0.001	−0.001	−0.000	−0.000	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Firm characteristics:								
Sales	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	0.027*	0.025	0.027*	0.028*	0.026*	0.026	0.026*	0.026
	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)
ROA	0.003	0.003	−0.000	−0.001	0.004	0.004	0.004	0.004
	(0.003)	(0.003)	(0.004)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)
Constant	−0.017	−0.020	0.093***	0.093***	0.061**	0.063**	0.061**	0.064**
	(0.030)	(0.027)	(0.025)	(0.025)	(0.026)	(0.027)	(0.026)	(0.028)
Industry dummies	No	Yes	No	Yes	No	Yes	No	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	62	62	62	62	62	62	62	62
R-squared	0.690	0.692	0.676	0.677	0.651	0.653	0.651	0.653

The table shows coefficient estimates from ordinary least squares (OLS) regressions of portfolio company cash flow risk, estimated as the average standard deviation of daily stock returns of five matched public firms over eight months prior to the acquisition. *Rel_ownership* is the GP's ownership in the fund scaled by the total wealth of either all its investment professionals or its partners only. The sample is 62 Norwegian firms acquired by 20 Nordic PE funds between 2000 and 2010. Standard errors are clustered by GP and shown in parenthesis. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

Table 4
Cross-sectional determinants of leverage.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GP ownership:								
%_ownership	−1.527	−1.512						
	(1.185)	(1.098)						
$_*ownership*			−0.798	−0.771				
			(0.569)	(0.538)				
Rel_ownership_all					0.072*	0.100**		
					(0.036)	(0.035)		
Rel_ownership_partners							0.071*	0.100***
							(0.035)	(0.035)
Fund characteristics:								
GP_age	0.003	0.003	0.006	0.005	−0.003	−0.005	−0.003	−0.005
	(0.009)	(0.009)	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)	(0.006)
Fund_size	0.035	0.029	0.134**	0.125**	0.038	0.022	0.036	0.018
	(0.056)	(0.060)	(0.061)	(0.060)	(0.054)	(0.047)	(0.055)	(0.047)
Fund_sequence	−0.020	−0.019	−0.025	−0.023	−0.036*	−0.038*	−0.037*	−0.039*
	(0.024)	(0.026)	(0.020)	(0.022)	(0.019)	(0.019)	(0.019)	(0.019)
Firm characteristics:								
Sales	0.022	0.022	0.018	0.019	0.008	0.003	0.009	0.003
	(0.022)	(0.021)	(0.019)	(0.019)	(0.013)	(0.012)	(0.013)	(0.012)
Tangibility	0.360*	0.370*	0.356*	0.311**	0.321	0.279	0.317	0.276
	(0.192)	(0.198)	(0.178)	(0.142)	(0.191)	(0.172)	(0.191)	(0.175)
ROA	−0.549*	−0.565*	−0.498*	−0.507**	−0.342	−0.307	−0.347	−0.311
	(0.309)	(0.284)	(0.264)	(0.240)	(0.241)	(0.181)	(0.241)	(0.182)
Constant	−0.121	−0.060	−2.221*	−2.073*	−0.157	0.221	−0.126	0.273
	(1.080)	(1.120)	(1.221)	(1.173)	(1.013)	(0.833)	(1.032)	(0.840)
Industry dummies	No	Yes	No	Yes	No	Yes	No	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	62	62	62	62	62	62	62	62
R-squared	0.385	0.426	0.394	0.430	0.428	0.525	0.427	0.525

The table shows coefficient estimates from ordinary least squares (OLS) regressions of portfolio company leverage, defined as liabilities/total assets. *Rel_ownership* is the GP's ownership in the fund scaled by the wealth of either all its investment professionals or its partners only. The sample is 62 Norwegian firms acquired by 20 Nordic PE funds between 2000 and 2010. Standard errors are clustered by GP and shown in parenthesis. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

with Proposition 2, the higher the proportion of the GP's wealth invested in the fund, the more debt the GP uses to finance the target firm relative to other portfolio companies in the same industry.

Thus, in line with the results for asset beta in Table 2, GP ownership affects the choice of portfolio company leverage when scaled by the

Table 5
Cross-sectional determinants of equity beta.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GP ownership:								
%_ownership	1.143	1.177						
	(2.312)	(2.312)						
$_ownership			1.072	0.786				
			(0.818)	(0.875)				
Rel_ownership_all					−0.141***	−0.164***		
					(0.033)	(0.037)		
Rel_ownership_partners							−0.133***	−0.158***
							(0.035)	(0.038)
Fund characteristics:								
GP_age	−0.039**	−0.042**	−0.043**	−0.045**	−0.029*	−0.031	−0.030*	−0.032*
	(0.018)	(0.018)	(0.017)	(0.017)	(0.015)	(0.018)	(0.015)	(0.018)
Fund_size	−0.011	−0.020	−0.129*	−0.112	0.012	0.013	0.014	0.017
	(0.080)	(0.084)	(0.068)	(0.085)	(0.059)	(0.054)	(0.061)	(0.056)
Fund_sequence	0.132**	0.141**	0.133**	0.142**	0.153***	0.164***	0.154***	0.166***
	(0.058)	(0.064)	(0.055)	(0.059)	(0.038)	(0.055)	(0.040)	(0.056)
Firm characteristics:								
Sales	−0.029	−0.014	−0.025	−0.012	−0.006	0.015	−0.008	0.013
	(0.029)	(0.028)	(0.028)	(0.028)	(0.019)	(0.023)	(0.019)	(0.023)
Tangibility	0.182	0.023	0.174	0.073	0.230	0.133	0.237	0.135
	(0.664)	(0.641)	(0.653)	(0.604)	(0.668)	(0.602)	(0.667)	(0.602)
ROA	−0.009	−0.043	−0.022	−0.079	−0.301	−0.383	−0.283	−0.367
	(0.351)	(0.341)	(0.372)	(0.371)	(0.325)	(0.323)	(0.323)	(0.319)
Constant	0.793	0.923	3.222**	2.822	0.073	−0.083	0.066	−0.114
	(1.662)	(1.733)	(1.342)	(1.685)	(1.095)	(1.091)	(1.133)	(1.131)
Industry dummies	No	Yes	No	Yes	No	Yes	No	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	62	62	62	62	62	62	62	62
R-squared	0.326	0.372	0.341	0.377	0.398	0.460	0.391	0.454

The table shows coefficient estimates from ordinary least squares (OLS) regressions of portfolio company equity beta, estimated by relevering the average asset beta of five matched public companies with the portfolio company's actual leverage. *Rel_ownership* is the GP's ownership in the fund scaled by the wealth of either all its investment professionals or its partners only. The sample is 62 Norwegian firms acquired by 20 Nordic PE funds between 2000 and 2010. Standard errors are clustered by GP and shown in parenthesis. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

wealth of the investment professionals or partners but not in itself. To gauge the economic impact of the wealth-adjusted GP ownership on leverage, note in Table 1 that the average leverage in the sample is 0.62. From column (6) of Table 4, a one standard deviation increase in the GP's relative ownership increases portfolio company leverage by 15%, from 0.62 to 0.71. The economic impact on leverage is substantial and shows the importance of considering the GP's wealth when gauging the incentive effects of her fund ownership.

4.3. GP ownership and PE fund portfolio risk

Our analysis so far shows that GPs with a relatively high fraction of their wealth invested in the fund tend to, on the one hand, select firms with lower asset beta and, on the other hand, use more debt to finance these firms. Both results follow from Propositions 1 and 2. Our model, however, stays silent on the combined effect of the lower cash flow risk and higher leverage. That is, whether or not the reduced cash-flow risk associated with higher GP ownership dominates the increased default risk from taking on more debt. Since this relationship is highly relevant to the controversy of excessive risk-taking in the PE industry, we next examine the effect of GP ownership on the systematic risk of the fund's equity investment in the target firm, capturing the net impact of the fund manager's investment and leverage decisions.

Table 5 shows the coefficient estimates from OLS regressions for portfolio company equity beta using the same model specifications as in Table 2. Again, the control variables *Fund_sequence* and *GP_age* generate significant coefficients. As discussed above, this is consistent with more successful GPs—having raised a higher number of funds in a shorter time—being wealthier and, hence, making riskier investments.

Turning to the variables capturing the GP's ownership in the fund, the coefficient estimates for *%_ownership* and *$_ownership* are again insignificantly different from zero. Consistent with Robinson and Sensoy (2013), who fail to find an effect of GP ownership on fund returns net of fees, we show that neither the percent nor the dollar amount of GP fund ownership can explain the choice of portfolio company equity beta. We argue, however, that these GP ownership measures fail to control for differences in risk aversion across GPs that must be taken into account.

As shown in columns (5)-(8), *Rel_ownership_all* and *Rel_ownership_partners*, which scale the GP ownership with wealth, both generate negative and highly significant coefficients ($p<0.01$). The higher the proportion of the GP's wealth invested in the fund, the lower the systematic equity risk of the fund's portfolio companies. The economic effect is large: A one standard deviation increase in the GP's relative ownership decreases the portfolio company equity beta from, on average, 0.69 to about 0.50 (column 6).

Another way to reduce risk is to diversify the idiosyncratic risk in the PE fund's portfolio. The GP can diversify risk by increasing the number of portfolio companies and investing a smaller amount in each firm. Whereas holding fewer companies in the portfolio increases the time the GP can monitor each firm, it leaves the GP more vulnerable to random exogenous shocks that may reduce company performance. We expect a higher GP fund ownership, making the GP more risk-averse, to manifest itself in a larger number of portfolio companies.

In Table 6, we examine the cross-sectional determinants of *Ticket_size* (the fund's equity investment in the target firm divided by fund size). In line with the results for portfolio company risk, the coefficients for *Rel_ownership_all* and *Rel_ownership_partners* are negative although only marginally significant ($p<0.10$). It appears that GPs with a relatively high fraction of their wealth invested in the fund not only select target firms with lower systematic equity risk but further diversify idiosyncratic fund risk by investing a smaller fraction of the fund's capital in each portfolio firm. A one standard deviation increase in the relative GP fund ownership reduces the fraction of the fund's capital invested in the average target firm from 0.10 to 0.06 (column 6).

Ticket size is also decreasing in *%_ownership* ($p<0.05$), consistent with increasing risk aversion as managers own a greater fraction of the fund (Proposition 1). However, *$_ownership* generates a positive coefficient ($p<0.05$), so the ticket size tends to increase with the

Table 6
Cross-sectional determinants of ticket size.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GP ownership:								
%_ownership	−0.265**	−0.271**						
	(0.096)	(0.097)						
$_*ownership*			1.020**	1.045**				
			(0.440)	(0.425)				
Rel_ownership_all					−0.031*	−0.030*		
					(0.015)	(0.015)		
Rel_ownership_partners							−0.030**	−0.030*
							(0.014)	(0.014)
Fund characteristics:								
GP_age	0.004	0.004	0.002	0.002	0.005	0.005	0.005	0.005
	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Fund_sequence	0.008	0.008	0.001	0.001	0.009	0.009	0.009	0.009
	(0.015)	(0.015)	(0.020)	(0.020)	(0.013)	(0.014)	(0.014)	(0.014)
Firm characteristics:								
Sales	0.010	0.010	0.008	0.008	0.015	0.014	0.014	0.014
	(0.010)	(0.011)	(0.010)	(0.010)	(0.014)	(0.015)	(0.014)	(0.015)
Tangibility	0.062	0.070	0.047	0.049	0.077	0.101	0.078	0.101
	(0.095)	(0.066)	(0.117)	(0.081)	(0.103)	(0.072)	(0.103)	(0.072)
ROA	−0.036	−0.044	0.037	0.035	−0.078	−0.085	−0.076	−0.083
	(0.071)	(0.074)	(0.073)	(0.076)	(0.096)	(0.096)	(0.095)	(0.095)
Constant	0.380**	0.358**	0.287*	0.274*	0.313	0.289	0.316	0.291
	(0.159)	(0.159)	(0.151)	(0.157)	(0.214)	(0.207)	(0.212)	(0.206)
Industry dummies	No	Yes	No	Yes	No	Yes	No	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	62	62	62	62	62	62	62	62
R-squared	0.451	0.461	0.474	0.486	0.462	0.465	0.462	0.465

The table shows coefficient estimates from ordinary least squares (OLS) regressions of portfolio company ticket size, defined as the ratio of the portfolio company's book value of equity to fund size. *Rel_ownership* is the GP's ownership in the fund scaled by the wealth of either all its investment professionals or its partners only. The sample is 62 Norwegian firms acquired by 20 Nordic PE funds between 2000 and 2010. Standard errors are clustered by GP and shown in parenthesis. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

absolute amount the GP has invested in the fund. This result is puzzling and contradicts a diversification effect. One possible explanation is that managers who have invested a relatively high dollar amount prefer to focus on a smaller number of target firms, monitoring each portfolio company more closely. All results are robust to using a different measure of ticket size, relying on the total assets of the portfolio company instead of the book value of equity.

In sum, the GP's fund ownership fundamentally influences the selection of individual portfolio companies with respect to their cash-flow risk and leverage, as well as the overall portfolio risk and diversification. However, our empirical results show that this incentive effect is typically not discernable unless adjusting for the personal wealth of the GP's investment professionals or partners, which we propose captures their relative risk aversion. Our evidence suggests that it is critical to control for wealth to correctly assess the impact of GPs' ownership on their appetite for risk-taking in the funds they manage. Importantly, LPs can mitigate concerns about excessive risk-taking by designing contracts requiring the GP to invest a sufficiently large fraction of her wealth in the PE fund, alongside the LPs.

4.4. Estimating the effect of GP ownership using WLS

For robustness, we estimate WLS regressions exploiting the notion that the accuracy of our wealth estimate increases with the number of investment professionals used to compute the GP wealth measure. Specifically, we use the square root of the number of GP professionals as weight, giving more weight to observations where the wealth estimate is based on a larger number of investment professionals. The WLS regressions results are tabulated in the Internet Appendix.

The WLS coefficient estimates are similar to the OLS estimates reported in Tables 2–6 in both statistical significance and magnitude. While the significance of the wealth-adjusted GP fund ownership is somewhat higher compared to the regular OLS regression estimates, that of the absolute ownership is slightly lower. Moreover, for the statistically significant coefficients, the point estimates are almost identical to those reported above, leaving the inferences unchanged. Overall, the results from the WLS regressions are consistent with Propositions 1 and 2, confirming the importance of controlling for wealth in assessing the effect of GP ownership on risk-taking

5. Conclusion

GPs are required to invest in the PE funds they manage. In this paper, we examine how this ownership affects the GP's delegated acquisition decision and, in particular, the choice of portfolio company risk. Since the GP's ownership is determined upfront when raising the fund and the target companies are selected over the subsequent years, this setting reduces concerns about endogeneity and reverse causality. In addition, reverse causality implies a relation between GP ownership and target company risk that the data do not support.

We first develop a simple model, showing that higher fund ownership incentivizes the GP to select less risky target firms and use more debt to finance the acquisitions. Moreover, letting GP risk aversion decline in wealth, the incentive effects of GP fund ownership on the target firm cash flow risk and leverage are decreasing in her wealth.

We then take the model predictions to the data using a unique sample of 62 Norwegian PE transactions with information about the investment professionals' personal wealth. The empirical evidence supports the predictions of the model. We find that portfolio company cash-flow risk decreases and leverage increases with the GP's fund ownership scaled by her wealth. Moreover, GPs with a relatively high fraction of the wealth invested in the fund tend to choose lower overall portfolio risk, both in terms of target company equity beta and ticket size, defined as the fraction of the fund's committed capital invested in the target firm.

Our evidence is important as it sheds light on the wide-spread allegations of reckless risk-taking in the PE industry. We show that LPs reduce GPs' risk-taking incentives by requiring them to invest a sufficiently large portion of their wealth in the PE fund. This result highlights that wealth is of first-order importance in designing contracts that mitigate GP's risk-taking incentives in the delegated investment decision.

CRediT authorship contribution statement

Carsten Bienz: Conceptualization, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Supervision. **Karin S. Thorburn:** Conceptualization, Methodology (tests), Writing – original draft, Writing – review & editing, Funding acquisition, Visualization. **Uwe Walz:** Conceptualization, Methodology (theory), Editing, Project administration.

Data availability

The data that has been used is confidential.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jfi.2023.101025.

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