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Size matters: Unpacking the relationship between institutional investor size and private equity asset allocation within diverse institutional contexts

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ABSTRACT

This study examines the relationship between institutional investors' size and their inclination towards private equity investments, hypothesizing a U-shaped pattern. It also explores how this relationship is influenced by the institutional context. Using a dataset of 5668 firms across 52 countries from 1991 to 2017, we observe that small and large institutional investors exhibit a stronger preference for private equity compared to intermediate-sized counterparts. Smaller investors show heightened interest in private equity within favorable contexts, while larger investors pursue such opportunities in unfavorable contexts. Our research offers valuable insights for policymakers and investors of diffferent sizes making private equity investments in diverse institutional contexts.

1. Introduction

Scholars have uncovered striking disparities in the behavior of institutional investors, with firm size emerging as a prominent driver of these differentials. Recent research has unveiled a notable shift in the investment strategies of large institutional investors, as they increasingly diversify their portfolios by allocating significant portions of their investments in illiquid assets (Andonov, 2022; Andonov et al., 2017; Broeders et al., 2021; Dai, 2022; Jansen & Tuijp, 2021). Larger institutional investors are witnessing a remarkable upswing in their involvement in direct PE investments in portfolio companies either as co-investors alongside funds or as independent investors (Fang, Ivashina, and Lerner, 2015). The increased allocations by large firms have been ascribed to the advanteges stemming from economies of scale, achieved by internalizing the investment managment process and circumventing the need for professional funds as intermediaries (Andonov, 2022). In addition, large investors leverage their superior due diligence capabilities, bargaining power, enhanced access to investment opportunities, extensive industry experience, and the ability to mitigate information asymmetry issues (Da Rin and Phalippou, 2017; de Vries et al., 2023; Dyck and Pomorski, 2011, 2016; Fuchs et al., 2022; Andonov et al., 2011). Da Rin &

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Phalippou (2017) demonstrate that large investors devote more time and undertake additional initiatives during the due diligence phase, distinguishing their approach from their smaller counterparts.

Nevertheless, it is important to acknowledge that the relationship between the size of institutional investors and the extent of cost advantages in this context is not definitively established. Broeders, van Oord, & Rijsbergen (2016) uncovered diseconomies of scale in performance fees for private equity, indicating that larger funds may face higher performance fees compared to smaller ones. Moreover, there is an alternative perspective on cost advantages achieved through disintermediation suggesting that outsourcing investment management to professional funds, known as general partners, can be a more cost-effective approach. This is particularly relevant considering the high fixed costs associated with establishing and maintaining an internal asset management division (Meyer and Mathonet, 2005; Fang, Ivashina and Lerner, 2015). While outsourcing investment management to external managers can introduce multiple agency problem and added coordination costs (Magnani & Sanfelici, 2023), it can also prove cost-effective due to the pooling of capital by financial intermediaries from multiple institutional investors. This pooling facilitates the distribution of evaluation, monitoring, transaction costs, and liquidity needs among these investors (Andonov, 2022, p. 4). Indeed, professional fund managers possess the expertise and specialized knowledge in private equity, enabling them to achieve superior returns and gain an information advantage. Their expertise allows them to navigate the complexities of the private equity market and make well-informed investment decisions (Admati & Pfleiderer, 1994; Allen, 2001).

Furthermore, even if we assume that institutional investors can achieve cost reductions through economies of scale, there are potential challenges that can impede their ability to achieve desirable returns. These challenges encompass the quality of investment deals, ineffective monitoring practices, and potential misjudgments in timing and choices for exiting investments. For instance, Bauer, Cremers, & Frehen (2010) discover that while larger funds benefit from economies of scale, smaller funds outperform their larger counterparts in generating returns. Additionally, Cumming, Fleming, and Johan (2011) ascertain that smaller institutional investors exhibit a higher likelihood of investing in listed PE. However, it is important to note that listed PE investments may elicit a distinctive response from institutional investors compared to non-listed PE investments.

The size factor further adds complexity when considering that economies of scale are not solely dependent on scale, as small financial institutions can also achieve cost advantages (Hughes & Mester, 2013). Goldberg, Hanweck, Keenan, & Young (1991) discovered that economies of scale were evident among smaller specialized firms, whereas larger and more diversified firms experienced diseconomies of scale. So, if smaller firms can outperform larger counterparts in terms of returns, is it not reasonable to expect that small firms may be equally motivated to invest in PE? Disagreements also arise regarding the diminishing economies of scale. Beckers & Vaughan (2001) and Agarwal, Nanda, & Ray (2013) suggest that size growth beyond a certain limit has adverse effects on performance, whereas Broeders et al. (2016) were unable to find evidence of diminishing economies of scale in investment costs. The discrepancies in previous work stem from the inherent complexity arising from diverse legal structures, motivations, and investment strategies, as highlighted by Cavagnaro et al. (2019), Da Gbadji, Gailly, & Schwienbacher (2015), and Fichtner (2020), as well as from the lack of comprehensive and high-quality data pertaining to institutional investment in the PE market (Harris, Jenkinson, & Stucke, 2012). The disparities in the relationship between institutional investors' size and allocations within the PE market warrant further investigation.

In this study, we adopt the perspective that larger and more influential firms are more likely to invest in PE. This viewpoint is supported by several factors. First, large firms possess enhanced contractual enforcement ability and a greater capacity to circumvent the disciplinary actions of capital markets (Scott & Martin, 1975). Second, they tend to accumulate more external debt (La Porta et al., 1997), exhibit improved risk diversification[1] strategies. Additionally, large firms have access to a vast repository of credit information (Fiet and Fraser, 1994). Moreover, large institutional investors with banking experience or active involvement in equities and bond markets can leverage their existing knowledge and expertise to the advantage of investing in alternative investments (Fang, Ivashina, and Lerner, 2013; Andonov, 2022). These institutional investors possess bargaining power, greater market access, and the resources to internalize exchanges (Da Rin & Phalippou, 2017; A. Dyck & Pomorski, 2016).

We further posit that small institutional investors possess certain advantages when it comes to investing in PE. Small firms often have stronger personal relationships, allowing them to better understand the true intentions and interests required to navigate unsystematic risks (Fiet and Fraser, 1994; Cole, Goldberg, and White, 2004). Additionally, small firms rely on qualitative information and target specific market niches, which enable them to allocate higher proportion of their investments to PE. In contrast, intermediate-sized firms have grown to a point where they have lost personal connections and tend to rely on bureaucratic processes. However, these firms are not large enough to wield influence in the markets, enforce contracts, achieve scale economies and diversification, or mitigate agency problems through a large base of information. As a result, they face disadvantages when investing in PE. Therefore, we anticipate a U-shaped relationship between the size of institutional investors and their inclination to allocate assets to PE, with both small and large investors being more inclined to invest in PE compared to intermediate-sized investors.

Indeed, larger and smaller firms employ distinct strategies to address challenges associated with agency risks, transaction and intermediation costs, and information asymmetries (Norton, 1996; Lerner, Schoar, and Wongsunwai, 2007). However, the effectiveness of these strategies is to some degree contingent upon the institutional environment (Naeem & Li, 2019; Smith et al., 2022). It is plausible that institutional investors of varying sizes must tailor their strategic responses to institutional conditions in terms of their investments in PE. For instance, small firms may lack the influence to shape markets or to enforce contracts and may therefore choose to invest solely in environments with robust protection of property rights compared to their larger counterparts. Prior studies have not

[1] Andonov (2022) demonstrated that institutional investors are willing to incur higher fees and accept lower returns in alternative assets, as they recognize the value of diversification benefits associated with such investments.

thoroughly examined how the relationship between firm size and allocation to PE varies across different institutional contexts. Our study distinguishes itself from previous research by delving into the mechanisms linked to the institutional context of societies, as suggested by Johnson, Schnatterly, Johnson, & Chiu (2010).

We operationalize the favorability of contextual factors by examining the quality of legal institutions, market openness, and level of development of financial institutions. Existing research suggests that favorable legal environments can lower agency problems and alleviate information asymmetries (Cumming, Fleming, and Schwienbacher, 2006; Shahzad and David, 2010). Sound financial institutions are able to diversify agency risks (Diamond, 1984; Williamson, 1986) and effectively monitor the managerial actions (Hoshi, Kashyap, and Scharfstein, 1990; Beck and Levine, 2004). Open markets promote transparency, competition, and enforcement capabilities, thereby facilitating the entry of new participants into financial sectors (Rajan and Zingales, 2003; Baltagi, Demetriades, and Law, 2009).

This study aims to provide a broader and more encompassing understanding by utilizing an extensive dataset comprising 5,668 firms from 52 countries over the period 1991–2017, resulting in total of 65,085 firm-year observations. Previous analyses have contributed to our knowledge of the effect of size of the institutional investor on PE allocations, but they have often focused on specific samples of institutional investors in the PE market. For instance, Broeders, Jansen, and Werker (2021) focused on 219 Dutch pension funds, while Andonov, Bauer, and Cremers (2017) analyzed 850 defined benefit pension funds from 1990 to 2012. A broader perspective was taken by Andonov (2022) by investigating 1,149 funds across the United States, Canada, Europe, and Australia/New Zealand, covering multiple regions. However, the utilization of an extensive dataset in the present study has the potential to provide a more comprehensive understanding of the relationship between size and PE allocations. Furthermore, it enables us to effectively capture contextual influences, thereby providing a robust foundation for our analysis.

This study employs the mixed-effects logistic regression estimation technique. The dependent variable is binary, indicating whether an institutional investor has allocated capital within a PE market or not. The findings indicate that small and large firms are more likely to invest in PE compared to intermediate-sized firms, thus supporting the U-shaped relationship hypothesis. The U-shaped relationship is robust to various tests suggested by Haans, Pieters, & He (2015) and Lind & Mehlum (2010). Furthermore, a favorable institutional environment enhances the probability of small firms allocating assets within the PE market.

2. Literature and hypotheses

2.1. Institutional investors' firm size and asset allocations in private equity

This section builds upon existing literature on firm size in finance and organizational theory to inform the relationship between the size of institutional investors and their invesments in illiquid assets, particularly private equity.

2.1.1. Small firms and investment in PE

We posit that small firms can gain a competitive edge through their adeptness in cultivating relationships and networks. These abilities provide small firms with an advantage in effectively addressing agency problems, positioning them well for investments in risky and illiquid projects. Bauer, Cremers, and Frehen (2010) conducted a comprehensive analysis of the cost structure and performance of US pension funds and found that while larger funds enjoy cost advantages due to their size, smaller funds surpass their larger counterparts in terms of generating returns. Other studies suggest that the growth of hedge and pension funds beyond a certain threshold has adverse effects on the portfolio performance of asset managers (Beckers and Vaughan, 2001; Agarwal, Nanda, and Ray, 2013) and that small financial institutions can also achieve scale economies (Goldberg et al., 1991; Hughes & Mester, 2013). Additionally, small pension funds exhibit a preference for listed PE investments (Cumming, Fleming, & Johan, 2011).

Similar tendencies have been observed in financial institutions such as banks. Carter, McNulty, and Verbrugge (2004) have provided empirical evidence that small banks are more effective at providing loans to small businesses, with superior performance attributed to their information and relationship advantages, as well as the power of "soft" information and organic organizational structures. Specifically, the information advantage hypothesis posits that smaller banks are more profit-efficient due to their enhanced access to proprietary information. The rationale behind this phenomenon stems from the proximity of loan officers in small banks to both bank management and the loan customers. This close proximity enables them to access superior credit information and effectively address agency problems (Akhigbe & McNulty, 2003). Additionally, lending relationships are instrumental in meeting high credit targets for small businesses (Petersen & Rajan, 1994). In addition to credit information, smaller banks with limited exposure to investment across various industries and geographies heavily rely on personal relationships. These relationships provide them with valuable insights into the true intentions and interests of parties involved, enabling them to effectively mitigate agency risks (Buchner et al., 2017; Fiet & Fraser, 1994).

Indeed, we can draw parallels between banks involvement in lending and allocations in PE. In fact, bank-affiliated investments in private equity comprised 30 % of all private equity investments in the US (Fang, Ivashina, and Lerner, 2015). Moreover, banks can exploit the lending information in private equity decisions, and their participation can be regarded as a positive signal about the deal quality to debt providers, resulting in better financing terms for the portfolio firms (Fang, Ivashina, and Lerner, 2015). Similarly, a positive relationship was found between the firms' experiences of active involvement in debt, public equities, and private equity allocations (Andonov, 2022).

We can also draw insights from the literature on venture capital firms, which are formal and larger in size and compare them to angel investors, who are informal and smaller in scale. In contrast to venture capitalists, angels mitigate agency risks through a higher degree of personal engagement with the investee firms (Capizzi, 2015), and rely more on relational governance rather than

transactional governance (Collewaert et al., 2017; Fiet, 1995). Similar characteristics can be attributed to smaller investors in PE when compared to their larger counterparts. Small investors often rely on smaller deals, leveraging their local knowledge, personal connections for quality information, and employing relational governance. Moreover, research indicates that small firms thrive because of strategic niches and dynamic complementarity, allowing them to seek markets where they can avoid direct competition with larger counterparts (Audretsch, Prince, and Thurik, 1999).

2.1.2. Large firms and investment in PE

Large institutional investors possess certain advantages over their smaller counterparts when it comes to allocating assets to PE. One key attraction for large firms in PE is to diversify income sources by investing in different asset classes, geographies, and industries. While liquidity plays a crucial role in shaping investment decisions for investors (Batten & Vo, 2019), Illiquid assets are viewed as a prudent investment option by large financial firms alongside public equity, mutual funds, hedge funds, real estate, and so forth (Andonov, Bauer, and Cremers, 2017; Broeders, Jansen, and Werker, 2021; Andonov, 2022). This is due to the risk–return trade-off and diversification benefits (Jansen & Tuijp, 2021). Due to their large scale, firms have greater access to diversified industries and have wide geographical presence. Large firms can achieve economies of scale by internalizing the process of investment management and bypassing the need for professional funds as intermediaries (Andonov, 2022). Large investors also take advantage of superior due diligence capabilities, bargaining power, enhanced access to investment opportunities, extensive industry experience, and the ability to mitigate information asymmetry issues (Andonov, Bauer, and Cremers, 2011; Dyck and Pomorski, 2011, 2016; Da Rin and Phalippou, 2017). Da Rin & Phalippou (2017) show that large investors take more time and carry out additional initiatives during the due diligence phase compared to their smaller counterparts.

Fiet and Fraser (1994) propose that large financial institutions have a distinct advantage stemming from their access to a large base of information. This advantage enables them to effectively diversify systematic risks, particularly market risks, in contrast to smaller financial institutions that excel at managing idiosyncratic risks. Small financial institutions typically adopt a "relationship approach," which relies on gathering and utilizing "soft" information. In contrast, large financial institutions tend to adopt a "transaction approach," which is built upon the use of "hard" information (Black & Strahan, 2002).

Also, from a resource-based perspective, large, resourceful firms have the ability to tap the potential of the PE market. Large firms can afford to take limited risk by setting aside a portion of their wealth for investment in PE to diversify risks and revenues, earn higher profits, or achieve strategic motives. Furthermore, large firms are more likely to possess the confidence and resources to enforce contracts and obtain the necessary resources. La Porta et al. (1997) demonstrate that large publicly traded firms perform well in obtaining external debt, regardless of the legal structure within a country. Financially powerful firms have the ability to avoid capital market discipline (Scott & Martin, 1975), which may give larger firms greater confidence to invest in PE.

Finally, large firms have the advantage of in paying lower transaction costs compared to their smaller counterparts (Nooteboom, 1993). These qualities provide the resourceful industry giants with the capacity to mitigate market and industry risks and access to market opportunities, despite possessing low relational capital and more bureaucratic processes. Both resource-based and risk-diversification perspectives can explain the involvement of large financial institutions in PE.

2.1.3. Intermediate-sized firms and investment in PE

The study of firm size is a well-established construct within organizational studies. Greiner's (1972) influential growth model, which highlights various stages that firms pass through as they mature and expand, posits that crises arise at each stage of development and offers potential solutions that firms have discovered. The model assumes that firms in their initial stages rely on organic network-based structures and personal relationships. As firms grow, they tend to move towards a more formal, bureaucratic, and decentralized system of control (Greiner, 1997). At this stage, large organizations typically opt to employ professional managers to lead them instead of relying on the entrepreneurial founders who initially established them. Moreover, they tend to employ bureaucratic control systems rather than relational control systems. Once a firm exceeds a certain size threshold, it must abandon personal relationships and use qualitative information and instead rely more on quantitative information (Cole, Goldberg, and White, 2004). Beyond that limit, firms may lack the field-level human intelligence required to select viable investment opportunities, monitor portfolio firms, or evaluate PE funds. Thus, large institutional investors with bureaucratic tendencies may be less inclined to invest in illiquid assets and lose their ability to ensure better returns, as shown by Bauer, Cremers, and Frehen (2010) and Beckers and Vaughan (2001).

However, we contend that there is a finite extent to this inclination. Owing to certain advantages, a rise in the scale of institutional investors' enterprises past a particular threshold is likely to enhance the probability of engaging in PE investments. Drawing from the work of Fiet and Fraser (1994), we classify total risk into two categories: unsystematic and systematic. Unsystematic risk includes market and agency risks, while systematic risk encompasses market risk and risks associated with the economy. Market risks are related to industry and geography, while agency risks are deal-specific idiosyncratic risks such as adverse selection and moral hazard, which are independent of the market or context environment. Large firms are better at dealing with systematic and market risks, whereas small firms are better at coping with unsystematic risks. Whereas intermediate-sized firms are neither large enough to effectively execute diversification or achieve scale economies nor small enough to depend on qualitative information and market niches.

Intermediate-sized firms find themselves in a quandary, as they subject themselves to bureaucratic procedures akin to large firms, yet they do not benefit from the specialized advantages enjoyed by either smaller firms or their larger counterparts highlighted above. Indeed, intermediate-sized firms are devoid of the distinctive attributes observed in small firms, such as the capability to cater to specific market niches and other characteristics, including relational capital, personal connections, and reliance on qualitative information. These attributes serve as effective risk mitigation mechanisms, helping small firms to mitigate agency risks. Similar to large

firms, intermediate-sized firms face constraints imposed by "bureaucratic procedures" or "transactional capital," which hinder their ability to effectively manage idiosyncratic risks. However, these medium-sized firms do not possess sufficient scale to fully capitalize on the advantages accessible to industry giants.

As a result, we put forward the following hypothesis:

H1. The relationship between firm size and the firm's propensity to invest in PE is characterized by a U-shaped pattern. Initially, as firm size increases, there is a negative association with the decision to invest in PE. However, once a certain size threshold is surpassed, the relationship becomes significantly positive.

It is essential to distinguish between "between-group" and "within-group" theorizations when examining the U-shaped relationship. The former pertains to the comparison of firms of varying sizes, while the latter investigates the impact of a firm's growth in size over time on its propensity to invest in PE. Although both types of theorizations are desirable, the data in the present study only allows for between-group comparisons to determine the effect of firm size on the likelihood of investing in PE. Examining how a firm's size influences its investment in PE as it passes through various size thresholds over time is not feasible with the current data set (see Haans, Pieters, and He, 2015 for details about these theorizations).

2.2. Firm size, institutional context, and asset allocations in private equity

Practices in the PE sector vary considerably across nations and are primarily attributed to institutional differentials (Schwienbacher, 2008). We operationalize a favorable institutional context, one with strong legal and financial institutions and market openness.

2.2.1. Institutional and financial frameworks

It is well documented that legal institutions have a strong positive effect on financial investments, including PE, external financing, and firm growth (Claessens and Laeven, 2003; Cumming, Fleming, and Schwienbacher, 2006; Shahzad and David, 2010; Vanacker, Heughebaert, and Manigart, 2014; Khan, Khan, and Hameed, 2020). The rationale is that firms in strong legal frameworks face fewer problems associated with transaction costs, agency risks, and information asymmetry (Aguilera and Jackson, 2003; Shahzad and David, 2010; Grilli, Mrkajic, and Latifi, 2018; Bellavitis, Cumming, and Vanacker, 2019). There is ample evidence documenting that firms, particularly PE firms, flourish in environments characterized by enhanced financial development. Such environments enable easier access to financing, as demonstrated by Claessens & Laeven (2003) and Da Gbadji et al. (2015) and reduce the cost of capital, as demonstrated by Rajan & Zingales (1998). Developed financial systems also alleviate financial constraints, as indicated by Love (2003) and mitigate the problem of investment inefficiencies such as overinvestment in firms (Stein, 2003). In a developed financial system, firms encounter fewer problems related to transaction costs, information asymmetry (Gazdar & Cherif, 2015; Levine, 2005; Naeem & Li, 2019) and agency risks (Hoshi, Kashyap, and Scharfstein, 1990; Beck and Levine, 2004).

This suggests that firms may encounter difficulties when attempting to make PE investments in societies characterized by weak legal and financial frameworks. In particular, smaller firms may lack the capability to effectively leverage the advantage of mitigating idiosyncratic risks through information advantage and lending relationships. Smaller firms may not be protected enough to invest in risk capital when transaction costs, agency risk, and information problems are high. Beck, Demirgüç-Kunt, & Maksimovic (2005) reveal that small firms are the most impacted segment in terms of growth when faced with challenges of legal and financial underdevelopment.

Indeed, the costs of information processing, information definition, and protection of property rights rise within weak legal frameworks (World Development Report, 2002) that compel firms to bypass markets and internalize exchanges (Scott, 2008). Nielsen (2008) suggests that dependence on external professional managers involves partnerships and syndication, consequently leading to principal-principal agency risks. As a result, effective governance mechanisms are necessary to mitigate the specific risks associated with this situation. This means that firms are likely to avoid the use of intermediaries for PE allocations in weak governance structures. In particular, smaller firms are often hesitant to rely on market intermediaries in high-risk environments. It is well-established that these firms struggle to reap cost advantages through the internalization of capital allocations and management, primarily because the internalization process entails extensive due diligence and monitoring, which may be impractical for small firms (Andonov, 2022). Consequently, smaller firms might decide against investing capital in PE when operating within frameworks characterized by weak financial and legal settings.

On the other hand, large firms may still exploit various advantages such as diversification, access to a sizable customer base, and the ability to enforce contracts in weak legal frameworks. Large firms have the capacity to cope with agency and transaction costs by internalizing exchanges, particularly regarding due diligence and monitoring. Indeed, larger institutional investors have witnessed a notable surge in direct PE investments bypassing intermediaries, irrespective of institutional and financial systems (Fang, Ivashina and Lerner, 2015). Research shows that, unlike small firms, the financing structure of large firms is not dependent on the development of financial institutions (Demirgüç-Kunt and Maksimovic, 1999). Thus, we propose that small firms may not enjoy any advantage in investing in weak institutional environments.

2.2.2. Market openness

Market openness is a metric that captures the degree of openness in a country's trade, investment, and financial sectors. Previous research has indicated that market openness plays a crucial role in financial development. For instance, Chinn and Ito (2006) have shown that both capital and goods markets are significant for equity investments, but the impact of capital market liberalization depends on the degree of goods market liberalization and banking system development. Baltagi, Demetriades, and Law (2009) have

Table 1
Descriptive statistics.

PANEL A: All Firms	N	Mean	SD	Median	Min	Max	p1	p5	p25	p75	p95	p99
Dependent Variable												
Firm Level												
Investment in PE	65,085	0.084	0.278	0	0	1	0	0	0	0	1	1
Independent Variables												
Firm Level												
Firm Size	65,085	27,322	175,000	261	0.511	2,100,000	0.565	2.18	44.55	1878	59,265	711,000
External Financing	65,085	0.005	0.022	0	0	0.183	0	0	0	0.001	0.017	0.183
Internal Financing	65,085	−0.028	0.726	0.052	−5.171	0.83	−5.171	−0.693	0.005	0.166	0.552	0.83
Profitability	65,085	0.046	0.052	0.042	−0.044	0.135	−0.044	−0.044	0.012	0.081	0.135	0.135
Country Level												
Property Rights	65,085	64.665	24.489	70	10	97.1	20	20	50	90	90	93.7
Financial Institutions Index	65,085	0.56	0.318	0.615	0.033	1	0.069	0.104	0.266	0.873	1	1
Market Openness	65,085	65.657	18.056	67	13.333	91.667	28.533	37.867	48.267	82.533	90	90
ICT Penetration	65,085	3.296	1.449	3.869	−9.006	4.605	−2.593	0.588	2.708	4.324	4.515	4.552
GDP Growth	65,085	3.798	3.261	3.457	−14.814	26.171	−5.619	−1.514	1.975	5.987	8.498	11.957
GDP Per Capita	65,085	24,065	21,582	24,439	258	124,000	443	781	2,960	41,500	58,041	86,548
Rate of Self-Employment	65,085	3.454	2.009	3.09	0.22	17.88	0.28	0.96	1.86	4.62	6.86	8.34
Human Capital Index	65,085	2.853	0.641	2.87	1.36	3.974	1.707	1.827	2.306	3.483	3.719	3.758

PANEL B: Firms not investing in PE	N	Mean	SD	Median	Min	Max	p1	p5	p25	p75	p95	p99
Independent Variables												
Firm Level												
Firm Size	59,612	28634.96	180,000	279.49	0.511	2,100,000	0.596	2.187	47.129	1985.805	64043.83	763,000
External Financing	59,612	0.299	38.251	0	0	9117.188	0	0	0	0.001	0.016	0.166
Internal Financing	59,612	−0.336	8.091	0.052	−815.25	15.875	−5.343	−0.624	0.006	0.163	0.535	0.83
Profitability	59,612	0.029	0.3	0.042	−15.397	14	−0.632	−0.131	0.013	0.081	0.185	0.339
Country Level												
Property Rights	59,612	64.02	24.578	70	10	97.1	20	20	50	90	90	93.7
Financial Institutions Index	59,612	0.552	0.316	0.6	0.033	1	0.069	0.103	0.254	0.866	0.985	1
Market Openness	59,612	65.181	18.05	65.667	13.333	91.667	28.533	37.867	47.967	81.267	90	90
ICT Penetration	59,612	3.266	1.463	3.834	−9.006	4.605	−2.648	0.574	2.676	4.319	4.507	4.552
GDP Growth	59,612	3.86	3.259	3.645	−14.814	26.171	−5.619	−1.135	2.046	6.014	8.498	12.15
GDP Per Capita	59,612	23464.99	21448.28	23206.57	258.471	124,000	441.999	780.19	2723.822	40991.81	57644.48	86547.67
Rate of Self-Employment	59,612	3.442	1.996	3.11	0.22	17.88	0.28	0.94	1.83	4.61	6.86	8.27
Human Capital Index	59,612	2.834	0.637	2.821	1.36	3.974	1.68	1.815	2.298	3.471	3.711	3.758

PANEL C: Firms investing in PE	N	Mean	SD	Median	Min	Max	p1	p5	p25	p75	p95	p99
Independent Variables												
Firm Level												

(*continued on next page*)

Table 1 (*continued*)

PANEL A: All Firms

	N	Mean	SD	Median	Min	Max	p1	p5	p25	p75	p95	p99
Firm Size	5473	13025.68	106,000	112.896	0.511	2,100,000	0.511	2.029	29.533	800.61	27032.71	298,000
External Financing	5473	0.363	14.794	0	0	1033.745	0	0	0	0.002	0.034	0.657
Internal Financing	5473	−0.576	11.231	0.051	−595.711	5.427	−8.254	−1.636	−0.038	0.207	0.685	0.937
Profitability	5473	−0.003	0.399	0.037	−16.07	6.426	−1.04	−0.309	−0.011	0.083	0.206	0.379
Country Level												
Property Rights	5473	71.683	22.322	86.9	10	97.1	20	30	50	90	90	93.8
Financial Institutions Index	5473	0.647	0.319	0.716	0.045	1	0.071	0.112	0.309	0.93	1	1
Market Openness	5473	70.842	17.285	78.667	13.333	91.667	31.067	40.333	57.4	85.7	88.867	90
ICT Penetration	5473	3.62	1.242	4.184	−5.307	4.605	−1.297	1.032	3.243	4.426	4.522	4.552
GDP Growth	5473	3.125	3.203	2.762	−14.814	21.347	−5.619	−2.5	1.695	4.855	8.296	11.185
GDP Per Capita	5473	30605.3	21954.54	35808.44	389.543	124,000	451.573	987.41	7020.338	43790.73	62511.69	90712.8
Rate of Self-Employment	5473	3.586	2.147	3.01	0.22	17.88	0.31	1.05	2.43	4.69	6.91	13.38
Human Capital Index	5473	3.059	0.652	3.283	1.434	3.974	1.775	1.9	2.476	3.644	3.742	3.758

The *Firm Size* is total assets of the firm in millions USD; *Profitability* is the ratio of the annual returns to total assets of the firm; *Internal Financing* is ratio of retained earnings to total assets of the firm; *External Financing* is the ratio of the total debt to total assets of the firm; *Property Rights* is the index from weakest as 0 to strongest as 100; *Financial Institutions Index* is the index that ranges from weakest as 0 to strongest as 1; *Market Openness* is the index that ranges from weakest as 0 to strongest as 100; *ICT Penetration* is the use of internet per 100 people; *GDP Growth* is the annual growth in GDP; and *GDP Per Capita* is GDP per person at current USD; *Rate of Self-Employment* is the % of employers to total employment; *Human Capital Index* the years of schooling and returns to education. All the Level-1 predictors have undergone winsorization, where the top and bottom 1% of values were replaced with values from the 1st and 99th percentiles, respectively.

found that the opening of both capital and goods markets is essential for the growth of the banking industry. Additionally, a recent study on Chinese market by Peng et al. (2021) has demonstrated that liberalizing the capital market significantly reduces over-investment in privately owned firms that have no previous foreign backing. It is reasonable to expect that market openness may have a positive effect on the propensity of institutional investors to allocate assets to PE. But how will small and large firms behave similarly in both closed and open markets? The advantages available to large firms may work in closed markets not necessarily because of their ability to internalize investment management but because of their monopoly over power.

We leverage Rajan and Zingales's (2003) interest group theory of financial development, which holds that prominent industrial and financial entities oppose financial transparency and disclosures in order to maintain their market dominance and avoid competition within an economy. While exerting their monopoly power and enjoying preferential access to funds, established corporations extract economic rents at the expense of new entrants in the economy. They fiercely defend the status quo in order to safeguard the continued relevance of their accumulated relational and human capital and the technology they have invested in. On the other hand, small new entrants lack the ability to obtain financing without collateral and thus rely on large incumbents to fund their projects or get acquired by these incumbents. We posit that enhanced market openness will confer advantages upon small firms endeavoring to engage in PE investments, as it will bestow upon them greater access to information, increased competition, and reduced barriers to entry.

Conversely, large incumbent firms that rely on their established market power, relationships, and proprietary knowledge to maintain their position may be more inclined to invest in PE when trade and capital flows are restricted, protecting their existing rents and limiting competition from new entrants. It is noteworthy that intermediate-sized firms are anticipated to allocate fewer assets within private equity markets regardless of the institutional, financial, and market systems in place, as they lack the advantages necessary to capitalize on such opportunities. Our hypothesis is as follows:

H2. The likelihood of small firms investing in PE is higher in favorable institutional environments, while the likelihood of large firms investing in PE is higher in unfavorable institutional environments.

2.3. Control variables

Entrepreneurial finance is influenced by a large variety of factors, and the selection of control variables needs explicit explanation that is embedded in both theory and the existing literature (Maula & Stam, 2019). The decision to invest in PE depends on several firm-level factors, which might include the financial position of the firm or human capital endowments (Zhang et al., 2024). Demirgüç-Kunt and Maksimovic (1998) show that in countries with well-established institutions, firms rely more on long-term external financing, partly because firms in such environments face lower profitability. Fund managers tend to display optimistic and overconfident biases on the prospects of the growth and riskiness of a firm with internal financing, which influences important investment and financing decisions (Kamoto, 2014). Similarly, the high profits of institutional investors could encourage firms to diversify their financial investment portfolios.

Table 2
Industry-wise summary statistics of firms offering PE.

Industry Classifications	NAIC*	PE = 0	P = 1	Total
Securities, Commodity Contracts, and Other Financial Investments and Related Activities	523	3,145	560	3,705
Property Lease & Valuations	531	9,131	165	9,296
Sales Financing	5222	805	13	818
Banking	5231	136	26	162
Misc. Intermediation	5239	142	27	169
Insurance	5241	3,186	16	3,202
All Other Financial Investment Activities	52,399	39	20	59
Land Subdivision	237,210	7,822	38	7,860
Commercial Banking	522,110	10,921	575	11,496
Savings Institutions	522,120	172	11	183
Sales Financing	522,220	550	21	571
Consumer Lending	522,291	767	24	791
Real Estate Credit	522,292	557	12	569
Other Non-Depository Credit Intermediation	522,298	2,117	134	2,251
Investment Banking and Securities Dealing	523,110	567	151	718
Securities Brokerage	523,120	3,043	465	3,508
Security and Commodity Exchanges	523,210	251	19	270
Investment Advice	523,930	386	31	417
Miscellaneous Financial Investment Activities	523,999	4,992	1,980	6,972
Direct Life Insurance Carriers	524,113	787	31	818
Open end Investment Funds	525,910	1,232	86	1,318
Other Financial Vehicles	525,990	4,575	1,039	5,614
Lessors of Non-Residential Buildings (except Mini Warehouses)	531,120	4,021	24	4,045
Offices of Real Estate Agents, Brokerage, and Brokers	531,210	268	5	273
	Total	**59,612**	**5,473*** **	**65,085** **

*North American Industry Classification Code, **All the firm-year observations, ***All the firm-year observations that has PE = 1. The table offers statistics of the firms belonging to different categories in the financial sector. For instance, there are total of 575 commercial banks investing in private equity (PE = 1) compared to 10,951 commercial banks not investing in private equity (PE = 0).

Previous studies show that investment in PE is associated with country-level characteristics such as a macroeconomic environment (Ning, Wang, and Yu, 2015), digitization, and entrepreneurial opportunities (Khan et al., 2021; Khan et al., 2020). Venture capital and PE are also associated with human capital development (Bottazzi, Da Rin, and Hellmann, 2008), informal economic activity (Khan et al., 2023), and depth of financial institutions (Khan & Khan, 2022). We use external financing, internal financing, firm profitability, GDP growth, GDP per capita, the human capital index, and the rate of self-employment as control variables.

3. Methodology

3.1. Data and descriptive statistics

3.1.1. Dependent variable

The dependent variable of the study is the firm's propensity to allocate assets to PE. Investment in PE is represented as a binary variable that has been derived from firms' descriptions. The current paper uses firm-level fundamental data from Compustat Global, offered by Wharton Research Data Services (WRDS). Firms that indicated investment in venture capital and/or private equity were assigned a score of 1, regardless of whether or not they were investing in other asset classes such as investment banking, public equities, real estate, and so forth. Conversely, firms that solely mentioned investments in other types of public or private domains without any reference to venture capital or private equity, received a score of 0. Since we are investigating the institutional investors that make PE investments as limited partners, we have removed all the firms that are potentially registered as venture capital and/or private equity firms. We broadly define 'institutional investors' to include all financial services firms and those that have taken a variety of forms, including banks, pension funds, mutual funds, insurance companies, real estate, sales financing, investment advice, and so forth. Venture capital and private equity firms are intermediaries that raise funds from institutional investors and invest as general partners by raising funds.

It is important to mention that the sample we used does not include pension funds or endowment funds, instead we use financial services firms that offer variety of services in banking and asset management. Our research differs by not including funds investing in private equity, focusing instead on the investigation of "publicly traded" financial firms that consist of banks and asset management companies complementing private/un-listed funds. These are the companies that are engaged in variety of services including pension services, insurance services, commercial banking, and so forth. So of course, these firms may be large conglomerates having their own subsidiaries or smaller ones focused on a single service such as commercial banking. From the perspective of the dependent variable, the study draws comparisons between institutional investors who invest in PE and those who do not. Compustat Global is a comprehensive source of data of public companies that offers accounting information such as external and internal financing, profitability, and so forth.

3.1.2. Independent variables

The present paper employs Scott and Martin's (1975) measure of firm size, which is based on the total assets at book value. This choice of measurement is aligned with prior studies investigating the association between size of institutional investor and allocation of assets in PE. For instance, Andonov, Bauer, and Cremers (2017) used the measure of total pension fund assets, while Andonov (2022) utilized assets under management as indicator of institutional investor size. This paper utilizes the Heritage Foundation's variable of Property Rights to capture the strength of a legal framework and the Heritage Foundation's Market Openness measure to capture the efficiency of market institutions.

The Property Rights variable measures the degree to which state institutions firm enable individuals to acquire, maintain, and exploit private property through effective laws and their enforcement. Market Openness covers Trade Freedom, Investment Freedom, and Financial Freedom. Trade Freedom measures the degree to which a country imposes tariff and nontariff restrictions on imports and exports of goods and services. Investment Freedom is a composite measure of the extent to which investment capital is free to flow into and out of activities in all industries, both within the country and across borders. Financial Freedom takes into account the banking industry and the autonomy of the financial sector, whether the financial institutions, central bank, and financial markets are owned, controlled, or interfered by the government. For Financial Institution Index, the paper employs the IMF World's Financial Institution Depth (Svirydzenka, 2016). Financial Institution Depth represents the overall activity undertaken by financial institutions, namely Private-Sector Credit to GDP, Pension Fund Assets to GDP, Mutual Fund Assets to GDP, and Insurance Premiums — life and non-life — to GDP. The control variables have been taken from different sources and are both at the firm level and country level. The variable descriptions and data sources have been presented in Appendix 1.

3.1.3. Descriptive statistics

The summary statistics are displayed in Table 1 (panels A, B and C). Initially, the dataset encompassed 6,974 companies across 64 countries from 1987 to 2017, with a total of 96,252 observations. However, due to missing data in certain variables, the dataset was not standardized. After excluding these missing values, the final dataset consisted of 5,668 firms spanning 52 countries, with 65,085 firm-year observations covering the period from 1991 to 2017. This resulted in a final sample with 8.4 % of the firms being involved in PE compared to initial 9 %. The dropped missing values did not change our results.

To mitigate the impact of outliers, we have employed a winsorization technique on all the Level-1 predictors, which involves replacing extreme values with winsorized values from the 1st and 99th percentiles. Specifically, Firm Size has undergone winsorization, resulting in a range from a minimum value of US$0.565 million to a maximum value of US$2,100,000 million in Panel A. This process helps ensure that extreme values do not disproportionately influence the analysis, providing a more robust and reliable dataset

Table 3
Country-wise frequencies and summary statistics of firms offering PE.

#	Country	PE = 0	PE = 1	All observations	#	Country	PE = 0	PE = 1	All observations
1	Australia	2,885	159	3,044	29	Malaysia	2,284	123	2,407
2	Austria	308	34	342	30	Mauritius	189	36	225
3	Bangladesh	838	41	879	31	Netherlands	610	32	642
4	Belgium	371	42	413	32	Nigeria	653	34	687
5	Brazil	1,069	47	1,116	33	Norway	548	6	554
6	China	3,883	213	4,096	34	Pakistan	1,204	51	1,255
7	Cyprus	331	41	372	35	Peru	383	19	402
8	Denmark	957	29	986	36	Philippines	1,162	18	1,180
9	Egypt	494	81	575	37	Portugal	126	13	139
10	Finland	247	42	289	38	Qatar	249	8	257
11	France	1,102	113	1,215	39	Romania	175	26	201
12	Germany	2,473	316	2,789	40	Russia	386	35	421
13	Ghana	115	26	141	41	Saudi Arabia	489	33	522
14	Greece	396	39	435	42	Singapore	1,190	59	1,249
15	Hong Kong	3,653	205	3,858	43	South Africa	1,053	109	1,162
16	Iceland	117	3	120	44	Spain	650	40	690
17	India	7,125	519	7,644	45	Sri Lanka	803	77	880
18	Indonesia	1,839	25	1,864	46	Sweden	770	150	920
19	Ireland	155	13	168	47	Switzerland	1,052	268	1,320
20	Israel	1,465	154	1,619	48	Thailand	1,738	53	1,791
21	Italy	797	100	897	49	Trinidad and Tobago	61	15	76
22	Japan	401	15	416	50	Tunisia	284	32	316
23	Kenya	241	19	260	51	Turkey	982	80	1,062
24	Kuwait	1,076	162	1,238	52	United Arab Emirates	778	32	810
25	Lithuania	51	30	81	53	United Kingdom	8,560	1,595	10,155
26	Luxembourg	194	49	243	54	Viet Nam	650	12	662
						Total	**59,612**	**5,473**	**65,085**

The table represents the summary statistics of firms distributed on the basis whether the firm has invested in private equity (equal 1) or not (equal 0) for each country. For instance, Australia has 2,885 firms that does not invest in private equity compared to 159 firms that invest in private equity.

for our study. The mean Firm Size (winsorized) in our sample is US$27,322 million and the median firm has assets worth US$261 million. The relatively high standard deviation of US$175,000 million indicates that the firm sizes in the dataset are highly varied and spread out. This significant level of variability in firm sizes, with extremely small and extremely large, meets our aim of properly comparing small and large firms for their allocations in PE.

In Panel B, we present descriptive statistics for firms that are not investing in PE, while in Panel C, we focus on firms that are investing in PE. Notably, the mean firm size for firms investing in PE is significantly smaller, with an average of USD 13,025.68 million, compared to firms not investing in PE, which have an average firm size of USD 28,634.96 million. This indicates that, on the whole, firms engaged in PE investments tend to be smaller than those that are not. Although the minimum and maximum values are the same in both panels due to winsorization, the value at the 99th percentile is higher for firms not investing in PE. However, the substantial standard deviation in both groups highlights the heterogeneity in terms of firm size within each group.

The variable Property Rights varies between a minimum value of 10, indicating weak property rights protection frameworks, and a maximum value of 97.1, representing strong property rights protections. The relatively large standard deviation of 24.489 indicates substantial variability in the property rights index among different countries. This variability provides an opportunity to investigate how Firm Size may interact differently with PE investments across various institutional settings. For Financial Institutions Index, the variable ranges from a minimum value of 0.027 to a maximum value of 1, with a mean value of 0.563. The standard deviation of 0.3 indicates a significant heterogeneity in the quality or development of financial institutions among the countries. The Market Openness variable ranges from a minimum value of 13.333 to a maximum value of 91.667. On average, the countries in the sample have a market openness index of 64.811, with a standard deviation of 17.79, suggesting a significant level of variation in the degree of openness across the countries.

Table 2 displays the institutional investors under investigation. The first column describes the sector of the firm, whereas the second column reports the North American Industry Classification Code. The third column displays the firm-year observations of all the firms under investigation, whether they offer PE or not, along with the percent in the next column. Then, we show all the firm-year observations that invest in PE. It shows that firms labeled as "Commercial Banking", "Miscellaneous Financial Investment Activities", and "Other Financial Vehicles" have more involvement in PE.

Table 3 shows the countries under investigation that display total observations in a country, observations with PE = 0, and observations with PE = 1. The United Kingdom and India demonstrate the highest number of PE activities, respectively. The correlation matrix shown in Table 4 shows that Property Rights, Market Openness, Financial Institutions, and the Human Capital Index are highly correlated to one another. To avoid multicollinearity, we do not use variables of interest together in a single model, as suggested by Wooldridge (2016). Firm Size is negatively correlated, whereas Property Rights, Market Openness, and Financial Institutions are positively correlated with the dependent variable.

Table 4
Matrix of correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Dependent Variable													
(1) Propensity to invest in PE	1.000												
Firm-Level Predictors													
(2) Firm Size	−0.025	1.000											
(3) External Financing	0.000	−0.001	1.000										
(4) Internal Financing	−0.008	0.007	−0.308	1.000									
(5) Profitability	−0.028	0.009	−0.055	0.322	1.000								
Firm-Level Predictors													
(6) Property Rights	0.087	0.025	0.007	−0.017	−0.072	1.000							
(7) Financial Institutions Index	0.083	−0.003	0.008	−0.024	−0.066	0.820	1.000						
(8) Market Openness	0.087	0.028	0.008	−0.024	−0.078	0.855	0.814	1.000					
(9) ICT Penetration	0.068	−0.009	0.005	−0.022	−0.056	0.462	0.566	0.635	1.000				
(10) GDP Growth	−0.063	−0.041	−0.014	0.013	0.067	−0.440	−0.410	−0.503	−0.357	1.000			
(11) GDP Per Capita	0.092	0.015	0.006	−0.022	−0.074	0.770	0.682	0.774	0.626	−0.444	1.000		
(12) Rate of Self-Employment	0.020	0.081	0.001	−0.020	−0.026	0.324	0.334	0.421	0.284	−0.274	0.265	1.000	
(13) Human Capital Index	0.097	0.013	0.008	−0.025	−0.067	0.781	0.818	0.836	0.678	−0.486	0.779	0.360	1.000

The *Firm Size* is total assets of the firm in USD millions; *Profitability* is the ratio of annual returns to total assets of the firm; *Internal Financing* is ratio of retained earnings to total assets of the firm; *External Financing* is the ratio of the total debt to total assets of the firm; *Property Rights* is the index from weakest as 0 to strongest as 100; *Financial Institutions Index* is the index that ranges from weakest as 0 to strongest as 1; *Market Openness* is the index that ranges from weakest as 0 to strongest as 100; *ICT Penetration* is the use of internet per 100 people; *GDP Growth* is the annual growth in GDP; and *GDP Per Capita* is the natural logarithm of the GDP per person at current USD; *Rate of Self-Employment* is the percentage of employers to total employment; *Human Capital Index* the years of schooling and returns to education at country level.

3.2. Research design

The current study involves potential clustering at firm level and country level, and, therefore, two-level logistic regression (also called mixed-effects models or hierarchical models) has been employed. Multilevel mixed effects analysis enables researchers to investigate the impact of variables at different levels, such as lower-level factors and higher-level factors, and examine interrelationships at both levels through a cross-level interaction (Sommet & Morselli, 2017). The application of multilevel analysis enables the incorporation of clustering effects within countries, effectively controlling for the non-independence of observations (Snijders & Bosker, 2012) and potentially resulting in unbiased standard errors and reliable regression coefficients (Rabe-Hesketh and Skrondal, 2012; Schmutzler, Andonova, and Diaz-Serrano, 2018). The multilevel design allows us to explore the variability in the effect of institutional contexts across countries (Hox, 2010). Moreover, the utilization of multilevel mixed effects structures helps us to avoid the individualistic fallacy of disregarding the broader context surrounding individuals and simultaneously circumvent the ecological fallacy, which assumes a direct reflection of collective-level variables in individual behavior (Peterson, Arregle, and Martin, 2012; Stenholm, Acs, and Wuebker, 2013; Schmutzler, Andonova, and Diaz-Serrano, 2018).

Level-1 predictors, also known as Firm-Level or Lower-Level Predictors, encompass variables such as External Financing, Firm Size, and Firm Profitability. Level 2 predictors, also referred to as Higher-Level or Country-Level Predictors, encompass variables such as Property Rights, Financial Institutions Index, Market Openness, and GDP Per Capita, among others. Level-1 data is nested within Level-2 data. To proceed with two-level logistic modeling, the current research employs the three-step methodology of Sommet and Morselli (2017), which involves certain tests as well as the specification of the final two-level model. As an initial step to assess the performance of two-level logistic modeling compared to single-level logistic regression modeling, an empty model is employed. The intercept-only model solely consists of an intercept term and does not include any predictors. The purpose of this model is to estimate the baseline probability or chance of observing a value of 1 (indicating the presence of PE) rather than zero (indicating the absence of PE) across different countries. The combined intercept-only equation for Level 1 and Level 2 is as follows:

$$logit = B_{00} + \mu_{0j} \tag{1}$$

where logit is the chance that a firm i from a country j invests in PE. The unconditional model[2] reflects the modeling between-country variation in logits, where B_{00} denotes the grand mean of country intercepts or fixed intercepts and μ_{0j} represents the difference between country j's intercept and the grand mean, or, in other words, the deviation of the group or country-specific intercept from the overall or fixed intercept. The term μ_{0j} computes the random intercept variance that takes into account the extent to which coefficients of intercept can vary from one country to another.

The second step is to develop a constrained intermediate model (CIM) and an augmented intermediate model (AIM) and test if AIM causes any significant improvement in the model. A CIM equation (also called a random intercept model) having two levels (i.e., the firm level, which is Level 1, and the country level, which is Level 2) would be:

$$logit = B_{00} + B_{10}(f_{ij} - \bar{f}) + B_{01}c_j + \mu_{0j} \tag{2}$$

for j = 1 … K countries, with i = 1 … n firms in a country j. In the current study, K is 52, n varies from one cluster to another, while the N is 65,085. The notation f_{ij} is the observed value of the predictor variable (e.g., the size of a firm i in a country j), whereas c_j denotes country-level predictors (e.g., GDP Growth, the property rights in country j). The firm-level predictors have been grand-mean centered by deducting the observed value f_{ij} from the grand mean $\bar{f}$. The symbol B_{00} measures the fixed intercept (i.e., the chance that a firm i in a country offers PE services when the value of B_{10} andB_{01} = zero). Moreover, the model encompasses fixed slope B_{10} of the firm-level predictors f_{ij}. Finally, B_{01} signifies the fixed slope of the relationship between country-level variables c_j and the chance that a firm offers PE services.

To test H1, we can modify Eq. (2) by adding a quadratic function for Firm Size.

$$logit = B_{00} + B_{10}(f_{ij} - \bar{f}) + B_{01}c_j + B_{11}[(f_{ij} - \bar{f}) \times (f_{ij} - \bar{f})] + \mu_{0j} \tag{3}$$

Further, we can modify Eq. (3) to include the random slope variance μ_{1j} of the firm-level predictors f_{ij} to determine the extent of the effect of variation across clusters. The challenge in multilevel modeling is that such data structures violate the assumption of independence of the residuals (Bressoux, 2010; Sommet, and Morselli, 2017). Moreover, the endogeneity of Level-1 predictors also arises from the unobserved cluster effects, particularly when the random effects at the country level are correlated with the firm-level predictors, which violates the basic working assumption of the multilevel analysis (Antonakis, Bastardoz, and Rönkkö, 2019). Previous work has often disregarded the assumption made in the random effects modeling that the μ_{1j} (random intercept or Level 2 error term) is uncorrelated with the Level-1 predictors, which gives rise to endogeneity (Antonakis, Bastardoz, and Rönkkö, 2019). This paper addresses the endogeneity concerns as suggested by Antonakis, Bastardoz, and Rönkkö (2019), where country-level characteristics, such as property rights, may be correlated with the characteristics of the firms as well as the outcomes of the firms, including the decision to invest in PE. In the present study, the firm-level variables have been cluster-mean-centered for random slope models, as we are also interested in the relative (within-cluster) effect of a firm-level variable to achieve relative effects apart from the between-observations effect (Sommet & Morselli, 2017). However, Antonakis, Bastardoz, and Rönkkö (2019) cautioned against the use of solely

[2] Because there are no predictors.

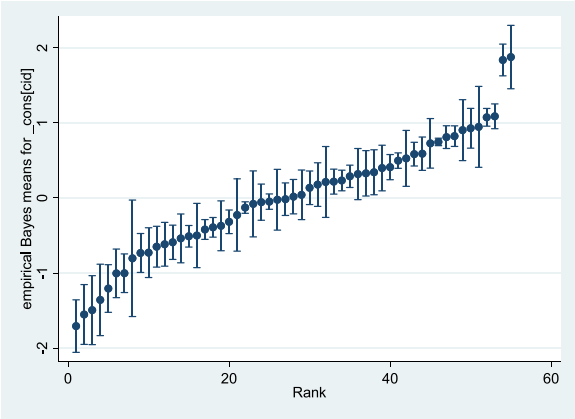

Fig. 1. Added value scores for 52 countries with comparative posterior confidence intervals. The figure is derived from the empty model and serves to rank the countries included in the sample based on their posterior means. Countries positioned higher in the ranking indicate greater opportunities for firms to allocate assets to PE compared to countries ranked lower.

cluster-mean centering as a method for addressing clustering effects. Instead, they suggested a correlated random effect approach (CRE), arguing that this assumption can be relaxed by adding cluster means.

Moreover, there is a substantial level of heterogeneity among the institutional investors due in part to differences in their organizational structures, sophistications, sizes, and objectives that they derive from sub-sectors within the financial industry; heterogeneity may affect their decisions to invest in PE (Lerner, Schoar, and Wongsunwai, 2007). Therefore, it is useful to include sectorial fixed effects to capture those variations. The general random slope model (i.e., AIM) with the CRE approach is as follows:

$$logit = B_{00} + \left(B_{10} + \mu_{1j}\right)\left(f_{ij} - \overline{f_j}\right) + B_{01}c_j + B_{20}(between)\overline{f_j} + B_{22}S_s + \mu_{0j} \tag{4}$$

In this AIM equation, random slope variance characterized by μ_{1j} corresponds to the degree of variation of the effect of a given firm-level predictor (the Firm Size, in our case) from one country to another. The representation μ_{1j} is the deviation of the cluster-specific slope of firm-level predictors within a country from a fixed slope, which is the average effect of firm-level predictors irrespective of country. When $\overline{f_j}$, which denotes the country-level mean, is deducted from the observed value of a Level-1 predictor i.e. Firm Size f_{ij}, the residual value fulfills cluster-mean centering. The coefficient B_{20} quantifies the impact of cluster-level means of Level-1 predictors on the outcome variable. It captures the average effect of these predictors across all clusters. On the other hand, the coefficient B_{22} captures the unobserved heterogeneity across financial sectorsrepresented by S_s, where s ranges from 1 to m sectors, with m=27. It measures how the investment in PE varies across different financial sectors.

In the third step, the final model adds a term for inter-level interaction effects[3] (i.e., interactions between a given Level-1 i.e., Firm Size, and a Level-2 predictor), which is as follows:

$$logit = B_{00} + \left(B_{10} + \mu_{1j}\right)\left(f_{ij} - \overline{f_j}\right) + B_{01}c_j + B_{23}\left(f_{ij} - \overline{f_j}\right) \times c_j + B_{20}(between)\overline{f_j} + B_{22}S_s + \mu_{0j} \tag{5}$$

where B_{23} denotes the slope of the relationship between the interaction term $\left(f_{ij} - \overline{f_j}\right) \times c_j$ and investment in PE.

In determining whether we should use the random slope model, we aimed to determine which Level-1 predictors should be tested for cross-country variations in their effect on the likelihood of firms' offering PE services. Regarding the first question, since we are also interested in relative (cross-country) effects in addition to absolute (between-observations) effects, we also use random slope models. Regarding the second question, some advocate the use of a maximum random effects structure (i.e., to test all lower-level predictors for their potential variation across clusters) (Barr et al., 2013), while others suggest a more parsimonious approach (Bates et al., 2018). We accept the suggestion of Sommet and Morselli (2017) that the use of a random slope variance needs to be embedded in theory. They argue for reliance on theoretical relevance before allowing any random coefficients to vary across clusters at a higher level. If a lower-level predictor has any theoretical relevance to the country-level characteristics, then random coefficients for that specific predictor should be added to the model. Theoretically, it is appropriate to contend that the Firm Size might, in part, correspond to Property Rights, Market Openness, and Financial Institutions Index at the country level, and, therefore, we allow the coefficients of the Firm Size to vary across countries.

Furthermore, we determine whether to add cross-level interaction terms to the random intercept model without including a random slope model. Previous studies performed both, and there are arguments on both sides about which is more appropriate.

[3] Sommet and Morselli (2017) explain that inter- or cross-level interactions cannot be used in intermediate models. In intermediate models, only intra-level interactions (i.e., between Level-1 predictors and/or between Level-2 predictors) are considered, but not cross-level interactions (i.e., between Level-1 and Level-2 predictors).

However, a recent study in the field of sociology has warned against using cross-level interactions in mixed models without including random slopes (Heisig & Schaeffer, 2019). Thus, cross-level interactions have been examined in random slope models only.

The current study uses the Wald ratio, which is the variance estimate divided by its standard errors, to assess the significance of the random effects. Because the current study is made up of a large sample, the Wald test is supposed to give results that are not alarmingly different from other tests, such as the chi-square test and likelihood ratio test, which are better when the sample size is small (Snijders & Bosker, 2012).

While there could be concerns about endogeneity, particularly regarding potential reverse causality where PE investment leads to larger Firm Size, we have two reasons to believe it may not be a significant issue. Firstly, we are not analyzing the quantity or frequency of investments, which could directly impact Firm Size. Secondly, it's important to note that PE investments are typically illiquid and have a long-term horizon. Once a firm allocates assets in PE, it tends to remain committed to the asset class for an extended period, irrespective of any variations in Firm Size over time. Considering these factors, the potential endogeneity concern regarding the influence of Firm Size on the propensity to invest in PE is mitigated. To address the issue of endogeneity arising from the correlation between Firm Size and the error term, we have employed an instrumental variable strategy using a probit model. We chose this approach due to the limitations of mixed effects models in addressing endogeneity.

Consider the following standard probit model:

$$P(Y_1 = 1) = \Phi\left(\beta_1 Y_2 + \beta 2 Y_2^2 + \gamma X1\right) \tag{6}$$

where $P(Y_1 = 1)$ represents the probability of Y_1 taking the value of 1 and Φ is the cumulative distribution function of the standard normal distribution, which transforms the linear combination of variables into a probability between 0 and 1. $\beta 1$, $\beta 2$, and γ are coefficients that represent the effect of Y_2, Y_2^2 and X_1 on the probability of Y_1 being 1. Y_1 denote PE dummy (0 or 1) which is the dependent variable; Y_2 and Y_2^2 symbolize Firm Size and Firm Size^2 respectively as endogenous regressors; exogenous regressors are represented by X_1. The instrumental variables probit (IV probit) model is presented with the same setup except the addition of the three instruments, that is, Firm Size in the year t-1, Firm Size^2 in the year t-1, and GDP Growth in the year t-1 as indicated by X_2, X_2^2 and X_3. Structural or second-stage equation for Y_1 is:

$$Y_1 = \beta_1 Y_2 + \beta_2 Y_2^2 + \gamma X1 + u \tag{7}$$

Where β_1, β_2 and γ are vectors of structural parameters and u is the error term. Reduced-form or first-stage equation for Y_2 and Y_2^2:

$$Y_2 = X_1\Pi_1 + X_2\Pi_2 + + X_2^2\Pi_3 + X_3\Pi_4 v \tag{8}$$

$$Y_2^2 = X_1\Pi_1 + X_2\Pi_2 + + X_2^2\Pi_3 + X_3\Pi_4 v \tag{9}$$

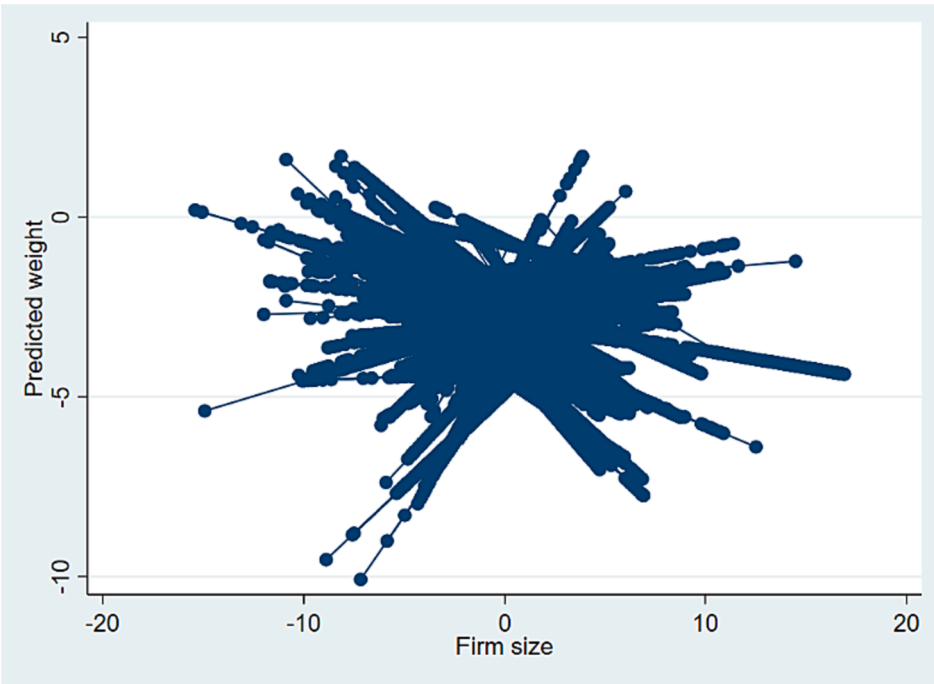

Fig. 2. Country level random slopes of Firm Size: Dependent variable is the likelihood that PE = 1. The figure is based on multilevel random slope univariate model. It represents industry-level random slopes of firm size for all firms. There is high level of randomness in the slopes across countries which imply that random slope models are relevant.

Table 5
Results of fixed-intercept (single-level) and random-intercept (multilevel) multivariate models: The dependent variable is the propensity to invest in private equity by institutional investors.

	Fixed-Intercept (1)	**Random Intercept** (2)	**Fixed-Intercept** (3)	**Random Intercept** (4)	**Random Intercept** (5)
FIXED EFFECTS					
Fixed Slopes					
Country Level Predictors					
Property Rights	−0.00147	0.0112***	−0.00105	0.0111***	0.00967***
	(0.00128)	(0.00303)	(0.00129)	(0.00306)	(0.00322)
ICT Penetration	−0.195***	−0.0882**	−0.192***	−0.0951**	−0.165***
	(0.0329)	(0.0423)	(0.0332)	(0.0427)	(0.0452)
Rate of Self-Employment	−0.0130	0.0350	−0.0116	0.0382	0.0446
	(0.00819)	(0.0268)	(0.00826)	(0.0279)	(0.0303)
GDP Growth	−0.496***	−0.118	−0.441***	−0.0845	−0.0788
	(0.0919)	(0.107)	(0.0918)	(0.107)	(0.114)
GDP Per Capita	0.0960***	−0.170**	0.112***	−0.182**	−0.344***
	(0.0310)	(0.0752)	(0.0311)	(0.0778)	(0.0867)
Human Capital Index	0.452***	0.231	0.395***	0.270	0.435**
	(0.0494)	(0.171)	(0.0496)	(0.178)	(0.195)
Firm Level Predictors					
External Financing	−4.674***	−5.024***	−8.440***	−10.92***	−5.811***
	(0.670)	(0.676)	(0.730)	(0.775)	(0.802)
Internal Financing	−0.00489	−0.0960***	0.0233	−0.0513**	−0.0523**
	(0.0205)	(0.0207)	(0.0206)	(0.0211)	(0.0221)
Profitability	−9.819***	−9.430***	−8.085***	−6.759***	−4.273**
	(1.764)	(1.837)	(1.770)	(1.855)	(1.869)
Firm Size	−0.136***	−0.110***	−0.388***	−0.112***	0.0125
	(0.00558)	(0.00639)	(0.0173)	(0.00580)	(0.00780)
Firm Size^2	–	–	0.0160***	0.0219***	0.0138***
	–	–	(0.00102)	(0.00118)	(0.00129)
Fixed Intercepts	24.44***	−4.332***	20.28***	−6.147***	−5.193***
	(4.921)	(0.783)	(4.934)	(0.822)	(1.017)
RANDOM EFFECTS					
Random Intercepts	–	0 0.4432***	–	0.5567***	0.7655***
	–	(0.0977)	–	(0.1219)	(0.1721)
Grand-Mean Centering	No	Yes	No	Yes	Yes
Industry Fixed Effects	No	No	No	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	65,085	65,085	65,085	65,085	65,085
Wald	1624	625.7	1840	974.8	3922
LL	−17975	−17543	−17867	−17385	−14837
Number of Countries	–	52	–	52	52
LR Test vs. Logistic Model	–	865.31***	–	945.06***	864.61***

The table examines the presence of a U-Shaped relationship between the Firm Size and the firm's propensity to invest in PE (H-1). In this analysis, all independent predictors are continuous variables. Firm Size, Profitability, GDP Growth, and GDP Per Capita have been transformed into natural logarithms. Column 1 and Column 3 show the Logistic Fixed Effect Models. Utilizing Eq. (3) Column 2, Column 4 and Column 5 demonstrate the Mixed Effects Random Intercept Models where the Level-1 predictors are Grand-Mean Centered. Significance of the LR test shows that Mixed Models are superior to the corresponding Single-Level Logistic-Regression Model of Column 1 and Column 3. Analysis is based on data without firms that are potentially registered as venture capital and private equity firms with NAIC Codes 523,910 and 523920. All Level-1 predictors have been winsorized with 1% of the top and bottom values. The *Firm Size* is total assets of the firm in millions; *Profitability* is the ratio of annual returns to total assets of the firm; *Internal Financing* is the ratio of retained earnings to total assets of the firm; *External Financing* is the ratio of the total debt to total assets of the firm; *Property Rights* is the index from weakest as 0 to strongest as 100; *Financial Institutions Index* is the index that ranges from weakest as 0 to strongest as 1; *Market Openness* is the index that ranges from weakest as 0 to strongest as 100; *ICT Penetration* is the use of internet per 100 people; *GDP Growth* is the annual growth in Log GDP; and Log *GDP Per Capita* is the natural logarithm of the GDP per person at current US$; *Rate of Self-Employment* is the percentage of employers to total employment; *Human Capital Index* represents the years of schooling and returns to education at country level. Standard errors were clustered at the country level to account for the potential correlation between firms within the same country. The country level was treated as a random intercept in the model, and the standard errors were adjusted accordingly. Standard errors are presented in parentheses and ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

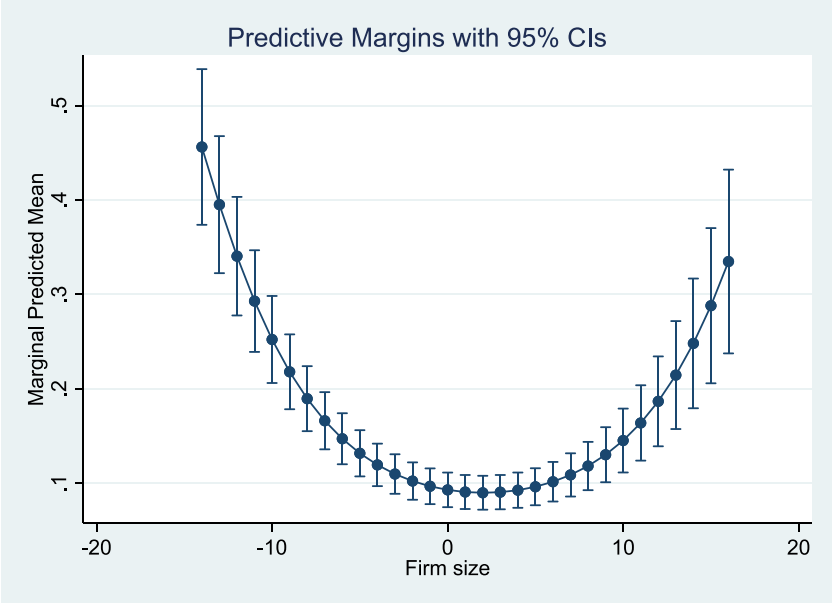

Fig. 3. Effect of Firm Size^2 on PE investment.

where Π_1, Π_2, Π_3, and Π_4 are matrices of reduced-form parameters and v is the error term. After adding interaction terms to test H-2, the modified form of equation (7) will be as under:

$$Y_1 = \beta_1 Y_2 + \beta_2 Y_2^2 + \beta_3 (Y_2 \times context) + \beta_4 \left(Y_2^2 \times context\right) + \gamma X1 + u \tag{10}$$

where "context" represents the contextual conditions, namely, Property Rights, Financial Institutions Index, and Market Openness.

4. Results

As a first step in implementing the three-step methodology, we run an empty model based on Eq. (1) and find that the LR test is highly significant with $\chi^2(1) = 1811.77$, indicating that incorporating the random intercepts in the current mixed effects represents a significant improvement in the fit relative to the single-level logistic regression. The LR test formally compares the mixed effects model with the pooled logistic regression model. Moreover, the interclass correlation is 0.1504, p = 0.0273, which is well above the conventional threshold of 0.05(Heck et al., 2014), reflecting substantial clustering. The chance that institutional investors allocate PE is 17 % dependent on the between-country differences and 83 % dependent on the within-country variations. Thus, there is evidence that multilevel logistic modeling is more useful than single-level standard binary logistic regression in our case.

It is informative to order countries based on their posterior means. Fig. 1 is based on the empty model. Countries high on the ranking are the ones where firms have more chances to raise PE funds compared to the countries low on the ranking. Since the sample size of some countries may not be large enough, it is appropriate to rely on confidence intervals rather than Level-2 residuals i.e., μ_{0j} (Snijders & Bosker, 2012). Though the lowest seven and highest two countries have a bit of outlier characteristics, the rest of the countries also demonstrate higher deviance. On average, confidence intervals for not more than 25 % of the countries overlap with each other, which show that country context significantly matters for firms investing in PE. The order should be helpful to policymakers because investment in PE is enormously dependent on context.

To visualize the randomness of slopes, we graphically demonstrate the slopes of Firm Size for each country based on univariate AIM or a multilevel random slope model (not reported for brevity). The random slopes have been plotted in Fig. 2, showing significant variations in the slopes of the relationship between Firm Size and investment in PE across countries. Countries' slopes for Firm Size demonstrate that some of them display a negative effect while others show a positive effect.

We test H1 for the behavior of firms of different sizes with respect to their asset allocations in Table 5. First, we run a base-line logistic regression model in Column 1 and, based on Eq. (3), a CIM (also called random intercept model) in Column 2. The likelihood ratio test exhibits LR, $\chi2(2) = 865.31$, $p < 0.000$ for CIM in Column 2, which indicates an improvement in the model after treating the intercept as random across countries compared to the single-level logistic regression of Column 1. We also employed Akaike's information criterion (AIC) and Bayesian information criterion (BIC) tests that confirm an improvement in the model after considering cross-cluster differences.

To test H-2, we run a single-level logistic regression model in Column 3 and a random intercept model in Column 4. The models have been controlled for year fixed effects but not industry fixed effects. The variable representing Firm Size^2 demonstrates statistical significance at the 1 % level, suggesting the presence of a U-shaped relationship. To fully comprehend the curvilinear nature of the

Table 6
Results of random-slope (multilevel) models: The dependent variable is the propensity to invest in private equity by institutional investors.

	Random Slope Models					
	(1)	(2)	(3)	(4)	(5)	(6)
FIXED EFFECTS						
Fixed Slopes						
Country Level Predictors						
Property Rights	0.00704**	–	–	0.00961***	–	–
	(0.00327)	–	–	(0.00353)	–	–
Financial Institutions Index	–	2.182***	–	–	1.247***	–
	–	(0.366)	–	–	(0.371)	–
Market Openness	–	–	0.0133***	–	–	0.00600
	–	–	(0.00450)	–	–	(0.00470)
ICT Penetration	0.0831***	0.0668**	0.0798***	−0.241***	−0.248***	−0.252***
	(0.0310)	(0.0307)	(0.0301)	(0.0468)	(0.0459)	(0.0455)
Rate of Self-Employment	−0.0320	−0.0230	−0.0244	0.0574*	0.0579*	0.0658**
	(0.0301)	(0.0303)	(0.0297)	(0.0319)	(0.0319)	(0.0321)
GDP Growth	−0.113	−0.0864	−0.0624	−0.132	−0.124	−0.112
	(0.0938)	(0.0942)	(0.0955)	(0.117)	(0.117)	(0.118)
GDP Per Capita	−0.312***	−0.345***	−0.363***	−0.348***	−0.314***	−0.316***
	(0.0735)	(0.0750)	(0.0767)	(0.0947)	(0.0933)	(0.0950)
Human Capital Index	0.534***	0.0144	0.472**	0.166	−0.0103	0.217
	(0.185)	(0.211)	(0.184)	(0.215)	(0.231)	(0.213)
Firm-Level Predictors						
External Financing	−1.084***	−1.049***	−0.926***	−1.137***	−1.085***	−0.983***
	(0.247)	(0.251)	(0.248)	(0.248)	(0.252)	(0.249)
Internal Financing	−0.00920	−0.00938	−0.0110	−0.0105	−0.0108	−0.0134
	(0.0231)	(0.0232)	(0.0231)	(0.0232)	(0.0233)	(0.0232)
Profitability	−4.088**	−5.243***	−4.091**	−4.617**	−5.066***	−4.709**
	(1.848)	(1.860)	(1.847)	(1.911)	(1.914)	(1.912)
Firm Size	0.243***	0.160**	0.363***	0.245***	0.164**	0.277***
	(0.0899)	(0.0755)	(0.101)	(0.0923)	(0.0768)	(0.103)
Firm Size^2	0.00619	0.00207	0.0323***	0.00518	0.00128	0.0296***
	(0.00655)	(0.00424)	(0.00824)	(0.00660)	(0.00423)	(0.00820)
Cross-Level Interactions		–	–			
Firm Size × Property Rights	−0.00299***	–	–	−0.00276**	–	–
	(0.00111)	–	–	(0.00114)	–	–
Firm Size^2 × Property Rights	−0.000212**	–	–	−0.000199**	–	–
	(9.12e-05)	–	–	(9.20e-05)	–	–
Firm Size × Financial Institutions Index	–	−0.215**	–	–	−0.194*	–
	–	(0.0999)	–	–	(0.102)	–
Firm Size^2 × Financial Institutions Index	–	−0.0202***	–	–	−0.0184***	–
	–	(0.00680)	–	–	(0.00678)	
Firm Size × Market Openness	–	–	−0.00470***	–	–	−0.00317**
	–	–	(0.00126)	–	–	(0.00128)
Firm Size^2 × Market Openness	–	–	−0.000608***	–	–	−0.000569***
	–	–	(0.000120)	–	–	(0.000119)
Fixed-Intercept	−132.7	−212.7	−67.92	203.0	154.2	262.3
	(195.5)	(217.6)	(188.9)	(208.8)	(215.4)	(208.0)
RANDOM EFFECTS						
Random-Slopes						
Firm Size	0.158***	0.169***	0.160***	0.168***	0.173***	0.172***
	(0.0394)	(0.0421)	(0.0399)	(0.0419)	(0.0433)	(0.0428)
Random Intercepts	0.790***	1.037***	0.765***	0.831***	0.890***	0.822***
	(0.181)	(0.238)	(0.173)	(0.191)	(0.205)	(0.192)
Cluster Means of firm level variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	65,085	65,085	65,085	65,085	65,085	65,085
Number of Countries	52	52	52	52	52	52
Wald	3425	3447	3434	3514	3523	3514

(*continued on next page*)

Table 6 (*continued*)

	Random Slope Models					
	(1)	(2)	(3)	(4)	(5)	(6)
LL	−14306	−14287	−14292	−14226	−14222	−14219
LR Test vs. Logistic model	1507.96***	1490.11***	1448.67***	1502.74***	1482.48***	1427.50***

The table explores cross-level interactions between Firm Size and the country-level contextual environment, represented by Property Rights, Financial Institutions Index, and Market Openness. This analysis aims to understand how these interactions influence firms' likelihood to invest in PE (H-2). In this analysis, all independent predictors are continuous variables. Firm Size, Profitability, GDP Growth, and GDP Per Capita have been transformed into natural logarithms. All the Columns are based on Equation (5), where Firm Size has been added as a random coefficient. All the Level-1 predictors have been Cluster-Mean Centered. Cluster means of all the Level-1 predictors have been controlled for. The data utilized excludes the firms that are potentially registered as venture capital and private equity firms with NAIC Codes 523,910 and 523,920 respectively. Significance of the LR tests at the bottom row show that the mixed models are superior to the corresponding random intercept models. All Level-1 predictors have been winsorized with 1% of the top and bottom values. *Firm Size* is total assets of the firm in millions; *Profitability* is the ratio of the annual returns to total assets of the firm; *Internal Financing* is ratio of retained earnings to total assets of the firm; *External Financing* is the ratio of the total debt to total assets of the firm; *Property Rights* is the index from weakest as 0 to strongest as 100; *Financial Institutions Index* is the index that ranges from weakest as 0 to strongest as 1; *Market Openness* is the index that ranges from weakest as 0 to strongest as 100; ICT Penetration is the use of internet per 100 people; *GDP Growth* is the annual growth in GDP; and *GDP Per Capita* is GDP per person at current USD; *Rate of Self-Employment* is the percentage of employers to total employment; *Human Capital Index* the years of schooling and returns to education at country level. Standard errors were clustered at the country level to account for the potential correlation between firms within the same country. The country level was treated as a random slope in the model, and the standard errors were adjusted accordingly. Standard errors are presented in parentheses; ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

quadratic equations in the mixed effects logistic regressions, the relationship between Firm Size and propensity to invest in PE (as shown in Column 4) has been represented in Fig. 3. The graph shows that small firms are most likely to invest in PE, followed by large firms, whereas medium-sized firms are least likely to invest in PE, confirming the U-shaped relationship. We control for industry-fixed effects in Column 5, yet the coefficient for the variable "Firm Size^2" continues to be statistically significant at the 1 % level.

We are cognizant of the sensitivities involved in U-shaped relationships and how to treat those sensitivities. We have conducted several tests to confirm that the result for the U-shape is robust (Lind and Mehlum, 2010; Haans, Pieters, and He, 2015). The tests confirm the presence of a U-shape [4]. Thus, we confirm H-1: small institutional investors inherit a higher propensity to invest in PE and that the proclivity decreases with an increase in Firm Size to a certain point, beyond which the likelihood that a firm will invest in PE increases again.

To test H-2, we run AIM models in Table 6, columns 1 to 6. The likelihood ratio test exhibits LR, $\chi 2(2) = 1507.96$, $p < 0.000$ for AIM in Column 1, which indicates an improvement in the model after treating the slope of cluster-mean centered Firm Size as random across countries compared to the random intercept models. This indicates the validity of the AIM models. We also employed Akaike's information criterion (AIC) and Bayesian information criterion (BIC) tests that confirm an improvement in the model after considering cross-cluster differences.

Haans, Pieters and He (2015) suggest that the correct way to compute moderations in quadratic equations is to control the model for the interaction term $X^2 \times M$. Consequently, we have incorporated the interaction term "Firm Size^2 × M" in all the models presented in Table 6. Here, "M" refers to the moderating variables namely Property Rights, Financial Institutions Index and Market Openness. Column 1 of Table 6 shows the effect of the interaction term "Firm Size × Property Rights" where the regression has been controlled for "Firm Size^2 × Property Rights".

The positive and statistically significant coefficient of Firm Size demonstrates its substantial impact on a firm's inclination to invest in private equity under weak property rights conditions. However, the negative polarity of the interaction term suggests that enhancements in property rights diminish the favorable influence of Firm Size. In fact, beyond a specific threshold, the effect of Firm Size becomes significantly negative. In the presence of strong Property Rights, it appears that small firms demonstrate better performance in allocating assets to private equity compared to large firms.

[4] The first-order term "Firm Size" has been added to the model in line with Aiken & West (1991). However, getting a statistically significant and positive coefficient for the second-order term is not enough to prove a U-shaped relationship. Instead, it is only the first step in a three-stage test (Haans et al., 2015; Lind & Mehlum, 2010). The second step of the test is to see if the slope of the curve is sufficiently steep at both the high and low ends of the data range or not. We conducted the *U* test after the model reported in Column 3 of Table 5. The t-value of the overall presence of a U shape is 13.82. Moreover, the slope at the lower boundary of the Grand-Mean Centered Firm Size (i.e., −7.27) $= B_{10} + (B_{20} \times 2 \times LowerBound) = -0.431$, which yields a t-value of –23.08. The slope of the higher boundary of grand-mean Centered Firm Size (i.e., 9.98) $= B_{10} + (B_{20} \times 2 \times HigherBound) = 0.325$ that yield a t-value of 13.82. B_{10} is the coefficient of Grand-Mean Centered Firm Size and B_{20} is the coefficient of Gran-Mean Centered Firm Size^2. This means that the U shape is significant, as the slope of the curve is significant at the 1% level at both the lower and higher ends. In the third step, we confirm that the extreme or turning point of the U shape is cluster-mean centered Firm Size = 2.55 and the Fieller confidence intervals at 95 percent [2.2194377; 2.9302486] are well within the data range [-7.278823; 9.981159]. The same test was conducted after the regression reported in Column 5, where industry fixed effects have also been controlled for. While the magnitudes of the test have changed, they are all within the acceptable range as suggested by Haans, Pieters and He (2015). The overall t value is 9.41, and the slope of the lower boundary of grand-mean-centered Firm Size is negative and significant (having t value of −9.407), and the slope of the higher boundary of grand-mean-centered Firm Size is positive and significant (having t value of 10.578).

Table 7
Robustness tests using probit and IV probit model.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Probit Model	IV Probit Models					
		Second Stage	First Stage	First Stage	Second Stage	Second Stage	Second stage
Country Level Predictors	Dependent Variable: PE dummy (0, 1)	Dependent Variable: PE dummy (0, 1)	Dependent Variable: Firm Size	Dependent Variable: Firm Size^2	Dependent Variable: PE dummy (0, 1)	Dependent Variable: PE dummy (0, 1)	Dependent Variable: PE dummy (0, 1)
Property Rights	−0.00581***	−0.00612***	−0.00158***	−0.0321***	0.0274***	−0.00514***	−0.00276**
	(0.000762)	(0.000806)	(0.000168)	(0.00311)	(0.00271)	(0.000961)	(0.00108)
Financial Institutions Index	–	–	–	–	–	2.144***	–
	–	–	–	–	–	(0.148)	–
Market Openness	–	–	–	–	–	–	2.336***
	–	–	–	–	–	–	(0.63PE dummy (0, 1) asdependent variable4)
ICT Penetration	−0.130***	−0.142***	0.0206***	0.369***	−0.154***	−0.143***	−0.146***
	(0.0194)	(0.0223)	(0.00410)	(0.0733)	(0.0224)	(0.0225)	(0.0233)
Rate of Self-Employment	0.00181	0.00377	−0.0148***	−0.338***	0.00809	0.00804	0.0138**
	(0.00491)	(0.00527)	(0.00162)	(0.0341)	(0.00515)	(0.00511)	(0.00559)
GDP Per Capita	0.125***	0.133***	−0.0247***	−0.651***	0.153***	0.160***	0.152***
	(0.0175)	(0.0189)	(0.00524)	(0.107)	(0.0192)	(0.0191)	(0.0198)
Human Capital Index	0.160***	0.174***	0.0737***	1.735***	0.0551	0.0418	0.0764**
	(0.0295)	(0.0314)	(0.0106)	(0.230)	(0.0345)	(0.0351)	(0.0376)
Lagged GDP Growth	−0.171***	–	0.0851***	1.154***	–	–	–
	(0.0532)	–	(0.0125)	(0.264)	–	–	–
Firm-Level Predictors							
Lagged Firm Size	–	–	0.955***	0.578***	–	–	–
	–	–	(0.00656)	(0.134)	–	–	–
Lagged Firm Size^2	–	–	0.000713*	0.948***	–	–	–
	–	–	(0.000423)	(0.00968)	–	–	–
External Financing	−1.750***	−2.155***	−1.620***	7.089***	−3.935***	−3.601***	−3.616***
	(0.430)	(0.474)	(0.209)	(2.425)	(0.500)	(0.508)	(0.698)
nternal Financing	−0.00387	−0.00588	0.0406***	0.364***	0.00313	0.0170	0.0100
	(0.0115)	(0.0120)	(0.00563)	(0.0688)	(0.0125)	(0.0127)	(0.0127)
Profitability	−3.201***	−3.806***	12.44***	119.8***	−3.374***	−3.290***	−3.460***
	(0.982)	(1.054)	(0.419)	(5.157)	(1.074)	(1.079)	(1.091)
Firm Size	−0.0474***	−0.0535***	–	–	0.494***	0.265***	2.411***
	(0.00954)	(0.0107)	–	–	(0.0416)	(0.0241)	(0.695)
irm Size^2	0.00252***	0.00276***	–	–	−0.0245***	−0.0126***	−0.114***
	(0.000525)	(0.000588)	–	–	(0.00206)	(0.00124)	(0.0414)
Cross-Level Interactions							
Firm Size × Property Rights	–	–	–	–	−0.00770***	–	–
	–	–	–	–	(0.000545)	–	–
Firm Size^2 × Property Rights	–	–	–	–	0.000398***	–	–
	–	–	–	–	(2.86e-05)	–	–
Firm Size × Financial Institutions iIdex	–	–	–	–	–	−0.510***	–
	–	–	–	–	–	(0.0350)	–
Firm Size^2 × Financial	–	–	–	–	–	0.0258***	–

(*continued on next page*)

Table 7 (*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Probit Model	IV Probit Models					
		Second Stage	First Stage	First Stage	Second Stage	Second Stage	Second stage
Institutions Index							
	–	–	–	–	–	(0.00203)	–
Firm Size × Market Openness	–	–	–	–	–	–	−0.580***
	–	–	–	–	–	–	(0.168)
Firm Size^2 × Market Openness	–	–	–	–	–	–	0.0275***
	–	–	–	–	–	–	(0.0101)
Constant	5.702**	6.761**	−34.27***	−331.5***	3.230	3.998	−4.333
	(2.741)	(2.947)	(1.170)	(14.43)	(3.011)	(3.019)	(4.347)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	65,085	57,748	57,748	57,748	57,748	57,748	57,748
Wald	5121	4567	4567	4567	4806	4969	4593
LL	−15274	−211974	−211974	−211974	−197375	−206227	−69894

The table explores the confirmation of the U-shape for Firm Size (H-1) and the influence of the cross-level interactions between Firm Size and the country-level contextual environment on the firms' likelihood to invest in PE (H-2) using IV probit technique. Lagged Firm Size, Lagged Firm Size^2 and Lagged GDP Growth have been used as 'excluded' instruments for the potential endogenous predictors i.e., Firm Size and Firm Size^2. Column 1 is based on Equation (6) and Column 2 is based on Equation (7). Columns 3–4 are based on Equation (8) & (9); whereas columns 5–7 are based on Equation (10). Firm Size, Profitability, GDP Growth, and GDP Per Capita have been transformed into natural logarithms. The data utilized excludes the firms that are potentially registered as venture capital and private equity firms with NAIC Codes 523,910 and 523,920 respectively. All Level-1 predictors have been winsorized with 1% of the top and bottom values. The *Firm Size* is total assets of the firm in millions; *Profitability* is the ratio of the annual returns to total assets of the firm; *Internal Financing* is ratio of retained earnings to total assets of the firm; *External Financing* is the ratio of the total debt to total assets of the firm; *Property Rights* is the index from weakest as 0 to strongest as 100; *Financial Institutions Index* is the index that ranges from weakest as 0 to strongest as 1; *Market Openness* is the index that ranges from weakest as 0 to strongest as 100; *ICT Penetration* is the use of internet per 100 people; *GDP Growth* is the annual growth in GDP; and *GDP Per Capita* is GDP per person at current USD; *Rate of Self-Employment* is the percentage of employers to total employment; *Human Capital Index* the years of schooling and returns to education at country level. Standard errors were clustered at the country level to account for the potential correlation between firms within the same country. Robust standard errors are presented in parentheses ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

We introduce the interaction term "Firm Size × Financial Institutions Index" in Column 2. The effect of the interaction term is significant and negative which indicates that smaller firms invest more in PE in countries with developed financial institutions, as hypothesized. Moreover, the effect of the interaction term "Firm Size × Market Openness" has been examined in Column 3. The strong positive effect of Firm Size shows that large firms invest and allocate more PE when markets are constrained, and the strong negative sign of the interaction term "Firm Size × Market Openness" indicates that small firms are more likely to invest in markets with free trade and capital flows. These results confirm H-2 that the institutional environment has a significant effect on the relationship between Firm Size and propensity to invest in PE. In columns 4 to 6, we introduced year fixed effects to account for temporal variations and reduce the influence of other confounding factors on the models. Despite this control, the three interaction terms remain statistically significant, reaffirming our initial hypotheses.

As previously discussed, the issue of endogeneity may arise from the potential correlation between Firm Size and the error term. To mitigate this concern, we have employed the instrumental variable probit technique in Table 7. This approach enables us to consider unobservable effects that might influence our results. In accordance with the methodology presented in Doraszelski et al. (2018) and Bøler et al. (2015), we have employed instrumental variables. Specifically, we have used the Firm Size in year -t-1, Firm Size^2 in the year -t-1, and GDP growth in year t-1 to instrument the Firm Size and Firm Size^2 in the year t. The rationale behind this choice is that these autoregressive lags are expected to be uncorrelated with the error term of the current year, making them suitable instruments for mitigating endogeneity concerns.

In Column 3 and Column 4, the first stage regressions clearly reveal the substantial and statistically significant effects of the instruments on the endogenous variables. This observation underscores the effectiveness of our chosen instruments in addressing the endogeneity concerns associated with these variables. Furthermore, the Cragg-Donald Wald F statistic exceeded the critical values associated with the Stock-Yogo weak identification test. This outcome suggests that our instrumental variables are not afflicted by the issue of weak identification, indicating a reliable estimation process, and reducing the likelihood of imprecise and biased parameter

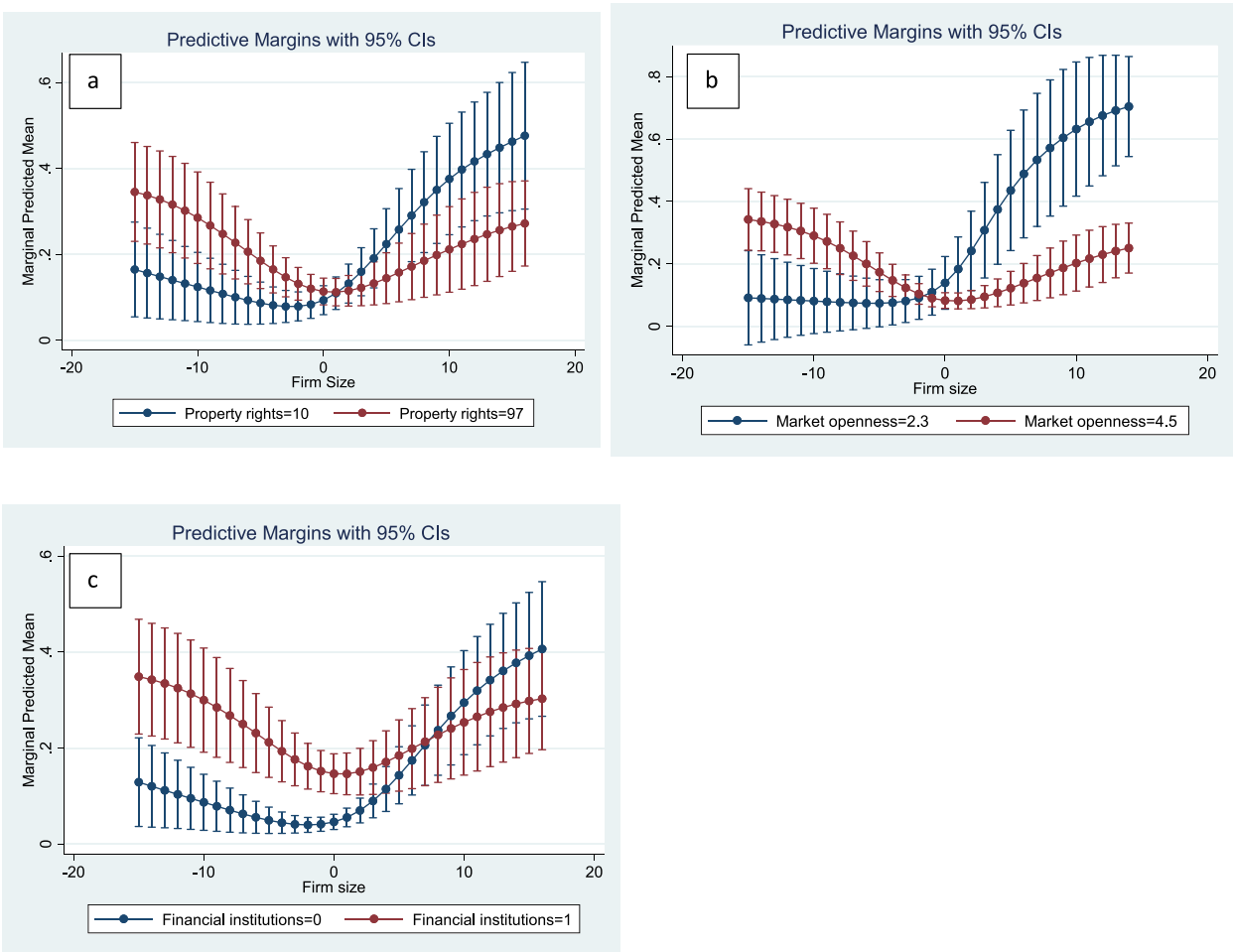

Fig. 4. Interaction plots.

estimates. We conducted a comparative analysis of the coefficients associated with Firm Size and the constants in the probit model, as presented in Column 1, and the results obtained from the IV probit model in Column 2.

In the IV probit model, we instrumented the two endogenous regressors with their respective autoregressive lags and GDP Growth variables. The coefficient of the Firm Size has observed a change, decreasing from −0.0474 to −0.0535, while the constant has increased from 5.702 to 6.761. There is no significant difference in the outcomes supporting our hypotheses, suggesting that the endogenous regressors are largely uncorrelated with the error term. The change may not affect our interpretations of the respective mixed effects results. Moreover, we conducted the U-test after the IV probit model and the outcome confirms the presence of the U shape passing the criteria suggested by Haans, Pieters and He (2015). The results presented in columns 5–7 show the three interaction terms introduced to test H-2. These regressions have been adjusted for firm fixed effects, country fixed effects, as well as year and industry fixed effects. The results remain consistent, with negative and statistically significant coefficients for the interaction terms, even after implementing these controls and addressing endogeneity using IV probit models.

Finally, the interactions have been visualized in Fig. 4(a). The blue line with circle shapes represents situations where weak property rights conditions prevail, while the red line with circle shapes depicts scenarios with strong property rights protection. Asset allocation in PE is lowest when the protection of property rights is weak (blue line) and the Firm Size is smallest (left side of the x-axis). In contrast to the red line, the blue line exhibits a sharp upward movement as it extends to the right (indicating larger firm sizes), suggesting that only large firms are investing in private equity in environments with weak property rights protections. Fig. 4(b) and Fig. 4(c) depict the interaction terms "Firm Size × Market Openness" and "Firm Size × Financial Institutions Index", respectively. These figures show similar patterns, which align with our initial hypotheses.

5. Discussion and conclusion

This paper presents the effect of firm size and country-specific characteristics on a firm's decision to allocate capital to PE. It was contended that the size of an institutional investor has a significant effect on the investor's propensity to invest in PE. The rationale is

that firms of different sizes float in different market realities and therefore adopt different strategies to deal with systematic and unsystematic risks. The paper provides evidence that both large and small firms exhibit a greater inclination to invest in PE compared to firms of intermediate size. We attribute this outcome to the well-documented and superior risk-management capabilities exhibited by both small and large firms, as extensively discussed in the literature.

Moreover, it was hypothesized that the coping strategies of institutional investors are influenced by the broader contextual environment. Specifically, it was proposed that small firms exhibit a greater propensity to invest in PE in favorable contextual frameworks. The paper presents empirical evidence demonstrating that the inclination of smaller firms to invest in PE diminishes in weak institutional settings. Conversely, the evidence suggests that larger firms' inclination to allocate assets to PE is resilient to adverse contextual conditions. It is noteworthy to mention that intermediate-sized firms were theorized to have lacked inherent advantages, regardless of any variations in the contextual environment and the results of the study validated this proposition.

Why the inclination of large firms to invest in PE remained unaffected by variations in contextual conditions is a question worth exploring. This ability of large firms to perform well in adverse contextual conditions can be attributed to certain advantages they possess. Indeed, large firms have the ability to internalize more resource allocation, which provides immunity against the adverse effects of weak legal frameworks (Beck, Demirgüç-Kunt, and Maksimovic, 2005). They have the ability to internalize exchanges when intermediation skills are scant and agency risks are high in financially less developed environments. Moreover, large firms strategically extract rents from from the existing financial system by leveraging relational capital, limiting market access to foreign capital and trade, and utilize various government-sponsored schemes to protect themselves against foreign competition.

Equally important is to inquire why small firms, which require additional safeguards against systematic risks, allocate more PE in favorable institutional contexts. Indeed, robust institutional, financial, and market frameworks enhance protection against market risks, promote healthy competition, ensure transparency, enforce regulations, and provide thorough information about potential deals. Strong protection of property rights reduces the costs associated with information, agency, and market transactions by facilitating reliable contract enforcement, which particularly benefits small firms. Developed financial institutions mitigate agency risks through strong intermediation and monitoring skills and better firm-level governance. Furthermore, this system nurtures sophisticated market intermediaries that provide opportunities for small firms to participate in the PE market without the need for extensive in-house asset management divisions or comprehensive due diligence capabilities. Market openness levels the playing field for small new entrants in product and capital markets and enhances transparency, information flows, and competition. A better institutional context encourages small financial investors to emerge and invest in illiquid assets.

The identification of the U-Shape trend carries profound implications for institutional investors of diverse sizes, equipping them to adeptly handle various risk types and make well-informed investment choices. Our robust explanations of the U-Shape phenomenon are firmly rooted in theories highlighting the inherent advantages accessible to firms of different sizes. The model significantly underscores the distinct market realities that firms encounter. Armed with this knowledge, firms can develop strategic approaches to leverage competitive advantages typically associated with either larger or smaller firms. For example, both large and intermediate-sized firms may adopt innovative practices similar to those of smaller firms to capitalize on niches and develop relational structures. This approach is in line with "corporate entrepreneurship" perspective, that advocates the view that, to be innovative, large firms should learn from structures, culture, leadership, and strategies of small firms. Similarly, small and intermediate-sized firms can design strategies to incorporate operational efficiencies akin to those of larger firms to leverage economies of scale. One effective approach to achieve this is by specializing in specific industries or markets. Also, like large firms, both small and intermediate-sized investors can diversify their portfolios through multiple intermediaries (Andonov, 2022). Both small and intermediate-sized investors can channel their investments to several smaller venture capital funds instead of one large buyout fund in order to achieve diversification (Metrick & Yasuda, 2010).

Furthermore, the findings from H-2 carry significant implications for firms of all sizes, particularly regarding their asset allocations within weak institutional environments. The question arises whether small and intermediate-sized financial institutions should redirect their attention to illiquid asset classes, despite the fact that such investments can potentially heighten their risk exposure (Batten & Vo, 2016). We highly recommend that small and intermediate-sized firms conduct comprehensive assessments of the idiosyncratic risks specific to their industry or company and the broader market risks. By gaining a deep understanding of these risks, small and intermediate-sized firms can develop comprehensive strategies to effectively navigate the challenges of adverse selection and moral hazard. Indeed, it is crucial for such firms to develop strategies that align with their unique strengths, including their ability to manage agency issues and their preferences for specialization versus diversification.

The paper contributes to the literature on institutional investors' asset allocations in PE. Indeed, there is a body of research that consider PE allocations as a function of institutional investors' characteristics such as firm size, type, location, decision-making authority, and liquidity preferences (Cumming, Fleming, and Johan, 2011). Furthermore, there exist other studies that investigated an association between institutional investors' characteristics and institutional investors' PE investments. The characteristics include investors' skills (Cavagnaro et al., 2019) and political expediency, along with political contributions from the financial industry (Andonov, Hochberg, and Rauh, 2018). The characteristics also encompass deal size and specific attributes of limited partners, such as experience, type, location, compensation structure, and the number of funds under management (Da Rin and Phalippou, 2017).

However, the current paper is specifically related to the work of Broeders, Jansen, and Werker (2021), Andonov (2022), and Andonov, Bauer and Cremers (2017) who found a positive effect of scale on allocations within the PE market. The paper is also related to the work of Fang, Ivashina, and Lerner (2015), Dyck and Pomorski (2016), and Da Rin and Phalippou (2017), who explained scale effects such as cost reduction, greater access, and increased bargaining power. The intervention of the current study in the literature is significant as it uncovers a U-shaped relationship between scale (Firm Size) and allocations towards PE. Moreover, the current paper brings in the role of institutional context in the relationship between firm size and PE allocations.

The present paper is not without limitations. It uses binary data from PE investments to investigate the propensity to allocate assets to PE, which is important. However, it is important to acknowledge that the available data from Compustat Global does not provide further granularity regarding specific details such as PE investment amounts or the number of PE investments made by institutional investors as used by Andonov (2022). The dataset that Andonov (2022) used has the advantage of being deep in terms of using binary variables like ours, along with returns and investment costs. On the contrary, our dataset offers the advantage of breadth as it provides extensive coverage across 52 economies, comprising a considerable number of firms. The amount and number of investments in PE, performance, and investment costs were not available at Compustat Global. Opportunities for future research are suggested, focusing on comparing the allocations, performance, and costs of PE investments by institutional investors. These analyses should consider both firm-level and country-level characteristics while incorporating both breadth and depth in the data. For instance, it is not known if the high debt ratio of institutional investors or its intangible intensity has any bearing on PE allocations or performance or whether these relationships have any connections to the institutional environment or not. It is also not known how the institutional environment has any implications for investment costs and performance within the PE market.

CRediT authorship contribution statement

Douglas Cumming: Conceptualization, Methodology, Project administration, Writing – original draft, Writing – review & editing. **Muhammad Zubair Khan:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Naimat U. Khan:** Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Zafir Ullah Khan:** Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix 1:. Description of variables

Variable	Proxy	Description	Data Source
Investment in PE	Investment in PE	A dummy variable that equals one when an institutional investor invests in venture capital and/or private equity directly or through fund of funds (FoFs) and zero otherwise. It considers all the firms in the entire financial services sector. However, we include only those sub-sectors in the data where at least one firm has any investment in venture capital and/or private equity.	Compustat Global
Firm Size	Total assets	Total assets of the firm in US$.	Compustat Global
External Financing	Debt ratio	Total debt to total assets of the firm	Compustat Global
Internal Financing	Retained earnings to assets	Total retained earnings to total assets of the firm.	Compustat Global
Profitability	Return on assets	Firm-level earnings before interest and taxes, divided by total assets of the firm.	Compustat Global
Financial Institutions Index	Financial institutions depth	Represents the overall activity undertaken by financial institutions, namely private-sector credit to GDP, pension fund assets to GDP, mutual fund assets to GDP, and insurance premiums, life and non-life, to GDP.	IMF
Rate of Self-Employment	Number of employers	Employers, total (% of total employment)	World Development Indicators
ICT Penetration	Internet use	Use of internet per 100 individuals in a society	World Development Indicators
GDP Growth	GDP Growth	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 US dollars.	World Development Indicators
GDP Per Capita	GDP Per Capita	GDP per capita at current US$.	World Development Indicators

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Variable	Proxy	Description	Data Source
Property Rights	Property Rights	Property Rights measures the degree to which the state institutions enable individuals to acquire, maintain, and exploit private property through effective laws and their enforcement.	Heritage Foundation
Market Openness	Composite index of Trade Freedom, Investment Freedom, Financial Freedom	Represents the extent of barriers on imports and exports, constraints on investment capital flows, and independence and efficiency of the banking system.	Heritage Foundation
Human Capital Index	Human Capital index	Index of human capital per person, based on years of schooling and returns to education.	Penn World

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