Size, returns and performance persistence: Do private equity firms allocate capital according to individual skill?

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ABSTRACT

Private equity firms have strong financial incentives to increase fund and deal sizes. As funds get larger it is harder to maintain relative performance, as the distribution of returns for larger deals becomes less skewed – with far fewer home-runs. On the other hand, larger funds have lower downside risk in terms of relative returns. Following the approach of Berk and van Binsbergen (2015), we contrast relative performance of a PE firm with their ability to generate increased absolute gross value added (GVA) as they increase fund size. One way to manage the size-performance trade-off is to allocate more capital to those individuals in the investment team with the most skill. We find evidence of such skill at the individual manager level, and that successful PE firms grow GVA in part by backing their winners with more capital to deploy. In this way, PE organizations can avoid sowing the seeds of their own decline: with initial strong performance leading to capital inflows and performance deterioration.

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1 Introduction

The size of the private equity (PE) sector has grown nearly eight-fold over the past two decades. Assets under management in leveraged buyout (LBO) funds which, globally, totaled just over $300 billion in 2000, reached nearly $2.4 trillion by 2020.[1] A significant part of this growth has been associated with existing funds becoming larger: the 20 largest funds raised in 2000 managed $66 billion. By 2020, the 20 largest funds raised $162 billion. Substantial capital inflows do not come without challenges for both investors and fund managers. In an efficient market, investors learn about fund manager skills and re-allocate their capital accordingly. However, prior literature based on public markets has shown that the complex interplay between skill, scale and returns renders it difficult for investors to allocate their funds optimally (Zhu, 2018; Barras et al., 2021). For fund managers, more capital may compromise relative performance, but skilled managers may continue to increase gross value added (Berk and van Binsbergen, 2015). The PE market is far less transparent and efficient, and yet investors are required to make long-term commitments to fund managers. Learning about a fund manager's skill is particularly challenging (Korteweg and Sorensen, 2017), and investors incur significant costs if they seek to reallocate capital from a chosen fund.[2] In this paper we analyze how scale, skill and returns are related in the PE setting and whether PE organizations, using private information, add value by learning about individual skill and allocating more capital to such managers.

The reason why PE firms[3] seek to raise larger funds is simple: success does not usually result in changes in headline fees or profit shares ('carried interest'). This carried interest is almost always 20% irrespective of fund size. Profits are calculated after management fees and, in most funds, require a preferred return or 'hurdle' – normally 8%, calculated as an IRR of the cashflows

[1] In this paper we equate private equity with buyout funds (in contrast to venture capital funds). Assets under management (AUM) include the value of existing investments in portfolio companies, and the amount raised from investors that has not yet been invested (known as 'dry powder'). We include dry powder as fees are earned on such capital commitments. The estimates of AUM are derived from Burgiss.

[2] This reflects the 'partnership' model of investing, involving a long-term (at least 10-year) commitment between the investor and the fund manager. The secondary market for stakes in private equity funds has developed considerably, but it is still essentially a bi-lateral market involving significant transactions costs.

[3] We use the terminology of PE *firm* to differentiate the organisation from the *individual managers* who work for the organisation, and from the *funds* they raise. The PE firm will be the general partner (GP) of a series of funds, but since individuals are often also referred to as GPs we avoid using this term.

– to be achieved.[4] Management fees, traditionally 2% per annum, were originally set to cover operational expenses, but have fallen very little as funds have grown in size. In 2020 the median PE management fee remains 2%, although the mean has fallen marginally to 1.8%. Lim (2021) estimates that the elasticity of management fees with respect to fund size is only -0.06, so total management fee revenue grows almost proportionally to fund size. Furthermore, larger deals do not require proportionately larger deal teams, and so there are significant economies of scale associated with running a larger fund. Given this invariance in the management fee rates and carried interest percentage, those managing larger funds have the possibility of considerably higher remuneration. The main challenge facing those running PE funds is therefore how to grow their fund size while minimizing the impact on returns.

We approach this issue by addressing the following three questions. First, how do PE funds manage additional capital and what are the implications for risk and return? To answer this, we look at the distribution of deal-level returns and capital allocation. Second, faced with the challenges of deploying larger amounts of capital, is there evidence, within PE firms, of skill at the level of the individual manager? Third, if there is evidence of skill at the individual manager level across deals, do PE firms learn about this and then allocate a larger proportion of the available capital in successive funds to the individuals that have performed most strongly in the past? The answers to these questions are by no means obvious. It could be, for example, that deal size has little impact on returns, and that the influence of the organization on investment decisions, and creating value, dominates any idiosyncratic skill of particular individuals within the PE firm. Furthermore, even if such individual manager skill exists, the organization will have to both recognize it and allocate more capital to such individuals in the future.

It also matters how skill is measured. Existing studies of performance persistence in private equity have focused on relative performance across successive funds, using techniques such as quartile transition matrices (for example, Kaplan and Schoar (2005), Braun et al. (2017), Harris et al. (2022)). However, given the significant increases in fund sizes, all these existing papers are susceptible to the critique of Berk and van Binsbergen (2015), who argue that skill should be

[4] Note, however, that this is a 'soft' hurdle: once the preferred return has been achieved, the PE firm receives 20% of the total profits. In contrast, a 'hard' hurdle, as used in performance fees in mutual funds and other asset classes, defines profits in terms of the excess return earned over and above the hurdle rate.

measured by the value-added, in dollar terms, created by a manager over time. Their focus is on mutual funds, where individual managers (or co-managers) can run huge funds, and where performance can be measured on a daily basis. Good performance results in capital inflows which will tend to reduce gross alpha, but total value added may still increase. This argument is also particularly relevant to PE funds given the increase in capital allocated to private assets. We introduce a simple measure of gross value added (GVA) in private equity by combining the gross excess return over a market index, using public market equivalent (PME) returns (Kaplan and Schoar, 2005), with the amount of dollars deployed.

Our ability to address these issues relies on high-quality deal-level data, based on cash flows, so that we can reliably compute PMEs and our measure of GVA. We employ a large proprietary dataset on 942 PE funds and 13,170 unique deals, which is an updated version of the dataset previously used by Braun et al. (2017, 2020). This contains data on cash flows, asset values, deal size, sector etc., and is notable for the completeness of the track records of the PE firms, which is critical when testing for skill over successive deals. For 94% of the PE firms, complete data for all their funds and deals are available. We augment this dataset with new, hand-collected data on the individual managers that are identified as leading the deal. This information is particularly challenging to assemble, and, despite employing several different data sources, not always available. However, we are able to match over 5,000 of the deals to individual managers. Since some deals have more than one identified manager, and some involve more than one PE firm (in 'club deals'), we end up with just over 10,000 deal involvements where one or more individuals are associated with deals.

We compute a measure of individual manager skill by comparing the performance of the deals they manage with those undertaken at a similar time. Given the significant increases in fund size, we measure capital allocation relative to the size of the fund and test whether there is evidence that PE firms allocate a greater proportion of the available capital to those individual managers that have identified and managed the more successful deals in the past. The largest funds may find it challenging to be the top performers in terms of PME returns, but by allocating capital effectively they may be able to continue increasing GVA as funds get larger.

Our main results are as follows. First, at the fund level, we find that mean returns fall in the cross-section as funds get larger. However, the distribution of fund returns becomes noticeably narrower, with fewer 'home-run' funds, but also fewer poorly performing funds. As a result, median fund returns are more similar, but still decline as fund size increases. Deal size has increased in tandem with fund size, with a similar number of deals per fund, and we find similar patterns for the distributions of returns as deal size increases. Therefore, the lower average returns are associated with lower risk, although in terms of absolute value there is clearly more money to lose on larger deals. This pattern holds true in OLS regressions, including vintage year fixed effects and other controls, and is confirmed in quantile regressions. LPs seeking to increase their allocation to private equity may find the greater capacity of larger funds, along with the lower risk and return, attractive, especially if they have limits on personnel that make investing in many smaller funds infeasible.[5]

Our deal-level analysis essentially removes the legal wrapper of the fund and analyzes the track-records of PE organizations, and many of the individual managers, as deals get larger. This analysis has some similarities to that of Lopez-de-Silanes, Phalippou and Gottschalg (2014), who find that the larger the *number* of investments held by a GP at any time, the lower the returns. However, we focus not on the number but on the size of investments, and the allocation of capital to particular individuals within the GP.

Second, we find that GVA increases with fund size, indicating that the fall-off in relative performance has not been so severe as to reduce the dollar amount of gross value added. PE firms managing larger funds have produced larger absolute amounts of value added. The time series evidence shows some interesting trends. The median fund GVA increased steadily over vintage years, but for funds formed since 2005 the mean GVA has fallen slightly. This demonstrates the potential pitfall of raising ever larger funds, as it suggests that the largest funds have paid a higher price in terms of declining relative performance. At the deal-level, there are fewer home-runs but

[5] There are significant due diligence, legal and monitoring costs for LPs when investing in a fund. Therefore, if investors want to increase their investments in private equity without increasing allocations to larger funds this would involve more staff being employed. Many LPs, in particular public pension schemes, operate with few investment professionals and with limited budgets.

also fewer deals where PME is below 1. Deal-level GVA, having risen steadily over time as buyout deals became larger, has seen a fall-off since 2005, in both mean and median GVA.

Third, for those deals where we identify individual(s) who are responsible for the investment, we find that, on average, PMEs similarly fall with deal size. However, we also find evidence of performance persistence across deals by the same individual: the performance of the previous deal is positively related to the current deal performance. An alternative way to measure skill is to include individual manager fixed effects, and test for their joint significance. The approach also confirms the existence of individual skill.

Fourth, we explore the relative importance of individual and firm fixed effects in explaining deal-level performance, using the approach employed by Ewens and Rhodes-Kropf (2015) in the context of VC funds. We find that individual managers explain a much larger proportion of the variation in deal performance than the organization they work for. Indeed, we find that individuals are relatively more important in buyout transactions than Ewens and Rhodes-Kropf estimated for VC deals. However, we augment their analysis by testing whether the organization plays an additional role in allocating capital to the successful managers. It should be noted that we have the benefit of cash flow information on each deal, and so can measure returns precisely, whereas previous research relied on exit routes of deals (IPO, acquisition etc.) as a proxy for returns.

Fifth, we find evidence that the allocation of capital to individual managers depends on past relative performance, but only for the better performing PE firms. Since funds and deals get larger over time, we focus on the allocation of capital in a given year. For the full sample we find no significant relationship between past performance and next deal size. However, for the top performing PE firms we find that the individual managers that produced the highest returns on their previous deal (relative to the returns earned by colleagues) are significantly more likely to be running larger deals in the future. We see the opposite effect for the PE firms in the bottom quartile in each year, although the difference in capital allocation is not significant in these firms. This manager performance-capital allocation sensitivity is confirmed in a regression framework, but again is only observed in the better-performing GPs each year.

Finally, we test whether the allocation of capital to those individuals with the best track record impacts on GVA at the GP level. We construct a capital deployment sensitivity for each PE

firm – with higher values reflecting those organizations that 'back their winners' – and test whether this sensitivity influences future GVA. We also control for average manager skill, using our earlier estimates of individual manager fixed effects. We find that both factors are significantly related to GVA: the firms with the best (past) performers and that back their winners more aggressively tend to perform more strongly.

Our paper contributes to a number of different strands of the literature. The interplay of scalability, skill, and performance measurement has been studied in the context of mutual funds. Berk and van Binsbergen (2015) argue that managerial skill should be measured by value added – the product of gross alpha and size – and that cross-sectional variation in performance is primarily driven by fund size. Zhu (2018) and Barras et al. (2021) show that value added can also be decomposed into skill and scalability, that both dimensions are strongly related, and that they vary in the cross-section of funds. Berk et al. (2017) show that firms in the mutual industry create value by reallocating capital across managers and Fang et al. (2014) show that fund families allocate more skilled managers to funds where their skill matters most. This paper applies similar ideas to the private equity sector where investors are much less able to reallocate capital themselves but may benefit from PE firms allocating capital according to skill. We also contribute to the literature by emphasizing the role of the organization in managing the size-performance relationship. As the PE industry is characterized by severe information asymmetries, strong illiquidity, and long investment horizons, the PE organization represents an important financial intermediary that learns about managerial skill. The organization then employs this knowledge to match better investment managers to larger deals, and, in doing so, improves the investment outcome at an aggregate level.

The paper also contributes to the private equity literature on performance persistence. Kaplan and Schoar (2005) provided the first analysis of performance persistence at the fund level, and this was updated and extended by Harris et al. (2022). Braun et al. (2017) provided the first analysis of performance persistence at the deal-level, which they found to be declining over time for buyout funds. Our analysis provides one explanation for this finding – the growth in the scale of funds and deals – but, through the lens of GVA, we find continued value creation. Our paper is also relevant to research which analyzes incentives within the PE firm, in particular Ivashina and

Lerner (2019), as those individuals that manage more capital are likely to receive a larger amount of carried interest.

The remainder of the paper proceeds as follows. In the next section we explain the incentives facing PE firms and introduce our GVA measure. In Section 3 we describe our data and discuss the general trends relating to size and fund and deal returns. Section 4 analyzes the relationship between fund size, deal size, relative performance and GVA. In Section 5 we focus on the deals where we can identify individual managers and test for the existence of skill at the individual level. In Section 6 we analyze whether GPs allocate capital according to our measure of individual skill, and the impact this has on their ability to continue to grow GVA as they raise larger funds. Section 7 concludes.

2 Incentives, performance and GVA

In this section we start by explaining the incentives facing PE firms and how performance and value-added may depend on the scale of investment. We then discuss the distinction between performance persistence and skill when fund size increases. Finally, we discuss how individual skill can be measured in the context of PE firms.

2.1 Incentives

PE firms are financial intermediaries who raise funds which they manage on behalf of investors. They identify companies to acquire and arrange debt financing for these investments alongside the equity committed to the fund by investors. As compensation for their services PE firms earn a management fee, usually 1.5% - 2% of committed capital for the first 4-5 years (the investment period) and thereafter based on net invested capital for the remainder of the fund life.[6] The PE firm, and senior individuals working for the firm, commit some capital to the fund (often totaling around 1-2%) and are also allocated a 'carried interest' in the fund.[7] Lim (2021) finds that

[6] In some fund agreements the management fee rate is reduced after the investment period, but the basis of the charge remains committed capital. In a minority of cases, the basis is reduced to net invested capital and the management fee rate is reduced as well.

[7] This is why performance-related remuneration in limited partnership structures attract capital gains tax treatment in most countries: the carried interest (in the fund) is associated directly with a capital investment. However, the contentious part of this tax treatment is the divergence between the proportion of capital invested by the buyout firm and the individual managers and the share of the profits they receive. Technically, this divergence is achieved by the

96% of PE funds have a 20% carried interest, subject, in most funds, to a hurdle rate of return (often 8%) being achieved.

A surprising feature of PE funds is that management fee rates fall only marginally as fund size increases: Lim (2021) finds an elasticity of only -0.06. Therefore, the typical PE compensation scheme incentivizes GPs to raise larger funds, subject to the constraint that if performance suffers then hurdle rates may not be achieved and future fund raising will become more difficult (Chung et al., 2012). Although the mantra of private equity is alignment of interest with investors, the fact that management fees have changed so little as funds have multiplied in size means that management fees have become a significant source of profit for PE firms, which does not depend on performance.

Although, in principle, PE firms could deploy larger funds across more deals (keeping deal size constant) there are strong incentives to increase deal size. There is a limit to the number of simultaneous deals an individual manager can source and execute, and Lopez-de-Silanes, Phalippou and Gottschalg (2014) find that average performance falls as the number of contemporaneous investments falls. More deals imply more complexity and work, and would require additional managers, who would demand a share in the fund economics (see Ivashina and Lerner (2019) on the allocation of carried interest within the private equity firm). Therefore, from the perspective of the owners of the PE firm, as well as the individual running the funds, there are strong incentives to grow fund size and average deal size. Indeed, if individual managers have a high level of skill, one way to reward, and therefore retain, them is to raise a larger fund and to allocate them more capital on which they may earn carried interest.

2.2 Organizations and individuals

PE firms are active shareholders in the LBO firms they back (Jensen, 1989). Hence, individual factors, like expertise, experience or network, of those PE managers responsible for a given deal might also matter (which we call a *deal involvement*). In the case of venture capital

LPs splitting their contributions between loans to the partnership and fund capital, such that whatever dollar contribution the fund managers make, it is 20% of the capital of the fund.

funds, Ewens and Rhodes-Kropf (2015) have shown that the individual is substantially more important than the VC organization in explaining the cross-section of investment performance.

If the individual managers have heterogenous levels of skill, the PE organization could add value through learning about such patterns and allocating more capital to skilled managers within an organization. This superior ability to learn about such skill, compared to a market in which individual managers directly compete for capital from investors, could be where PE organizations add value. By increasing the sensitivity of capital allocation to manager skill, the average skill level per dollar invested would increase, along with overall fund success. Berk and van Binsbergen (2017) have shown this for the mutual fund industry. However, in the case of mutual funds individual manager performance is easier to track, performance signals much more frequent, and capital can be withdrawn easily. In the case of PE, individual managers are only involved in few transactions, reliable returns at the deal-level are opaque, difficult to benchmark, and are only observed years later, and capital cannot be withdrawn during the life of the fund without significant cost.

This opaqueness is a likely reason why PE firms are organized as partnerships in which partners within the organization monitor each other (Ivashina and Lerner, 2019). The governance body for this is the investment committee, in which senior investment professionals' information and expertise is aggregated to take informed investment decisions (Malenko et al., 2021). Partners are expected to source deals and to champion them through the investment process. However, they need to convince the investment committee to vote in favor of an investment. Decision-making by investment committees varies, but in their survey of VC firms, Gompers et al. (2020) find that 49% of organizations require unanimous approval. Although we are not aware of any equivalent empirical evidence, there are good reasons to assume this share of firms to be even higher among PE organizations.[8]

[8] In a survey of more than 100 VC and PE investment professionals in 2018, The British Private Equity & Venture Capital Association (BVCA) found that 76% of organizations require consensus voting in their investment committee [Source: https://bvca.medium.com/demystifying-the-investment-committee-860e50d5db44; retrieved: February 24th 2022]. In another paper on VC investment committee voting, Malenko et al. (2021) argue that the optimal rule for aggregating information in investment committees depends on the underlying distribution of signals. They reason that the more mature the companies on which is voted are, the more relevant is a well-rounded view and the better are decisions made by majorities or even unanimous approval. This definitely applies to mature LBO firms which require stable cash flows to finance leverage.

In this organizational setting, the observed deal sizes are partially exogenous because managers can only source and pick from the available set of investment opportunities in private capital markets. However, given this set of opportunities, the decisions regarding which deals to undertake, and how much capital to deploy, are key decisions that the PE organization, via their investment committee, must take. An important contribution of this paper is to test whether PE organizations do allocate capital according to individual manager skill, and whether any such differences can explain the pattern of fund returns as the size of deals and funds increases. We empirically assess these patterns in Section 6 of this paper.

2.3 Performance persistence, skill and GVA

In the first analysis of performance persistence in private equity, Kaplan and Schoar (2005) construct performance terciles by fund vintage year and compute a transition matrix showing the probability of successive funds being in the same tercile.[9] This approach was replicated, on a more recent, and therefore larger, dataset by Braun et al. (2017) who find only modest relative performance persistence for buyout funds. In particular, they find a 39% probability of repeating top tercile performance – only slightly above the random outcome of 33%. Harris et al. (2022) find that performance persistence has fallen, as the buyout sector has experienced growth and more competition: for funds formed since 2001 there is modest top quartile persistence (33%) relative to the random (25%) outcome.

However, this traditional way of analyzing skill and performance persistence is challenged by Berk and van Binsbergen's (2015) work on mutual fund managers, who argue that returns do not measure skill and are not comparable unless capital under management is equally distributed. They reason that skill is actually extracting value from markets and, thus, introduce a value added measure computed by a fund's gross excess return over its benchmark multiplied by assets under management. We apply a similar logic to PE by defining gross value added (*GVA*) as a function of the fund size and the gross public market equivalent (PME) for a given fund *f*:

$$GVA_f = q_f \times \left(PME_f - 1\right) \tag{1}$$

[9] Kaplan and Schoar (2005) used data from Thomson Venture Economics, which had good coverage of VC funds, but only included 169 buyout funds. Of these, data on successive funds raised was only available for 76 buyout firms. Consequently, in the transition matrix analysis in their paper, VC and buyout funds were merged.

This PME is obtained by discounting all gross cash inflows from a fund with the total return to a public index and dividing this value by the value obtained from discounting all fund cash outflows (equaling q_f) with the same public index. The GVA can therefore be interpreted as the value a PE investment generates in excess of the public markets, before compensation to the PE firm. Another interpretation is that of a fund's net present value (NPV) using public market returns as discount rate. An important implication is that returns, like PMEs, are only indicative for success or skill if it is accounted for the heterogeneity of capital deployed or fund sizes. We provide an empirical investigation of the associations between size, return and GVA in Section 4 of this paper.

3 Data and summary statistics

3.1 Sources of data and sample construction

This paper employs a comprehensive deal-level database of buyout transactions. This proprietary database was sourced from three large institutional investors who collected fund- and deal-related data as part of their due diligence processes. Earlier versions of the data were used by Braun et al. (2017), which provides a detailed description of the data, and Braun et al. (2020). For nearly all private equity firms in the data set, we observe their complete investment history across multiple funds (for 5% of firms some early deals are missing). The database provides monthly gross cash flows between funds and their respective portfolio companies as well as fund- and deal-related characteristics. If an investment has not been fully realized at the time of reporting, we observe the latest net asset value. The timed cash flow data makes it possible for us to measure gross performance for every transaction in our database, which renders the data set particularly suited to analyse GVA and manager skill.

We augment this database by adding novel information, wherever possible, on the manager responsible for each investment. We source person-related information from five public databases. We start by collecting data from Preqin which contains information on more than 40,000 manager-deal involvements between 1970 and 2017. We augment the sample by adding manager-deal involvements from Pitchbook and MergerMarket. Next, we search VentureSource for private equity managers with board memberships at PE-backed firms. Similar to Ewens and Rhodes-Kropf (2015), we interpret an individual manager having a board seat as being one of the lead investment

professionals for the corresponding buyout investment. Finally, we collect data from a book series called "Who's Who in private equity". These industry directories, published annually, list individual investment managers stating their latest deal involvements. In this case, information on deal involvements is collected through an annual survey. Since managers are surveyed frequently, information about deal involvements is usually reported during the holding period rather than after the investment has been exited. Later on, we will exploit this feature to examine the role of potential reporting biases (see Section 5.2). Furthermore, considerable overlap between the above sources allows for cross-checks on manager-deal involvements.

Having combined all these data sources, the final sample comprises 942 buyout funds raised by 309 private equity firms with vintage years spanning 1974 to 2011. Since the funds deploy the capital raised over a 4-5 year period, our deal sample spans 1974-2015. We choose to restrict the sample in this way to ensure a large proportion of the deals are fully realised. The cash flows, and remaining net asset values, are observed until the end of 2018. These funds invested in 13,170 unique deals (on average 14 per fund). For 5,030 of these deals, we are able to find information on at least one investment manager responsible for the transaction. In total we identify 3,977 unique investment managers. As many of the deals in the sample have multiple individuals associated with the deal, be it from within the same GP or in club deals, we arrive at 10,330 manager-deal involvements.

3.2 Fund-level descriptive statistics

Table 1 shows fund-level characteristics of our sample. In this table, as well as all other analyses in this paper, investment sizes and performance measures are winsorized at the 99th percentile to account for right-skewness.[10] Still, even after winsorization there is a substantial discrepancy between average and median fund sizes amounting to $944.7m and $331.5m, respectively. There is also right-skewness in terms of gross performance. The average total value-to-paid in (TVPI) return is 2.36, while the median value amounts to 2.04. The mean (median) PME (using the Kaplan-Schoar, 2005, approach), calculated relative to three regional MSCI indices, is

[10] In our regression analysis we generally use log size to account for the right skew in deal size.

1.85 (1.67). Using gross PME as a measure for excess return, the average GVA (obtained from Equation 1) by a buyout fund amounts to $570.1m and median GVA is $210.2m.

Table 1 also summarizes the data across different geographic areas and market periods. Most of the data comes from European (47.9%) and North American (39.2%) funds. While we do not find substantial differences in terms of TVPI or PME returns between Europe and North America, larger fund sizes in the latter group are associated with considerably higher GVAs: the mean (median) GVA in North America is $700.9m ($285.7m), while the corresponding value in the European subsample amounts to $500.2m ($157.1m).

With regards to vintage year categories, Table 1 documents the substantial increase in fund sizes over time. While the mean (median) fund in our sample had $260.4m ($91.0m) under management prior to 1990, these values have increased to $1,838.4m ($811.0m) in the late 2000s. This increase in fund sizes is also illustrated in Panel A of Figure 1. At the same time, however, we also observe a negative time trend in terms of TVPI returns, illustrated in Panel B of Figure 1. The lowest TVPIs are in the funds formed from 2005-10, but this period includes the funds formed in the few years before the global financial crisis, which have the lowest average returns in the whole sample period. These investment multiples are heavily influenced by trends in market returns. PME returns, which control for market movements, are more stable over time and range between 1.94 and 2.03 for means and 1.74 and 1.86 for medians. Combining increasing fund sizes and stable PME returns over time results in growing GVA over time. While the mean (median) fund closed before 1990 generated GVA of $196.9m ($72.4m), these values grew to $706.5m ($262.5m) for funds closed between 2000 and 2004. Funds raised in the 2005-10 period produced slightly lower mean GVA, although the median fund GVA continued to increase.

3.3 Deal-level descriptive statistics

Table 2 provides descriptive statistics for the deal-level data set. Average values for the full sample of 13,170 investments by the 942 buyout funds are displayed in Columns 1 and 2, respectively, of Panel A. Investment size is the equity invested into a portfolio company by the PE fund and the mean (median) amount in our sample is $47.94m ($15.72m). As intuition suggests, we find even more skewed gross returns at the deal-level: the mean TVPI in our sample is 2.42, while the median is only 1.53. The same applies to PME with a mean of 1.88 and a median of 1.24.

However, the discrepancy is most pronounced for deal-level GVA with values of $28.80m (mean) and $2.20m (median). The average investment in the full sample took place in 2000, was held for 4.21 years and 83% of deals were realized at the end of 2018.

Columns 3 and 4 in Panel A show the average deal characteristics for the subset of 5,030 deals for which we observe at least one investment manager. This corresponds to about 38% of deals in the full universe (13,170 deals). Investment manager information tends to be available for larger and more recent deals. It is reassuring that the average performance is similar for the full sample and the sub-sample for which we have identified individuals. Therefore, we document a somewhat larger mean (median) deal GVA of $44.99m ($8.91m) in this subsample. On average, there are 3.1 managers involved in a deal (median: 2).

In Columns 5 and 6 of Panel A, we show the same variables, but this time observed at the deal-involvement level, i.e., for each of the 10,330 manager-deals. Again, mean and median values for all deal characteristics resemble those for the full universe and the subsample of matched deals, although deals at the deal-involvement level become a bit larger in size because larger deals involve more managers and, hence, are more often included in this sample.

Panel B of Table 2 shows deal-level time trends for investment size, PME returns as well as GVA. We document a steady increase in mean (median) investment size from $10.8m ($1.7m) before 1990 to $85.8m ($38.0m) after 2004. The average deal PME is more cyclical. The difference between the mean and median deal-level PMEs suggests that the right-skewness of returns was substantially higher during the pre-1990 period. Indeed, median PMEs in this period were below 1, even though the mean PME was above 2. Consequently, mean (median) GVA rises from $8.75m ($-0.05m) in the 1970s and 1980s to $40.66m ($6.23m) in the period between 2000-2004. The corresponding GVA values for the most recent period are lower, again reflecting the lower average performance of buyout transactions undertaken before the global financial crisis.[11]

[11] Some of these more recent deals are not fully realized, but the patterns are similar if we restrict the sample to realized deals.

4 Size, returns and GVA

The impact of size on performance remains unresolved for the buyout asset class. Given that good relative performance generally results in increased capital inflows, the size-performance relationship is inevitably linked to the issue of performance persistence. In the cross-section, Kaplan and Schoar (2005) find no significant impact of fund size on performance, as measured by public market equivalent (PME), for buyout funds. However, returns drive capital flows into successful GPs, and they find some modest performance persistence over successive funds raised by the same buyout GP, but they are not able to directly identify the impact of the growth in fund size on performance due to the small sample of GPs for which data on successive funds was available at the time. Harris et al. (2022), using a much larger sample of buyout funds, find that performance persistence across funds has fallen in recent years, which could be linked to the growth in fund size impacting on relative performance.

At the deal-level, Braun et al. (2017) also find declining performance persistence for buyouts which they relate to increasing competition as the buyout sector has matured. The only other study that provides empirical evidence on the size-return-relationship at the investment level is Lopez-de-Silanes, Phalippou and Gottschalg (2014) who find that the *number* of deals being undertaken simultaneously is detrimental to returns. They also document a negative relationship between investment size and returns. In this section, we provide univariate and multivariate evidence for such diseconomies of scale at the fund and deal-level and the implications of size on investors' risk exposure.

4.1 Univariate analysis

Table 3 illustrates the distribution of performance by fund size and deal size. Size quartiles are built by vintage years for the fund analysis and by investment years for the deal analysis.

The fund-level numbers, displayed in Panel A, suggest a negative association between size and returns. For the largest quartile of funds, the median size is $2,094.0m, more than 20-times larger than the median fund in the smallest quartile. However, the smallest funds achieve the highest average returns, while the largest quartile produce the lowest average returns. The difference in returns is substantial in economic terms: the largest funds in our sample return TVPIs

that are 16% lower than those of the smallest funds. Standard deviations within fund size quartiles reveal that the dispersion of returns is significantly higher in smaller funds. Interestingly, the negative relation of size and fund returns mostly comes from the right tail in the return distribution: at the 90% percentile of each size quartile, performance drops sharply from 4.96 to 3.39. In contrast, at the 10% percentile performance is slightly higher in the largest funds (1.15 vs. 1.04). A similar pattern can be observed for PMEs. On average, the largest funds in our sample produce PMEs that are 18% lower than those of the smallest funds. Again, the standard deviation of PME returns is substantially higher for the smallest quartile of funds, driven by the right hand-tail of the distribution.

Turning to fund GVA, the negative correlation between fund size and PME returns is more than offset by much larger increases in fund size, resulting in a strong positive association between fund size and value. The mean GVA in the largest fund quartile is $1,573.6m, more than ten times higher than in the smallest quartile ($113.0m). This ratio is even more pronounced for median GVA ($1,014m vs. $60.4m). Because scale works as an amplifier, it is not surprising that we also document a much higher standard deviation of GVA among the largest funds in our sample. These patterns between size, returns and value added are shown in Figure 2.

The analysis at the fund level is interesting as these are the portfolios of deals that LPs invest in. However, fund data aggregates much interesting information. For instance, larger fund sizes could reflect larger deals and/or more investments. Panel B of Table 3 repeats the analysis at the deal-level, confirming the patterns between size and performance. Mean TVPI and PME returns decrease as deals become larger, whereas GVA increases with deal size. The mean TVPI (PME) in the smallest quartile of deals is 14.8% (17.7%) higher than the corresponding mean for the largest quartile of investments. However, GVA for the largest quartile of deals is more than 10-times that of the smallest deal size quartile.

However, it is also important to note that the riskiness of returns is contingent on size. While the upside potential of returns is considerable among smaller deals, this comes at the expense of a more pronounced downside risk. At the 90% percentile, the TVPI (PME) return for the smallest deals is 5.87 (4.77), whereas equivalent returns for the largest deals are 4.69 (3.54). However, both TVPI and PME returns at the 10% percentile are zero in the smallest deal quartile,

while the corresponding values for the largest quartile of deals are 0.15 and 0.12 for TVPI and PME, respectively. Given its definition, it is not surprising that the GVA distribution exhibits the fattest tails at both ends: poorly performing large deals destroy substantially more economic value than their smaller counterparts. The economic value destroyed by large deals (at the 10% percentile) is about 25-times larger. At the same time, the economic upside potential for value creation is more than 20 times higher. The distributional nature of buyout deal-level returns, contingent on size, is illustrated in Figure 3.

4.2 Multivariate analysis

So far, the empirical patterns we have documented for deal size and relative returns suggest that an increase in size is associated with smaller relative returns, which is driven by a lower probability of extraordinarily high returns. But larger deals also come with a lower downside risk. However, this is only one side of the coin. Through the amplifying effect of size, the upside and downside for GVA is much more pronounced for large deals: there is much more value at risk for larger deals. In Table 4 we examine the robustness of these patterns in a multivariate setting.

In Model 1 of Panel A we run OLS regressions of gross fund PME (winsorized at the 99th percentile) on the natural logarithm of fund size. We add vintage year fixed effects and, in order to rule out that unrealized deals in a fund's portfolio confound our results, we also include the share of realized deals, and a count variable to control for any differential effects associated with first-time funds relative to later funds raised by a given PE firm. We also include vintage year and region fixed effects. Robust standard errors are clustered at the private equity firm-level. The coefficient on fund size is negative and is statistically and economically significant. All else equal, doubling fund size is associated with a decrease in fund PME of -0.09 (= -.137 x ln(2)).

The empirical analysis in Table 3 revealed that the negative relation between fund size and performance stems from certain parts in the size/performance distribution. To further explore this, we perform quantile regressions in Models 2 to 4. In Model 2, we look at the 10% quantile. Interestingly, and consistent with Table 3, we arrive at a positive, albeit insignificant coefficient for fund size, consistent with larger funds being less risky. In contrast, the coefficients for fund size in the median and 90% quantile regressions are negative and statistically significant. These results show that the overall negative relationship between fund size and PME return is largely

driven by the higher probability of small funds to realize a particularly high return. Analogous to Models 1 to 4, Models 5 to 8 in Panel A of Table 4 show the somewhat mechanical positive relationship between size and GVA at the fund-level.

In Panel B of Table 4, we examine the relation between PME and size at the deal-level. An OLS regression of PME on deal size, controlling for realization status, deal sequence (at the PE firm-level), year, region, and industry fixed effects, produces a strong negative relation between deal size and performance. The economic size of the coefficient (-0.154) is similar to the fund-level regression. Again, we observe a positive relation between deal size and performance at the 10% quantile. In line with Panel B of Table 3, the deal size coefficient turns negative in the 90% quantile regression, consistent with the notion that the negative correlation between deal size and PME is driven by large deals. Altogether our deal PME regressions underline that, overall, there are diminishing returns to scale. However, this pattern seems to be mainly driven by smaller deals having a higher potential of yielding very strong returns. In turn, larger deals seem to have a much lower risk of performing poorly.

Again, this is only one side of the coin: while Model 5 in Panel B of Table 4 shows that there is, on average, a positive association between GVA and scale, Models 6 to 8 show that size works as an amplifier. Although large deals have a lower probability to deliver a poor return, they also have higher value at risk in dollar terms. Model 6 confirms that this indeed results in higher value losses in larger deals. At the same time, a large deal size also offers the possibility to generate a particularly high value added, which is confirmed in Models 7 and 8.

5 The importance of individual managers

The previous findings underline how important the size-return trade-off is: in terms of GVA, larger deals are associated with larger up- and downsides. In addition, beyond a certain size threshold, relative returns are negatively related to size. Hence, the management of these trade-offs could be viewed as a crucial ‘skill’ of PE firms.

To illustrate differences across PE firms in this regard, we run an unreported deal-level regression of gross PME return on investment size and add PE firm fixed effects as well as interactions of these with investment size. We store the coefficients of these interaction terms and

plot them by size of the coefficient (from negative to positive) in Figure 4. This plot shows that there is considerable heterogeneity in managing the size-return trade-off amongst PE firms. For some firms, we even document a positive relationship. In this section, we analyse a potential reason why some are better than others in this exercise: the extent to which PE firms are able to identify individual manager skill, and whether more capital is allocated to the best managers.

5.1 Performance persistence

We start by examining the performance persistence of buyout managers in Table 5. For this, we rely on the subsample of 5,030 deals that we could match to at least one PE manager. As there are multiple managers involved in many deals, this results in 10,330 manager-deal involvements.

In Models 1 to 3 of Table 5, we follow Braun, Jenkinson, and Stoff (2017) and regress a manager's current deal-level PME return (*n*) on the performance of the previous deal (*n-1*). As we require at least two deals per manager, the sample drops to 6,352 observations. Standard errors, clustered at the manager level, are reported in parentheses. In Model 1, we control for the realization status of the deal and we find a positive and highly significant relation between a manager's previous deal performance and her current deal performance. In economic terms, when prior deal performance increases by 1%, current deal performance increases by 9.0 basis points.

To account for differences in investment styles, we add industry, region, and investment year fixed effects to Model 2. The persistence coefficient remains highly statistically significant, although it somewhat drops to 0.080. In Model 3, we additionally control for (log) investment size, the (log) holding period as well as the manager's (log) deal number. Again, we observe a strong positive relation between a manager's current and previous deal return. In economic terms, when the manager's previous deal return increases by 1, we would expect the current deal return to rise by 0.073, i.e., roughly 4% of the average gross PME return in the data set (1.91).

Next, we examine the role of investment size for performance persistence. For this, we interact the ratio of the manager's current investment size to her previous investment size with prior deal performance. In Model 4, we observe a negative and highly significant coefficient for the interaction of investment size increases and prior performance, suggesting that PE managers

find it difficult to repeat their investment success when they invest in larger deals. This does not come as a surprise given the negative relation between deal size and relative performance documented in Tables 3 and 4. Nevertheless, from an absolute return perspective, deal size increases may be valuable if they produce greater GVAs for the PE firm's investors.

So far, we have documented performance persistence in the overall sample. However, it could be that performance persistence mainly stems from repeatedly underperforming managers, while persistence at the top might be non-existent. We therefore replace the PME variable by dummy variables that indicate whether a deal was in the top or bottom quartile of deals in a given investment year. The results can be found in Models 5 to 8. Models 5 and 7 suggest that there is performance persistence at both ends of the return distribution, with the coefficient at the bottom end being slightly larger in magnitude. Unsurprisingly, deal size increases mostly affect more successful managers (Model 6).

5.2 Robustness

In Table 6, we examine the robustness of the persistence result. In doing so, we mostly address concerns related to (1) differences in realization status across deals, (2) potential backfill reporting biases, and (3) survivorship biases.

First, many of the deals in the dataset are not exited when the institutional investors perform their due diligence of the PE firms in the sample. In this case, we can only observe the latest net asset value (NAV) at that point in time. Since there may be biases in reported NAVs (Barber and Yasuda, 2017, Brown, Gredil, and Kaplan, 2019), we limit the sample to deals that are at least partially realized in Models 1 and 2 of Table 6. In Model 1, the coefficient for a manager's prior PME equals 0.098, which is slightly higher compared to the full sample. It also remains statistically significant at the 1%-level. This pattern persists after the addition of control variables and fixed effects in Model 2. Overall, the results suggest that the results from the full sample are not driven by biases arising from reported net asset values.

Second, as described in Section 3, our data collection relies on self-reported data by private equity firms. Even public databases, such as Preqin or Pitchbook, rely on information shared by private equity firms. In this context, concerns about the validity of self-reported data can be

twofold. First, private equity firms might try to only report successful deals to public data providers and delete unsuccessful investments from the firms' and their managers' track records. Second, in order to signal team quality to potential investors, firms might have an incentive to retrospectively assign managers who are still with the firm to successful prior investments.

In both cases, our results could be affected by backfill reporting bias. To address this concern, we build a subsample of deal involvements taken from a book series called "Who's Who in private equity." These books surveyed PE managers on an annual basis, so current deal involvements were reported without knowing the final deal performance. Such a subsample of deal involvements, assigned to individual private equity managers using 'contemporaneous' information, should be relatively free of ex-post manipulation, e.g., if an exit has not been successful, and effectively deal with backfill reporting bias.

Models 3 and 4 of Table 6 report the results when limiting the sample to such manager-deal involvements. Across both models, the persistence coefficients are comparable to the main sample in terms of their economic magnitude. Statistical significance drops to 5%, which is driven by the considerably lower sample size. Nevertheless, these regressions suggest that backfill reporting bias is unlikely to drive our results.

Third, survivorship is a major concern in all studies on performance persistence. If the survival of the managers in our dataset depends on their early performance, worse performing managers will drop out, resulting in survivorship bias. To examine the potential role of such a survivorship bias, we exclude a manager's first three investments, i.e., the median number of deal involvements per manager, and repeat the persistence analysis based on this subsample. The results can be found in Models 5 and 6 of Table 6.[12]

The coefficient for prior deal performance in Model 5 is 0.103, which is statistically significant at the 1%-level. Even when including investment type fixed effects and deal-level control variables in Model 6, the persistence coefficient remains significant at the 1%-level. Again,

[12] Carpenter and Lynch (1999) document that if survival depends on performance over multiple periods, spurious reversals may bias against finding performance persistence.

this suggests that survivorship bias is unlikely to spuriously explain managerial performance persistence.

5.3 Private equity manager fixed effects

To further examine the importance of PE managers, we take a more general approach in Table 7 and include manager fixed effects (Model 1). As we do not require that a manager engages in at least two deals, the number of observations increases back to our full sample of 10,330 manager deal involvements. The F-value of the joint significance of the manager fixed effects amounts to 1.130 (p-value: 0.00), which is statistically significant at the 1%-level. This supports the above findings. Model 2, where we add deal-level control variables and investment style fixed effects, also confirms this. Thus, individual private equity managers seem to show a relevant level of heterogeneity in deal PME performance that is not attributable to deal-level characteristics, including the deal's size.

Next, we examine the relative importance of managers and the firm. For this, we use the methodology initially proposed by Abowd, Kramarz, and Margolis (1999) and redefined by Abowd, Creecy, and Kramarz (2002) to simultaneously estimate manager and firm fixed effects. Interestingly, this approach also allows to assess the relative importance of both types of fixed effects in a more formal way. In doing so, we follow Ewens and Rhodes-Kropf (2015) who use the AKM method in the investment context to disentangle the relative importance of individual venture capital managers from the importance of the corresponding investment firms in explaining venture capital investment outcomes. [13]

Following the AKM methodology, we estimate a model which includes both individual manager and private equity firm fixed effects. The results can be found in Models 3 and 4 of Table 7. Similar to Ewens and Rhodes-Kropf (2015), we restrict our sample to those managers with at least four deal involvements, which results in a greater share of movers (around 12% of managers) across firms and, accordingly, a more accurate estimation of the manager and PE firm fixed effects.

[13] See Graham, Li, and Qiu (2012) for a more detailed discussion of the methodology.

Model 3 does not include any control variables except for the realization status of the investment. Both the manager and the firm fixed effects are statistically significant at the 5% and 10% significance level, respectively. We also report the covariance of the deal performance with the manager and the firm fixed effects. Whereas 14.7% of variation in the dependent variable is attributable to the group of manager fixed effects, only 4.0% is attributable to firm fixed effects. Thus, the manager fixed effects explain 3.7 times the variation of performance relative to the firm fixed effects.

In Model 4, we further include industry, region, and investment year fixed effects as well as investment size, the manager deal sequence, and the length of the holding period as control variables. Again, individual manager fixed effects remain statistically significant at the 5%-level, whereas the private equity firm fixed effects become statistically insignificant. Importantly, the degree to which both sets of fixed effects can explain the variation in the cross-section of returns remains unchanged at 14.5% and 3.7%, respectively. This leads to a relative importance of 3.9, which supports the results from Model 3.

Studies using the AKM methodology rely on a high share of movers across firms. In recent papers such as Graham, Li, and Qiu (2012) or Ewens and Rhodes-Kropf (2015), the share of movers ranges from 4.9%, to 28.5%, respectively. In our main specification in Model 4 of Table 7, we arrive at a share of movers of 12%, which does relatively well compared to prior studies. In addition, the results are robust to restricting the sample to movers only (in the spirit of Bertrand and Schoar, 2003). Finally, since the number of fixed effects explodes with increasing sample size (and there may be serial correlation in deal performance), standard asymptotic theory underlying the tests of joint significance of manager fixed effects may be violated. When calculating the standard errors for the joint F-statistic of the manager fixed effects, we only use regular standard errors, i.e., we intentionally do not use robust or clustered standard errors. This is because the problem is amplified by using robust or clustered standard errors (e.g., Wooldridge, 2002, p. 276; Fee, Hadlock, and Pierce, 2013), resulting in exploding F-statistics.[14]

[14] In unreported analysis, we further show that the manager fixed effects estimated from the subsample of movers are strongly correlated to the manager fixed effects estimated based on the full sample. Furthermore, to reduce serial correlation, we calculate manager residuals by firm, collapse the data, and observe that these residuals are strongly correlated within-manager. Finally, following the placebo test proposed by Fee, Hadlock, and Pierce (2013), the

Overall, in this section, we have found evidence of skill, in the form of performance persistence, at the individual manager level. In the next section we explore whether PE firms take advantage of such skill by allocating more capital to such individuals.

6 Internal Labour Markets: Matching capital with skill and PE firm success

6.1 Descriptive results

If an individual manager has performed consistently well relative to their peers, an efficient organization should let this skilled manager deploy more capital than the other, less skilled managers. In other words, winners should be backed. To obtain a measure of such performance-sensitivity within a PE organization, we benchmark investment size and return to other deals within the same PE firm and year. It is important to account for temporal variation as managerial performance-sensitivity might change, and persistence itself might attenuate over time (e.g., Nanda et al., 2020). This is particularly important as the time span for the deals included in our sample is 15 years for the average PE firm, and more than 30 years for some of the PE firms. We introduce the PE firm-year as the level of analysis to avoid a look ahead bias in our analysis. We want to assess whether past manager success impacts the investment committee's willingness to let a manager do a deal of a given size. The larger the deal, the higher its relevance for the overall fund success. The judgement of what is a large deal is relative in nature, i.e., it largely depends on a comparison to other investment opportunities and deals available at the same time. If we computed whether a deal, e.g., in a fund's first year, turned out to be large, relative to other deals in the same fund, we would benchmark it against other deals done in the future, e.g., in year five of the fund. For these reasons, benchmarking a deal against all other deals in the same year should more closely mimic the investment committee's decision.

In a first step, we compute a measure for the investment size of a deal relative to all other deals done by the same PE firm in the corresponding calendar year. Because investment sizes and the number of deals per year vary over time and across PE firms, we transform this into a binary variable which is set to one if a deal is larger than the median investment size in this PE firm-year.

random assignment of managers to firms does not produce significant F-statistics, consistent with the notion that serial correlation in deal returns does not inflate F-statistics.

In a second step, we compute a binary variable set to one if the same manager's previous deal (with the same PE firm) returned a gross PME greater than the median performance in that PE firm-year, and zero otherwise.[15] Because of the variables' binary nature, we ignore all deals, both current and previous, in this analysis that were the only investments of a PE firm in the corresponding year.

Table 8 shows descriptive statistics on the relative size variable. 55.4% of the 8,984 deal involvements in our sample are larger than the median in the corresponding PE firm-year. In Panel A of Table 8, we display relative deal size by manager deal sequence categories. Manager deal sequence counts the number of deals a manager has with a PE firm. Therefore, the first deal of a manager who migrates from one PE firm to another is also assigned a value of one, since the PE firm will have more information from deals undertaken as part of the organisation, rather than from a prior track record in another firm. An unreported two-sided binomial test confirms that the value of 51.2% - being the relative sizes of managers' first deals with a PE firm - is not statistically different from random (i.e., 50%). However, once a manager has a track record with the PE firm, the odds of doing a large deal for the organisation is 59.1%. The difference between the two values is also highly statistically significant.

This positive correlation between relative deal size and manager deal sequence could also be a result of improved managerial credibility within the PE industry per se, rather than private information collected within the organization. A potential placebo test for this is to only look at the first deals of managers who move from one PE firm to another.[16] If the deal size of the first deal with the *new* PE firm was sensitive to the manager's performance with the *old* PE organization, PE firms would collect information about manager skill at the industry-level. However, our findings suggest that PE firms only incorporate signals from within the organization: the probability of doing a relatively large deal with the first deal at the new PE firm is only 52.5%, which is not different from being random (p-value: 0.27).

In Panel B of Table 8, we display relative deal size contingent on whether the same manager's previous deal with the same firm has outperformed the median in the corresponding PE

[15] While information on the responsible investment managers is only available for a subset of deals, we observe all deals by a PE firm when benchmarking size and performance within a PE firm year. Therefore, these binary measures do not suffer from potential biases due to sample selection.
[16] These deals are a subsample of the 4,243 first manager deals with a PE firm as displayed in Panel A of Table 8.

firm-year (*outperformer*) or not (*underperformer*). We document that 60.2% of all deals managed by outperformers are larger than the median, while this applies to 57.7% of deals by underperformers only. A Chi-squared test is statistically significant at the 5%-level. It seems that PE firms, on average, back, at least to some extent, their winners. Based on our previous findings we argue that such sensitivity to managerial skill should help PE firms in increasing the average level of skill per dollar invested and, consequently, result in higher average returns and value added at the PE firm-level.

To investigate this, we compute the investment size-weighted average PME of all deals by a PE firm in a given calendar year. We then benchmark the firm-level PME against all other PE firms in that calendar year and determine whether a PE firm performed better than the median PE firm at this point in time. Panel C of Table 8 shows univariate results and displays relative deal sizes contingent on past manager performance below (*low*) and above (*high*) the median in each PE firm-year. For PE firms underperforming in a year, we virtually find no sensitivity to past performance. The delta of our binary relative deal size variable between out- and underperforming managers is almost zero (59.8% vs. 60.1%). In contrast, we document a sizeable delta between relative deal sizes of out- and underperformers in PE firm-years that beat the industry median: the probability of observing a large deal is 60.7% for out- and 55.5% for underperformers. This difference is also statistically significant at the 1%-level.[17] Overall, the positive correlation between the delta in relative deal sizes between skilled and less skilled managers and the PE firm's performance is consistent with the notion that there is cross-sectional heterogeneity in terms of manager performance-sensitivity across PE firm-years and this aggregates to higher returns. In the next section, we examine this in a multivariate setting.

6.2 Multivariate regressions

Table 9 shows OLS regressions of the relative deal size dummy on the relative deal PME performance dummy that compares the performance of the manager's previous deal to other concurrent deals within the same PE firm. The linear probability estimation, only including these

[17] Again, the first deals by moving managers with a new PE firm do not exhibit a relevant contingency on past performance with another PE firm. The difference, 53.4% for out- and 51.8% for underperformers, is not statistically different from zero (Chi-squared test p-value: 0.728).

two variables and presented in Model 1, shows that the difference in the probability to do a relatively large deal between out- and underperformers across all 4,741 deal-involvements is 2.5%-points. This estimate is economically identical to the delta documented in Panel B of Table 8 and statistically insignificant because we cluster standard errors at the PE firm level (the effect is statistically significant at the 10%-level when standard errors are not clustered). This remains unchanged when we include industry, region and investment year fixed. We, therefore, conclude that across all PE firm-years there is no significant manager performance-sensitivity in our sample.

Nevertheless, as documented above, there may be cross-sectional heterogeneity across PE firms. Therefore, we split our sample based on the median firm-level PME return in a given calendar year. We run separate regressions for the subsamples of low-performing PE firm-years (Model 3) and the high-performing PE firm-years (Model 4). The coefficients on past relative deal performance confirm that we detect no managerial performance-sensitivity in underperforming PE firms, while we find an economically and statistically significant positive relationship in outperforming PE firms.[18] PE firms that outperform in a given calendar year are characterized by a 5.3%-points higher probability to assign a larger deal to a previously outperforming manager relative to an underperforming manager. Finally, in Model 5, we interact the managerial performance-sensitivity with an indicator for whether a PE firm outperforms in a given calendar year. The interaction coefficient is significant at the 10%-level and suggests that the difference in the probability for outperformers to do a large deal is 6.4%-points higher in outperforming PE firm-years. This exceeds the 4.5%-points difference from the univariate analysis (see Table 8).

To formally test for such heterogeneity, we estimate (but do not report) the same regression as in Model 2 but add interactions of the past manager performance variable (*Outperformer*) with the PE firm-year dummies. The coefficients of these interaction terms can be interpreted as PE firm-year specific managerial performance-sensitivity and we can perform a joint F-test to see whether there is significant variation in these coefficients: indeed, their F-value amounts to 1.71 and it is statistically significant at the 1%-level. In addition, Figure 5 displays these PE firm-year level sensitivities ranked from negative to positive. The negative values illustrate that there are PE

[18] Note that we refer, for simplicity, to under- or out-performing firms, but the analysis is performed at the firm-year level. Thus, a given PE firm could out-perform for some years and under-perform in other years.

firms that in some years even let underperformers do larger deals, while positive values represent years in which PE firms indeed do reward past manager performance. The standard deviation of this distribution is .497, which means that the difference in the probability that an outperformer does a large deal between the corresponding PE firm years is about 50%-points.

Next, we provide a more direct test of the relationship between the manager-performance-sensitivity and subsequent aggregate PE firm performance. We use the estimated sensitivities, as displayed in Figure 5, as independent variables of PE firm-year performance regressions. In Models 1 to 3 in Table 10 the dependent variable is a PE firm's size-weighted PME across all deals in a given year. In the table, we control for the natural logarithm of total investment size (at the PE firm-year-level), the share of realized deals, and the number of deals in a given PE firm-year, as well as year and PE firm fixed effects. As we want to capture the marginal contribution of the PE firm as an organization that stems from the effective allocation of labour to capital, and not just any manager-inherent skill, we also control for the average manager skill (in each PE firm-year). To operationalize individual manager skill at any given point in time we first compute time-sensitive individual manager fixed effects of deal gross PME returns. First, we run timed models of deal gross PME (specified as Model 2 in Table 7) in which all deals prior to a given deal are included. For each individual manager who had done at least one deal prior, we obtain a fixed effect we store. This quantifies her past deal performance compared to all other PE professionals in the industry. Second, for each PE firm-year we then compute the unweighted average of these time-sensitive fixed effects' of all managers who do a deal in this year. This gives us a proxy for the available talent, benchmarked against all talent in the industry, within the PE organization at a given point in time. In line with our previous findings that individual manager skill strongly drives deal success, this measure is significantly (5%-level) positively correlated with PE firm-year PME in Model 1 of Table 10.

However, while being positively correlated with PE firm-year performance, the coefficient on our performance-sensitivity proxy is not statistically significantly different from zero in Model 2. This remains unchanged if we add average managerial skill in Model 3. This finding is in line with the interpretation that PE firms are willing to sacrifice average returns at the firm-level by

giving the most skilled managers the largest deals. If this holds true, we should nevertheless observe a positive correlation of past performance-sensitivity with PE firm-year GVA.

In Models 4 to 6 of Table 10 we, therefore, use PE firm-year GVA as the dependent variable. Manager performance-sensitivity is strongly correlated with GVA produced at the PE firm-level. In Model 6, a one standard deviation change in managerial performance-sensitivity is associated with a 62.0 mUSD-change in GVA (beta coefficient of .052). The results are in line with our interpretation that PE firms, given the structure of compensation in the asset class, have an incentive to maximize GVA by managing individual talent in the organization. Interestingly, the beta coefficient for the average skill coefficient amounts to .079, or a 95.5 mUSD-change in GVA. Hence, while the organization's role in allocating capital within the firm seems to be important, consistent with the results on the manager and PE firm FE, the skill of the managers employed seems to be a more influential force of buyout performance.

7 Conclusions

Based on a large sample of buyout deals, we document a negative relation between relative returns and both deal and fund sizes. Following the approach of Berk and van Binsbergen (2015), we contrast relative performance of a PE firm with the ability to generate increased gross value added as it attracts more capital. We find that as funds grow in size, they do larger, rather than more, deals. These larger deals have lower average returns but also lower risk: the probability of delivering 'home-run' returns reduces, but so does the probability that deals do not return capital. One way in which PE firms can potentially navigate the challenges of managing larger funds is to identify, and allocate more capital to, their most successful managers.

We observe considerable cross-sectional heterogeneity in the size-performance relation across PE firms and identify the sensitivity of capital allocation to individual manager performance as a significant explanatory factor. It appears that some PE organizations adapt to the scalability challenge by learning about the skill of their managers and then more effectively matching labour to capital. Successful PE firms grow GVA in part by backing their winners with more capital to deploy and, in this way, avoid sowing the seeds of their own decline, with initial strong performance leading to capital inflows but worse performance.

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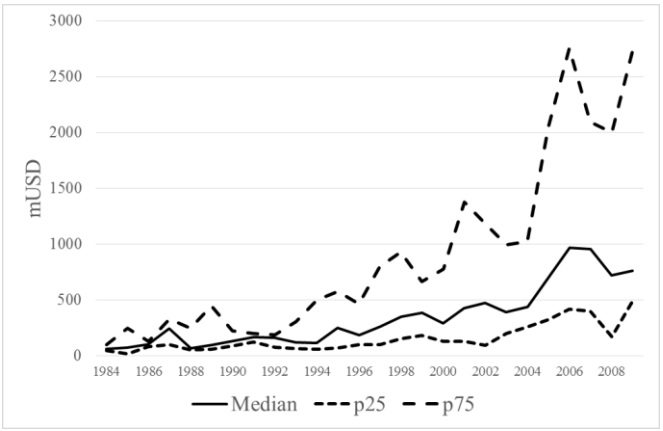
TABLES AND FIGURES

Figure 1: Fund Size and Performance over Time

This figure plots buyout fund size and performance over time in our sample of 942 buyout funds. Panel A depicts the 50th (median), 25th and 75th percentiles of fund size in millions of US dollars by vintage year. Panel B plots median gross fund performance by vintage year. Relative returns are measured by total value-to-paid (TVPI) and the Kaplan-Schoar public market equivalent (PME, calculated relative to three regional MSCI indices (Asia, Europe, and North America) in local currency). Absolute Gross Value Added (GVA) is obtained by multiplying fund size with PME minus one.

Panel A: Fund Size over Time



Panel B: Median Performance over Time

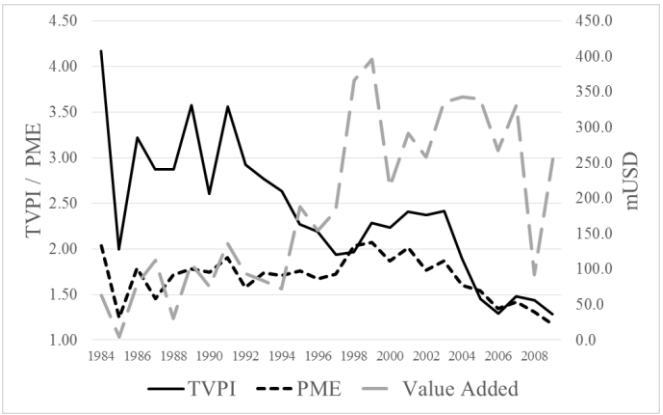


Figure 2: Fund Size and Performance

This figure plots relative and absolute performance metrics by fund size deciles in our sample of 942 buyout funds. Relative returns over time are measured by total value-to-paid (TVPI) and the Kaplan-Schoar public market equivalent (PME, calculated relative to three regional MSCI indices (Asia, Europe, and North America) in local currency). Absolute Gross Value Added (GVA) is obtained by multiplying fund size with PME minus one. Fund size deciles are built by vintage year, i.e., each fund is assigned to a decile based on its size relative to funds closed in the same year.

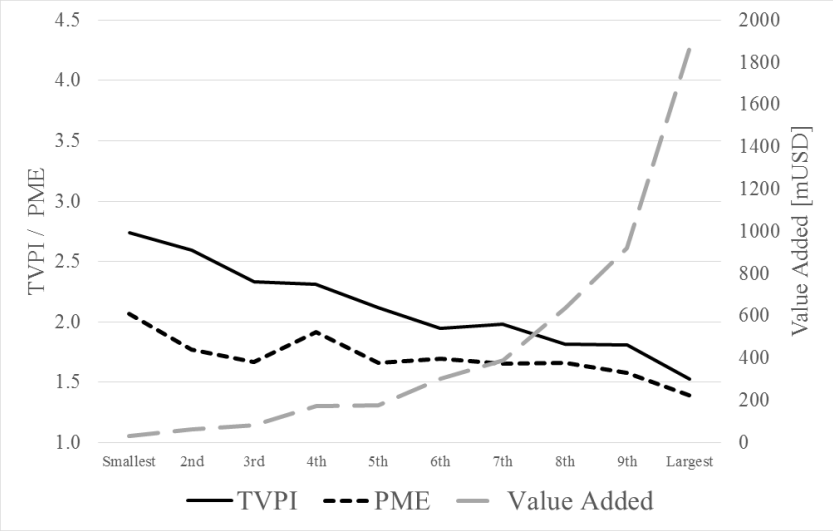
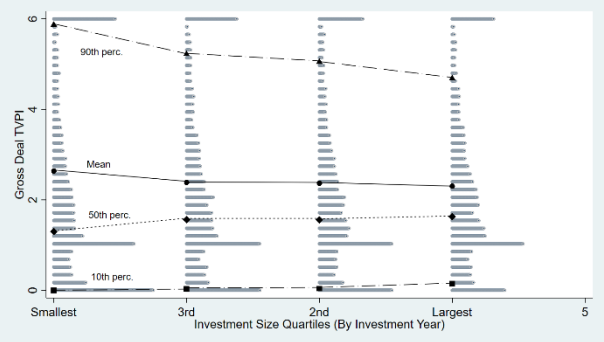


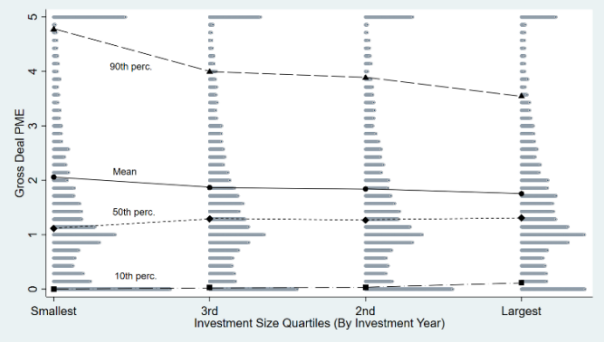
Figure 3: Deal Performance by Size Quartiles

This figure plots the distribution of deal gross performance by deal size quartiles in our sample of 13,170 deals. Deal size quartiles are computed by investment year, i.e., each deal in our sample is assigned to a quartile based on its equity investment size compared to all other deals from the same investment year. Panel A shows the total value-to-paid in (TVPI) return gross of fee and carried interest. Panel B displays gross Kaplan-Schoar public market equivalent (PME, calculated relative to three regional MSCI indices (Asia, Europe, and North America) in local currency). Panel C exhibits deal gross Gross Value Added (GVA) in millions of US dollars, which is obtained by multiplying fund size with PME minus one. All variables are winsorized at the 99th percentile. Each panel displays the unweighted averages, as well as 10th, 50th, and 90 percentiles by deal size quartiles. For illustration purposes, in each panel all performance values substantially larger than the largest 90th percentile are put into one bracket. This applies to all deals with a gross TVPI of larger than 5.87x (90th perc. of smallest deals). Equivalent thresholds are 4.77 for gross PME (smallest deals), and 296.2 millions of US dollars for gross GVA (largest deals).

Panel A: Gross Deal TVPI



Panel B: Gross Deal PME



Panel C: Gross Deal GVA

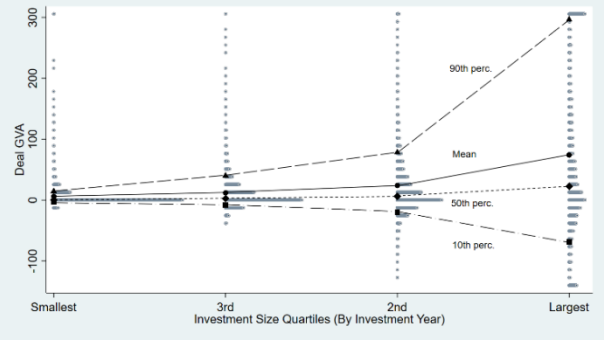


Figure 4: Deal PME-Size Slope Heterogeneity across PE firms

This figure plots GP-specific correlations between deal gross PME and log deal size ranked by correlation strength. We obtain these correlations from a regression of deal gross PME on interactions of log deal size and GP-year fixed effects, controlling for the deal realization status, deal sequence, investment year fixed effects, region fixed effects, and industry fixed effects. We store the coefficients of the interaction terms to measure the GP year-specific slope on deal PME and log deal size.

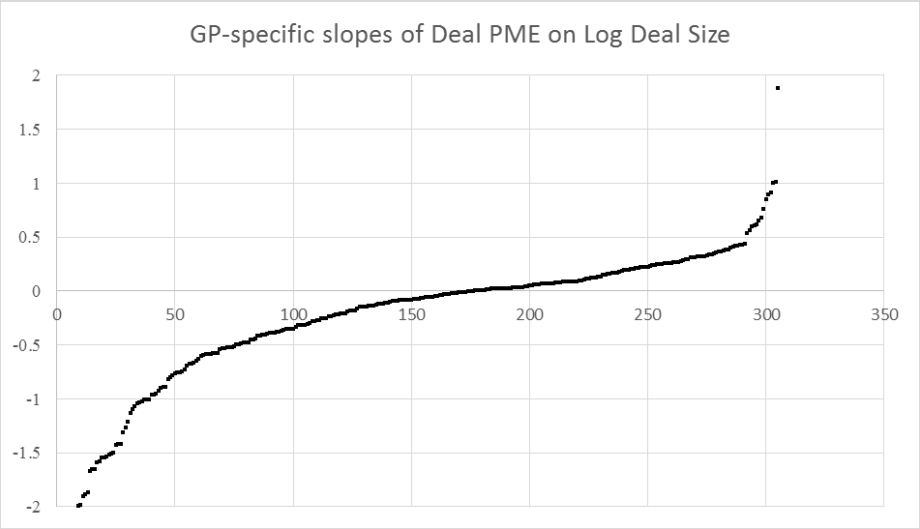


Figure 5: Managerial performance sensitivity across PE firms

This figure plots the sensitivity of relative deal size on past manager performance at the PE firm-year level. Sensitivity for each PE firm-year is obtained by running a linear probability regression of a *relative deal size* dummy adopting a value of one if a given deal is larger than the median of deals done by the same PE firm in the same year, and zero otherwise. The independent variable of interest is a dummy variable (that we call *outperformer*) that adopts a value of one if the last deal by the same manager with the same PE firm returned a gross PME larger than the median of deals by the same PE firm in this past year. This variable is interacted with PE firm-year dummies. The coefficients on these interaction terms can be interpreted as PE firm-year specific managerial performance-sensitivity.

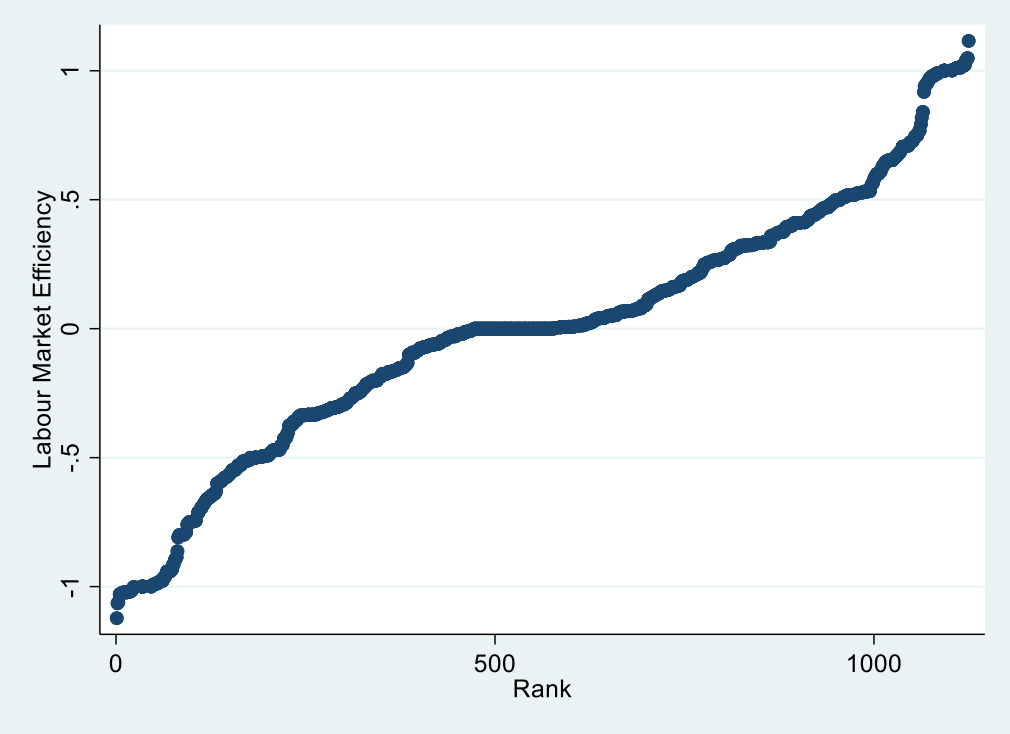


Table 1: Fund Characteristics

This table shows descriptive statistics for our sample of 942 buyout funds. The table reports mean and median values for fund size (in millions of US dollar), the total value-to-paid in (TVPI) return, the Kaplan-Schoar public market equivalent (PME, calculated relative to three regional MSCI indices (Asia, Europe, and North America) in local currency) and fund gross value added (GVA), which is obtained by multiplying fund size with PME minus one. All variables are winsorized at the 99th percentile.

		Fund Size		**TVPI**		**PME**		**GVA**	
	Obs.	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Full sample	942	944.7	331.5	2.36	2.04	1.85	1.67	570.1	210.2
Region categories									
North America	369	1159.6	500.0	2.41	2.05	1.82	1.71	700.9	285.7
Europe	451	825.6	257.3	2.29	2.03	1.85	1.66	500.2	157.1
Asia	43	530.7	340.8	2.06	1.90	1.89	1.75	346.7	256.2
Other/Unreported	79	845.5	268.6	2.66	2.17	1.99	1.68	480.1	179.0
Time categories									
1974-1989	75	260.4	91.0	3.59	3.22	2.03	1.76	196.9	72.4
1990-1994	113	302.3	145.7	3.19	2.78	1.94	1.74	304.8	79.7
1995-1999	245	601.0	305.0	2.38	2.09	2.00	1.86	550.8	229.9
2000-2004	264	903.6	371.4	2.37	2.22	1.94	1.85	706.5	262.5
2005-2010	245	1838.4	811.0	1.57	1.39	1.50	1.41	679.2	305.4

Table 2: Deal Characteristics

Panel A shows univariate statistics at the deal-level for three different samples. The overall sample of 942 funds contains 13,170 unique deals (*full sample*). For 5,030 of these deals, we could identify at least one individual manager running the deal for a GP organization (*matched sample*). Finally, as some deals were managed by several individuals from one PE firm or as club deals were managed by individual managers from different PE firms, we observe 10,330 *deal involvements* (i.e., manager-unique deal dyads). We report the total value-to-paid in (TVPI) return, the Kaplan-Schoar public market equivalent (PME, calculated relative to three regional MSCI indices (Asia, Europe, and North America) in local currency) and deal gross value added (GVA), which is obtained by multiplying deal size with PME minus one. *Investment size* denotes the private equity firm's investment measured in millions of US dollars. All of the above variables are winsorized at the 99th percentile. *Holding period* indicates the difference between an investment's date and the exit date or the latest reported valuation (in case of unrealized transactions), measured in years. *Investment year* is measured based on the first cash flow into a deal. *Realization status* is a dummy variable set to one if a deal is at least partially realized, and zero otherwise. *Managers on deal* counts the number of managers we were able to assign to a given deal. *Manager deal sequence* represents the ordering of the manager's deal involvements, sorted by investment date. In Panel B, we report equity investment size (in millions of US dollar), PME, and GVA for several time categories.

Panel A: Deal Characteristics by Sample Type

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Full Sample (n=13,170)**		**Matched Sample (n=5,030)**		**Deal Involvements (n=10,330)**	
	Mean	Median	Mean	Median	Mean	Median
Investment Size	47.94	15.72	79.03	31.43	107.56	41.03
TVPI	2.42	1.53	2.36	1.57	2.30	1.53
PME	1.88	1.24	1.95	1.36	1.91	1.35
GVA	28.80	2.20	44.99	8.91	56.89	11.16
Holding Period	4.21	3.75	4.05	3.67	3.97	3.67
Investment Year	2000	2001	2003	2004	2004	2005
Realization Status	0.83	1.00	0.77	1.00	0.74	1.00
Managers on Deal	-	-	3.10	2.00	3.05	2.00

Panel B: Time Categories (Full Sample)

Variables	**Obs.**	**Investment Size**		**PME**		**GVA**	
		Mean	Median	Mean	Median	Mean	Median
1974-1989	816	10.81	1.70	2.04	0.91	8.75	-0.05
1990-1994	1,388	12.68	4.50	1.81	1.23	9.67	0.54
1995-1999	3,146	27.20	9.97	1.99	1.25	21.79	1.36
2000-2004	3,632	44.07	17.25	2.04	1.49	40.66	6.23
2005-2010	4,196	85.78	37.99	1.66	1.15	34.02	4.27

Table 3: Performance by Size Quartiles

This table shows the performance of 942 funds (Panel A) and 13,170 deals (Panel B) measured across quartiles of fund and investment size, respectively. Size quartiles are constructed by fund vintages and investment years. Fund and investment size are measured in millions of US dollars. We report the total value-to-paid in (TVPI) return, the Kaplan-Schoar public market equivalent (PME, calculated relative to three regional MSCI indices (Asia, Europe, and North America) in local currency) and gross value added (GVA), which is obtained by multiplying fund or investment size with PME minus one. All variables are winsorized at the 99th percentile.

Panel A: Fund Performance by Yearly Fund Size Quartiles

	Obs.	Fund Size		TVPI					PME					GVA				
		Mean	Median	Mean	10th	Median	90th	SD	Mean	10th	Median	90th	SD	Mean	10th	Median	90th	SD
Smallest	238	99.8	77.5	2.74	1.04	2.19	4.96	2.01	2.14	0.95	1.79	3.83	1.23	113.0	-2.7	60.4	207.4	410.1
2nd	234	292.0	241.0	2.53	1.21	2.12	4.00	1.69	1.98	1.09	1.76	2.95	1.00	301.6	16.8	177.1	598.9	574.5
3rd	243	688.6	550.0	2.25	1.09	2.00	3.74	1.46	1.74	1.00	1.63	2.58	0.87	422.9	2.6	303.7	1015.7	495.3
Largest	227	3042.0	2094.1	2.30	1.15	1.97	3.39	1.25	1.76	1.05	1.62	2.48	0.66	1573.6	115.6	1014.0	3808.0	1578.9

Panel B: Deal Performance by Yearly Investment Size Quartiles

	Obs.	Investment Size		TVPI					PME					GVA				
		Mean	Median	Mean	10th	Median	90th	SD	Mean	10th	Median	90th	SD	Mean	10th	Median	90th	SD
Smallest	3,305	4.1	2.6	2.64	0.00	1.30	5.87	4.03	2.06	0.00	1.12	4.77	2.98	5.8	-2.7	0.1	14.2	32.5
2nd	3,291	13.9	10.9	2.38	0.03	1.56	5.22	2.88	1.87	0.03	1.29	3.99	2.12	11.9	-8.3	2.6	39.9	34.4
3rd	3,293	33.3	25.5	2.37	0.04	1.56	5.05	2.92	1.84	0.03	1.27	3.88	2.09	23.9	-19.9	6.0	78.1	64.8
Largest	3,281	140.9	99.0	2.30	0.15	1.63	4.69	2.55	1.75	0.12	1.31	3.54	1.77	73.9	-68.8	22.5	296.2	160.8

Table 4: Regressions of Performance on Size

This table reports OLS regressions of performance at the fund (Panel A) and the deal (Panel B) level on size. In Models 1 to 4, we measure performance by gross public market equivalent (PME) returns. PMEs are Kaplan-Schoar type returns and calculated relative to three regional MSCI indices (Asia, Europe, and North America) in local currency. In Models 5 to 8, we measure performance by gross value added (GVA) in millions of US dollars. Both performance variables are winsorized at the 99th percentile. Models 1 and 5 represent OLS regressions, while Models 2 to 4 and Models 6 to 8 represent quantile regressions for the 10th, 50th, and 90th percentiles, respectively. *Fund size* is measured in millions of US dollard. *Fund sequence* represents the ordering of the private equity firm's funds, sorted by vintage year. *Fund share realized* measures the share of deals in a fund that have at least been partially realized. *Investment size* denotes the private equity firm's investment measured in millions of US dollars. Holding period indicates the difference between an investment's date and the exit date or the latest reported valuation (in case of unrealized transactions), measured in years. *Deal sequence* represents the ordering of the private equity firm's deal involvements, sorted by investment date. *Realization status* is a dummy variable set to one if a deal is at least partially realized, and zero otherwise. Panel A includes vintage and fund region fixed effects, while Panel B includes investment year, deal industry, and deal region fixed effects. Standard errors are in parentheses. In Models 1 and 5, standard errors are clustered at the private equity firm-level, while quantile regressions employ robust standard errors. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Fund-Level Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Fund PME				**Fund GVA**			
	OLS	Quantile Reg. (percentile)			OLS	Quantile Reg. (percentile)		
VARIABLES		10th	Median	90th		10th	Median	90th
Log Fund Size	-0.137***	0.023	-0.080***	-0.279***	422.868***	27.726***	205.203***	545.972***
	(0.028)	(0.018)	(0.022)	(0.080)	(33.512)	(9.787)	(13.252)	(80.423)
Log Fund Sequence	-0.098*	-0.099***	-0.076	-0.085	11.465	-22.868	0.207	122.975
	(0.055)	(0.038)	(0.047)	(0.171)	(51.465)	(20.999)	(28.436)	(172.568)
Fund Share Realized	0.543***	0.238***	0.517***	0.450	395.938***	85.378*	175.850***	-153.758
	(0.140)	(0.090)	(0.111)	(0.403)	(117.284)	(49.483)	(67.008)	(406.643)
Observations	942	942	942	942	942	942	942	942
R-squared	0.149	0.064	0.094	0.198	0.339	0.024	0.178	0.329
Vintage Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES	YES	YES	YES

Panel B: Deal-Level Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Deal PME				**Deal GVA**			
	OLS	Quantile Reg. (percentile)			OLS	Quantile Reg. (percentile)		
VARIABLES		10th	Median	90th		10th	Median	90th
Log Investment Size	-0.154***	0.014***	0.041***	-0.291***	6.920***	-2.063***	1.602***	12.24***
	(0.014)	(0.004)	(0.007)	(0.031)	(0.555)	(0.344)	(0.148)	(1.309)
Log Holding Period	0.293***	0.038***	0.125***	0.435***	10.482***	-0.519	1.795***	14.64***
	(0.028)	(0.009)	(0.017)	(0.077)	(1.115)	(0.835)	(0.359)	(3.182)
Log Deal Sequence	-0.179***	-0.013**	-0.089***	-0.178***	-3.115*	-1.661***	-0.437*	3.720*
	(0.041)	(0.006)	(0.011)	(0.051)	(1.638)	(0.559)	(0.240)	(2.130)
Realization Status	0.614***	-0.188***	0.303***	1.103***	36.834***	2.120	8.477***	65.14***
	(0.064)	(0.022)	(0.040)	(0.176)	(2.555)	(1.926)	(0.827)	(7.339)
Observations	13,170	13,170	13,170	13,170	13,170	13,170	13,170	13,170
R-squared	0.104	0.039	0.033	0.078	0.146	0.061	0.023	0.154
Investment Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 5: Manager Persistence

This table reports the results of OLS regressions of the investment performance of a manager's current deal (*n*) on the performance of the manager's previous deal (*n-1*). The analysis is at the manager-deal involvement level. In Models 1 to 4, we look at gross PME. PMEs are winsorized at the 99th percentile. In Models 5 to 6 (Models 7 to 8), we look at dummies for whether a deal was in the top (bottom) quartile in a given investment year. *Investment size increase* is the ratio of the manager's current deal size to the deal size of the previous deal. Standard errors are in parentheses. Standard errors are clustered at the manager-level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Deal PME_n				Top PME $Quartile_n$		Bottom PME $Quartile_n$	
PME_{n-1} / Top / Bottom Quartile	0.090***	0.080***	0.073***	0.089***	0.045***	0.055***	0.062***	0.066***
	(0.015)	(0.015)	(0.015)	(0.020)	(0.012)	(0.015)	(0.014)	(0.020)
Investment $Size\ Increase_{(n/n-1)}$				-0.000		-0.001		0.002
				(0.005)		(0.001)		(0.002)
PME_{n-1} * Inv. $Size\ Increase_{(n/n-1)}$				-0.004***		-0.004*		-0.001
				(0.001)		(0.002)		(0.003)
Log Investment $Size_n$			-0.118***	-0.111***	-0.027***	-0.025***	0.006	0.005
			(0.019)	(0.027)	(0.004)	(0.006)	(0.004)	(0.006)
Log $Holding\ Period_n$			0.168***	0.168***	0.086***	0.086***	0.024***	0.024**
			(0.026)	(0.036)	(0.006)	(0.010)	(0.008)	(0.012)
Log Manager Deal $Sequence_n$			-0.043	-0.046	-0.005	-0.006	0.003	0.004
			(0.040)	(0.046)	(0.010)	(0.011)	(0.011)	(0.013)
Realization $Status_n$	1.064***	1.052***	0.979***	0.976***	0.246***	0.245***	-0.096***	-0.096***
	(0.049)	(0.068)	(0.066)	(0.106)	(0.016)	(0.027)	(0.019)	(0.031)
Observations	6,352	6,352	6,352	6,352	6,352	6,352	6,352	6,352
Adjusted R-squared	0.088	0.105	0.117	0.118	0.091	0.092	0.024	0.024
Investment Year FE	NO	YES	YES	YES	NO	YES	NO	YES
Region FE	NO	YES	YES	YES	NO	YES	NO	YES
Industry FE	NO	YES	YES	YES	NO	YES	NO	YES

Table 6: Manager Persistence: Robustness

This table reports the results of OLS regressions of the public market equivalent (PME) of a manager's current deal (*n*) on the PME of the manager's previous deal (*n-1*). The analysis is at the manager-deal involvement level. PMEs are winsorized at the 99th percentile. In Models 1 and 2, we restrict our sample to at least partially realized deals. In Models 3 and 4, we only consider deal involvements that we also identify through the book directories "Who's Who in private equity". In Models 5 and 6, we delete the first three deal involvements by each manager. Standard errors are in parentheses. Standard errors are clustered at the manager-level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Deal PME_n					
VARIABLES	Realized deals only		"Who is Who" Sample		Deal sequence > 3	
PME_{n-1}	0.098***	0.080***	0.092**	0.075**	0.103***	0.078***
	(0.019)	(0.019)	(0.037)	(0.037)	(0.019)	(0.018)
Log Investment $Size_n$		-0.128***		-0.320***		-0.099***
		(0.028)		(0.049)		(0.023)
Log Holding $Period_n$		0.207***		-0.030		0.186***
		(0.050)		(0.106)		(0.032)
Log Manager Deal $Sequence_n$		-0.101*		-0.007		-0.038
		(0.055)		(0.145)		(0.073)
Realization $Status_n$	0.844***	0.733***	0.920***	1.214***	0.981***	0.900***
	(0.062)	(0.081)	(0.108)	(0.156)	(0.077)	(0.095)
Observations	4,547	4,547	1,195	1,195	2,979	2,979
Adjusted R-squared	0.041	0.072	0.045	0.102	0.088	0.126
Investment Year FE	NO	YES	NO	YES	NO	YES
Region FE	NO	YES	NO	YES	NO	YES
Industry FE	NO	YES	NO	YES	NO	YES

Table 7: Manager and PE firm fixed effects

This table reports the results from ordinary least square (OLS) regressions of the public market equivalent (PME) on manager and private equity firm fixed effects. The analysis is at the manager-deal involvement level. PMEs are winsorized at the 99th percentile. In Models 3 and 4, we only include managers with at least four deal involvements. The bottom part of the table reports the variation in the dependent variable that is attributable to the sets of manager and private equity firm fixed effects, respectively. We further document the relative importance of the manager and the firm fixed effects. Standard errors are in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)
Variables	**Deal PME_n**			
Log Investment Size		-0.177***		-0.103**
		(0.0216)		(0.0495)
Log Manager Deal Sequence		-0.082		-0.0852
		(0.067)		(0.133)
Log Holding Period		0.150***		0.115
		(0.039)		(0.0762)
Realization Status (%)	1.316***	1.152***	1.239***	1.186***
	(0.056)	(0.075)	(0.0874)	(0.120)
Investment Year FE	NO	YES	NO	YES
Region FE	NO	YES	NO	YES
Industry FE	NO	YES	NO	YES
Manager FE	YES	YES	YES	YES
PE Firm FE	NO	NO	YES	YES
Observations	10,330	10,330	3,429	3,429
Share of Movers	0.072	0.072	0.122	0.118
F-test on FE				
Manager FE	1.130***	1.105***	1.150**	1.110*
PE Firm FE	-	-	1.260*	1.164
$\frac{cov(Y, Manager\ FE)}{var(Y)}$			0.147	0.145
$\frac{cov(Y, PE\ Firm\ FE)}{var(Y)}$			0.040	0.037
Relative importance: Manager FE vs. PE Firm FE			3.67	3.88

Table 8: Manager-Performance Sensitivity: Univariate Analysis

This table reports the probability that a manager's current deal is larger than the median deal within the corresponding PE firm-year, denoted as *Relative Deal Size*. This variable adopts a value of one if a deal is larger than the median of all deals in a PE firm-year. When a manager's PME return of the previous deal exceeds the median PME return in the corresponding PE firm-year, we call the manager an *Outperformer*, and an *Underperformer* otherwise. We only keep deal involvements if the PE firm-years of the manager's current and previous deal comprise at least of two deals, respectively (8,984 deal involvements). In Panel A, we split the sample according to whether a deal represents a manager's first deal within a PE firm. In Panel B, we split the sample of 4,741 deal involvements for which we observe at least two deals for a given manager (in the same PE firm) based on whether the manager outperformed her peers with her previous deal. In Panel C, we distinguish both between out- and underperforming managers (as in Panel B) as well as out- and underperforming PE firms in a deal year. PE firm performance is defined as the investment size-weighted average of all deal PME returns in a given PE firm and year. An outperforming PE firm exceeds the median PE firm in a given year, denoted as *high*. Across all panels we display chi-squared tests, which examine whether the share of managers with larger deals varies across the respective samples. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	Relative Deal Size$_n$		**Pearson's Chi-Squared**
	Obs.	**Mean**	
All	8,984	55.4%	
Panel A: By Manager Deal Sequence			
1	4,243	51.2%	
>1	4,741	59.1%	56.68***
Panel B: By Manager Past Performance			
Outperformers$_{n-1}$	2,621	60.2%	
Underperformers $_{n-1}$	2,120	57.7%	3.05*
Panel C: By PE Firm-Year Performance			
Low$_n$			
Outperformers $_{n-1}$	1,194	59.8%	
Underperformers $_{n-1}$	1,040	60.1%	0.02
High$_n$			
Outperformers $_{n-1}$	1,426	60.7%	
Underperformers $_{n-1}$	1,081	55.5%	6.73***

Table 9: Manager-Performance Sensitivity: Multivariate Analysis

This table reports OLS regressions of a dummy variable set to one for deals exceeding the median deal size in a given PE firm year, and zero otherwise (*Relative Deal Size*). The sample is restricted to managers *m* whose previous deal (*n-1*) took place within the same PE firm. *Outperformer* is set to one when a manager's PME return of the previous deal exceeds the median PME in the corresponding PE firm-year, and zero otherwise. *PE firm year PME dummy* is set to one when a PE firm has returned a size-weighted PME return greater than the median PME return across all PE firms in a given year, and zero otherwise. Models 3 and 4 are based on a median sample split according to the PE firm's PME return in a given year. We control for the number of deals in a given PE firm-year, as well as year, region, and industry fixed effects. In Model 4, we also include PE firm fixed effects. Standard errors are in parentheses and clustered at the PE firm-level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)
	Relative Deal Size$_{m,n}$				
	All	All	PE Firm Year PME Split		All
VARIABLES			Low	High	
Outperformer$_{m,n-1}$	0.0239	0.0164	-0.00324	0.0531**	0.0239
	(0.0161)	(0.0135)	(0.0212)	(0.0249)	(0.0161)
PE Firm Year PME Dummy					-0.0338
					(0.0215)
Outperformer * PE Firm Year PME Dummy					0.0635*
					(0.0352)
Observations	4,904	4,904	2,335	2,592	4,904
R-squared	0.053	0.107	0.083	0.064	0.053
PE Firm Year No. of Deals FE	YES	YES	YES	YES	YES
Investment Year FE	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
PE Firm FE	NO	YES	NO	NO	NO

Table 10: Manager-Performance Sensitivity and Subsequent PE Firm Performance

This table reports the results of OLS regressions at the PE firm-year level. The dependent variables are the gross public market equivalent (PME) return in Models 1 to 3 and gross value added (GVA) in Models 4 to 6. *PE Firm Year Performance Sensitivity* measures are obtained from running a linear probability regression of the *Relative Deal Size* dummy on interactions of PE firm-year dummies and *Outperformer*. *Relative Deal Size* adopts a value of one if a manager's deal is larger than the median of deals done by the same PE firm in the same year, and zero otherwise. *Outperformer* adopts a value of one if the last deal by the same manager with the same PE firm returned a gross PME larger than the median of deals by the same PE firm in this past year. *PE Firm Year Average Manager PME FE* is the unweighted average of all individual manager fixed effects within a PE firm, obtained from Model 2 in Table 7. For the estimation, all deals prior to a given deal are included, i.e., the manager fixed effect is updated over time as the manager invests in more deals. We control for the natural logarithm of total investment size (at the PE firm-year level), the share of realized deals, fixed effects for the number of deals within a PE firm-year, as well as investment year and PE firm fixed effects. Standard errors are in parentheses and clustered at the PE firm-level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	PE Firm Year PME			PE Firm Year GVA		
PE Firm Year Perf. Sensitivity		0.0485	0.0477		129.7***	125.2***
		(0.0576)	(0.0575)		(46.73)	(46.53)
PE Firm Year Avg. Manager PME FE	0.0850**		0.0848**	104.3***		101.6***
	(0.0397)		(0.0397)	(32.20)		(32.1)
LN PE Firm Year Investment Size	-0.379***	-0.379***	-0.382***	751.3***	743.9***	742.7***
	(0.0577)	(0.0579)	(0.0578)	(47.04)	(47.18)	(46.96)
PE Firm Year Share Realized	0.615***	0.606***	0.611***	347.8***	341.1***	343.7***
	(0.135)	(0.135)	(0.135)	(109.6)	(109.8)	(109.3)
Observations	1,124	1,124	1,124	1,124	1,124	1,124
R-squared	0.488	0.525	0.488	0.772	0.771	0.774
Investment Year FE	YES	YES	YES	YES	YES	YES
PE Firm Year No. of Deals FE	YES	YES	YES	YES	YES	YES
PE Firm FE	YES	YES	YES	YES	YES	YES