Investor Horizon and Innovation: Evidence from Private Equity Funds

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ABSTRACT

I explore whether the contractually fixed horizon of private equity funds affects their propensity to invest in innovative companies. I identify the effect of horizon on investment decisions with between- and within-fund variations in fund age. Long-horizon funds select young companies at an early stage of their development, that grow their patent stock significantly more than companies funded by short-horizon investors. Funds shift their investments towards less innovative targets as their horizon shrinks. The effect of horizon is the strongest for funds managed by experienced investors. Altogether, the results indicate that investor horizon matters for the funding of corporate innovation.

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Introduction

A majority of initial public offerings (IPOs) in the U.S. are backed by private equity funds (Kaplan and Lerner, 2010). Yet, little is known about how this class of investors select the companies to which they provide funding. These funds usually buy significant blocks of shares in private companies and divest after a few years through the IPO of the company or the sale to a third party. One important yet unexplored channel potentially affecting their decisions is their investment horizon. Contrary to most financial intermediaries, private equity funds generally have an investment lifetime of ten years fixed *ex ante*.[1] Funds are raised in year 0 from outside investors - "Limited Partners" (LPs) - and trusted to fund managers - "General Partners" (GPs), who invest and return funds and capital gains to LPs within ten years.

This paper explores whether the fixed investment horizon of private equity funds affects their ability to undertake innovative projects. In frictionless capital markets, prices reflect firms' fundamental value, and horizon does not affect investment decisions. Investors can meet their liquidity needs anytime by selling their shares before the firm's investments payoff, at no discount. Horizon may matter, however, when (i) there are asymmetries of information between sellers and buyers, and when (ii) investors are faced with projects exploiting existing ideas *and* projects exploring new ideas. Exploration arguably takes longer to produce observable outcomes and payoffs (Manso, 2011). Combined with asymmetries of information, this heterogeneity in the timing of payoffs implies that investor horizon matters. Two projects with the same net present value, but involving different levels of exploration are of different interests for a short and a long-term investor, because the market might fail to recognize the potential of the exploratory project at the time when the short-term investor needs to exit.

I test the validity of this story in the context of private equity investments. I compare the behavior of funds with heterogeneous investment horizon as well as the evolution of a given fund's behavior as it moves closer to the end of its investment life. I ask whether private equity funds with a longer investment horizon invest in more exploratory ventures, and shift towards less exploratory investments as their horizon shrinks. I assemble a sample of private equity investments involving

[1] See Sahlman (1990); Gompers and Lerner (1996); Gompers (1996); Gompers and Lerner (1999); Lerner and Schoar (2004); Cheffins and Armour (2007); Metrick and Yasuda (2009); Masulis and Thomas (2009); and Harris (2010). While this paper focuses mostly on venture capital funds, buyout funds share the same contractual structure.

3,400 private equity funds from 1980 to 2010. I first ask whether funds further away from liquidation invest in younger and less mature companies, which are by essence the place of exploration of new ideas rather than the exploitation of existing ones. I measure the maturity of a company with its age, its development stage, and the number of prior financing rounds it has received. I check that investments in less mature companies are indeed held for a longer period of time, are staged more, and have a lower probability of a successful exit. Then, in simple univariate tests, I find that with respect to funds within their first three years of operations, older funds select companies that are 3.5 years older, that have already received 0.47 more prior rounds of financing and that have a 9% smaller probability to be at the seed or early stage of their development.

I carefully analyze and rule out alternative explanations for this shift in investment style throughout fund's investment life. First, compensation and career concerns that GPs face might affect their risk aversion and their propensity to select exploratory projects throughout their fund's life. If compensation contracts are set in a manner that reduces the risk appetite of GPs through time, this might explain that they fund less innovative companies as they move closer to liquidation. Compensation agreements in private equity funds typically give GPs a fixed management fee that is a percentage (around 2%) of the amount of capital committed to the fund, as well as a call option on a share (almost always 20%) of the fund's total cumulative profits which they receive at the fund's liquidation: the carried interest. The option-like nature of this compensation generates risk incentives when earlier performance has been low. If funds systematically perform well in their first years, their incentives to take risks might decrease with time and tilt their asset selection towards less risky targets. I address this concern by controlling for the fund's past performance. I find interesting evidence that funds with a lower track record of successful exits tend to select more innovative companies.

Moreover, it could be the case that funds focus on exploration to show skills to their investors in order to raise a follow-up fund and then shift towards more mature projects. Since private equity firms raise follow-up funds every three to five years on average, this is likely to influence their portfolio management to an important extent, especially in the case of first-time funds (Gompers, 1996). I control for follow-up fundraisings in the regressions, to insure that this important pattern in a fund's life is not driving the results. I also use a "first-time fund" dummy to insure that the results are not driven by the career concerns of first time fund managers.

After controlling for these confounding factors, I still obtain a robust relationship between the age of the fund and the maturity of its targets. A one standard deviation increase in the age of the fund leads to an increase in the maturity of targeted companies by 8 to 16%. It reduces the probability that the fund invests in a company that already applied for a patent in the past by 5 to 13%. Although the innovative effort is not observable ex ante, I analyze ex post with standard patent-based metrics. A one standard deviation increase in the age of the fund leads to a 17 to 25% larger growth in patent count around the investment. The analysis of citations per patent indicates that this increase in patent count is not achieved at the expense of the quality of innovation. I run the same test on a sample Corporate Venture and Evergreen funds, which are typically not constrained by an investment horizon.[2] I find no effect of fund age on the maturity of investments.

The sensitivity of target characteristics to investor horizon might vary with market conditions. Nanda and Rhodes-Kropf (2010, 2013) stress that market conditions are important determinants of the incentives to fund innovation. There are several reasons why horizon should matter less in hot markets. If recent returns on innovative companies have been high, PE investors could infer that the appetite for innovation has increased. Those with shorter horizon could select more innovative projects with the hope of re-selling them quickly at no discount. I find that the propensity of shorter horizon funds to select more mature companies decreases when past returns of the Nasdaq Composite index have been abnormally high.

I also explore whether limited horizon distorts private equity fund management decisions. If this is the case, GPs with more experience and a better track record of performance should attempt to emancipate themselves from this constraint. I ask whether the sensitivity of project selection to horizon is weaker for experienced GPs, such as those with the largest number of prior fundraisings or investments. Instead, I find that the sensitivity of target maturity to fund age is larger for more experienced GPs. They operate a steeper shift towards less innovative projects as their funds get closer to liquidation. These findings indicate that more experienced investors have a better ability to match their assets with their fixed horizon liability structure. This ability could result from an enhanced access to a wider range of projects or to the fact that more experienced PE firms run several overlapping funds, and could therefore better match target and fund maturity. These results

[2]Corporate venture funds are typically structured as subsidiaries of corporations, and Evergreen funds typically return any proceeds from sales of investments or dividends back to the fund rather than making distributions to its investors.

should not come as a complete surprise: if the fixed horizon structure of limited partnerships was hurting the performance of experienced PE firms, they would certainly offer an alternative contract to their LPs. These findings highlight that one dimension of private equity investing is to match target and fund maturity, and that experienced investors seem to be better at doing so.

Finally, I ask whether exit patterns are consistent with time constrained funds selecting more mature targets, i.e., targets with a larger probability of a successful exit. Indeed, I find that a one standard deviation in fund age is associated with a 5% (2.4 percentage points) increase in the probability of a successful exit, but this pattern is only observed among experienced investors.

Altogether, the results presented in this paper suggest that horizon is a strong driver of private equity funds asset allocation. They provide empirical ground for the concern among practitioners[3] and academics[4] that the structure of venture capital funds, and in particular their finite investment horizon, might be an impediment to the funding of fundamental innovation. While the selection of mature investments is optimal from the point of view of the fund manager and its investors, it could indeed be suboptimal from a welfare standpoint, for instance, if fundamental innovation is associated with more externalities than conventional projects. On a broader note, these results emphasize the relevance of the horizon of corporate owners in the funding of new and innovative ideas.

This paper relates to several streams of the literature, the first of which focuses on the economic impact of private equity funds contractual structure. The structure of private equity funds is very similar across funds in North America and in Europe. Gompers and Lerner (2001) argue that the first (Venture Capital) limited partnership was formed in 1958 and followed the template of other limited partnerships common at the time, such as those that had been formed to develop real estate projects and explore oil fields, and which had predetermined finite lifetimes of usually ten years. While this setting is not common among financial intermediaries, finite mandates are commonplace in other markets, such as the CEO or academics labor market. Lerner and Schoar (2004) show that restrictions imposed by private equity funds on their investors are aimed at selecting liquid investors so as to invest in industries with longer cycles. Axelson, Strömberg, and Weisbach (2009) argue that by trusting private equity fund managers with the cash to be spent on a series of deals,

[3]See The Economist, "Has the ideas machine broken down", January 2013.
[4]See Lerner (2012) and Fagnan, Fernandez, Lo, and Stein (2013).

rather than on a deal by deal basis, their incentives to take excessive risks are mitigated. Kandel, Leshchinskii, and Yuklea (2011) model the behavior of Venture Capital funds and find that the age of the fund should have an important effect on the type of projects it takes and on the tendency to continue or stop projects. On the empirical side, the impact of fund age on performance metrics has been investigated in a few papers. Closer to liquidation, funds sell companies cheaper (Masulis and Nahata, 2009). Younger funds invest in riskier buyouts towards the end of their life, especially if they have underperformed earlier in their life, in an attempt to achieve superior performance (Ljungqvist, Richardson, and Wolfenzon, 2008). Leverage buyouts sponsored by private equity funds with more experience exit earlier, and funds that are publicly traded (and hence have an infinite investment horizon) take more time to exit their investments (Strömberg, 2008). Finally, Robinson and Sensoy (2011) show that cash flow variation within private equity funds is mostly idiosyncratic and that most predictable variation is explained by the age of the fund.

This paper also builds on the literature focusing on investor horizon and its impact on corporate decisions. Bushee (1998) finds that ownership by financial institutions with a high portfolio turnover significantly increases the probability that managers reduce R&D to reverse an earnings decline. Polk and Sapienza (2009) and Derrien, Kecsks, and Thesmar (forthcoming) also use portfolio turnover as a proxy for shareholders investment horizon. They show that when firms are mispriced, the horizon of their shareholders affects their corporate policy. Cella, Ellul, and Giannetti (2013) find that institutional investors with shorter trading horizons were incited to sell their holdings to a larger extent than investors with longer horizons following Lehman Brother's bankruptcy, thereby contributing to the amplification of the market shock. Xu (2011) uses CEO employment contracts and finds that contract length is positively correlated with both capital expenditure and R&D expenses. I contribute to this literature by using the time until liquidation of private equity funds as a new proxy for investment horizon. It is plausibly more exogenous than previously used measures since the evolution of a given private equity fund's horizon is deterministic and unlikely to be correlated with unobserved variables also correlated with investigated outcomes. Moreover, I am able to study *within investor* changes in investment horizon by using fund fixed effects. In addition, while this literature has focused on the causal effect of investor horizon on innovation, the contribution of this paper is to emphasize that the horizon of investors has a strong impact on their investment decisions.

Finally, the results presented here relate to an emerging body of theoretical and empirical literature on the relationships between corporate ownership and innovation.[5] Aghion, Van Reenen, and Zingales (2013) argue that institutional owners increase managerial incentives to innovate by reducing the career risk for managers to undertake risky projects. Ferreira, Manso, and Silva (2012) show that it is optimal for a firm to go public when it exploits existing ideas, and optimal to go private when it explores new ideas. In their model, private firms are less transparent to outside investors, and their owners can therefore time the market by choosing an early exit strategy if they receive bad news. Belenzon, Berkovitz, and Bolton (2009) and Belenzon and Berkovitz (2010) show that firms affiliated with business groups are more innovative than standalone firms. Seru (forthcoming) finds that firms acquired in diversifying mergers produce both a smaller number of innovations and less novel innovations. Bernstein (2011) compares the patenting activity of firms going public and firms withdrawing their IPO and finds that going public has a causal effect on the quality of innovation. In the context of private equity investments, Lerner, Sorensen, and Strömberg (2011) show that patent count does not decrease and that citation count increases when companies undergo a leveraged buyout. In the case of venture capital, Tian and Wang (2011) show that private equity firms that have shown a high propensity to finance failed ventures in the past (and thus have a high tolerance for early failure) invest in companies that are more innovative. Chemmanur, Loutskina, and Tian (2011) show that companies held by Corporate Venture Capitalists patent more actively than companies held by independent venture capitalists, an effect that they attribute to a difference in tolerance for early failure. Azoulay, Zivin, and Manso (2011) find that scientists receiving grants with a larger tolerance for early failure and rewarding long-term success produce more innovative research. Atanassov (2013) shows that anti-takeover laws stifle innovation, unless the company has alternative governance mechanisms including large shareholders and pension fund ownership. The results presented in this paper add to this literature by highlighting that the horizon of corporate investors drive their decisions to fund more or less innovative companies.

The rest of the paper is organized as follows. Section I develops the hypothesis to be tested; Section II presents the sample and data; Section III presents the results; and Section IV concludes.

[5] A closely related literature examines the drivers of innovation within the firm, such as compensation and incentives. See for instance: Lerner and Wulf (2007), Hellmann (2007) Hellmann and Thiele (2011), and Manso (2011).

I. Theoretical framework and empirical predictions

In frictionless capital markets, investor horizon should not affect their investment decisions. This paper argues that horizon matters when (i) there are asymmetries of information between sellers and buyers, and when (ii) investors are faced with projects exploiting existing ideas *and* projects exploring new ideas. The theoretical motivation of this paper borrows from the framework developed in Manso (2011), and used in Ferreira et al. (2012). Initially, the exploration of a new idea it not as likely to succeed as the exploitation of an existing one. However, following an early success, agents update their beliefs about the new idea's expected probability of success, which becomes perceived as higher than the expected probability of success of the conventional one.

For the purpose of this study, I am interested in one specific feature of this framework: the fact that the expected payoff of an innovative project is initially low, and that it increases conditional on an early success. Combined with asymmetries of information between investors and outside buyers, this generates an incentive for short-term investors to avoid innovative projects. I provide a very simple illustrative model to fix ideas. The key intuition is that early outcomes of an innovative project are indistinguishable from those of a conventional one by outside investors, but they occur with smaller probability. This discourages short-term investors from selecting the innovative project initially.

Suppose that investors can provide funding to two company types that are operational for two periods. Companies of the first type exploit existing ideas, while companies of the second type explore new ideas. Type 1 delivers cash flows of 1 with probability p and 0 otherwise. If 1 is obtained in the first period, then type 1 delivers 1 again with probability p in the second period, and 0 otherwise. If 0 is obtained in the first period, then the company shuts down. Type 2 has a similar payoff structure and delivers 1 with probability δp, and 0 otherwise in period 1. If 1 is obtained in the first period, then type 2 delivers X with probability θp in the second period, and 0 otherwise. If 0 is obtained in the first period, then the company shuts down.[6]

I assume for simplicity that δ, X and θ are such that both types have the same net present value over the two periods:

[6]The fact that projects shut down following an early failure simplifies the exposition. The same result could be obtained if, as in Ferreira et al. (2012), both projects deliver 1 with probability p and 0 with probability $1-p$ in the second period, following a failure in period 1.

$$\delta p + \delta\theta p^2 X = p + p^2$$

However, type 2 is less profitable than type 1 in period 1 and the reverse is true in period 2:

$$\delta < 1 \text{ and } \theta X > 1$$

There are short-term and long-term risk neutral investors deciding on a unique investment at the beginning of period 1. Short-term investors have to liquidate their investment by selling it to outside unsophisticated short-term investors at the end of period 1. Long-term investors can hold on to their investment for two periods and have the option to sell their investment at the end of period 1 to outside unsophisticated short-term investors.[7]

Outside unsophisticated short-term investors can buy companies at the end of period 1 when the initial investors wish to sell them. They observe interim results (1 or 0) and whether the initial investor is short or long-term. But they do not observe the type of the company, i.e., whether the company is exploiting an existing idea or exploring a new one.

At the end of period 1, if investors wish to liquidate their investment, they need to agree on a price with outside buyers. These unsophisticated potential buyers will bid a price not less than their estimation of the residual project cash flows, conditional on the information they observe at the end of period 1. Let us call this estimation E. Since they do not know and have no way to observe types, they will offer a single price E such that:

$$p \leq E \leq \theta p X$$

Coming back to the beginning of period 1, long-term investors are indifferent between the two types since they both have the same net present value. The only way for them to make more money would be to invest in type 1 and try to sell it at a price $E > p$ at the end of period 1. However, outside investors would be aware of that and offer a price $E = p$ to long-term investors, making them indifferent between selling or keeping type 1 company in period 2.

Consider now the decision of short-term investors. Since they live only one period, they have to sell their investment at the end of period 1. The payoff from funding type 1 is $p + pE$ while the payoff of funding type 2 is $\delta p + \delta pE$. Since $\delta < 1$, short-term investors will always select type 1.

[7] The assumption that only unsophisticated short-term investors can buy at the interim period could be interpreted as the fact that the supply of unsophisticated short-term investors is large while the supply of sophisticated ones is smaller.

This simple model shows that when there is information asymmetry between buyers and sellers, and when there are projects exploiting existing ideas *and* projects exploring new ideas, then short-term investors have a preference for projects maturing more quickly.

To generate testable predictions from this framework, I need to make an additional assumption. I cannot directly observe from the data whether a company is of type 1 or type 2. Hence I hypothesize that while any company might be involved in either exploitation or exploration, start-up companies are a natural place for the exploration of new ideas rather than the exploitation of existing ones. While some established firms might decide to take some radical strategic orientation and seek private equity funding to finance exploration, a larger share of each invested dollar finances exploration in a company in its first year than in a company in its fifth year of operations. In addition to their age, less mature companies are more likely to be at an earlier stage of their development and to have received less external financing prior to the investment. Companies that are less mature along these three dimensions are more likely to be more exploratory in the sense of the theoretical framework presented above. Hence, since a short-term investor always selects a conventional project, it is more likely to be a mature company than a less mature one.

Prediction 1: Funds with a longer horizon invest in less mature companies. I expect funds with a longer investment horizon to select younger companies at an earlier stage of their development, or companies that previously received fewer rounds of financing than funds with a shorter horizon. I also expect a given fund to shift its investments towards more mature companies as its investment horizon shrinks.

Consistent with the framework highlighted above, funds with a longer investment horizon should select companies that do more innovation and produce more or newer ideas. Although I do not observe the innovation effort ex ante, I analyze it ex post with the growth in patent count.

Prediction 2: Funds with a longer horizon invest in more innovative companies. I expect funds with a longer remaining horizon to select companies that have a smaller initial patent stock but which grow it faster than companies selected by funds with a shorter horizon. Again, funds should shift their portfolio of investments toward less innovative companies as their horizon shrinks.

II. Data and sample

SDC Platinum VentureXpert (henceforth "Venture Xpert" or "SDC") is the main source used in this paper. SDC provides information on private equity investments between 1962 and 2010. For the purpose of this study, I focus on all funds raised from 1980 to 2010 labeled by SDC as "Independent Private Partnership" involved in "Venture Capital" and based in North America.[8] I restrict the sample to investments made up to 2010 in unlisted companies. I exclude all funds for which the parent private equity firm is unknown, or for which SDC does not provide either the "initial closing date" or the "fund year',' which enable me to identify the starting point of the fund's life.

To measure the investment horizon of any given fund in the sample at the time of any investment, I build a variable which I call fund age, measured as the difference in years between the month of an investment and the month when the fund was created. The creation date of a fund is a noisy concept: one could consider the date when the fund was launched, the date of its first closing or the date of its final closing. I identify the creation of the fund as the "initial closing date" provided by SDC. The "initial closing date" is unavailable for 30% of funds in the sample. In this case, I use the "fund year" provided by SDC and set the creation of the fund in January of this year.[9] I check that 48%, 66%, and 98% of investments in the sample occur respectively within 2, 3, and 10 years following fund creation.

I am left with 3,435 funds managed by 1,397 PE firms. I only consider the first cash outlay of each fund in each company in the sample. In what follows, I call an "investment" or "deal" the initial investment of a distinct fund in a distinct company. Hence, if there are two funds investing in the same company at the same date, this counts as two investments or two deals. When a fund makes several sequential investments in a given company, I only consider the first one. I am left with 46,673 investments of distinct funds into 19,607 distinct companies.

SDC's investment database has a companion database of private equity backed initial public offerings (IPOs) and merger acquisitions (M&As) which relates any such event to the names of the

[8]The results are similar or stronger when I filter out private equity partnerships whose name does not include the acronym "LP" or "L.P.", or the expression "Limited Partnership".

[9]When there are investments in the database prior to the fund creation date I computed, I reset the fund creation date at the time of the first investment if it happens within the twelve month prior to the computed creation date. I drop any investment prior to this date.

funds backing the company. I match my sample with this database on fund names to identify the timing of exits. I am left with 16,711 exits, of which 6,437 IPOs and 10,274 M&As.

For a subset of companies in the main sample, I obtain patenting information from the NBER patent database and the HBS patent database (Lai, D'Amour, and Fleming, 2009) which together cover U.S. patents granted through December 2010. I merge it with my sample on company name and city. I then follow the procedure recommended by Hall, Jaffe, and Trajtenberg (2001) and applied in Lerner et al. (2011) to adjust patents and citations for the truncation bias. I restrict this sample to private equity investments occurring up until 2006. I only keep patents applied in the three years before and the five years after the investment of any given fund in any given firm. I am left with 13,366 investments by 2,364 distinct funds in 4,230 distinct companies, which file a total of 41,971 patents in the eight years around the investment year.

The great advantage of SDC over other private equity data providers is that it relates investments and companies to private equity funds rather than private equity firms. However, Stucke (2011) and Harris, Jenkinson, and Kaplan (2012) have recently established that Venture Economics performance data suffers from severe sample selection issues, with the coverage dropping sharply in the early 2000s. Since Venture Economics is a unit of SDC, one might worry that the reporting bias also applies to the investment level data used in this study. Fortunately, two recent studies have assessed the ability of VentureXpert to accurately report deal level data. Kaplan, Sensoy, and Strömberg (2002) examine 143 financing rounds in 98 companies from 1986 to 1999. They argue that VentureXpert and VentureSource, another mainstream venture capital database, both exclude 15% of financing rounds, and that the former oversamples larger rounds and California companies. Maats, Metrick, Yasuda, Hinkes, and Vershovski (2011) examine investments made by a sample of 40 Venture Capital funds raised between 1992 and 2003 and compare the quality of the coverage of these investments by VentureXpert and VentureSource. They find that the consistency between both databases is low, but that the reliability of fund coverage is higher in VentureXpert, which should be the preferred source for collecting data at the fund level. They note, however, that fund coverage increases with the number of portfolio companies in a given fund. In the appendix to this paper, I compare the coverage of VentureXpert and VentureSource from 1990 to 2010. Panel A compares the annual number of investment rounds in U.S. based companies in each of these datasets. Panel B compares the annual number of new U.S. based private equity funds. There does

not seem to be any downward reporting bias in VentureXpert after 2000. Hence, I am confident that the sample used in this paper is fairly representative.

A. Measuring investor horizon

Since virtually all private equity funds have a ten year finite horizon, I identify between-fund as well as within-fund variations in investment horizon by using the age of the fund at the time of the investment, measured as the log of the number of years between the creation of the fund and any given investment. Funds' contractual agreements usually allow GPs to extend the fund's duration after ten years for up to three years in one year increments, with the consent of the LPs.[10] An extension of the fund's life enables GPs to liquidate stale investments at a profit instead of having to fire sell them. There is little room for LPs and GPs to extend the fund's duration *beyond* these contractual extensions. Gompers and Lerner (2001) note that *"unlike other agreements (for example, employment contracts or strategic alliances), these contracts are rarely renegotiated."* Moreover, conversations with practitioners indicate that LPs are unlikely to agree to receive in-kind distributions of shares of unliquidated private companies. Instead, they will trust the private equity firm with a liquidation mandate and stop paying (or demand a cut in) management fees. This suggests that the contractual lifespan of the fund is indeed a binding constraint on GPs investment horizon.

B. Measuring innovation

I proxy for the innovativeness of a company in two ways. I first approach it ex ante with its age, its development stage, and the number of financing rounds it has received prior to the investment. I construct the following three variables. *Log company age* is the log of the number of years between the month of the investment and the month when the company was founded, as reported by VentureXpert. *Development stage* is a dummy equal to zero for companies classified by VentureXpert as "Startup/Seed" or "Early Stage" and one for later stages. Finally, *Log number of prior rounds* is the log of the number of financing rounds that the company received (from other funds) prior to the investment, according to VentureXpert.

[10] I analyzed a series of 24 hand-collected private equity fund prospectus. They allow for an average of two extensions of one year. A majority of them require the consent of a majority of LPs for an extension to be granted.

I then proxy for the innovativeness of companies with their research and development effort around the private equity investment, measured with the growth in their patent count. To do so, I follow Lerner et al. (2011) and Bernstein (2011) and measure innovation from the NBER and HBS patent databases. I first compute the number of patents per year that any company in the sample applies for in the three years before and the five years following any given private equity investment. Then, for each patent, I count the number of times the patent has been cited by other patents in the calendar year of the patent grant and the three subsequent years. The innovation literature usually interprets the number of citations as a measures of the quality, or economic importance, of the patent. The propensity to patent and to cite previously issued patents varies over time and across technologies. Moreover, towards the end of the sample, patent count underestimates the actual patenting, since many patents that had been applied for, might not have been granted. I follow Hall et al. (2001) and compute scaled patents by dividing each patent by the average number of patents of all companies in the same year and technology class. Similarly, I compute scaled citations as the number of citations a patent receives divided by the average number of citations received by all patents granted in the same year and technology class.[11]

C. Summary statistics

Table II to VI present the summary statistics of the sample. Again, I use the terms "investment" or "deal" to describe the initial cash outlay of a distinct fund in a distinct company. If two funds invest in the same company at the same date, this counts as two investments or two deals. When a fund makes sequential investments in a given company, I keep only the first one.

Table II presents the distribution of fund creations, investments, and exits through time. As expected, 1983-1990, 1997-2000, and 2004-2008 are the most active private equity periods. Fundraisings, investments, and exits all increase sharply. Table III presents the distribution of investments across the 30 Fama-French sectors. Investments are more concentrated in the Business services, Business equipment, and Health-care sectors, which account for respectively 36%, 17%, and 17% of total investments. Panel A of table IV presents fund level summary statistics. On average, funds

[11] One potential concern with using patent data is that firms may decide not to protect their new ideas with patents. Given that I consider within-firm changes in patenting, this concern could affect the analysis only if companies receiving investments by funds with a longer remaining horizon strategically increase patenting following the investment, for reasons orthogonal to their true research and development effort. It is unclear why patenting strategy would depend on horizon, independent of the innovative effort.

invest in 14 different companies and are in their third year when they invest. Panel B presents statistics at the investment level, for dependent and explanatory variables used in the main regression analysis. Table V shows the distribution of private equity funds investments throughout their investment life. Two-thirds of investments occur within the first three years of the life of private equity funds. Half of the exits in the sample occur within the first six years. Table VI presents the sub-sample for which patenting information is available. Companies apply for 1.1 patents per year on average in the three years before and the five years following any private equity investment. These patents receive on average 8.3 citations in the year each patent was granted and in the three following years.

III. Results

A. Company maturity and investment outcome

I start by measuring the extent to which investments in more or less mature companies differ in terms of outcomes, such as holding period, subsequent staging, and probability of a successful exit. I run an investment level OLS regression of investment outcomes on three measures of company maturity. *Log investment holding period* is the log of number of years between the investment and the exit through an IPO or a M&A deal. *Log number of rounds* is the log of the number of financing rounds subsequent to the initial investment of a given fund in a given company. *Successful exit dummy* is a dummy equal to one if the investment is exited through an IPO or a M&A, and zero otherwise.[12] The explanatory variables, *Log company age*, *Development stage*, and *Log number of prior rounds* are the three proxies for company maturity and are defined in section II. All regressions include year fixed effects. Standard errors are corrected for the clustering of investments at the monthly level. Table VII presents the results.

Panel A shows that investments in less mature companies are held for a longer period of time. Investments in companies at the seed or early stage of their development are held for 36% longer than companies at later stages of their development. This is consistent with the theoretical framework presented in section I, according to which conventional projects can be sold earlier than exploratory ones. Given that exploration takes longer to yield observable payoffs, investments in

[12]Exits through IPOs or M&As are the most common proxy for successful exits in the literature.

less mature companies should be held longer than investments in more mature ones.

Funds often stage their funding of young companies, especially Venture Capital funds. They split funding through time and sometimes also condition new funding to the achievement of certain operational milestones. Staging is a way to overcome agency costs related to low asset tangibility or high asset specificity (Gompers, 1995). Moreover, staging is a way for private equity funds to gradually learn about a company's type (Bergemann and Hege, 1998). Staging is thus more likely to apply to investments in companies involved in exploration rather than exploitation. Results in panel B of table VII confirm that investments in less mature companies are staged more often. Investments in companies at the seed or early stage of their development are staged by 25% more than investments in companies at later stages of their development.

Finally, I ask whether investments in less mature companies have a higher probability of success. I define a successful exit as the sale to a third party or an IPO. The alternative to a successful exit is a write-off, whereby the investment is discontinued. In the sample, 64% of investments are written off, 22% are exited through the sale to a third party, and 14% are exited through an IPO. Results in panel C suggest that investments in more mature companies are more likely to be successfully exited than investments in less mature companies. Investments in companies at the seed or early stage of their development have an 8% larger probability than investments in companies at a later stages of their development to be exited through a sale to a third party or an IPO. This is consistent with exploration being less likely to succeed than exploitation. This also suggests that the former might be somewhat more risky than the latter. This might influence the results presented in the upcoming analysis if the appetite for risk varies systematically along funds life. I will therefore control for within-fund time varying risk incentives in the baseline multivariate specification. This preliminary analysis suggests that investments in less mature companies along these three dimensions (age, development stage, and number of prior financing rounds) have the features of exploratory investments.

B. Univariate tests

I then ask whether a fund's age is systematically related to the maturity of targets. Before turning to multivariate regression analysis, I compare the characteristics of companies receiving investments from funds close or far away from the end of their investment horizon in simple univariate

tests.

Table VIII presents the mean and difference in means of characteristics of companies receiving an investment by funds within their first three years (30,769 investments) and funds beyond their third year of operations (15,904 investments).

It turns out that older funds invest in companies that are 3.5 years older on average, and have previously received 0.5 more rounds of investments. The probability of older funds to invest in "Startup/Seed" and "Early Stage" companies is smaller by 9 percentage points. Altogether, these results suggest that younger and older funds select projects with different characteristics. So far, however, these observations cannot be tied down to the predictions of the theoretical framework above.

The way the sample is constructed could indeed generate these results mechanically. First, note that the sample is truncated towards the end of the sample (the last investments of the latest vintages are not observed). Suppose that for some reasons the general investment style of private equity funds changed over time and that the latest fund vintages specialized in very exploratory investments. I would find that younger funds invest on average in more exploratory projects. I address this issue in the OLS regressions of the following section by using fund and fund vintage fixed effects. Second, suppose that private equity firms differ systematically with respect to their investment styles, with some of them having higher skills at detecting and investing in exploratory projects early following their fundraising. The difference in means observed above might simply reflect the difference between skilled and unskilled private equity investors. I rule out this channel by adding private equity firm (investor) fixed effects in the regression analysis below. Finally, if new business creations are cyclical, and if most fundraisings occur at the height of those cycles, then the univariate tests in table VIII might simply reflect this correlation. I shut down this effect by using year fixed effects in the regressions of the multivariate regressions presented below.

Moreover, even if funds indeed systematically shift towards less mature projects as they get closer to liquidation, other features of private equity funds (rather than their limited lifespan only) may account for this fact. The first one is risk aversion. GPs are usually compensated based on an annual 2% of commitments and 20% of the overall performance of the fund above a hurdle rate (usually around 8%), the carried interest. Hence, at any given point in a given fund's investment

life, if cumulative performance has been lower than the hurdle rate, the value of the carried interest is zero. Suppose that a fund manager can choose either a high risk and high return project or a low risk and low return project. It is clear that a lower level of past performance shifts the manager's preference towards the high risk and high returns project, since it is more likely to bring her carried interest back in the money in case of success, and since it won't change the carried interest value in case of failure. I use the number of past exits as a proxy for past performance, a measure widely used in the literature.

Private equity firms raise new funds every three to five years. As has been evidenced by Gompers (1996) and more recently Chung, Sensoy, Stern, and Weisbach (2012), this is likely to dramatically influence managers' behavior, especially young ones that have not yet established reputation and that potentially face more difficulty in raising funds. I address this concern by including in all regressions a dummy for first-time funds and a dummy indicating whether the PE firm has raised a follow-up fund already. If fundraisings have an influence on the change in investment behavior towards the end of a fund's investment life, then these variables should capture it.

Since funds have limited resources, they are likely to pick less complicated assets once they already have a number of other investments to manage, which is likely to happen towards the end of their investment life. Suppose that innovative projects are more costly to monitor. Then I might observe that as a fund gets closer to the end of its investment life, it invests in less innovative assets because it already devotes all its available resources to monitor its existing investments. I control for this with the number of investments that the fund has made since its creation.

C. Fund horizon and company maturity

In this section, I formally test *Prediction 1.* I use OLS regressions to show that as a fund gets closer to liquidation, it selects more mature companies. I analyze the maturity of a company along three dimensions: its age, its development stage at the time of the investment, and the number of financing rounds (involving other funds) it received prior to the investment.

I estimate the following OLS specification at the investment level:

$$V_{i,t} = \alpha + \lambda_1 Age_{i,t} + \lambda_2 X_{i,t} + \gamma_i + \mu_t + \epsilon_{i,t}$$

$V_{i,t}$ is the variable of interest at time t of the investment of fund i, $Age_{i,t}$ is the log of the age of fund i at time t, $X_{i,t}$ is a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. γ_i and μ_t are fund and time fixed effects. Standard errors are clustered by month.

I first consider how funds shift their investments towards younger companies as their horizon shrinks. To do so, I run the investment level OLS regression with the log of company's age as the dependent variable. Several specifications are run with fund vintage, year, private equity firm and fund fixed effects. As evidenced in table IX, funds with shorter horizon invest in younger companies. A one standard deviation increase in the age of the fund (which roughly amounts to moving from the first year to the fourth year of operations of the fund) leads to an increase in the age of the target by between 8 and 16%.

The age of the company might fail to account precisely for its development stage. Companies might have been founded for a few years and yet remain at a very early stage of their development. So I run a similar investment level OLS regression of the development stage dummy on the log of fund age and the same set of controls and fixed effects. As expected, the coefficient on fund age is positive and significant across specifications presented in table X. A one standard deviation increase in the age of the fund leads to an increase in the probability of the target to be beyond the early stage by 5 to 13%.

Finally, I run the investment level OLS regression of the log number of prior rounds on the log of fund age and the same set of controls and fixed effects. Again, the coefficient on fund age is positive and significant across specifications presented in table XI. A company receiving an investment by fund in its fourth year has had 11% to 15% more previous rounds of financing than a company receiving an investment by a fund in its first year of operations.

Interestingly, the level of past performance has a negative effect on the propensity of funds to select exploratory projects. In virtually all regressions, the coefficient on the number of past exits is positive and statistically significant. This is consistent with the idea that funds select more exploratory projects when their risk incentives increase (when their carried interest is out of the

money). Moreover, the coefficient on the interaction between the first-time fund dummy and the number of past exits is of the opposite sign. This is consistent with Chung et al. (2012) and other related papers, which argue that most of the performance of first-time funds should be related to future fund flows while the performance of established funds should be related to the carried interest on their current fund. Therefore, the behavior of established funds should be more sensitive to the value of the carried interest: when performance has been low, their incentives to take on more risk increase, which might lead them to undertake more exploratory projects. Note however that these effects do not subsume the effect of fund horizon.

If the strong and robust pattern in fund investment is due to their limited horizon, the effect should be weaker or absent for investors that have fewer or no constraints on their investment horizon. In table I of the Appendix, I perform the same test on a sample corporate venture and Evergreen funds, which are typically not constrained by an investment horizon. I find no effect of fund age on the maturity of investments.

D. Fund horizon and innovation

In this paragraph, I take another perspective at the innovative effort. I check whether companies which receive investments by younger funds are more innovative, as measured by the increase in the number of patents they issue each year and the number of citations these patents receive (*Prediction 2*).

I start by providing graphic evidence of the different patenting dynamics in companies targeted by funds with different horizon. To do so, I keep any investments in the sample up until December 2006. I am left with 13,366 investments of 2,364 funds in 4,230 companies. I split the sample into two sub-samples of investments involving old and young funds. An investment is allocated to the young fund sample if it happens within the first 36 months of the life of the fund. It is allocated to the old fund sample otherwise. In each sub-sample, I compute the average number of patent applications in the three years prior and the four years following the investment. The results are presented in figure 2. As it appears on the graph, funds with a longer investment horizon select companies that applied for fewer patents prior to the investment. I formally check this by running the same OLS regression as in the previous paragraph on a dummy equal to one if the company has ever applied for a patent prior to the investment. Results are presented in table XII. A one

standard deviation increase in the age of the fund increases the probability that the fund invests in a company that has already applied for a patent by 5 to 13%.

I then analyze patenting dynamics around the investment. From figure 2, it appears that companies with long horizon investors issue approximately 0.5 more patents and 0.2 more scaled patents per year following the investment. They grow their patent count faster than companies with short horizon investors both before and after the investment. I consider the three years before and the five years after the investment of any fund in any company in the sample up until December 2006 and run the following company×year OLS regression:[13]

$$\begin{aligned} PC_{j,t+k} &= \alpha_0 + \alpha_1 Age_{i,t} + \alpha_2 F_{i,t} + \alpha_3 C_{j,t} + \sum_{k=-3}^{5} \lambda_k Y_{t+k} + \sum_{k=-3}^{5} \beta_k Y_{t+k} \times Age_{i,t} \\ &+ \sum_{k=-3}^{5} \delta_k Y_{t+k} \times F_{i,t} + \sum_{k=-3}^{5} \theta_k Y_{t+k} \times C_{j,t} + \epsilon_{i,j,t} \end{aligned}$$

$PC_{j,t+k}$ is the log of one plus the number of patent applications by company j in year k around the investment year t. Y_{t+k} is a dummy equal to one in the k^{th} year around the investment of fund i in company j which occurs in year t. $Age_{i,t}$ is the log of the age of fund i at the time of the investment. $F_{i,t}$ is a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. $C_{j,t}$ is a vector of company level controls, including the log of company age, state, and sector dummies. Standard errors are clustered at the company level. Panel A of table XIII presents the results of the specifications using company fixed effects, while Panel B includes company level controls for age, sector, and state of incorporation. As expected, the results presented in table XIII show that companies invested by private equity funds further away from liquidation increase their patenting activity more in the five years following the investment. A one standard deviation increase in the age of the fund leads to a 17 to 25% larger increase in patent count following the investment. Part of the effect of fund age on patent growth could be attributed to the causal effect of having long term funding on the incentives of the company to innovate. However, the fact that the slope of patent growth is also related to fund age *before* the

[13] I check that all the results using patenting and citation data are robust when using a Poisson model instead of an OLS regression model.

investment confirms that younger funds target more innovative companies. When controlling for observable company characteristics in panel B, the difference in patenting *before* the investment is smaller. However, the difference remains significant following the investment.

I check whether the relatively stronger increase in patenting activity in companies with long-term funding is not achieved at the cost of the quality of patents by studying the change in citation count per patent. I consider the three years before and the five years after the year of the investment of any fund in any company in the sample up until December 2006 and run the same regression as above, although at the patent level rather than the company×year level. Results in table XIV provide evidence that patent quality does not decrease in companies that have received investment from funds further away from liquidation. Following the investment, companies which receive funding from a fund in its first year of operations apply to patents that receive 3 to 6% more citations than patents applied by companies which receive funding from a fund in its fourth year of operations.

E. Horizon and market conditions

I ask whether the sensitivity of project selection to investor horizon varies with market conditions. There are several reasons why horizon should matter less in hot markets. If recent returns on innovative companies have been high, investors could infer that the appetite for innovation has increased. Those with shorter horizon could select more innovative projects with the hope of re-selling them quickly at no discount. I measure market conditions with the cumulative returns on the Nasdaq Composite index in the twelve months up to the month of the deal. I rank months in the sample based on these backward-looking returns. *Hot market conditions* is a dummy equal to one (zero) if past twelve month returns on the Nasdaq Composite index lie in the top (bottom) tertile of the sample distribution. I then run an investment level OLS regression of the proxies for company's maturity on the log of fund age interacted with *Hot market conditions*. All specifications include a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. Several specifications are run with year and private equity firm fixed effects. Standard errors are clustered by month.

Table XV presents the results. The coefficient on the interaction term is always negative and significant, suggesting that the wedge between the investment decision of young and old funds shrinks in hot markets. The propensity of shorter horizon funds to select more mature companies is significantly lower when the returns of the Nasdaq Composite index in the past year have been abnormally high.

F. Horizon and private equity firm experience

This section explores the extent to which limited horizon distorts private equity fund management decisions. If this is the case, GPs with a higher reputation, due to their experience and track record of performance, should attempt to emancipate themselves from this constraint. I check whether the sensitivity of project selection to horizon is weaker for reputable GPs. I measure the experience of the GP alternatively with *log PE firm age*, i.e., the log of the number of years since the PE firm has been operating, the *log PE firm number of investments*, i.e., the log of the number of investments made by the GP (PE firm) before raising the fund and the *log PE firm nb. of funds raised*, i.e., the number of funds raised by the PE firm prior to the investment. I then run an investment level OLS regression of the proxies for company's maturity on the log of fund age interacted with the three measures of GP experience. All specifications include controls for the average of the maturity proxy in companies in which the fund invested prior to time t, and a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time fund. Several specifications are run with year and private equity firm fixed effects. Standard errors are clustered by month.

Table XVI presents the results. In Panel A, *log PE firm age* proxies for the reputation of the PE firm. The results indicate that more reputable firms show a larger shift towards less innovative projects as their fund moves closer to liquidation. Panel B and C confirm this results when reputation is proxied with the *Log GP number of investments* and the *log PE firm nb. of funds raised*. Hence, more reputable PE firms operate a steeper shift towards less innovative projects as their funds get closer to liquidation. These findings suggest that more reputable funds have a better ability to match their assets with their fixed horizon liability structure. This ability could stem from

know-how or access to a wider range of projects, or from the fact that more experienced private equity firms run overlapping funds and thus better match target and fund maturity. These results should not come as a complete surprise: if the fixed horizon structure of limited partnerships was hurting reputable PE investors more than non reputable ones, the former would be likely to offer an alternative contractual agreement to their LPs. They point out, however, that one dimension of private equity investing is to match target and fund maturity, and that experienced investors seem to be better at doing so.

Horizon and exits Finally, I ask whether exit patterns are consistent with time-constrained funds selecting more mature targets, i.e., targets with a larger probability of a successful exit. I run an investment level OLS regression of the successful exit dummy on the log of fund age, and a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. Results are presented in table XVII. In columns (2) to (4) the log of fund age is interacted with successively the *log PE firm age*, i.e., the log of the number of years since the PE firm has been operating (column 2), the *log PE firm number of investments*, i.e., the log of the number of investments made by the GP (PE firm) before raising the fund (column 3) and the *log PE firm nb. of funds raised*, i.e., the number of funds raised by the PE firm prior to the investment (column 4). Overall, a one standard deviation increase in fund age is associated with a 5% (2.4 percentage points) increase in the probability of a successful exit. When fund age is interacted with the measures of PE firm experience, in columns 2 to 4, the coefficient on the interaction term is highly significant. These results are consistent with the idea that more experienced investors are better at matching fund and target maturity, which translates in more successful exits towards the end of their fund's investment life.

IV. Conclusion

Investments exploring new ideas typically take more time to payoff than investments exploiting existing ones. I check that, consistent with this idea, investors with a longer horizon have a larger

propensity to fund innovation than investors with a shorter horizon. I consider the case of private equity funds, which investment horizon is fixed ex ante. I find that their contractual structure limits their ability to undertake innovative projects.

I show that funds further away from liquidation invest in younger companies at an earlier stage of their development that grow their patent count faster. I find that more experienced PE investors operate a steeper shift towards less innovative projects as their funds get closer to liquidation, and that the propensity of shorter horizon funds to select more mature companies decreases when the returns of the Nasdaq Composite index in the past year have been abnormally high.

Altogether, these results suggest that horizon is a strong driver of private equity funds investment decisions throughout their life-cycle. On a broader note, they highlight that investor characteristics matter to an important extent for the funding of corporate innovation.

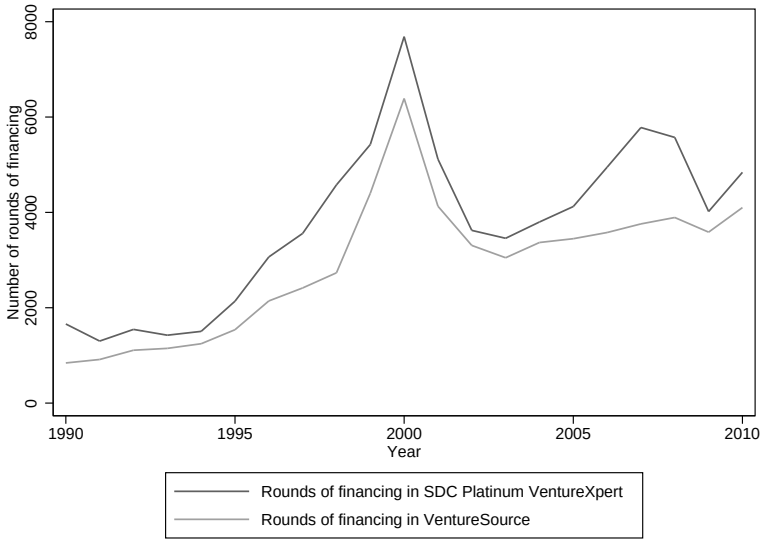
Appendix A. Variables definition

Definition of the main variables

Log fund age	Log of one plus the number of years between the month of the investment and the month when the fund was created.
Log number of rounds	Log of one plus the number of investment rounds of the fund in the company following the initial investment of a fund in this company.
Log number of prior rounds	Log of the number of financing rounds (involving other funds) received by the company until the investment of the fund.
Development stage dummy	Dummy equal to zero for companies classified by VentureXpert as "Startup/Seed" or "Early Stage" and one for later stages.
Log company age	Log of one plus the number of years between the month when the company was founded and the month of the initial investment of a fund in this company.
Log investment holding period	Log of the number of years between the month of the initial investment of a fund in the company and the initial public offering of the company or its sale to a third party (M&A).
Log number of past exits	Log of one plus the number of IPOs or M&As of companies which previously received an investment from the fund.
Log number of past investments	Log of one plus the number of previous investments made by the fund.
Follow-up fund dummy	Dummy equal to one if the private equity firm operating the fund has raised a follow-up fund at the time of the investment, and zero otherwise.
Log fund size	Log of the size of the fund measured in million dollars.
First-time fund dummy	Dummy equal to 1 if the fund is the first one raised by the private equity firm.
Log patents	Log of one plus the number of patents applied by a company in a given year around a private equity investment.
Log scaled patents	Following Hall et al. (2001): log of one plus the number of patents applied by a company in a given year scaled by the average number of patents applied by all companies in the same year and technology class.
Log citations	Log of one plus the number of citations received by a patent in the year it was granted and in the three following calendar years.
Log scaled citations	Following Hall et al. (2001): log of one plus the number of citations a patent receives divided by the average number of citations received by all patents granted in the same year and technology class.
Hot market conditions	Dummy equal to one for months that lie in the top tertile of the distribution of past twelve months cumulative Nasdaq Composite returns, and zero for months in the bottom tertile
Log PE firm nb. of inv.	Log of the total number of investments reported in VentureXpert made by the private equity firm prior to raising the fund.
Log PE firm nub. of funds raised	Log of the number of the fund in the sequence of funds raised by the private equity firm.
Log PE firm age	Log of the number of years of operations of the private equity firm.
Prior patenting dummy	Dummy equal to one if the company has ever applied for a patent prior to the investment.

Appendix B. Representativeness of the sample

A. Annual number of investment rounds (1990-2010)



B. Annual number of fundraisings (1990-2010)

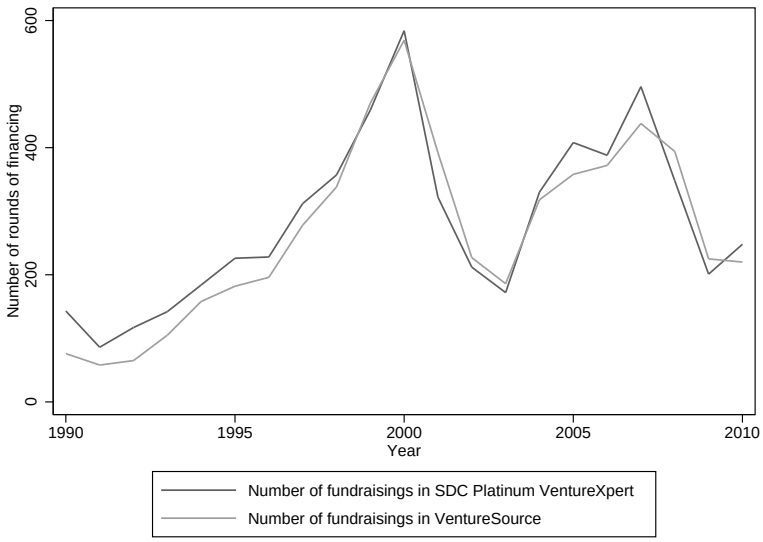


Figure 1. Coverage of SDC Platinum VentureXpert and VentureSource This figure compares the coverage of SDC Platinum VentureXpert and Venturesource, the two main venture capital investment level datasets. Panel A compares the annual number of investment rounds in U.S. based companies in each of these datasets. Panel B compares the annual number of new U.S. based private equity funds.

Appendix C. Unconstrained funds

Table I: Unconstrained funds and company maturity

This table replicates the results obtained in tables IX, X, and XI on a sample of Corporate Venture Capital and Evergreen funds. A set of OLS regressions are run of proxies for company maturity on the log of fund age and a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. In columns (1) and (2), the dependent variable is the log of the number of years between the creation of the company and the investment. In columns (3) and (4), the dependent variable is a dummy equal to zero for companies classified by VentureXpert as "Startup/Seed" or "Early Stage" and one for later stages. In columns (5) and (6), the dependent variable is the log of the number of previous financing rounds (involving other funds) received by the company until the investment by a given fund. Standard errors are clustered by month and presented in parenthesis. ***, ** and * indicate significance at the 1, 5 and 10 percent level.

	(1)	(2)	(3)	(4)	(5)	(6)
	Log company age		Dev. stage dummy		Log nb. of prior rounds	
Log fund age	0.01	0.01	0.02	0.03	0.02	0.03
	(0.03)	(0.04)	(0.02)	(0.02)	(0.02)	(0.03)
Log fund nb. of exits		-0.03		-0.04**		-0.04*
		(0.03)		(0.02)		(0.02)
First-time fund		0.03		-0.01		0.01
		(0.05)		(0.04)		(0.05)
Log fund nb. of past investments		0.01		0.02		0.00
		(0.02)		(0.01)		(0.02)
Follow-up fund dummy		0.01		0.00		0.03
		(0.04)		(0.03)		(0.03)
Log fund size		0.00		0.01		-0.01
		(0.02)		(0.02)		(0.02)
Constant	1.40***	1.35***	0.32**	0.31**	0.31	0.34
	(0.22)	(0.24)	(0.14)	(0.15)	(0.32)	(0.33)
Inv. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
PE firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4923	4923	4923	4923	4923	4923
R^2	0.208	0.208	0.228	0.229	0.246	0.247

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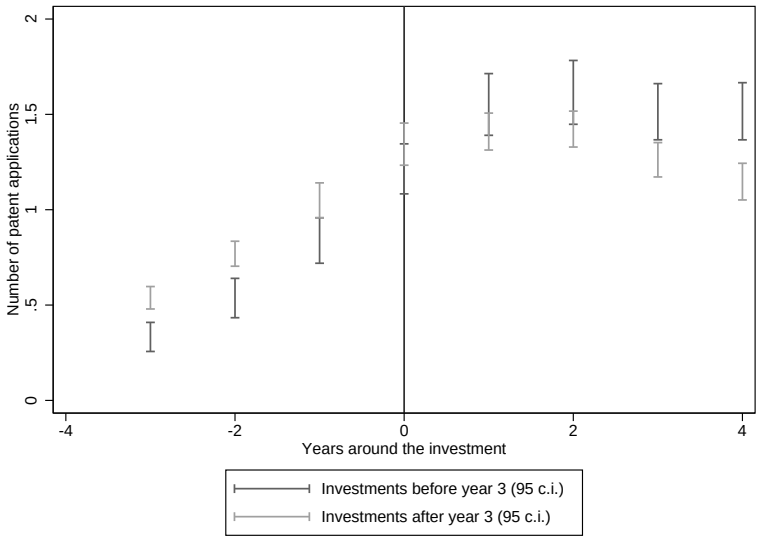
A. Average number of patent applications per year



B. Average number of scaled patent applications per year

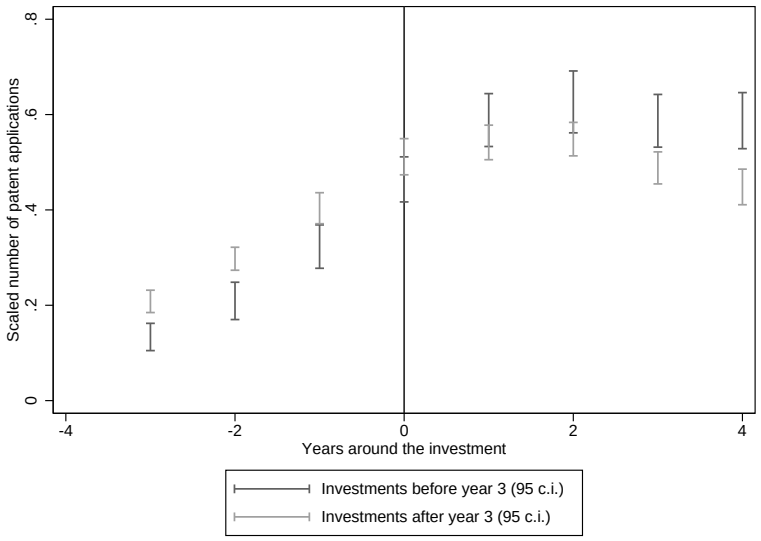


Figure 2. Fund horizon and patenting around private equity investments This figure presents the average patent applications in the three years prior and the five years following each investment. For the purpose of this analysis, the sample is restricted to investments made up until 2006 in companies that could be matched to the NBER and HBS patent databases. In each panel, the darker brackets present the 95 confidence interval of the average annual patent count of companies receiving investments by funds in their first three years of operations (8,681 investments), while the lighter brackets present the 95 confidence interval of the average annual patent count of companies receiving investments by funds beyond their third year of operations (4,685 investments). Panel A presents average patent counts, while panel B presents average scaled patent counts, where the number of patents applied for by a given company is scaled by the average number of patents granted to all companies in the same year and technology class.

Table II: Distribution of fund creations, investments and exits through time

This table presents the distribution of fund creations, investments, and exits across years.

Year	Number of new funds	Number of investments	Number of exits
1980	42	92	1
1981	64	338	2
1982	74	757	2
1983	98	1180	19
1984	93	1267	13
1985	78	1118	13
1986	63	1390	43
1987	76	1331	32
1988	63	1291	26
1989	74	1132	22
1990	39	906	25
1991	33	643	59
1992	61	895	93
1993	71	767	98
1994	79	836	89
1995	97	803	133
1996	113	1159	164
1997	175	1603	128
1998	188	2002	149
1999	276	3477	268
2000	402	5106	305
2001	196	2877	170
2002	84	1813	173
2003	93	1876	177
2004	141	2108	271
2005	155	2035	247
2006	154	1995	265
2007	145	2006	290
2008	120	1789	215
2009	51	1041	179
2010	37	1040	308

Table III: Distribution of investments across sectors

This table presents the distribution of investments in the sample across Fama-French 30 sectors (classification obtained from Kenneth French's website).

Sector	Number of investments	% of deals
Food Products	202	0.43%
Beer & Liquor	14	0.03%
Tobacco	1	0.00%
Recreation	318	0.68%
Printing and Publishing	207	0.44%
Consumer Goods	209	0.45%
Apparel	59	0.13%
Healthcare	7746	16.60%
Chemicals	214	0.46%
Textiles	23	0.05%
Construction	184	0.39%
Steel Works	132	0.28%
Fabricated Products	454	0.97%
Electrical Equipment	427	0.91%
Automobiles and Trucks	49	0.10%
Aircraft, ships	26	0.06%
Mines, Precious Metals	23	0.05%
Coal	13	0.03%
Oil	114	0.24%
Utilities	135	0.29%
Communication	1813	3.88%
Business Services	16920	36.25%
Business Equipment	8481	18.17%
Business Supplies	48	0.10%
Transportation	179	0.38%
Wholesale	681	1.46%
Retail	920	1.97%
Restaurants, Hotels	118	0.25%
Finance	1133	2.43%
Other	5830	12.49%

Table IV: Summary statistics

This table presents summary statistics for the sample used in most of the analysis. Panel A shows fund level statistics while panel B shows investment level statistics.

Variables	Obs.	Mean	Median	Std. dev.
Fund level summary statistics				
Number of investments (in distinct companies)	3435	13.59	9.00	14.46
Number of sectors	3435	4.06	4.00	2.65
Fund age	3435	3.27	2.82	2.07
Investment level summary statistics				
	Observations	Mean	Median	Std. dev.
Log company age (in years)	46673	1.079	1.099	0.883
Log investment sequence number	46673	0.634	0.693	0.674
Stage dummy (=0 for seed and early stage)	46673	0.510	1.000	0.500
Log fund age (in years)	46673	0.949	1.099	0.697
Log number of past exits	46673	0.446	0.000	0.708
Log number of past investments	46673	2.171	2.303	1.081
Follow-up fund dummy	46673	0.446	0.000	0.497
Log fund size	46673	4.313	4.404	1.604
First-time fund dummy	46673	0.273	0.000	0.446
Exit dummy	46673	0.358	0.000	0.479

Table V: Distribution of investments and exits throughout fund life

This table presents the distribution of investment and exits through initial public offerings of merger and acquisitions by fund age (in years).

Fund age	Investments			Exits (IPOs + M&As)			IPOs		
	Nb.	Percent.	Cum . percent.	Nb.	Percent.	Cum. percent.	Nb.	Percent.	Cum. percent.
1	11224	24%	24%	398	2%	2%	151	1%	1%
2	11254	24%	48%	974	6%	8%	496	5%	6%
3	8291	18%	66%	1517	9%	17%	812	8%	14%
4	5608	12%	78%	1797	11%	28%	1039	10%	24%
5	3657	8%	86%	1903	11%	39%	1195	12%	36%
6	2277	5%	91%	1994	12%	51%	1255	12%	48%
7	1355	3%	94%	1599	10%	61%	1000	10%	58%
8	902	2%	95%	1591	10%	70%	1039	10%	68%
9	646	1%	97%	1254	8%	78%	897	9%	77%
10	359	1%	98%	1025	6%	84%	707	7%	84%
11	253	1%	98%	744	4%	89%	488	5%	88%
12	185	0%	99%	525	3%	92%	302	3%	91%

Table VI: Summary statistics: patenting firms

This table presents summary statistics for the sub-sample of firms matched with the NBER and HBS patent databases. Panel A displays the distribution of investments, patent applications, and grants per year. Panel B shows the distribution of patents (per year around the investment) and citations (per patent).

PANEL A: Distribution of investments, patent applications and patent grants per year

Year	Investments	Patent applications	Patent grants
1978	-	9	1
1979	-	21	-
1980	9	45	11
1981	80	107	19
1982	170	144	23
1983	251	159	69
1984	268	243	134
1985	311	329	175
1986	352	410	198
1987	351	475	345
1988	393	499	395
1989	333	563	579
1990	221	622	500
1991	218	644	554
1992	312	717	610
1993	285	746	607
1994	312	1046	659
1995	256	1708	668
1996	355	1642	833
1997	544	2436	1122
1998	714	2846	1734
1999	951	3325	1991
2000	1396	4271	2420
2001	1157	4756	2699
2002	833	4646	3088
2003	923	3936	3587
2004	929	3199	3523
2005	799	2965	3168
2006	643	1788	3827
2007	-	1305	3287
2008	-	476	2864
2009	-	115	2922
2010	-	11	3593

PANEL B: Mean patent and citation count

	Observations	Mean	Standard deviation
Patent applications per year	106925	1.13	5.51
Scaled patent applications per year	106925	0.44	2.06
Citations per patent	41971	8.29	14.46
Scaled citations per patent	41919	1.92	4.60

Table VII: Company maturity and investment outcome

This table presents the results of investment level OLS regressions of various investment outcomes on three proxies for company maturity. Log company age is the log of the number of years between the creation of the company and the investment. The log number of prior rounds is the log of the number of previous financing rounds (involving other funds) received by the company until the investment by a given fund. The development stage of a company is measured with a dummy equal to zero for companies classified by VentureXpert as "Startup/Seed" or "Early Stage" and one for later stages. In Panel A, the dependent variable is the log of number of years between the investment and the exit through an IPO or a M&A deal. In panel B, the dependent variable is the log of the number of financing rounds subsequent to the initial investment of a given fund in a given company. In panel C, the dependent variable is a dummy equal to one if the investment is exited through an IPO or a M&A and zero otherwise. Standard errors are corrected for clustering at the monthly level and presented in parenthesis. *** indicates that the difference in means is significant at the 1% level.

PANEL A: Log investment holding period			
Log company age	-0.12***		
	(0.01)		
Development stage dummy		-0.36***	
		(0.02)	
Log nb. of prior rounds			-0.27***
			(0.01)
Constant	1.25***	1.31***	1.31***
	(0.01)	(0.01)	(0.01)
Year FE	Yes	Yes	Yes
Observations	10379	10379	10379
R^2	0.090	0.117	0.121
PANEL B: Log number of subsequent rounds			
Log company age	-0.12***		
	(0.00)		
Development stage dummy		-0.25***	
		(0.01)	
Log nb. of prior rounds			-0.14***
			(0.01)
Constant	0.70***	0.69***	0.65***
	(0.01)	(0.01)	(0.01)
Year FE	Yes	Yes	Yes
Observations	31690	31690	31690
R^2	0.071	0.079	0.061
PANEL C: Successful exit dummy			
Log company age	0.02***		
	(0.00)		
Development stage dummy		0.08***	
		(0.01)	
Log nb. of prior rounds			0.09***
			(0.00)
Constant	0.30***	0.29***	0.27***
	(0.00)	(0.00)	(0.00)
Year FE	Yes	Yes	Yes
Observations	31690	31690	31690
R^2	0.068	0.074	0.083

Table VIII: Horizon and company maturity: univariate tests

This table presents the mean and difference in means of characteristics of companies receiving an investment by funds within their first three years (30,769 investments) and funds beyond their third year (15,904 investments). Company age is the number of years between the creation of the company and the investment. Number of prior rounds is the number of previous financing rounds (involving other funds) received by the company until the investment by a given fund. The development stage of a company is measured with a dummy equal to zero for companies classified by VentureXpert as "Startup/Seed" or "Early Stage" and one for later stages. Number of rounds is the number of follow-up cash outlays made by the fund in the company subsequent to the initial investment. The holding period is the number of months between the investment and a successful exit, conditional on a successful exit. Standard errors are presented in parenthesis. *** indicates that the difference in means is significant at the 1% level.

		Investments until year 3	Investments beyond year 3	Difference
Company age at investment (in years)	Mean	1.59	5.08	-3.49***
	Std. dev.	(0.78)	(1.95)	
Nb. of prior rounds	Mean	2.23	2.71	-0.47***
	Std. dev.	(1.80)	(2.22)	
Development stage dummy (=0 for seed and early stage)	Mean	0.48	0.57	-0.09***
	Std. dev.	(0.50)	(0.50)	
Number of rounds	Mean	2.41	2.06	0.35***
	Std. dev.	(1.81)	(1.59)	
Holding period (months)	Mean	57.58	53.32	4.27***
	Std. dev.	(39.56)	(37.20)	

Table IX: Fund horizon and company age

This table presents the results of an investment level OLS regression of the log of company's age on the log of fund age and a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. Several specifications are run with fund vintage, year, private equity firm, and fund fixed effects. Standard errors are clustered by month and presented in parenthesis. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

Dependent variable: log company age (in years)						
Log fund age	0.23***	0.18***	0.22***	0.21***	0.13***	0.21***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund nb. of exits	0.06***	0.06***	0.03***	0.04***	0.05***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
First-time fund × Log fund nb. of exits	-0.05***	-0.05***	-0.05***	-0.06***	-0.05***	-0.06***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
First-time fund	-0.01	-0.00	-0.11***	-0.04**	-0.03*	
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	
Log fund nb. of past investments	-0.05***	-0.05***	-0.05***	-0.04***	-0.04***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Follow-up fund dummy	-0.07***	-0.06***	-0.02*	-0.02*	-0.00	-0.03*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Log fund size	0.00	0.00	-0.00	-0.03***	-0.03***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Constant	0.97***	1.01***	1.01***	0.85***	1.18***	0.94***
	(0.02)	(0.02)	(0.02)	(0.13)	(0.09)	(0.02)
Vintage fixed effects	Yes	No	No	Yes	No	No
Inv. year fixed effects	No	Yes	No	No	Yes	No
PE firm fixed effects	No	No	Yes	Yes	Yes	No
Fund fixed effects	No	No	No	No	No	Yes
Observations	46673	46673	46673	46673	46673	46673
R^2	0.035	0.040	0.148	0.152	0.160	0.209

Table X: Fund horizon and company development stage

This table presents the results of an investment level OLS regression of a development stage dummy on the log of fund age and a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. The development stage dummy is equal to zero for companies classified by VentureXpert as "Startup/Seed" or "Early Stage" and one for later stages. Several specifications are run with fund vintage, year, private equity firm, and fund fixed effects. Standard errors are clustered by month and presented in parenthesis. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

Dependent variable: Development stage dummy						
Log fund age	0.08***	0.08***	0.07***	0.08***	0.06***	0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund nb. of exits	0.05***	0.06***	0.02***	0.02***	0.03***	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
First-time fund × Log fund nb. of exits	0.01*	0.01	-0.02***	-0.01*	-0.02**	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
First-time fund	-0.03***	-0.03***	-0.04***	-0.02*	-0.01	
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Log fund nb. of past investments	-0.04***	-0.03***	-0.03***	-0.03***	-0.02***	-0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Follow-up fund dummy	0.00	0.00	0.04***	0.02***	0.02***	0.01
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund size	0.02***	0.02***	0.01***	-0.01***	-0.01***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Constant	0.42***	0.42***	0.44***	0.33***	0.51***	0.45***
	(0.01)	(0.01)	(0.01)	(0.07)	(0.04)	(0.01)
Vintage fixed effects	Yes	No	No	Yes	No	No
Inv. year fixed effects	No	Yes	No	No	Yes	No
PE firm fixed effects	No	No	Yes	Yes	Yes	No
Fund fixed effects	No	No	No	No	No	Yes
Observations	46673	46673	46673	46673	46673	46673
R^2	0.031	0.031	0.129	0.137	0.138	0.199

Table XI: Fund horizon and company number of prior rounds

This table presents the results of an investment level OLS regression of the log number of prior rounds on the log of fund age and a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. The investment sequence number is the number of previous financing rounds (involving other funds) received by the company until the investment of the fund. Several specifications are run with fund vintage, year, private equity firm, and fund fixed effects. Standard errors are clustered by month and presented in parenthesis. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

Dependent variable: Log number of prior rounds						
Log fund age	0.14***	0.10***	0.15***	0.16***	0.11***	0.14***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund nb. of exits	0.05***	0.07***	0.03***	0.03***	0.05***	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
First-time fund × Log fund nb. of exits	0.06***	0.05***	-0.01	-0.00	-0.02**	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
First-time fund	-0.10***	-0.09***	-0.10***	-0.06***	-0.04***	
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Log fund nb. of past investments	-0.04***	-0.04***	-0.05***	-0.05***	-0.05***	-0.02***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Follow-up fund dummy	0.02**	0.02***	0.04***	0.03***	0.03***	0.03**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund size	-0.01***	-0.01***	-0.01***	-0.04***	-0.04***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Constant	0.64***	0.66***	0.66***	0.46***	0.42***	0.53***
	(0.01)	(0.02)	(0.02)	(0.09)	(0.05)	(0.01)
Vintage fixed effects	Yes	No	No	Yes	No	No
Inv. year fixed effects	No	Yes	No	No	Yes	No
PE firm fixed effects	No	No	Yes	Yes	Yes	No
Fund fixed effects	No	No	No	No	No	Yes
Observations	46673	46673	46673	46673	46673	46673
R^2	0.035	0.042	0.144	0.150	0.157	0.224

Table XII: Fund horizon and patenting history

This table presents the results of an investment level OLS regression of the prior patenting dummy on the log of fund age and a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. The sample is restricted to investments in companies that are matched with the NBER and HBS patent databases. The prior patenting dummy indicates whether the company has ever applied for any patent before receiving the investment. Several specifications are run with fund vintage, year, private equity firm, and fund fixed effects. Standard errors are clustered by month and presented in parenthesis. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

Dependent variable: Prior patenting dummy						
Log fund age	0.12***	0.05***	0.12***	0.12***	0.05***	0.11***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
incentives	0.03***	0.03***	0.01	0.02**	0.02*	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
First-time fund × Log fund nb. of exits	-0.03**	-0.01	-0.02	-0.04**	-0.02	-0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
First-time fund	0.02	0.02	-0.10***	-0.03*	-0.02	
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	
Log fund nb. of past investments	-0.02***	-0.02***	-0.02***	-0.01**	-0.01**	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Follow-up fund dummy	-0.02*	-0.01	0.02	0.01	0.01	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Log fund size	-0.02***	-0.02***	0.02***	-0.01**	-0.01***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Constant	0.45***	0.51***	0.33***	0.40***	0.60***	0.35***
	(0.02)	(0.02)	(0.02)	(0.14)	(0.22)	(0.02)
Vintage fixed effects	Yes	No	No	Yes	No	No
Inv. year fixed effects	No	Yes	No	No	Yes	No
PE firm fixed effects	No	No	Yes	Yes	Yes	No
Fund fixed effects	No	No	No	No	No	Yes
Observations	13365	13365	13365	13365	13365	13642
R^2	0.068	0.087	0.155	0.170	0.188	0.260

Table XIII: Fund horizon and increase in patent count

This table presents the results of the following company × year regression (investment made up until December 2006 are included):

$$PC_{j,t+k} = \alpha_0 + \alpha_1 Age_{i,t} + \alpha_2 F_{i,t} + \alpha_3 C_{j,t} + \sum_{k=-3}^{5} \lambda_k Y_{t+k} + \sum_{k=-3}^{5} \beta_k Y_{t+k} \times Age_{i,t} + \sum_{k=-3}^{5} \delta_k Y_{t+k} \times F_{i,t} + \sum_{k=-3}^{5} \theta_k Y_{t+k} \times C_{j,t} + \epsilon_{i,j,t}$$

$PC_{j,t+k}$ is successively the log of one plus the number of patent applications and the log one plus the number of scaled patent applications by company j in year k around the investment year t. Y_{t+k} is a dummy equal to one in the k^{th} year around the investment of fund i in company j which occurs in year t. $Age_{i,t}$ is the log of the age of fund i at the time of the investment. $F_{i,t}$ is a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. $C_{j,t}$ is a vector of company level controls, including the log of company age, stat, and sector dummies. Standard errors are clustered at the company level. Panel A the results of the specifications using company fixed effects, while Panel B includes company level controls (age, sector, and state of incorporation). Standard errors are clustered by company and presented in parenthesis. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

PANEL A: Within company

	Log patents + 1			Log scaled patents + 1		
Log fund age	0.14***	0.03***	0.15***	0.08***	0.02***	0.09***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Inv. year -3 × Log fund age	0.05***	0.05***	0.06***	0.02***	0.02***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Inv. year -2 × Log fund age	0.06***	0.06***	0.06***	0.03***	0.03***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Inv. year -1 × Log fund age	0.04***	0.04***	0.04***	0.02***	0.02***	0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Inv. year +1 × Log fund age	-0.07***	-0.07***	-0.07***	-0.04***	-0.04***	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Inv. year +2 × Log fund age	-0.10***	-0.10***	-0.08***	-0.06***	-0.06***	-0.05***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Inv. year +3 × Log fund age	-0.11***	-0.11***	-0.07***	-0.06***	-0.06***	-0.05***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Inv. year +4 × Log fund age	-0.14***	-0.14***	-0.09***	-0.08***	-0.08***	-0.06***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Inv. year dummies × Fund controls	Yes	Yes	Yes	Yes	Yes	Yes
Inv. year dummies × Company controls	No	No	No	No	No	No
Company fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Inv. year fixed effects	No	Yes	No	No	Yes	No
Vintage fixed effects	Yes	No	No	Yes	No	No
PE firm fixed effects	Yes	Yes	No	Yes	Yes	No
Fund fixed effects	No	No	Yes	No	No	Yes
Observations	106925	106925	106925	106925	106925	106925
R^2	0.394	0.398	0.396	0.414	0.418	0.417

PANEL B: Controlling for company's observable characteristics

	Log patents + 1			Log scaled patents + 1		
Log fund age	0.03**	0.04***	0.04***	0.01	0.02***	0.03***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Inv. year -3 × Log fund age	0.04***	0.04***	0.05***	0.02**	0.02**	0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Inv. year -2 × Log fund age	0.04***	0.04***	0.04***	0.02***	0.02***	0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Inv. year -1 × Log fund age	0.02	0.02	0.02**	0.01	0.01	0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Inv. year +1 × Log fund age	-0.05***	-0.05***	-0.05***	-0.03***	-0.03***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Inv. year +2 × Log fund age	-0.07***	-0.07***	-0.05***	-0.04***	-0.04***	-0.03***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Inv. year +3 × Log fund age	-0.08***	-0.08***	-0.04***	-0.05***	-0.05***	-0.03***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Inv. year +4 × Log fund age	-0.11***	-0.11***	-0.06***	-0.07***	-0.07***	-0.04***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Inv. year dummies × Fund controls	Yes	Yes	Yes	Yes	Yes	Yes
Inv. year dummies × Company controls	Yes	Yes	Yes	Yes	Yes	Yes
Company fixed effects	No	No	No	No	No	No
Inv. year fixed effects	No	Yes	No	No	Yes	No
Vintage fixed effects	Yes	No	No	Yes	No	No
PE firm fixed effects	Yes	Yes	No	Yes	Yes	No
Fund fixed effects	No	No	Yes	No	No	Yes
Observations	95060	95060	95060	95060	95060	95060
R^2	0.145	0.146	0.180	0.142	0.143	0.181

Table XIV: Fund horizon and increase in citation count

This table presents the results of the following patent-level regression (investment made up until December 2006 are included):

$$CC_{j,t+k} = \alpha_0 + \alpha_1 Age_{i,t} + \alpha_2 F_{i,t} + \alpha_3 C_{j,t} + \sum_{k=-3}^{5} \lambda_k Y_{t+k} + \sum_{k=-3}^{5} \beta_k Y_{t+k} \times Age_{i,t} + \sum_{k=-3}^{5} \delta_k Y_{t+k} \times F_{i,t} + \sum_{k=-3}^{5} \theta_k Y_{t+k} \times C_{j,t} + \epsilon_{i,j,t}$$

$CC_{j,t+k}$ is successively the log of one plus the number of citations and the log of one plus the number of scaled citations received by a patent applied by company j in year k around the investment year t. Y_{t+k} is a dummy equal to one in the k^{th} year around the investment of fund i in company j which occurs in year t. $Age_{i,t}$ is the log of the age of fund i at the time of the investment. $F_{i,t}$ is a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. $C_{j,t}$ is a vector of company level controls, including the log of company age, state, and sector dummies. Standard errors are clustered at the company level. Panel A the results of the specifications using company fixed effects, while Panel B includes company level controls (age, sector, and state of incorporation). Standard errors are clustered by company and presented in parenthesis. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

PANEL A: Within company

	Log citations + 1			Log scaled citations + 1		
Log fund age	-0.11***	0.06**	-0.12***	-0.07***	0.03**	-0.08***
	(0.04)	(0.02)	(0.04)	(0.02)	(0.01)	(0.02)
Inv. year -3 × Log fund age	0.19***	0.23***	0.17***	0.08***	0.10***	0.07**
	(0.05)	(0.06)	(0.05)	(0.03)	(0.03)	(0.03)
Inv. year -2 × Log fund age	0.13***	0.16***	0.13***	0.04**	0.06***	0.05**
	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)
Inv. year -1 × Log fund age	0.06**	0.08***	0.06**	0.02	0.03	0.01
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Inv. year +1 × Log fund age	-0.01	-0.02	-0.02	0.00	-0.00	-0.00
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.01)
Inv. year +2 × Log fund age	-0.07**	-0.09***	-0.07**	-0.03	-0.04**	-0.04**
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Inv. year +3 × Log fund age	-0.13***	-0.16***	-0.10**	-0.07***	-0.08***	-0.06**
	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)
Inv. year +4 × Log fund age	-0.17***	-0.21***	-0.15***	-0.09***	-0.11***	-0.10***
	(0.05)	(0.05)	(0.05)	(0.03)	(0.03)	(0.03)
Inv. year dummies × Fund controls	Yes	Yes	Yes	Yes	Yes	Yes
Inv. year dummies × Company controls	No	No	No	No	No	No
Company fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Inv. year fixed effects	No	Yes	No	No	Yes	No
Vintage fixed effects	Yes	No	No	Yes	No	No
PE firm fixed effects	Yes	Yes	No	Yes	Yes	No
Fund fixed effects	No	No	Yes	No	No	Yes
Observations	119064	119064	119064	118959	118959	118959
R^2	0.441	0.444	0.443	0.401	0.403	0.403

PANEL B: Controlling for company's observable characteristics

	Log citations + 1			Log scaled citations + 1		
Log fund age	-0.02	0.03	0.00	-0.04*	0.02	-0.02
	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)
Inv. year -3 × Log fund age	0.17**	0.23***	0.18***	0.04	0.07*	0.05
	(0.07)	(0.07)	(0.06)	(0.04)	(0.04)	(0.03)
Inv. year -2 × Log fund age	0.14***	0.19***	0.13***	0.04	0.06**	0.04*
	(0.04)	(0.05)	(0.04)	(0.03)	(0.03)	(0.02)
Inv. year -1 × Log fund age	0.02	0.06	0.03	-0.01	0.01	-0.01
	(0.04)	(0.04)	(0.03)	(0.02)	(0.02)	(0.02)
Inv. year +1 × Log fund age	0.00	-0.01	-0.01	0.02	0.01	0.00
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Inv. year +2 × Log fund age	-0.03	-0.08*	-0.06*	-0.02	-0.04	-0.04**
	(0.05)	(0.05)	(0.03)	(0.03)	(0.03)	(0.02)
Inv. year +3 × Log fund age	-0.11**	-0.18***	-0.09**	-0.06**	-0.09***	-0.07***
	(0.05)	(0.05)	(0.04)	(0.03)	(0.03)	(0.02)
Inv. year +4 × Log fund age	-0.07	-0.17***	-0.09**	-0.06*	-0.10***	-0.08***
	(0.05)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)
Inv. year dummies × Fund controls	Yes	Yes	Yes	Yes	Yes	Yes
Inv. year dummies × Company controls	Yes	Yes	Yes	Yes	Yes	Yes
Company fixed effects	No	No	No	No	No	No
Inv. year fixed effects	No	Yes	No	No	Yes	No
Vintage fixed effects	Yes	No	No	Yes	No	No
PE firm fixed effects	Yes	Yes	No	Yes	Yes	No
Fund fixed effects	No	No	Yes	No	No	Yes
Observations	110743	110743	110743	110648	110648	110648
R^2	0.135	0.153	0.183	0.101	0.108	0.149

Table XV: Fund horizon and market conditions

This table presents the results of an investment level OLS regression of the proxies for company maturity on the log of fund age interacted with *Hot market conditions*, a dummy equal to one (zero) if past twelve month returns on the Nasdaq Composite index lie in the top (bottom) tertile of the sample distribution. All specifications include a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. In columns (1) and (2), the dependent variable is the log of the number of years between the creation of the company and the investment. In columns (3) and (4), the dependent variable is a dummy equal to zero for companies classified by VentureXpert as "Startup/Seed" or "Early Stage" and one for later stages. In columns (5) and (6), the dependent variable is the log of the number of previous financing rounds (involving other funds) received by the company until the investment by a given fund. Standard errors are clustered by month and presented in parenthesis. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

	(1)	(2)	(3)	(4)	(5)	(6)
	Log company age		Dev. stage dummy		Log nb. of prior rounds	
Log fund age	0.21***	0.17***	0.10***	0.08***	0.13***	0.16***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
Log fund age × Hot market conditions	-0.05**	-0.04**	-0.02***	-0.02***	-0.06***	-0.06***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Hot market conditions	0.01	0.01	0.02	0.03	-0.01	0.01
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
Log fund nb. of exits	0.05***	0.03**	0.06***	0.02**	0.09***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
First-time fund	-0.04***	-0.06***	-0.03***	-0.02*	-0.08***	-0.07***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund nb. of past investments	-0.05***	-0.03***	-0.03***	-0.02***	-0.04***	-0.05***
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Follow-up fund dummy	-0.07***	-0.03*	-0.01	0.01	0.01	0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund size	0.01*	-0.02***	0.02***	-0.01***	-0.01***	-0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.99***	1.09***	0.40***	0.53***	0.66***	0.79***
	(0.03)	(0.08)	(0.02)	(0.03)	(0.02)	(0.09)
Inv. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
PE firm fixed effects	No	Yes	No	Yes	No	Yes
Observations	33240	33240	33240	33240	33240	33240
R^2	0.043	0.173	0.033	0.148	0.043	0.169

Table XVI: Fund horizon interacted with PE firm experience

This table presents the results of an investment level OLS regression of the proxies for company maturity on the log of fund age interacted with alternatively the *log PE firm age*, i.e., the log of the number of years since the PE firm has been operating (Panel A), the *log PE firm number of investments*, i.e., the log of the number of investments made by the GP (PE firm) before raising the fund (Panel B) and the *log PE firm nb. of funds raised*, i.e., the number of funds raised by the PE firm prior to the investment (Panel C). All specifications include a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. In columns (1) and (2), the dependent variable is the log of the number of years between the creation of the company and the investment. In columns (3) and (4), the dependent variable is a dummy equal to zero for companies classified by VentureXpert as "Startup/Seed" or "Early Stage" and one for later stages. In columns (5) and (6), the dependent variable is the log of the number of previous financing rounds (involving other funds) received by the company until the investment by a given fund. Standard errors are clustered by month and presented in parenthesis. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

	(1)	(2)	(3)	(4)	(5)	(6)
	Log company age		Dev. stage dummy		Log nb. of prior rounds	
Panel A: Log PE firm age						
Log fund age	0.14***	0.10***	0.05***	0.03***	0.07***	0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund age × Log PE firm age	0.02***	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log PE firm age	-0.01**	-0.01	-0.00	-0.01***	-0.00	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)
Fund level controls	Yes	Yes	Yes	Yes	Yes	Yes
Inv. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
PE firm fixed effects	No	Yes	No	Yes	No	Yes
Observations	46673	46673	46673	46673	46673	46673
R^2	0.040	0.160	0.032	0.139	0.042	0.157
Panel B: Log PE firm number of investments						
Log fund age	0.14***	0.10***	0.06***	0.04***	0.08***	0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund age × Log PE firm nb. of past inv.	0.02***	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log PE firm nb. of past inv.	-0.02***	-0.02***	-0.01*	-0.02***	-0.00	-0.01
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)
Fund level controls	Yes	Yes	Yes	Yes	Yes	Yes
Inv. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
PE firm fixed effects	No	Yes	No	Yes	No	Yes
Observations	46673	46673	46673	46673	46673	46673
R^2	0.041	0.160	0.032	0.139	0.042	0.157
Panel C: Log PE firm nb. of funds raised						
Log fund age	0.14***	0.08***	0.06***	0.04***	0.08***	0.07***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log fund age × Log PE firm nb. of funds raised	0.04***	0.04***	0.02***	0.02***	0.02***	0.04***
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Log PE firm nb. of fund raised	-0.06***	-0.10***	-0.01	-0.03**	-0.02**	-0.06***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
Fund level controls	Yes	Yes	Yes	Yes	Yes	Yes
Inv. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
PE firm fixed effects	No	Yes	No	Yes	No	Yes
Observations	46673	46673	46673	46673	46673	46673
R^2	0.041	0.160	0.032	0.139	0.041	0.157

Table XVII: Fund horizon, PE firm experience and exits

This table presents the results of an investment level OLS regression of the successful exit dummy on the log of fund age, and a a vector of fund level controls including (i) the log number of investments exited by the fund, (ii) the log number of past investments made by the fund, (iii) a dummy indicating whether the PE firm has raised a follow-up fund at the time of the investment, (iv) the log of fund size, and (v) a dummy for first-time funds. In columns (2) to (4), the log of fund age is interacted with successively the *log PE firm age*, i.e., the log of the number of years since the PE firm has been operating (column 2), the *log PE firm number of investments*, i.e., the log of the number of investments made by the GP (PE firm) before raising the fund (column 3) and the *log PE firm nb. of funds raised*, i.e., the number of funds raised by the PE firm prior to the investment (column 4). Standard errors are clustered by month and presented in parenthesis. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

	(1)	(2)	(3)	(4)
	Dependent variable: successful exit dummy			
Log fund age	0.024***	0.011	0.012*	0.006
	(0.006)	(0.007)	(0.007)	(0.007)
Log fund age × Log PE firm age		0.005***		
		(0.002)		
Log fund age × Log PE firm nb. of past inv.			0.005***	
			(0.002)	
Log fund age × Log PE firm nb. of funds raised				0.015***
				(0.004)
Log PE firm age		-0.003		
		(0.004)		
Log PE firm nb. of past inv.			-0.003	
			(0.004)	
Log PE firm nb. of funds raised				-0.026**
				(0.013)
Log fund nb. of exits	-0.010**	-0.011**	-0.011**	-0.012**
	(0.005)	(0.005)	(0.005)	(0.005)
First-time fund	0.001	0.009	0.007	-0.003
	(0.007)	(0.012)	(0.011)	(0.011)
Log fund nb. of past investments	-0.002	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)
Follow-up fund dummy	-0.014**	-0.014**	-0.014**	-0.015**
	(0.006)	(0.006)	(0.006)	(0.006)
Log fund size	-0.004	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)
Constant	0.417***	0.416***	0.415***	0.416***
	(0.033)	(0.034)	(0.033)	(0.033)
Inv. year fixed effects	Yes	Yes	Yes	Yes
PE firm fixed effects	Yes	Yes	Yes	Yes
Observations	46673	46673	46673	46673
R^2	0.137	0.138	0.138	0.138