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Topics in Corporate Finance

Recent research on the investment behavior of private equity fund managers

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AND ARMIN SCHWIENBACHER

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Preface

The growing importance of private equity is closely related to the core mission of the Amsterdam Center for Corporate Finance, which centers around the financial management of corporations and the functioning of the financial sector. Private equity has become an indispensable part of the modern financial markets. For these reasons, the ACCF dedicates the eleventh issue of its Topics in Corporate Finance series to this important topic.

Private equity has become an important funding source for corporations in various stages of development. Venture capital, and seed-capital in particular, are types of private equity that aim at funding new initiatives. Private equity for more established operations is much in the news as well. Almost daily we read in the newspapers that a private equity firm has taken control of a particular business activity, often in need of future expansion or restructuring. The investment behavior of these private equity investors is the subject of this booklet.

In this study, Professor Douglas Cumming (Severino Center for Technological Entrepreneurship, Rensselaer Polytechnic Institute), Grant Fleming (Wilshire Private Markets Group) and Armin Schwienbacher (University of Amsterdam) focus on the investment behavior of private equity fund managers. What drives their investment choices? What types of activities do they invest in, and what determines this. Moreover, to what extent is private equity a predictable asset class for institutional investors? We should not interpret predictability in terms of low risk but in terms of adhering to ex ante announced objectives and investment guidelines. These questions are of considerable importance for assessing the growth potential of the industry, and ultimately for the viability and availability of private equity as a source of funding.

We trust that you will find the insights interesting and hope that you enjoy reading it, so that it may contribute to bridging the gap between theory and practice.

A.W.A. Boot
October 2005

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SUMMARY

This booklet is a collection of two recent studies on the investment behavior of private equity fund managers. It contributes to a better understanding of how changes in financial markets and the real economy affect the way fund managers in the private equity sector adjust their investment decisions.

Private equity has grown substantially over the 1990s as a viable alternative asset class for all kinds of institutional investors. Limited partners in a private equity partnership are able to achieve superior risk-adjusted returns, particularly if manager selection is confined to the upper quartile of ability. As such, institutional investors ranging from pension funds to university endowment funds tend to allocate up to 5% (and sometimes as much as 10%) of their capital to private equity and venture capital. To facilitate the investment process of institutional investors (as limited partners), private equity funds are invariably established with stated objectives in terms of the focus for investments at particular stages of entrepreneurial firm development and industry. Investors pay very close attention to the stated objectives of the funds in which they invest in order to manage the risk/return profile of their portfolio. At the same time, general market conditions play a crucial role in determining investment decisions and incentives for the venture capital fund managers. In particular, exit conditions are important for facilitating the exit of venture capitalists from the portfolio companies.

Given the importance, academic research has denoted much attention in the last few years in understanding the investment behavior of venture capitalists as active and value-adding portfolio managers. We offer two analyses on that topic. The first study "Liquidity Risk and Venture Capital Finance" provides theory and evidence in support of the proposition that venture capitalists adjust their investment decisions according to liquidity conditions on IPO exit markets. We refer to *technological risk* as a choice variable in terms of the characteristics of the entrepreneurial firm in which the venture capitalist invests, and *liquidity risk* as the current and expected future external exit market conditions. We show that in times of expected illiquidity of exit markets (high liquidity risk), venture capitalists invest proportionately more in new high-tech and early-stage projects (high technology risk) in order to postpone exit requirements. When exit markets are liquid, venture capitalists rush to exit by investing more in later-stage projects. We further provide complementary evidence that shows conditions of low liquidity risk give rise to less syndication. Our theory and supporting empirical results facilitate a unifying theme that links related research on illiquidity in private equity.

The second study "Style Drift in Venture Capital" introduces the concept of style drift to private equity investment. A style drift is defined as an investment that deviates from the fund's stated objectives. These are typically included in the partnership agreements and pertain to dimensions such as the focus for investments at particular stages of entrepreneurial firm development, geography and industry. We present theory and evidence

pertaining to style drifts in terms of a fund's stated focus on particular stages of entrepreneurial development. We present a model that derives conditions under which style drifts are less likely among younger funds, in order to signal ability and commitment to stated objectives for the purpose of raising follow-on funds. We also show ways in which changes in market conditions can affect style drifts, and show differences for funds committed to early stage investments versus funds committed to late stage investments. The Venture Economics data examined provide strong support for our theoretical predictions as to when private equity investors will style drift. Finally, we find some evidence of a positive relation between style drifting and investment performance. This suggests, due to the potential reputation costs of deviation, style drifts are more common for investments that are more likely to yield favorable realizations.

This research draws policy implications for the development of viable private equity markets. The liquidity of exit markets, in particular of stock markets for young high-growth firms, seems a crucial ingredient in making attractive investments in the private equity sector. This ought to reduce risk and thus foster investments in entrepreneurial firms. Moreover, while style drift seems to be common and a concern for institutional investors (especially in the first years of a new fund), its importance needs to be put into perspective given that much of it is driven by significant changes in market conditions.

A last note is warranted. In practice the terms private equity and venture capital typically refer to distinct assets classes, but also often used interchangeably. In this study, we also use both terms interchangeably.

1. Liquidity Risk and Venture Capital Finance

1.1 Introduction

Policymakers around the world often express concern why there is not more investment in privately held early-stage companies.[1] Further, the extreme cyclicality of early-stage investment, and what the drivers are, remains a relatively unexplored issue in private equity and venture capital research.[2] This paper introduces a new and somewhat counterintuitive theory to facilitate an understanding of these issues. The U.S. data examined herein support the theory.

Venture capitalists invest in small private growth companies that typically do not have cash flows to pay interest on debt or dividends on equity. VCs invest in private companies over a period that generally ranges from 2-7 years prior to exit. As such, VCs derive their returns through capital gains in exit transactions. IPO exits typically provide VCs with the greatest returns and reputational benefits to VCs (Gompers, 1996; Gompers and Lerner, 1999, 2001).[3] *Liquidity risk* in the context of VC finance therefore refers to *exit risk*, particularly IPO exit risk. That is, liquidity risk refers to the risk of not being able to effectively exit and thus being forced either to remain much longer in the venture or to sell the shares at a high discount.[4] The risk of not being able to effectively exit an investment is an important reason for why VCs require high returns for their investments (Lerner, 2000, 2002; Lerner and Schoar, 2004, 2005). It is therefore natural to expect that exit market liquidity affects VCs' incentives to invest in different types of entrepreneurial firms.

Liquidity risk is of course not the only type of risk that VCs face when deciding to invest in a particular project. The other types of risk may be grouped into a broad category of what we refer to in this paper as *technological risk*, or the risk of investing in a project of uncertain quality (particular types of technological risk could include the quality of the product technology as well as the quality of entrepreneurs' technical

1 Practitioner summaries of public policy initiatives are available on links from www.evca.com (for Europe), www.ventureeconomics.com (for the US) and www.cvca.ca (for Canada). Various policy initiatives are summarized in Gilson (2003) and Lerner (1999).

2 In a collection of their groundbreaking work, Gompers and Lerner (1999) study fundraising, fund structure, staging, syndication, monitoring, and venture capital backed IPOs. This work provides the basis for all private equity and venture capital research, including our own paper.

3 Acquisition exits (sales to a large strategic acquirer) can also be a profitable form of exit, although perhaps typically less desirable in terms of profitability and less desirable to the entrepreneur who would otherwise prefer to be the CEO of a publicly traded corporation (Black and Gilson, 1998). Less successful investments might be sold by the VC to another investor (a "secondary sale" whereby the entrepreneur maintains her share of the company), or repurchased by the entrepreneur (a "buyback exit"). Many VC investments (20-30%) are written off (Gompers and Lerner, 1999, 2001; Cochrane, 2005; Das *et al.*, 2003).

4 Market microstructure models refer to the latter as the *cost of immediacy*, which represents the price discount that the holder of the asset has to incur if he wants to sell it now instead of waiting to get the market price. More generally, Harris (2003) distinguishes between four different dimensions of liquidity: (*i*) width (difference between the buy price and the sell price); (*ii*) immediacy (how fast large volumes of shares can be traded); (*iii*) depth (amount of shares that can be exchanged without affecting prices); and (*iv*) resiliency (how quick prices go back to "normal price level").

and managerial abilities). This paper considers whether changes in external conditions of liquidity risk give rise to adjustments in VCs' undertaking of projects with different degrees of technological risk. In particular, we investigate whether exit market liquidity affects the frequency of VC investment in nascent early stage firms and high-tech firms with intangible assets. We provide a theory and supporting empirical evidence that show the willingness of VCs to undertake projects of high technological risk is directly related to conditions of liquidity risk. We further provide complementary evidence that shows external conditions of high liquidity risk give rise to more prevalent syndication, which shows that while VCs assume more technological risk in periods of low liquidity, they take steps to mitigate this risk through syndication. We show the theory and evidence in regards to liquidity risk introduced herein provides a unifying theme that links the results in a number of related papers on venture capital finance.

We introduce a theoretical model that shows VCs will rationally trade-off liquidity risk with technological risk by investing more in early-stage projects when liquidity of exit markets is low and thus exit risk high. The intuition underlying our model is as follows. By adjusting their portfolio of investments for long term positions, VCs reduce their exposure to liquidity risk. This is important in explaining the choice of projects according to their stage of development (early-stage versus expansion-stage), and on the decision whether to invest in completely new projects or to limit investments to ongoing projects. In contrast, when liquidity of exit markets is high VCs tend to invest proportionately more in later-stage projects in order to *rush for exit* and thus to hold short term positions and technologically less risky projects. The theory therefore gives rise to a somewhat counterintuitive conjecture of a positive correspondence between conditions of external exit market liquidity risk and VCs' contemporaneous undertaking of a greater amount of technological risk.

It is important to point out that the ultimate source of the liquidity risk analyzed in this paper is the difference in time preferences between VC and management, since there is a greater incentive for *VC* to cash out earlier than management. The time horizon of a VC is typically shorter because of his exit requirements. If VCs were long term investors and would not wish to exit already after a few years, liquidity risk would not matter and incentives between VCs and management would probably be better aligned (provided managers are capable and wish to remain in place).

With respect to early-stage investments, there are therefore two opposite effects documented in this paper. On the one hand, more liquidity increases the likelihood of investing in *new* ventures; but on the other hand, it reduces the likelihood that these new ventures are in the *early-stage*. In other words, liquidity increases the absolute number of new investments but reduces the proportion of ventures that get early-stage finance relative to the total number of investments. These results thus indicate VCs adjust their expected demand for liquidity based on the expected supply. If they expect low liquidity in the future, they reduce today their future demand for liquidity by reducing the absolute number of new ventures *and* by postponing the demand for liquidity for a portion of the new investments by financing ventures in their early stages.

We empirically test our theory by examining how investment decisions evolve over time by looking at the period from 1985 to 2004 in regards to the stage of entrepreneurial firm development, as well as the technological focus of investment. We use investment data from the VentureXpert database to test our research hypotheses. We document the existence of a negative relationship between liquidity of exit markets and the likelihood of investing in new early-stage projects. The proxy used for liquidity is the annual IPO volume. Our estimations indicate that an increase of liquidity by 100 IPOs in a year reduces the likelihood of investing in new early-stage projects (as compared to new investments in other development stages) by approximately 1.5% – 2.3% depending on the specification. These values are not excessively large, but are nevertheless economically significant as it is well documented that the IPO markets themselves experience very large swings (for recent work, see, e.g., Bradley, Jordan and Ritter, 2002; Helwege and Liang, 2002; Lowry, 2003).

At first thought, it may seem counter-intuitive that there is a negative relation between the liquidity of IPO markets and early-stage investments. The oft-repeated casual empiricism (see, e.g., practitioner articles on www.ventureeconomics.com) is that there is more early stage investment when stock markets are performing better (i.e., IPO markets are more liquid). In our analysis we provide independent controls for stock market conditions (with and without simultaneous consideration of IPO volume), and show a positive correspondence between the NASDAQ composite index and the likelihood of early-stage investments. This latter result is somewhat analogous to the money chasing deals phenomenon analyzed by Gompers and Lerner (2000), but is an independent effect and different from central liquidity issues considered in this paper.[5]

Further to our evidence on liquidity risk and early stage investment, we show that conditions of exit market liquidity impact the decision to invest in new projects versus follow-on investment in continuing projects pursuant to staged financing (in the spirit of Gompers, 1995). An increase in IPO volume by 100 increases the probability of investment in a new project (as opposed to a follow-on project) by approximately 1.2% – 4.1% depending on the specification (similar to the evidence in Gompers and Lerner, 2000). Taken together with the first effect of IPO volume mentioned above, this means that there are two opposite effects when liquidity risk increases: first, there are proportionately more new early-stage projects, and second, since VCs invest in fewer new projects,

5 In a recent paper, Gompers, Kovner, Scharfstein and Lerner (2005) work on issues related to ours. That paper considers a sample up to 1998 in order to exclude the Internet bubble. Our sample, described below in sections 1.4 – 1.6, considers the period 1985-2004 and excludes the period surrounding the Internet bubble as a robustness check. Consistent with seminal work (Gompers and Lerner, 1998) and subsequent studies (e.g., Jeng and Wells, 2000, Armour and Cumming, 2005, and Cumming and MacIntosh, 2005), Gompers, Kovner, Scharfstein and Lerner (2005) argue that the pattern of venture capital investing follows economic trends in a fairly rational way.

there are more follow-on projects in the VCs' portfolio. The weight of follow-on investments in the overall portfolio will therefore be greater when liquidity risk is high since fewer new investments are made, while follow-on investments are often continued and are most likely already at the expansion-stage and later-stage of development.

We further provide complementary analyses of the relation between liquidity risk and syndication, in the spirit of Lerner (1994) and Brander *et al.* (2002). When liquidity risk is low, investment is less risky and thus we expect a less pronounced incentive to syndicate. Conversely, when liquidity risk is high, VCs prefer to mitigate risk by syndicating with more partners in order to better screen their projects and provide complementary value-added assistance across undertaken projects. The data examined support this conjectured effect of liquidity on syndicate size. An increase in IPO volume by 100 gives rise to approximately 0.2 fewer syndicated partners.

The remainder of this paper proceeds as follows. In section 1.2 we discuss the liquidity concept for private equity, and explain how our model and empirics relate to prior research on the topic. Section 1.3 provides a model that shows the effect of external exit market liquidity on the VC's assumption of technological risk. Three core testable hypotheses are summarized in section 1.3. In section 1.4, we present and describe the data. The empirical tests and results are provided in section 1.5. Thereafter we discuss limitations and future research, and provide concluding remarks.

1.2 Liquidity Concept for Venture Capital and Private Equity

For financial assets like publicly listed equity, there seem to be consensus about the concept of liquidity. Four different dimensions have been suggested to define the concept for traded assets (Harris, 2003; Kyle, 1985): width, immediacy, depth, and resiliency. Loosely speaking, liquidity refers to the ability to trade at low (explicit and implicit) transaction costs. Kyle (1985) further stresses the importance of continuous trading and frictionless markets to achieve perfect liquidity of assets.

As for real estate or art objects, private equity is infrequently traded and thus the standard concept of liquidity hardly applies.[6] Private equity investments are not continuously traded, since by definition they are private prior to the IPO. An important element that distinguishes private from public equity is that IPO markets are characterized by "hot" and "cold" issue phases and through clustering waves. In this paper, liquidity is related to the possibility of exiting by either listing the company on a stock market or finding a strategic buyer. The notion of liquidity used here is closest to the dimension of immediacy, since liquidity here represents the likelihood of being able to divest (*cost of immediacy*). Das *et al.* (2003) show that this illiquidity may induce a substantial non-tradability discount.

6 Recently, new approaches have been suggested to value illiquid assets and build a VC index (e.g., Peng, 2001a, 2001b).

Throughout this paper, we use the number of IPOs per year on the NASDAQ, NYSE and AMEX as proxy for liquidity of exit markets.[7] Although this proxy only considers the IPO markets, it also gives a good idea of what happens on corporate M&A markets. There are strong links between stock markets and corporate M&A markets. In particular, stock market conditions are also crucial for acquisitions ("trade sales") for different reasons: (1) an IPO may represent an outside option for highly profitable ventures that have the potential to go public (in this case it directly affects the price in an acquisition); (2) capital inflow into the VC market is strongly correlated with stock market conditions (this affects total investments and therefore also the absolute number of trade sales); (3) stock market conditions determine the cost of capital for acquisitions when the buyer is listed; and (4) stock markets also mirror general economic conditions. Therefore, we should expect M&A markets to closely follow the IPO cycle. Also, an IPO is very often (but not only) what VCs aim at when investing in a new venture (Gompers and Lerner, 1999, 2001). In fact, when we introduced controls for the liquidity of M&A markets,[8] we encountered a number of collinearity problems with our other liquidity measures. As such, consistent with Gompers and Lerner (1999, 2000, 2001), our focus is on the liquidity of IPO exit markets.

Our theory and supporting empirical evidence facilitate a unifying theme that links related research on illiquidity in private equity, including studies on VC fundraising, investing and exiting. In regards to VC fundraising, Lerner and Schoar (2004) introduce an innovative model and provide new data that show VCs chose greater technological risk (using the terminology in our paper) in order to screen deep pocket investors. Their intuition underlying the Lerner and Schoar result is that institutional investors that face illiquidity constraints may not be able to provide additional capital in the VC's next round of fundraising, which would increase the cost of capital for the VC if the VC had to approach new outside investors. Our results are consistent, in that we may view the effectiveness of this screening tool as being subject to *external* exit market liquidity conditions. In periods of low exit market liquidity risk (in boom periods), the incentive of a VC to assume greater technological risk as a screening tool would be diminished, since institutional investors tend to be less subject to capital constraints in boom periods. Conversely, in period of high liquidity risk, a greater number of institutional investors will be faced with constraints (i.e., a greater proportion do not have deep pockets in bust periods), and therefore the VC's assumption of greater technological risk facilitates a more effective screening tool for institutional investors that have deep pockets.

Our paper is further related to a number of papers that fall in the category of VC investing and value added advice. Kanniainen and Keuschnigg (2003, 2004) and Keuschnigg (2004) provide theoretical work indicating liquidity affects VC portfolio size

7 Jenkinson and Ljungqvist (2001) denote this same proxy as the annual "IPO volume". We further consider alternative definitions of the annual IPO volume based on data posted on Jay Ritter's website: http://bear.cba.ufl.edu/ritter/ipodata.htm>, as discussed below.

8 Our M&A liquidity market controls were based on data available from the Mergerstat review (www.mergerstat.com).

and the demand for and supply of VC. Cumming (2006) provides consistent evidence that VC portfolio sizes per manager are larger in boom periods. Neus and Walz (2005) provide a theory that relates exit market liquidity to VC dispositions, consistent with evidence in Gompers and Lerner (1999). Kortum and Lerner (2000), and Lerner (2002) provide evidence that VCs add less value and contribute less to innovation among their entrepreneurial investee firms in boom periods (e.g., the Internet bubble) relative to more normal times. Gompers and Lerner (2000) provide evidence of "money chasing deals" in boom periods, where VCs have excess capital and there are too few quality projects. Our theory and evidence is supportive of all of these papers. VCs funded an impressive number of later-stage projects during the Internet bubble of 1998-2000 where exit was not a problem, while today they are more selective (*proactive*) and again prefer ventures with break-through technology. During the bubble period, many ventures of low innovation were funded and for which *time-to-market* is shorter; after the bubble burst, low innovation ventures did not receive funding as VCs were much more selective. Our paper provides a theory and supportive evidence that this change in investment behavior is largely attributable to conditions on the exit markets (i.e., their cyclicality).

Our evidence in regards to VC syndication and liquidity is also related to a number of papers on liquidity and transaction structures. Black and Gilson (1998) discuss the relation between exit market liquidity, VC contracting and the development of VC markets. Bascha and Walz (2001) provide a theory relating IPO exit markets to the use of convertible securities in venture finance. Lerner and Schoar (2005) relate liquidity and other market characteristics to the structure of VC contracts in developing countries. In seminal work, Gompers (1995) shows staging decisions are related to market conditions, and Lerner (1994) shows syndication is affected by incentives to mitigate risk, among other things (see also Gompers and Lerner, 1999, 2001).

Finally, our evidence is consistent with the view that illiquidity is one reason why VCs require high returns on their investments (Gompers and Lerner, 1999a, 2001; see also Barry *et al.*, 1990; Megginson and Weiss, 1991; Lerner and Schoar, 2004; Cochrane, 2005; Das *et al.*, 2003). Our evidence is consistent, in that the greater assumption of technological risk occurs at times when we may infer the relative cost to finance innovative deals is lower. That is, in bust periods when illiquidity is high, it is generally viewed that the deal cost (in terms of the amount that a VC must pay for a given equity share in a company) is low; therefore, in bust periods, the cost of financing the more innovative companies is lower. This is consistent with our finding of a higher proportion of financings of early-stage firms in periods of exit market illiquidity.

1.3 The Model and Testable Hypotheses

This section provides a theoretical framework for the empirical predictions that are empirically tested in the rest of the paper. Note that we refer to *technological risk* as a choice variable in terms of the characteristics of the entrepreneurial firm in which the

VC invests, and *liquidity risk* as the expected external exit market conditions. Testable hypotheses derived from the model are formally stated.

Suppose a start-up venture requires external funding for two consecutive rounds; the first one is called early-stage, the second one later-stage. In each round, an amount of funding is needed, $I_1 > 0$ for the first round and $I_2 > 0$ for the second round. The probability of failure at each stage/round is $(1 - p) > 0$ and determines the *technological risk* of the project; we assume this risk is $(1 - p)$ for a later-stage investment and $(1 - p^2)$ for an early-stage investment. To keep exposition as simple as possible, and without loss of generality, we assume a discount rate of zero and all parties are risk-neutral. The market value of the start-up at the end of the second rounds is $V > 0$ if successful, and 0 in case of failure. When financing the project since the 1st round, suppose that the VC gets all the value V. On the other hand, denote by $0 < s < 1$ the proportion of V that the VC would get when joining the project at the later-stage only. To have the desired trade-off we require that $p > s$ (otherwise later-stage projects are always more profitable).[9] Abstracting from exit issues, the NPV of an early-stage investment therefore is $[p^2 \cdot V - I_1 - pI_2]$ and the NPV of a later-stage investment is $[p \cdot sV - I_2]$.

Suppose further that the VC wants to exit after the 2nd round; let us denote by λ the probability of being able to exit in time (the *liquidity risk*), which here (for simplicity) can take two values, depending whether the IPO market is "hot" (h) or "cold" (c). Given this distinction, we of course have $0 \leq c \leq h \leq 1$. Also, let us define the mean of λ by m (for instance, consider it as the long-run, average liquidity risk). Suppose also that the VC can assess liquidity risk of the current round but not beyond. This implies that when investing in a later-stage project, he can assess whether λ is h or c but will use the expected value m for any early-stage project.

In the event that the VC faces exit problems (which, in this case, occurs with probability $(1 - \lambda)$), he suffers a discount (e.g., a *cost of immediacy*) of δ on the firm value. By definition, $0 < \delta < 1$. The VC then faces the following trade-off, with their respective expected payoff:

- Invest in an early-stage project: $p^2 \cdot V - I_1 - pI_2 - (1 - m)p^2 \cdot \delta V$
- Invest in a later-stage project: $p \cdot sV - I_2 - (1 - \lambda)p \cdot \delta sV$

Obviously, the VC will always prefer h over c in case he invests in the later-stage as long as $h > c$:

$$p \cdot sV - I_2 - (1 - h)p \cdot \delta sV > p \cdot sV - I_2 - (1 - c)p \cdot \delta sV$$

This means that if it is better for the VC to invest in a later-stage project under state $\lambda = c$, he will also prefer a later-stage project under $\lambda = h$. On the other hand, a preference for

9 Note that finance is committed much longer for early-stage projects. We implicitly assume here that the VC cannot re-invest the funds from later-stage projects in the next round. A more complete analysis should include the fact that funds invested in later-stage projects can be redeployed more quickly in new projects. In that case, it would potentially weaken the results stated here but not reverse them.

a later-stage project under $\lambda = h$ does not imply the same investment decision for $\lambda = c$. More generally, investing in an early-stage project may be better whenever

$$p \cdot sV - I_2 - (1-\lambda)p \cdot \delta sV < p^2 \cdot V - I_1 - pI_2 - (1-m)p^2 \cdot \delta V \quad (1)$$

or, when rearranging:

$$[p^2 \cdot V - p \cdot sV] + [(1-\lambda)p \cdot \delta sV - (1-m)p^2 \cdot \delta V] - [I_1 - (1-p)I_2] > 0 \quad (2)$$

The two terms in the first squared brackets represents the additional gains for the VC when investing in early-stage, the terms in the second squared brackets is the difference in cost of immediacy, and the terms in the last squared brackets are the additional investment costs when getting involved in the early-stage.

For instance, a natural assumption could be to state that the VC is indifferent between an early-stage and a later-stage investment whenever there is no fluctuation in the liquidity risk over time; i.e., whenever $h = c = m$. Then, there would be no incentive to strategically diversify the portfolio among early-stage and later-stage projects over time. The condition would then require that

$$pV(p-s) \cdot [1 - \delta(1-m)] = I_1 - (1-p)I_2 \quad (3)$$

Suppose now again that $h > m > c$. In this case, it is straightforward to check that under condition (3) the VC will be better off investing in a later-stage (early-stage) project whenever the current liquidity risk is low (high). This simple framework allows us to derive empirical predictions on the likelihood of investing in early-stage projects. This can be easily seen after simplifying Equation (2), which yields:

$$pV \cdot \{p[1 - \delta(1-m)] - s[1 - \delta(1-\lambda)]\} > I_1 - (1-p)I_2$$

It follows that investment in early-stage projects (with higher technological risk p^2 instead of p) is more likely whenever liquidity risk is high ($\lambda = c$) and the market value of the firm (V) is high.

The theoretical framework indicates VCs trade-off liquidity risk with technological risk by investing more in early-stage projects when the exit markets become less liquid. On the other hand, when liquidity is high, they *rush to exit* by investing more in expansion-stage and later-stage projects. Such a strategic behavior yields a negative relationship between liquidity of exit markets and investment in new early-stage projects. Thus, we formulate the following prediction:

HYPOTHESIS 1 (EFFECT ON NEW EARLY-STAGE INVESTMENTS): *For new investments, the likelihood of investing in early-stage projects decreases with the liquidity of exit markets.*

It is important to point out that related stock market variables may lead to alternative predictions in regards to the decision to invest in early-stage projects. Gompers and Lerner (2000) show that the supply of funds to the VC market is positively correlated with stock market returns. As supply increases, the required returns to new venture project decreases (the "money chasing deals" phenomenon), and early stage projects could more likely receive financing in periods of boom stock markets. In order to focus on our central issue pertaining to liquidity and early-stage projects in a simple model, our analytical model abstracted from changing deal prices with different market conditions. Without examining the data, one could speculate as to different predictions regarding NASDAQ market conditions and deal prices, which are not necessarily the same as the liquidity effect described above. In our empirical tests, we control for stock market conditions (NASDAQ levels), economic growth (real GDP) as well as IPO market conditions to study and control for these different effects, and to formally test our central hypotheses.

Our second hypothesis involves the decision whether to invest in new projects irrespective their stage of development. The intuition is again based on Gompers and Lerner (2000). An increase in the liquidity of exit markets increases the expected returns to investment. After all, conditions on exit markets are highly affected by growth expectations of the overall economy. When exit markets are more liquid, VCs require a lower rate of return for their investments (given that they then face less risk), increasing the pool of projects worth being funded. This drives up the propensity of VC funds to start new investments, and should affect all the stages of development in the same way. Therefore, the likelihood of funding new companies is also increased, and thus is positively affected by liquidity of exit markets. This is summarized in HYPOTHESIS 2:

HYPOTHESIS 2 (EFFECT ON NEW INVESTMENTS): *The likelihood of investing in new projects (irrespective of their development stage) increases with the liquidity of exit markets.*

Regarding the relative importance of early-stage investment, notice that if HYPOTHESES 1 and 2 hold we should expect an ambiguous effect on the overall portfolio of the VC, since from HYPOTHESIS 1 we should expect a decrease in the fraction of *new* early-stage projects when liquidity of exit markets is high but HYPOTHESIS 2 would imply more early-stage projects in absolute value. For instance, denote by α_i the fraction of new projects in the early-stage, where subscript i refers to the state of liquidity of exit markets. Thus, $i = h$ when liquidity is high (*hot issue* market) and $i = c$ if liquidity is low (*cold issue* market). Denote also by N_i the absolute number of new projects financed and by F the number of current follow-on investments. Then, HYPOTHESIS 1 says that $\alpha_h > \alpha_c$, while HYPOTHESIS 2 says that $N_h > N_c$. The proportion of new early-stage investments as a fraction of all the projects in the VC's portfolio is then equal to $\alpha_i N_i / [F + N_i]$, where obviously this ratio depends on the state i. Comparing this ratio for both states h and c shows no clear-cut and largely depends on the current number of follow-on investments in the overall portfolio of the VC. Since $N_h > N_c$, the minimum threshold level for α_h decreases with F.[10]

$$\frac{\alpha_h N_h}{F + N_h} \leq \frac{\alpha_c N_c}{F + N_c} \quad \text{iff} \quad \alpha_h \leq \alpha_c \cdot \frac{1 + F / N_h}{1 + F / N_c}$$

10 For instance, assume that $\alpha_h = 0.20$, $\alpha_c = 0.5$, $N_h = 10$, $N_c = 2$, and F is either 5 or 10 (assume also for simplicity that no follow-on investments are in the early-stage anymore). Then, the condition mentioned above is satisfied for $F = 5$ but not $F = 10$.

This means that there are two opposite effects when liquidity risk increases: first, there are proportionately more new early-stage projects (cf. HYPOTHESIS 1), and second, since VCs invest in fewer new projects (cf. HYPOTHESIS 2), there are more follow-on projects in the VCs' portfolio. The weight of follow-on investments in the overall portfolio will therefore be greater when liquidity risk is high since fewer new investments are made, while follow-on investments are often continued and are most likely already at the expansion-stage and later-stage of development.

The first two hypotheses are related to portfolio composition, liquidity and technological risk. The last hypothesis pertains to VC decisions to potentially mitigate these risks through syndication. The analysis of syndication is not central to the theme in the paper, but is quite complementary to the analysis of new versus follow investment and early- versus late-stage investment as it considers whether VCs adjust their deal structures in response to liquidity conditions.

HYPOTHESIS 3A (SYNDICATION FOR DIVERSIFICATION PURPOSES): *The syndicate size increases with the liquidity of exit markets as a way to diversify the portfolio.*

HYPOTHESIS 3B (SYNDICATION FOR SCREENING PURPOSES): *The syndicate size increases as the liquidity of exit markets decreases in order to improve the screening process.*

HYPOTHESES 3A and 3B provide opposite predictions regarding the effect of exit markets liquidity on the syndicate size. The effect can be positive for risk diversification purposes, or can be negative to improve the screening process of business plans. In HYPOTHESIS 3A, an increase in liquidity requires greater portfolio diversification if HYPOTHESIS 1 holds, since later-stage investments require greater amounts of funds.[11] This is also what is required whenever VCs are constrained in the amount of capital they can invest in any single portfolio company (by restrictive covenants from institutional investors; see Gompers and Lerner, 1996, 1999). On the other hand, HYPOTHESIS 3B conjectures a negative relationship through screening effects. More liquid exit markets represent lower risk for the investment, which weakens the requirements for good screening and thus the need for syndicating with other VC as a way to improve screening of projects (cf. the "second opinion" rationale mentioned by Lerner, 1994, and Brander *et al.*, 2002).

1.4 Data

In this section, we present the data we use in this paper for testing our research hypotheses. We also analyze here how the investment behavior of VCs evolved over time. Finally, we present summary statistics of the data used throughout this paper.

11 An alternative rationale for a positive relationship stems from the often-heard preference of some VCs in bad times to retain the remaining of their available funds for their own projects. This is well possible as raising new funds gets difficult in cold issue markets.

1.4.1 Data Source

The data source considered is the VentureXpert dataset of Venture Economics. A total of 18774 investment rounds (and 4065 first-round investments) that span the period from January 1, 1985 until December 31, 2004 were randomly selected. Information available for each portfolio company and each round include date of investment round, its amount, its stage, the industry sector of the portfolio company and the number of investors involved in financing the given round. Limitations with these data are discussed in section 1.6.

The unit of observations considered in this paper is an investment round in an entrepreneurial firm. In our dataset, syndication does not result in additional rows for the same entrepreneurial firm, but staging does result in additional rows (and we check robustness by considering only first-round investments). In our dataset, each entrepreneurial firm has at least one limited partnership VC as an investor. We wanted at least one limited partnership VC as an investor in the entrepreneurial firms considered in order to focus on the effect of exit requirements (liquidity risk) on investment behavior. Since investments of other types of VCs do not necessarily have the same need to exit as for limited partnership VCs. VCs such as corporate VCs or government VCs (Lerner, 1999; Gompers and Lerner, 1999), often have funds that last longer than the typical 10 years so that the pressure to exit from their investments is lower. This inevitably affects the impact of liquidity risk. By limiting the sample to limited partnerships, we make sure that liquidity (or exit) risk matters in all our investments. We believe our focus on limited partnerships allows us to directly examine the issue of liquidity risk. Therefore, we do not include fund characteristic variables in our empirical analyses.[12] As discussed further below, we did not find material differences across funds with the exclusion or inclusion of different types of syndicated funds in the dataset.

We use the definition for investment stages provided by VentureXpert, which distinguishes between four broad classes of stages:

i. *Early-Stage*: this includes seed, start-up early, R&D early, other early, first stage, R&D equity and other R&D stages.
ii. *Expansion-Stage*: this includes expansion, R&D expansion and second stages.
iii. *Later-Stage*: this includes third stage, bridge, bridge loan, other later-stage, open

12 There is one exception to this. We did consider including a variable for the proportion of investments from an investor of a certain type, but did not find this materially affected the empirical results of interest in our paper. We do not report such variables, also in part mainly because it is unclear as how the economics of such variables would work: the minor presence of a syndicated government investor, for example, may have a major effect on the investment decision or a minor effect, depending on unobservable factors not picked up by Venture Economics (and therefore the appropriate definition of such a variable is at best very unclear). We check the robustness of our results to different investor effects by considering a subsample of the data of limited partnerships only and non-syndicated investments only. As shown below, the results in this paper are robust. In a somewhat related paper, Cumming, Fleming and Schwienbacher (2004) consider each investor effects (where each syndicated investor is a different row in the data) and study the notion of 'style drift' in private equity; the questions addressed in that paper are from the 'fund characteristics' perspective. In this paper, we focus on the entrepreneur characteristics (where each row in the data is a different entrepreneur) and macroeconomic variables to study which types of firms receive venture finance depending on the economic environment.

market purchase, private investment in public company and other expansion-stages.

iv. *Other Stages (including Buyout/Acquisition)*: this includes acquisition, acquisition for expansion, leverage buy-out (LBO), turnaround, special situation, secondary purchase, VC partnership and unknown stages.

In what follows, we will focus the analysis on the first three classes of development, since these are the ones that really deal with technological risk. For robustness checks, we alternatively use a more restrictive sample by comparing early-stage with expansion-stage investments only. Note that the last class, the so-called “other stages”, even includes all observations for which no information is available about the investment stage (this forth class of stages only represents 5.3% of all the investment rounds in our sample). In other words, when analyzing the investment decision of VCs, we will concentrate on the first three classes (early-stage versus either expansion-stage or later-stage) and in some cases (for robustness purposes) exclude the third class (so that we only look at early-stage versus either expansion-stage). Overall, we have a total of 18774 investment rounds and 4065 first-round investments.

1.4.2 Definition of Variables

The variables used in the regression analysis are defined in Table 1. The main variables are: EARLY_STAGE is a dummy variable equal to one if the considered investment round is in the early-stage (otherwise, equal to zero); EXPANSION_STAGE is a dummy variable equal to one if the investment round is in the expansion-stage (otherwise, equal to zero); LATER_STAGE is a dummy variable equal to one if the investment round is in the later-stage (otherwise, equal to zero); AMOUNTS is the total amount of funds invested in the given round (in millions of 2000 US$); NBR_INVESTORS gives the number of VCs involved in raising AMOUNTS (the size of the syndicate in a given round); NBR_IPO represents the number of IPOs in the US during the year in which the investment round was done, as reported by Jay Ritter on his IPO website <http://bear.cba.ufl.edu/ritter/ipodata.htm> (see also Ritter and Welch, 2002, Table 1); NEW_INVESTMENT is a dummy variable equal to one if the investment is a first-round investment (otherwise, equal to zero); FOLLOW_ON (:= 1 – NEW_INVESTMENT) is a dummy variable equal to one if the considered investment round is a follow-on investment (otherwise, equal to zero); and GDP represents the real annual growth rate of the U.S. economy during the year in which the considered investment is done. Finally, we also include industry dummies in all the regressions to control for industry-specific (technological) risk: INTERNET (Internet communication, e-commerce, Internet services, Internet software and programming), COMPUTER (hardware and software), BIOTECH (biotechnology), and MEDICAL (medical and health-related).

Table 1. Definition of Variables
This table defines the variables used in the empirical analyses, figures and subsequent tables in this paper.

EARLY_STAGE	A dummy variable equal to one if the considered investment round is in the early-stage (otherwise, equal to zero)
EXPANSION_ STAGE	A dummy variable equal to one if the investment round is in the expansion-stage (otherwise, equal to zero)
LATER_STAGE	A dummy variable equal to one if the investment round is in the later-stage (otherwise, equal to zero)
AMOUNTS	The total amount of funds invested in the given round (in millions of 2000 US$)
NBR_INVESTORS	The number of venture capitalists involved in raising AMOUNTS (it gives the size of the syndicate in a given round)
NBR_IPO	The number of IPOs in the US during the year in which the investment round was done. When (+n) is added, this means the number of IPOs in n years after the time in which the investment round was done.
P_IPO	The predicted number of IPOs in the US one year in the future, based on prior current underpricing and the current number of IPOs. $P\_IPO(t) = \beta_0 + \beta_1 \cdot IPO(t\text{-}1) + \beta_2 \cdot Underpricing(t\text{-}1) + \beta_3 \cdot Real\ GDP(t\text{-}1) + \varepsilon(t)$. Details are provided in section 4 of the text.
NEW_ INVESTMENT	A dummy variable equal to one if the investment is a first-round investment (otherwise, equal to zero)
FOLLOW_ON	(= 1 – NEW_INVESTMENT) A dummy variable equal to one if the considered investment round is a follow-on investment (otherwise, equal to zero)
GDP	The real annual growth rate of the U.S. economy during the year in which the considered investment is done
INTERNET	A dummy variable equal to one if the entrepreneurial firm is in the communication, e-commerce, Internet services, or Internet software and programming sectors (otherwise, equal to zero)
COMPUTER	A dummy variable equal to one if the entrepreneurial firm is in the hardware and software sectors (otherwise, equal to zero)
BIOTECH	A dummy variable equal to one if the entrepreneurial firm is in the biotechnology sector (otherwise, equal to zero)
MEDICAL	A dummy variable equal to one if the entrepreneurial firm is in the medical and health-related sectors (otherwise, equal to zero)

1.4.3 Graphical Analysis

Figure 1 shows the number of observations available in each year for the full sample of 18774 investment rounds, as well as the sample of all new investments (4065 observations). More generally, it shows the great increase in VC investments during the second half of the 1990s, followed by a sharp decrease after 2000. Not so surprisingly, the correlation on an annual basis between the two data series is very strong, namely +93%. When overall investment increases, so do investments in new companies.

Figure 2 presents the total number of IPOs that took place in the US during the period of 1985 to 2004. These include IPOs on the NASDAQ, NYSE and AMEX. In what follows in this study, we use these data as *liquidity measure* of exit markets for VC investments. Notice that using yearly aggregate values of liquidity leads to consider the more general liquidity condition of markets. The time series exhibits a strong positive autocorrelation. Figure 2 also highlights the relative importance of new early-stage investments as compared to new investments in the two other stages. For each year, it shows the ratio of new early-stage investment rounds over new expansion-stage and later-stage investment rounds (:= new early-stage investments in year *t* ÷ new expansion-stage and later-stage investments in year *t*). In other words, it represents the average number of new early-stage investments for every new expansion-stage or later-stage investment; the evidence shows that it has been changing considerably over time. For instance, in 1987 *VCs* invested 4 times more often in new early-stage projects than in new expansion-stage projects, while in 1997 it was only 2 times. Notice that on an annual basis the empirical correlation of both series is –58%, which provides preliminary support for HYPOTHESIS 1.

Figure 3 shows the importance of new (first-round) investments relative to follow-on investments, irrespective of development stages. It provides the ratio of new investments over all data available. For instance, we can see that in 2001 only 11% of all investment rounds were in new projects, while in the late 1990s it was about 30%. When comparing these values (on annual basis) with the annual number of IPOs, one obtains a correlation of +53%. This provides preliminary evidence that is consistent with HYPOTHESIS 2.

Finally, Figure 4 presents the average syndicate size for all first-round investments each year, and again with comparisons to IPO volume. Average syndicate size seems to have been lower during the 1990s. On the annual basis the correlation with IPO volume is –62%. Figure 4 is thus consistent with HYPOTHESIS 3.

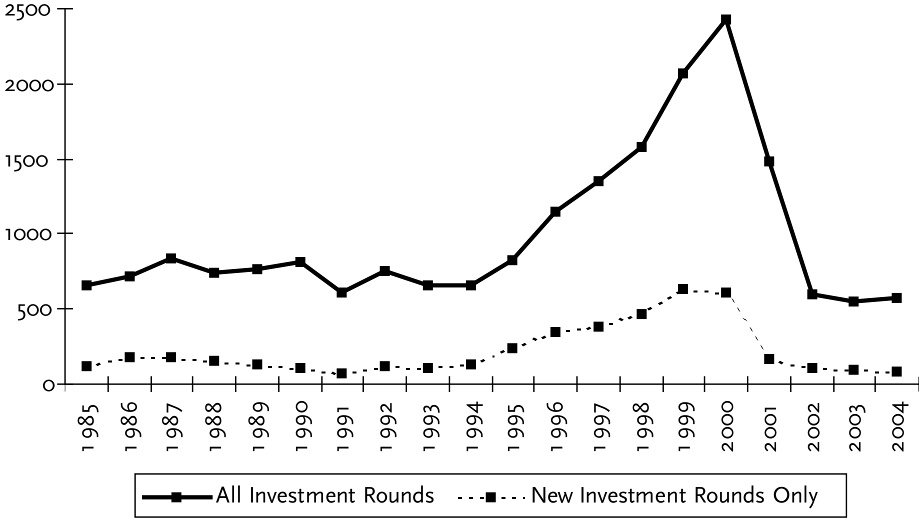

Figure 1: Number of Observations in each Year from 1985 to 2001. The unit of observations is an investment round. The bold line shows the number of observations available using all the investment rounds (i.e., new and follow-on rounds), while the dashed line only considers new (first-round) investment rounds.

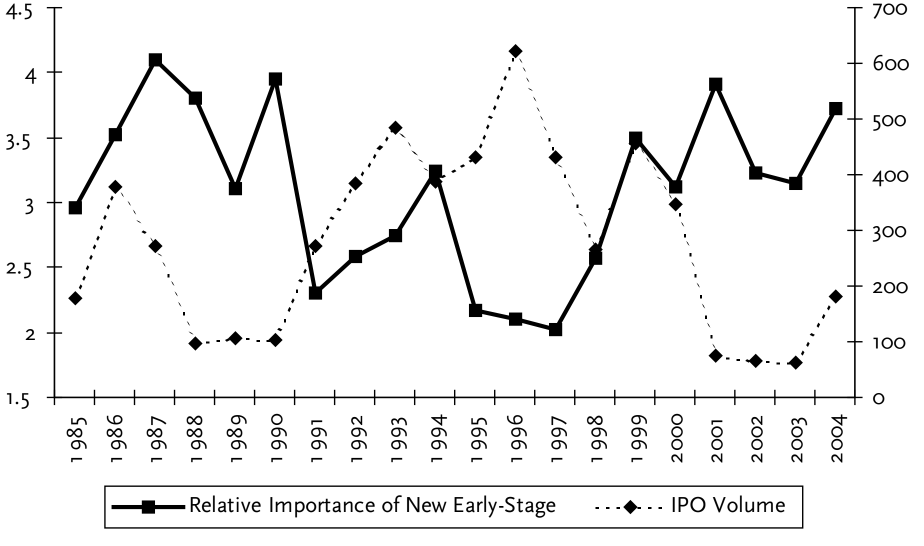

Figure 2: Importance of New Early-Stage Investments and IPO Volume in the United States from 1985 to 2001. The bold line (with left-hand Y-axis) gives the ratio of new early-stage investments over all new expansion-stage and later-stage investments in each year. The IPO volume (right-hand Y-axis) is shown by the dashed line and represents the number of initial public offerings (IPOs) as reported by Ritter and Welch (2002). It refers to IPOs on the NASDAQ, NYSE and AMEX.

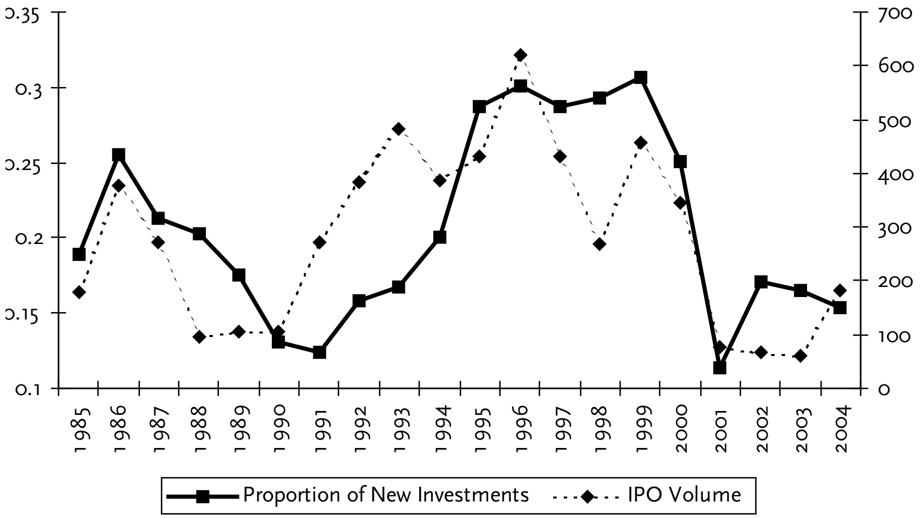

Figure 3: Importance of New Investments Compared to Follow-On Investments. The bold line (left-hand Y-axis) gives the proportion of new investments from all investments (new and follow-on) in each year. The dashed line (right-hand Y-axis) gives again the number of IPOs in each given year (IPO volume), as in Figure 2.

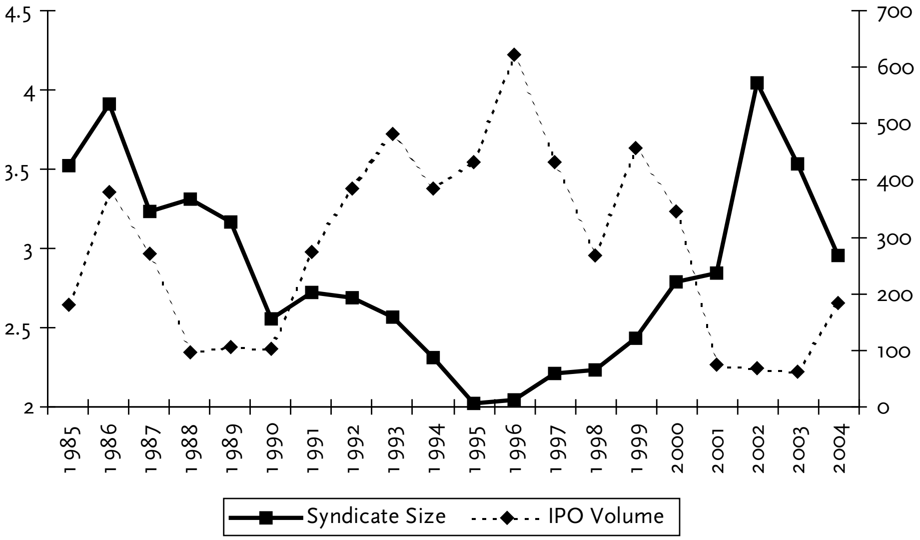

Figure 4: Syndicate Size for New (First-Round) Investments and IPO Volume in the United States from 1985 to 2001. The bold line (left-hand Y-axis) gives the average number of syndicate partners involved in new investments in each year. The dashed line (right-hand Y-axis) gives again the number of IPOs in each given year (IPO volume), as in Figure 2.

1.4.4 *Summary Statistics*

Panels A to C in Table 2 present summary statistics of the data. Panel A presents the data for new investment rounds only and for all investment rounds. A few interesting observations are worth highlighting. First, a large fraction of first-round investment rounds are in the early-stage, but this fraction is considerably lower for new and follow-on investment rounds. Second, the average syndicate size (NBR_INVESTORS) is of smaller for first-round investments relative to all investment rounds (an average of 2.6 investors for first round, versus 3.6 for all rounds). Third, 22% of all investment rounds included are new investments. Fourth, regarding differences in industry sectors, note that there are fewer investments in biotech and medical sectors relative to the Internet and computer sectors. This result is certainly attributable to the Internet boom during the end of the 1990s, and the large proportion of all VC investments. Fifth, note that new investment rounds are in the early-stage (74%), while about 20% of new investments are in the expansion stage.

Table 2. Summary Statistics

Panel A. New and Follow-On Rounds

This table summarizes the data by the percentage of observations by each industry sector and each stage of firm development. The unit of observation is an investment round. The data are presented for the new (first round) investments (column 1) and for the new and follow-on investment rounds (column 2). The average amounts invested are expressed in millions of 2000 US dollars. Variables are as defined in Table 1.

	New Investment Rounds Only	New and Follow-On Investment Rounds
Industry Sectors:		
- INTERNET	23 %	17 %
- BIOTECH	7 %	8 %
- COMPUTER	25 %	28 %
- MEDICAL	13 %	15 %
- Other Sectors	32 %	32 %
Stages of Investment:		
- EARLY_STAGE	74 %	33 %
- EXPANSION_STAGE	20 %	40 %
- LATER_STAGE	6 %	27 %
AMOUNTS	5.33	7.11
NEW_INVESTMENT	–	22 %
NBR_INVESTORS	2.6	3.6
Number of Observations	4443	18774

Table 2. Summary Statistics
Panel B. Stages of Investment.
This table summarizes the data by stage of entrepreneurial firm development at time of investment, as it relates to the firm's industry sector, amounts invested and number of syndicated investors. Each cell comprises two numbers: the first concerns all new investment rounds only; the second (in brackets) provides the same summary statistics for both new and follow-on rounds. The average amounts invested are expressed in millions of 2000 US dollars. Variables are as defined in Table 1.

	Early-Stage	Expansion-Stage	Later-Stage
Industry Sectors:			
- INTERNET	23 % (19 %)	28 % (19 %)	11 % (11 %)
- BIOTECH	9 % (10 %)	3 % (6 %)	5 % (10 %)
- COMPUTER	24 % (24 %)	26 % (29 %)	24 % (31 %)
- MEDICAL	14 % (17 %)	8 % (14 %)	11 % (15 %)
- Other Sectors	30 % (30 %)	35 % (32 %)	51 % (33 %)
AMOUNTS	4.65 (4.88)	7.11 (8.91)	7.84 (7.19)
NBR_INVESTORS	2.7 (3.2)	2.5 (4.0)	2.2 (3.7)
Number of Observations	3018 (6216)	802 (7535)	245 (5023)

Table 2. Summary Statistics
Panel C. Industry Sectors.
This table summarizes the data by industry sector, with details on the average amounts invested, number of syndicated investors, and proportion of early stage investors. Each cell comprises two numbers: the first is for new investment rounds in all the 3 stages of development (early-, expansion- and later-stage); the second (in brackets) provides the same summary statistics for both new and follow-on rounds in all 3 stages. The average amounts invested are expressed in millions of 2000 US dollars. Variables are as defined in Table 1.

	Number of Observations	AMOUNTS	NBR_ INVESTORS	EARLY_STAGE
INTERNET	944 (3207)	6.64 (11.14)	2.5 (3.5)	74 % (36 %)
BIOTECH	300 (1593)	5.13 (7.31)	3.0 (4.0)	87 % (40 %)
COMPUTER	1001 (5243)	4.14 (5.08)	2.6 (3.6)	73 % (29 %)
MEDICAL	529 (2856)	4.81 (5.76)	2.8 (3.6)	82 % (36 %)
Other Sectors	1291 (5875)	5.54 (7.34)	2.6 (3.6)	69 % (31 %)

Panel B in Table 2 provides summary statistics by investment stages. Average amounts (expressed in year 2000 values) invested per round were much lower for early stage (US$ 4.65 million) relative to expansion stage (US$ 7.11 million) and later stage (US$ 7.84 million). There was a lower proportion of later-stage investments for Internet companies (11%) relative to the Internet sector early-stage and expansion-stage investments (23% and 28%).

Panel C in Table 2 presents the data by industry sectors. In each cell, we provide summary statistics for first round investments in all 3 stages of development, as well as for new and follow-on rounds (the latter statistics are in brackets). An large proportion (23%) of the investment rounds are in the Internet sector. Internet investments also had, on average, the largest amounts invested per round (US$ 6.64 million). There are no notable differences in the average syndicate size across industry sectors, except perhaps for the biotech sector. The majority of first round investments are in the early-stage, and there are few such differences across sectors. The category of "other sectors" includes investment projects in business and financial services, communications and media, consumer-related services and products, and semiconductors.

Table 3 presents tests for differences in proportions and averages. We examine differences between years exhibiting high IPO volume and low IPO volume, in terms of the median IPO volume (Parts 1 and 3 of Table 3) and the upper and lower quartiles (Part 2 of Table 3). The univariate summary test statistics in Table 3 provide strong support the conjectured effects. In regards to HYPOTHESIS 1, we observe a smaller proportion of early-stage investments with there are a greater number of contemporaneous IPOs as well as IPOs two years hence, and all of these differences are significant at the 1% level of significance. In support of HYPOTHESES 2, we observe a significantly greater proportion of new investments when IPO volume in greater, and again these differences across Parts 1 – 3 are all significant at the 1% level. Finally, in regards to HYPOTHESIS 3, the data support the conjecture of a significant and positive relation between conditions of high liquidity risk and the number of syndicated partners for each comparison test at the 1% level.

Table 3. Tests for Differences in Proportions and Averages.

Comparisons of proportions tests are provided for the proportion of new (first round) early stage investments to the total number of new investments, and the proportion of new projects to the total number of investments in the sample (1985 – 2004). Comparisons of means tests are provided for the average syndicate size for new early stage investments, and for new and follow-on early stage investments. The tests are provided for ranges that compare concurrent values above and below the median, and the bottom to top quartiles of IPOs (both concurrent and 2 years ahead of the time of investment), and for median IPOs 2 years ahead of the investment for the sample. *, **, *** significant at the 10%, 5% and 1% levels, respectively.

	Part (1)			Part (2)			Part (3)		
	Number of Concurrent IPOs < 342 (median)	Number of Concurrent IPOs > 342 (median)	Difference in Proportions or Averages	Number of Concurrent IPOs < 203 (bottom quartile)	Number of Concurrent IPOs > 482 (top quartile)	Difference in Proportions or Averages	Number of Predicted IPOs 2 Years Ahead < 342 (median)	Number of Predicted IPOs 2 Years Ahead > 342 (median)	Difference in Proportions or Averages
Total Number of New and Early Stage Projects	1138	1880		660	295		1951	1067	
Total Number of New Projects	1498	2567		850	427		2564	1501	
Proportion of New and Early Stage Projects	0.76	0.73	2.96***	0.78	0.69	4.06***	0.76	0.71	4.31***
Total Number of New Projects	2685	3531		1645	576		3861	2355	
Total Number of Projects	8702	10072		5862	1699		11969	6805	
Proportion of New Projects	0.31	0.35	-6.15***	0.28	0.34	-4.27***	0.32	0.35	-3.12***
Average Syndicate Size for New Early Stage Projects	2.92	2.49	6.77***	3.22	2.17	10.73***	2.85	2.30	9.96***
Average Syndicate Size for New and Follow-on Early Stage Projects	3.91	3.42	10.72***	4.15	2.78	19.32***	4.02	2.99	23.89***

Table 4. Correlation Matrix. Correlation coefficients are presented for the subsample of first round (new) investments only (4065 observations); for the correlations with the variable NEW_INVESTMENT, the full sample of 18774 observations was used. Correlations of 0.03 [0.02 for the NEW_INVESTMENT correlations] or more in absolute value are statistically significant at the 5% level for the subsample of 4065 investments [full sample of 18774 observations]. Variables are as defined in Table 1.

	EARLY_STAGE	EXPANSION_STAGE	LATER_STAGE	NEW_INVESTMENT	NBR_INVESTORS	AMOUNTS	INTERNET	BIOTECH	COMPUTER	MEDICAL	NBR_IPO	NBR_IPO (+1)	NBR_IPO (+2)	PREDICTED_IPO	GDP (-1)	GDP	NASDAQ (-1)	NASDAQ	NASDAQ_RET
EARLY_STAGE	1.00																		
EXPANSION_STAGE	-0.84	1.00																	
LATER_STAGE	-0.43	-0.13	1.00																
NEW_INVESTMENT	0.45	-0.22	-0.25	1.00															
NBR_INVESTORS	0.07	-0.04	-0.07	-0.16	1.00														
AMOUNTS	-0.09	0.07	0.05	-0.05	0.24	1.00													
INTERNET	0.00	0.05	-0.08	0.09	-0.04	0.06	1.00												
BIOTECH	0.08	-0.08	-0.02	-0.02	0.05	-0.01	-0.16	1.00											
COMPUTER	-0.01	0.01	0.00	-0.04	-0.01	-0.05	-0.32	-0.16	1.00										
MEDICAL	0.07	-0.07	-0.01	-0.04	0.03	-0.02	-0.21	-0.11	-0.22	1.00									
NBR_IPO	-0.05	0.03	0.04	0.12	-0.17	0.02	0.17	-0.04	0.01	-0.02	1.00								
NBR_IPO (+1)	-0.05	0.03	0.05	0.07	-0.17	-0.09	-0.04	0.01	0.03	0.05	0.48	1.00							
NBR_IPO (+2)	-0.07	0.02	0.08	-0.01	-0.13	-0.13	-0.24	0.07	0.09	0.08	0.12	0.60	1.00						
P_IPO	-0.04	0.00	0.08	0.06	-0.07	-0.09	-0.14	0.05	0.03	0.04	0.21	0.13	0.38	1.00					
GDP (-1)	0.02	0.01	-0.05	0.05	0.00	0.02	0.16	-0.09	-0.05	-0.08	-0.12	-0.03	-0.26	0.12	1.00				
GDP	-0.01	0.01	0.00	0.12	-0.07	0.01	0.21	-0.05	-0.04	-0.05	0.37	0.10	-0.04	0.44	0.36	1.00			
NASDAQ (-1)	0.03	0.01	-0.07	-0.01	0.01	0.15	0.24	-0.08	-0.06	-0.11	-0.21	-0.50	-0.52	-0.37	0.11	-0.18	1.00		
NASDAQ	0.02	0.02	-0.07	0.04	-0.02	0.18	0.38	-0.11	-0.08	-0.15	0.06	-0.47	-0.59	-0.33	0.22	0.15	0.86	1.00	
NASDAQ_RET	0.01	0.03	-0.06	0.06	-0.08	0.16	0.39	-0.11	-0.07	-0.15	0.20	-0.26	-0.43	-0.26	0.14	0.20	0.85	0.94	1.00

Table 4 shows a correlation matrix of all the variables for the subsample of all new investments (except for the variable NEW_INVESTMENT, where the full sample was used because otherwise there would be no variation). The correlation statistics are consistent with the summary statistics provided in Table 3. For example, the number of IPOs is negatively and significantly correlated with the number of early-stage investments and positively correlated with the number of new investments, which supports HYPOTHESES 1 and 2.[13] Further, syndicate size is negatively correlated with IPO conditions, in support of HYPOTHESIS 3. The other correlations in Table 4 provide guidance for collinearity issues in regards to the appropriate specifications in the multivariate tests in the next section.

1.5 Multivariate Regression Analysis

Our regression analyses are organized into three parts in this section to test the three respective hypotheses outlined in section 1.3: sections 1.5.1 – 1.5.3 comprise regressions that test HYPOTHESES 1 – 3 in Tables 5 – 7 for dependent variables EARLY-STAGE, NEW_INVESTMENT, and NBR_INVESTORS, respectively.

The regressions are specified with right-hand-side variables for IPO exit market conditions, amounts invested, and industry dummy variables. Moreover, we examine the impact of the NASDAQ Composite Index (denoted by NASDAQ) at the end of the investment year, in order to control for general market effects. We also control for real GDP, since Gompers and Lerner (1998, 1999) show that general economic conditions (which they also proxied by the real GDP) impacted significantly the flow of capital into the US VC market. With the different included right-hand-side variables our pseudo R^2 values are not very large (less than 5%), but this is quite consistent with other papers in venture finance that use similar U.S. industry data (for example, Cochrane (2005) estimates the determinants of U.S. VC returns and explains at most 1% of the variation in the data).

We further consider in the regressions the number of IPOs per year occurring one and two years ahead (NBR_IPO(+1) and NBR_IPO(+2)) to capture the fact that future liquidity might matter. By including these two variables, we implicitly assume that *VC*s have perfect foresight over future exit markets liquidity for the next two years ahead, which is of course a very strong assumption. As an alternative specification and robustness check, we estimated a forecasting model for predicted values of future liquidity. In particular, we use an AR(1) model to obtain predicted values of NBR_IPO, which we denote by P_IPO (as indicated in Table 1). The estimation equation uses the number of IPOs in the prior

13 There is one exception: the correlations between New Investment and NBR_IPO(+2) is insignificantly correlated in Table 3. The subsequent tables control for other factors with multivariate tests.

14 For this specification, we made use of publicly available annual IPO data on Jay Ritter's webpage going back to 1960. These data were used as they comprise a sufficient number of years to obtain reliable estimates of the future number of IPOs. This procedure is somewhat similar to the alternatives reported in Lowry (2003). We did consider numerous alternatives, and our predicted IPO numbers did not materially alter the results and qualitative conclusions presented herein.

year, the average underpricing of such IPOs in the prior year and the prior year's real GDP growth to predict the subsequent year's number of IPOs, as follows:[14]

$P\_IPO(t) = \beta_0 + \beta_1 \cdot IPO(t\text{-}1) + \beta_2 \cdot Underpricing(t\text{-}1) + \beta_3 \cdot Real\ GDP\ Growth(t\text{-}1) + \varepsilon(t)$

In all the tables, we show the regression results for testing Hypothesis 1 when using P_IPO instead of NBR_IPO.

In each regression table (Tables 5-7) we consider the effect of dropping years around the Internet bubble. Model (11) in each regression table drops the years 1999 and 2000. Model (12) drops the years 1998-2001. We explicitly show the robustness of the econometric results to the inclusion and exclusion of these outlier years, as well as the consideration of different explanatory variables. As well, note that the graphical analysis of the data (subsection 1.4.3 above) shows the patterns of investment in relation to economic cycles are not attributable to the years surrounding the Internet bubble. We discuss further robustness checks not explicitly presented but available upon request in section 1.6 below.

Table 5. The Effect of Liquidity on Financing First Round Early Stage Entrepreneurial Firms

This table tests HYPOTHESIS 1 on the negative relationship between liquidity of exit markets and the likelihood of investing in early-stage projects. The regressions comprise the subsample of observations using all the first-round (new) investment only. Model (2) excludes 2004 by virtue of NBR_IPO(+1) and Model (3) excludes 2003 and 2004 by virtue of NBR_IPO(+2). Model (11) excludes the bubble years 1999 and 2000, while Model (12) excludes the years 1998-2001. For each cell, the first number is the Logit coefficient, and the second number is the marginal effect that indicates economic significance. *, **, *** statistically significant at the 10%, 5% and 1% levels, respectively. White's (1980) robust standard errors are used. Variables are as defined in Table 1.

	Logit Regressions. Dependent Variable: Early_Stage											
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CONSTANT	1.075***	1.049***	1.070***	1.294***	0.893***	0.681***	1.174***	0.989***	1.510***	1.212***	1.258***	1.1574***
	0.203	0.198	0.202	0.244	0.169	0.129	0.221	0.186	0.284	0.228	0.241	0.223
NBR_IPO	-0.0008***						-0.0008***	-0.0008***			-0.0011***	-0.0011***
	-1.555E-04						-1.540E-04	-1.533E-04			-2.163E-04	-2.054E-04
NBR_IPO (+1)		-0.0008***										
		-1.566E-04										
NBR_IPO (+2)			-0.001***									
			-2.088E-04									
P_IPO				-0.001***					-0.001***	-0.001**		
				-1.927E-04					-2.346E-04	-1.876E-04		
GDP					-0.024			0.002		1.145E-02	-1.932E-02	3.466E-02
					-4.502E-03			3.574E-04		2.154E-03	-3.706E-03	6.677E-03
NASDAQ						0.00009**		0.0001***		1.025E-04	-1.215E-05	-1.047E-04
						1.633E-05		2.443E-05		1.928E-05	-2.330E-06	-2.016E-05
AMOUNT							-0.00002***	-0.00002***	-0.00002***	-0.00002***	-0.00002***	-0.00003***
							-2.947E-06	-3.488E-06	-3.190E-06	-3.568E-06	-4.128E-06	-5.094E-06
INTERNET	0.270***	0.224**	0.164*	0.184*	0.221**	0.126	0.286***	0.163	0.196**	0.100	0.159	0.112
	4.900E-02	0.041	0.030	0.034	0.041	2.333E-02	0.052	0.030	0.036	0.018	0.030	0.021
COMPUTER	0.226**	0.204**	0.252***	0.202**	0.206**	0.204**	0.198**	0.192**	0.172*	0.168*	0.215**	0.240**
	0.041	0.038	0.046	0.037	0.038	0.037	0.036	0.035	0.032	0.031	0.040	0.045
BIOTECH	1.067***	1.083***	1.104***	1.073***	1.059***	1.085***	1.063***	1.096***	1.071***	1.095***	1.181***	1.248***
	0.156	0.158	0.160	0.157	0.155	0.158	0.155	0.158	0.156	0.158	0.173	0.182
MEDICAL	0.736***	0.735***	0.768***	0.721***	0.721***	0.743***	0.721***	0.752***	0.704***	0.729***	0.876***	0.797***
	0.120	0.120	0.124	0.118	0.118	0.121	0.117	0.122	0.115	0.118	0.143	0.134
Number of Observations	4065	3980	3897	4065	4065	4065	4065	4065	4065	4065	2877	2291
Observations with Dependent Variable = 1	74%	74%	74%	74%	74%	74%	74%	74%	74%	74%	73%	73%
Loglikelihood	-2281.569	-2236.834	-2186.480	-2282.976	-2287.009	-2283.860	-2265.839	-2258.791	-2265.197	-2260.914	-1618.979	-1289.948
Pseudo R^2	0.016	0.017	0.019	0.016	0.014	0.015	0.023	0.026	0.023	0.025	0.032	0.035
LR Statistic	74.979***	75.687***	84.593***	72.166***	64.099***	70.396***	106.439***	120.535***	107.724***	116.288***	106.536***	93.452***

1.5.1 *Effect of Liquidity Risk on Early-Stage Investments*

Table 5 reports the result of different Logit regressions. The dependent variable is EARLY_STAGE, a dummy variable equal to one if the new investment is in the early-stage and zero otherwise.[15] Since many of our explanatory variables exhibit collinearity, we estimate the impact in separate regressions. The coefficient of NBR_IPO is negative and significant in all the regressions in which it was included, strongly supporting the prediction stated in HYPOTHESIS 1. Table 5 indicates that an increase of liquidity by 100 IPOs will reduce the likelihood that a VC invests in new early-stage projects (as compared to new investments in other development stages) by approximately 1.5% (Models 7 and 8) - 2.3% (Model 9) depending on the model specification. The results therefore indicate a clear statistically and economically important effect of IPO conditions on the probability of early-stage investment, particularly in view of the fact that IPO conditions fluctuate widely (Bradley, Jordan and Ritter, 2002; Helwege and Liang, 2002; Lowry, 2003). Note as well that the results are robust to the inclusion or exclusion of the Internet bubble years (years 1999-2000 are excluded in Model 11, and 1998-2001 are excluded in Model 12).

We have stressed that the predicted effect derived from our model and stated in HYPOTHESIS 1 is not immediately obvious, and even somewhat counter-intuitive. Our model is largely based on the decision to postpone exit requirements by undertaking projects of greater technological risk when IPO markets are illiquid. One could just as easily conjecture that there is a positive correspondence between market conditions and early-stage investment based on an oft-repeated casual empiricism (as is often stated in practitioner articles on, e.g., www.ventureeconomics.com). To this end, we control for NASDAQ market levels, and show that indeed, year in which NASDAQ market levels are higher are consistent with more early-stage investments, both independent of controls for IPO conditions (Model 6) and with controls for IPO conditions (Models 8 and 10). An increase of the NASDAQ composite index by 1000 points increases the likelihood of early-stage investments by approximately 1.6% (Model 6) to 2.4% (Model 8) depending on the specification.

The models also generally indicate a greater economic significance in the probability of early-stage financing through VC funds in biotech and medical industries relative to the Internet and computer sectors. One possible explanation is that the different sectors take longer to bring a project to bring to fruition (Gompers and Lerner, 1999). Another explanation could be that there might be less scope for VCs to invest in biotech to trade-off liquidity risk with technological risk when exit markets are illiquid. Biotech entrepreneurial firms typically lack ability to internally fund themselves, and therefore there is a comparative dearth of expansion stage biotech firms seeking capital for the first time from VCs.

15 Throughout the paper, we test investments in early-stage rounds against investments in either expansion- or later-stage investments. We also tested early-stage investments against expansion-stage investments only and did not find any significant difference in the results.

Note that the larger the investment amount (variable AMOUNT), the lower the likelihood that the new investment is an early-stage project, as would be expected.[16] Interestingly, since later-stage projects also involve greater amounts of finance, this suggests that the shift from early-stage to expansion-stage induced by liquidity of exit markets is even more pronounced in dollar values as compared to the number of investments.

1.5.2 *Effect of Liquidity Risk on New Investments*

Table 6 shows results of Logit regressions with NEW_INVESTMENT as dependent variable to test HYPOTHESIS 2. To this end, we use the full sample for early and expansion stage projects.[17]

The results in Table 6 provide strong support for HYPOTHESIS 2 ("New Investment Decision"), which conjectured a positive effect of IPO volume on the propensity to invest in new projects as a result of reduced liquidity risk. An increase in contemporaneous IPO volume by 100 increases the probability to invest in a new project (as opposed to a follow-on project) by approximately 1.2% (Model 1) to 4.1% (Models 7). The estimated marginal effects are slightly smaller for the future IPO variables (Models 2 and 3) and predicted future IPO variables (Model 4, 9 and 10). These results are quite robust to the inclusion of control variables for GDP (which is positive and significant, as expected), NASDAQ (positive and significant, as expected, but only in Models 8 and 10) and AMOUNTS (negative and significant, as expected). Further, note that as in Table 5, Table 6 shows the results are robust to the inclusion or exclusion of the years surrounding the Internet bubble (Models 11 and 12).

16 We view capital requirements as exogenously determined in Models (7) – (10). Numerous alternative specifications and assumptions (available upon request) did not materially affect the results.

17 Specifications with late-stage investments, which are typically not considered as "venture capital" but rather "private equity", did not materially affect the results and are available upon request.

Table 6. The Effect of Liquidity on Financing First Round Entrepreneurial Firms

This table tests HYPOTHESIS 2 on the positive relationship between liquidity of exit markets and the likelihood of investing in new first-round projects. The regressions comprise the subsample of investments in the early and expansion stage only. Model (2) excludes 2004 by virtue of NBR_IPO(+1) and Model (3) excludes 2003 and 2004 by virtue of NBR_IPO(+2). Model (11) excludes the bubble years 1999 and 2000, while Model (12) excludes the years 1998-2001. For each cell, the first number is the Logit coefficient, and the second number is the marginal effect that indicates economic significance. *, **, *** statistically significant at the 10%, 5% and 1% levels, respectively. White's (1980) robust standard errors are used. Variables are as defined in Table 1.

	Logit Regressions. Dependent Variable: New_Investment											
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CONSTANT	-1.566***	-1.327***	-1.085***	-1.842***	-1.829***	-0.958***	-1.384***	-1.902***	-1.552***	-2.035***	-2.091***	-1.994***
	-0.310	-0.265	-0.218	-0.367	-0.362	-0.192	-0.270	-0.369	-0.306	-0.396	-0.391	-0.377
IPO	0.002***						0.002***	0.002***			0.002***	0.002***
	4.076E-04						4.067E-04	3.040E-04			3.023E-04	3.065E-04
IPO (1)		0.001***										
		2.840E-04										
IPO (2)			0.0006***									
			1.238E-04									
P_IPO				0.002***					0.002***	0.0009***		
				3.880E-04					3.333E-04	1.676E-04		
GDP					0.265***			0.183***		0.231***	0.197***	0.133***
					5.253E-02			3.554E-02		4.506E-02	3.693E-02	2.522E-02
NASDAQ						4.386E-06		0.00006***		0.00009***	0.0002***	0.0002***
						8.773E-07		1.178E-05		1.818E-05	3.798E-05	3.446E-05
AMOUNTS							-0.00003***	-0.00003***	-0.00003***	-0.00003***	-0.00003***	-0.00003***
							-5.540E-06	-6.190E-06	-5.141E-06	-6.214E-06	-6.208E-06	-4.927E-06
INTERNET	0.227***	0.360***	0.387***	0.362***	0.250***	0.312***	0.316***	0.225***	0.437***	0.270***	-0.039	0.200*
	0.046	0.075	0.082	0.076	0.051	0.065	0.064	0.045	0.091	0.055	-0.007	0.039
COMPUTER	-0.131**	-0.136***	-0.125**	-0.110**	-0.127**	-0.115**	-0.159***	-0.167***	-0.137***	-0.155***	-0.171***	-0.075
	-0.026	-0.027	-0.025	-0.022	-0.025	-0.023	-0.031	-0.032	-0.026	-0.030	-0.031	-0.014
BIOTECH	-0.141*	-0.149*	-0.124	-0.103	-0.090	-0.104	-0.142*	-0.115	-0.101	-0.081	-0.013	0.091
	-0.027	-0.029	-0.024	-0.020	-0.017	-0.020	-0.027	-0.022	-0.019	-0.015	-0.002	0.017
MEDICAL	-0.255***	-0.283***	-0.251***	-0.212***	-0.219***	-0.211***	-0.290***	-0.284***	-0.240***	-0.249***	-0.176**	-0.052
	-0.048	-0.054	-0.048	-0.041	-0.042	-0.041	-0.054	-0.052	-0.045	-0.046	-0.032	-0.010
Number of Observations	13751	13405	13015	13751	13751	13751	13751	13751	13751	13751	10222	8090
Observations with Dependent Variable = 1	0.278	0.279	0.281	0.278	0.278	0.278	0.278	0.278	0.278	0.278	0.261	0.262
Loglikelihood	-7941.962	-7816.535	-7671.696	-8022.147	-7967.499	-8081.105	-7840.105	-7787.811	-7936.899	-7844.918	-5656.811	-4518.812
Pseudo R^2	0.023	0.015	0.008	0.013	0.019	0.005	0.035	0.041	0.023	0.034	0.036	0.028
LR Statistic	365.950	236.732***	119.055***	205.580***	314.877***	87.664***	569.664***	674.253***	376.076***	560.038***	427.566***	260.694***

Interestingly, note from Table 6 that Internet projects are more often new investments (as opposed to staged follow-on investments). This is consistent with evidence money chasing deals during boom periods like that of the Internet bubble (Gompers and Lerner, 2000). The comparatively less frequent staging of Internet projects is also consistent with other evidence of less value-added and monitoring provided to VCs in boom periods (Gompers, 1995; Kortum and Lerner, 2000).

1.5.3 Effect of Liquidity Risk on Syndicate Size

Table 7 examines optimal syndicate size to test HYPOTHESIS 3A versus HYPOTHESIS 3B. We use NBR_INVESTORS as dependent variable, as defined in Table 1, and use a Poisson regression to account for the ordinal nature of the data.[18] The Vuong test statistic strongly supported the Poisson specification in all cases. We carry out similar robustness checks as in Tables 5 and 6. We also considered alternative specifications (not reported in the tables for reasons of succinctness), such as a dependent variable equal to one if the deal was syndicated, and zero otherwise. Our results are robust to this alternative specification, among others. We focus on the more intuitive Poisson specification, which accounts for the number of syndicated partners, and a declining marginal benefit of adding additional syndicated partners.

18 An ordered Logit model was considered, but yielded estimation problems where there were too few observations for some of the syndicated investments with a very large number of syndicated partners. Redefining and/or deleting these problematic observations for that methodology did not yield results that were materially different from the reported Poisson regression approach. Alternative specifications are available upon request.

Table 7. The Effect of Liquidity on Syndication

This table tests HYPOTHESIS 3 on the negative relationship between liquidity of exit markets and the number of syndicated investors. The regressions in models (1) – (8) comprise the subsample of observations using all the first round investments only in any investment stage, and models (9) – (10) consider first round investments in early stage firm only. Model (2) excludes 2004 by virtue of NBR_IPO(+1) and Model (3) excludes 2003 and 2004 by virtue of NBR_IPO(+2). Models (11) and (12) are similar to Model (9), but Model (11) excludes the bubble years 1999 and 2000, while Model (12) excludes the years 1998-2001. For each cell, the first number is the Logit coefficient, and the second number is the marginal effect that indicates economic significance. *, **, *** statistically significant at the 10%, 5% and 1% levels, respectively. White's (1980) robust standard errors are used. Variables are as defined in Table 1.

	Poisson Regressions. Dependent Variable: Nbr_Investors											
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CONSTANT	1.214***	1.183***	1.118***	1.267***	1.108***	0.967***	1.202***	1.293***	1.207***	1.282***	1.349***	1.289***
	3.214	3.124	2.932	3.351	2.927	2.562	3.310	3.572	3.505	3.735	3.942	3.754
IPO	-0.0008***						-0.0008***		-0.0008***		-0.0009***	-0.0009***
	-0.002						-0.002		-0.002		-0.003	-0.003
IPO (1)		-0.0008***										
		-0.002										
IPO (2)			-0.0007***									
			-0.002									
P_IPO				-0.0006***				-0.0006***		-0.0005***		
				-0.002				-1.599E-03		-1.344E-03		
GDP					-0.043***		0.000	-0.015	0.007	-0.012	-0.004	0.016
					-0.112		0.001	-0.040	0.021	-0.036	-0.012	0.045
NASDAQ						2.739E-07	-1.450E-05	-0.00003***	-9.922E-06	-2.264E-05	-0.0001***	-0.00007**
						7.254E-07	-3.993E-05	-7.899E-05	-2.882E-05	-6.595E-05	-2.991E-04	-2.126E-04
AMOUNTS							0.000006***	0.000006***	0.000007***	0.000007***	0.000007***	0.000006***
							1.736E-05	1.647E-05	2.142E-05	2.001E-05	2.062E-05	1.771E-05
INTERNET	-0.001	-0.064**	-0.106***	-0.079***	-0.043	-0.066**	0.007	-0.050	-0.064	-0.125**	-0.134*	-0.140
	-0.001	-0.168	-0.279	-0.208	-0.113	-0.176	0.019	-0.139	-0.185	-0.365	-0.391	-0.407
COMPUTER	0.007	-0.007	-0.004	-0.014	-0.010	-0.012	0.020	0.001	-0.018	-0.044	-0.001	-0.016
	0.018	-0.018	-0.011	-0.038	-0.025	-0.032	0.055	-0.001	-0.051	-0.129	-0.002	-0.045
BIOTECH	0.143***	0.151***	0.153***	0.145***	0.138***	0.140***	0.130***	0.124***	0.077	0.062	0.099*	0.079
	0.379	0.399	0.401	0.382	0.364	0.370	0.357	0.341	0.222	0.182	0.289	0.230
MEDICAL	0.075***	0.074***	0.079***	0.061**	0.063**	0.063**	0.069**	0.054	0.044	0.022	0.073	0.077*
	0.198	0.195	0.206	0.161	0.166	0.166	0.191	0.148	0.129	0.063	0.213	0.225
Sigma	0.093***	0.096***	0.102***	0.090***	0.098***	0.097***	0.284***	0.295***	0.364***	0.373***	0.344***	0.260***
Number of Observations	4065	3980	3897	4065	4065	4065	4065	4065	3018	3018	2106	1672
Loglikelihood	-7580.113	-7400.399	-7255.664	-7613.978	-7627.262	-7637.166	-7453.979	-7502.549	-5618.835	-5649.917	-3958.747	-3189.628
Pseudo R^2	0.012	0.003	0.002	0.002	0.003	0.003	0.003	0.005	0.0002	0.002	0.007	0.011
LR Statistic	185.163***	37.373***	36.35551	38.060***	40.393	38.408	48.434***	69.345***	2.500	21.540***	58.632***	69.125***

Table 7 shows that the coefficients of the variables NBR_IPO(+n) are again statistically significant in all the regressions. An increase of IPO volume by 100 gives rise to around 0.2 fewer syndicated partners on average. Thus, greater exit market liquidity reduces syndicate size. This is very supportive of HYPOTHESIS 3B, which is based on the screening motive for syndication (among other things described in section 1.3). This result is also not attributable to the Internet bubble years, as the results hold for Models 11 and 12, where the years 1999-2000 and 1998-2001 are excluded, respectively.

In Table 7 note as well that all of the AMOUNTS coefficients are positive and significant, as expected (greater capital requirements give rise to more syndicated partners). Moreover, the syndicate size is greatest for companies in the biotech sector and smallest for companies in the Internet sector. These industry effects are supportive of the role of exit market liquidity, in that technologically riskier sectors with a longer gestation period are financed by larger investor syndicates.

1.6 Limitations, Alternative Explanations and Future Research

The issues considered in this paper give rise to a number of questions and further research issues. Our sample was based on data from a randomly selected group of limited partnership VCs in the United States over the 1985 – 2004 period. We considered a large number of robustness checks, many explicitly provided. An earlier version of this paper explicitly reported other robustness checks, such as the exclusion/inclusion of Internet firms, and hot and cold markets, among things; those excluded results were very supportive of the results explicitly reported herein. In Tables 5-7 we showed the robustness of the results to the inclusion and exclusion of the years 1999 and 2000, as well as the years 1998-2001. We also explicitly showed the robustness of the results to numerous different explanatory variables.

There are other issues that are beyond the scope of this paper, but bear relevance for further research. Five potential avenues for future research are as follows. First, it could be instructive to consider other types of investors. Our data are derived from VCs only.[19] In practice, there are various ways how entrepreneurs can finance their early-stage investments without seeking VC, although not all of these sources are available to all entrepreneurs. Often, entrepreneurs rely on "friends and family" to finance the starting of the company. Others may also obtain governmental subsidies or even being first able to do R&D in universities before they are spun-off so that substantial parts of their early-stage development is done without any additional capital injection from VCs. Many other entrepreneurs prefer to work with *Business Angels* before approaching VCs. Empirical evidence show that Business Angels invest by far in more projects than VCs do but in a much smaller amount (cf. Prowse, 1998; Freear, Sohl and Wetzel, 1996; Lerner, 1998; Fenn,

19 Each transaction comprises at least one limited partnership VC. We did not find material differences across funds with the exclusion or inclusion of different funds in the dataset.

Liang and Prowse, 1998; Wong, 2002; Chemmanur and Chen, 2002).[20] Therefore, VCs do not always have to enter into start-up companies in the early-stage but may choose to join in later rounds for the first time. Although there is no reason to believe our sample is biased by considering a sample of VCs only, an analysis of other types of investors would give a more complete analysis of the effects of liquidity risk.

Second, there are different definitions of liquidity that could be analyzed. The concept of liquidity is broader than what considered in our paper. As mentioned in section 1.2, the liquidity concept seems better defined for listed equity than for private equity. On the other hand, the dimension we analyze in this paper is arguably the most appropriate one to focus on in private equity. For instance, it would be hard to obtain any reasonable proxy for depth or resiliency of liquidity for initially non-traded shares. Another potential limitation is the fact that we only focus on the IPO exit market but omit the other main exit route, namely the corporate merger & acquisition market. We did consider M&A data,[21] but this did not improve upon the richness of the results presented herein. As discussed, VCs and the investees typically have a preference for IPO exits (Black and Gilson, 1998; Gompers and Lerner, 1999).

Third, there are different aspects of deal structures that could be studied in relation to liquidity other than the ones considered herein (i.e., our focus was on syndication, in the spirit of Lerner, 1994). For instance, it could be instructive to study the use of covenants in relation to liquidity concerns (e.g., in the spirit of Bascha and Walz, 2001), which might explain reported differences in contractual terms used in different countries. Further research is warranted.

Fourth, it would be instructive to investigate the effect of liquidity in relation to legality in different countries (e.g., as in Jeng and Wells, 2000, and Lerner and Schoar, 2005). Whether the development of VC markets is more closely connected to issues of liquidity or legality is an unanswered question worthy of future study.

Finally, the data herein and the asymmetric effects in particular suggest the importance of behavioral finance factors in affecting VC decisions (e.g., see Landier and Thesmar, 2003). Our model was based on rational decision making. While an analysis of VCs in a behavioral setting could prove fruitful in future work, it is beyond the scope of the paper.

20 Freear, Sohl and Wetzel (1996) estimated that about 250,000 angels invested US$ 10-20 billion in around 250,000 companies each year, which is by far more than the VC market. In Europe, the number of active business angels was estimated by the European Business Angels Network (EBAN) with 125,000.

21 See note 8 and accompanying text.

2 Style Drift in Venture Capital

2.1 Introduction

The process of financial intermediation in both mutual fund and private equity investing involves fund managers that receive capital from investors (see, e.g., Wermers, 2002, for the mutual fund industry; Mayer *et al.*, 2002, for the venture capital industry). To facilitate this process, mutual funds and private equity funds are invariably established with stated objectives in terms of the focus for investments at particular stages of entrepreneurial firm development and industry. Investors pay very close attention to the stated objectives of the funds in which they invest in order to manage the risk/return profile of their portfolio. A deviation from the stated objectives – known as a "style drift" – could be viewed quite negatively by investors that contributed capital to the fund. In the case of a mutual fund that invests in publicly held companies, investors may simply withdrawal capital in relatively short order if they view the drift as unfavorable. In the case of a private equity fund, however, the ability to liquidate a position in a fund may take many years. Style drift, therefore, is at least as important in private equity as it is among publicly traded companies, and potentially more important.[22]

Institutional fund providers increasingly categorize their investments in asset classes (Wermers, 2002, Brown and Harlow, 2004, Barberis and Shleifer, 2003, and Chan, Chen and Lakonishok, 2002). Among other things, this allows them to better assess and control their overall portfolio risk as well as more easily come up with the comparable performance benchmark for assessing the performance of each fund manager. This explains why fund providers investing in private equity also impose a pre-determined investment focus to VC funds. Moreover, this explains the importance of style-consistent investments by venture capitalists.[23]

Style drift is a topic of much academic interest for institutional investment in publicly traded companies and mutual funds (see, e.g., Wermers, 2002). But despite an equal or even greater importance of style drift in the private equity industry, to the best of our knowledge the topic remains unstudied in the academic literature in private equity and venture capital.[24] The goals of this paper are to introduce the concept of style drift in venture capital and private equity [hereafter we simply use the term 'private equity'],[25] to provide empirical regularities on the frequency of style drifts in private equity, and to provide a theoretical model and empirical evidence that facilitates an understanding of why private equity funds do in fact drift.

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22 See, e.g., Clausen and Sood (2003); see also http://www.altassets.com/features/arc/2003/nz2649.php, and numerous other practitioner articles on style drift in private equity available on the Internet.

23 For instance, Cochrane (2001), Das *et al.* (2002), and Jones and Rhodes-Kropf (2003) provide comprehensive analyses of the venture capital asset class in terms of risk and return.

24 Most of the seminal articles in venture capital finance are collected in the book prepared by Gompers and Lerner (1999); see also subsequent work, such as Kortum and Lerner (2000), and Lerner and Schoar (2004). Gompers and Lerner (1996, 1999), Lerner and Schoar (2004) and Ljungqvist and Richardson (2003a) refer to the notion of style drift but do not analyze style drift in terms of theory and/or empirics.

Private equity has grown substantially over the 1990s as a viable alternative asset class for all kinds of institutional investors (Berger and Udell, 1998, Gompers and Lerner, 1999, Hamao, Packer, and Ritter, 2000, Cressy, 2002, and Megginson, 2004). Empirical evidence suggests that limited partners (LPs) in a private equity partnership are able to achieve superior risk-adjusted returns, particularly if manager selection is confined to the upper quartile of ability (Gompers and Lerner, 1999; see also Cochrane, 2005). As such, institutional investors ranging from pension funds to university endowment funds tend to allocate up to 5% (and sometimes as much as 10%) of their capital to private equity and venture capital (Gompers and Lerner, 1999). Achieving a desired exposure to private equity investments, however, is not an exact science. While public equity investments immediately provide the desired exposure level for institutional investors, it is not possible to achieve the desired exposure to private equity immediately at the time of investment. Private equity limited partnerships typically have 10-13 year limited lives with terms, conditions and covenants (Gompers and Lerner, 1996). An institutional investor first provides a capital commitment to a private equity fund, and this commitment is drawn down over the lifespan of the fund (Poterba, 1989; Gompers and Lerner, 1998, 2001). The time for a pension fund to achieve the desired exposure to venture capital typically takes between three and five years depending on the rate of commitments, and the rate of draw-downs by the underlying private equity managers. In view of the difficulty in achieving the desired exposure to the private equity and venture capital asset class, alongside the illiquidity of the investments, institutional investors typically view style drifts by private equity fund managers with a pronounced degree of disapproval.[26] It is therefore particularly interesting and worthwhile to undertake an analysis of style drift in private equity.

An institutional investor's design of optimal portfolio exposure to private equity is naturally a function of risk and return objectives. In particular, optimal portfolio design for a LP is determined by the industry sector, time/vintage year, managers, and geography. It is well established that the risk and return to private equity vary significantly across different stages of firm development at time of first investment, industry sector, among other things (in the academic literature, perhaps the most extensive documentation in the US is provided by Das *et al.*, 2002; see also Cochrane, 2005, for issues pertaining to measuring risk and return). A style drift by a fund manager may therefore have serious consequences for the risk/return profile for the institutional investor. Given the institutional setup of a private equity fund, it takes many years for an institutional investor to rebalance its private equity exposure. Hence, style drifts potentially lower the attracti-

25 The distinction between the terms 'venture capital' and 'private equity' is particularly blurred by the fact that venture capital funds often style drift into later stage investments commonly referred to as 'private equity' investments, and likewise private equity funds often style drift into earlier stage investments commonly referred to as 'venture capital' investments. Hence, for expositional simplicity (except in specific parts of the text where stage focus is referenced), we use the more generic term 'private equity' to refer to early stage venture capital as well as late stage private equity.

26 See, e.g., industry webpages such as those provided by Frank Russell, at: http://www.russell.com/II/Research_and_Resources/Alternative_Investing/Private_Equity_Materials.asp

veness of private equity as an asset class as it makes it more difficult for an institutional investor to manage risk/return profiles.

In order to alleviate the risk of style drift in private equity, the private equity investment process places great emphasis on the upfront design of partnership agreements to contract/covenant the relationship between institutional investor limited partners (LPs) and the private equity fund manager general partners (GPs) (Gompers and Lerner, 1999). These covenants are important because they guide the behavior of the GP and provide the LP with an indication of the expected risks and returns to their investment. Partnership agreements are crucial for portfolio design for two reasons. First, LPs invest into a blind pool of capital. As such, they wish to have the risk profile of their investment at the time of commitment, within boundaries. Second, as mentioned, LPs face a relatively illiquid investment in private equity and cannot easily adjust portfolio holdings or rebalance if a GP undertakes actions that are inconsistent with governing documentation.

In contrast to our initial expectations, in this paper we document the fact that private equity style drifts are in fact extremely common. In our US sample of more than 11,000 private equity transactions in the US over the years 1985 – 2003, we find style drifts occur more than 50% of the time for deviations from the stated stage focus of the fund. In an alternative, broader definition of style-drift, we still observe it in about 30% of the investments in our large sample.

The large frequency of drifts is suggestive of significant benefits associated with drift to fund managers. These benefits include:

- An increased pool of projects from which to choose potentially profitable investments, and GPs want to undertake the best investment opportunities as they arise over the 10 – 13 year lifespan of the fund (both LPs and GPs are unable to foresee those investment opportunities at the time of fund formation);
- Greater diversification of the VC fund (which can be a gain for the GP but not the LPs – cf. Jones and Rhodes-Kropf, 2003) in order to minimize risk of failure (increases chances of not under-performing peers);
- Potentially early exit from investee companies (for late stage investments), and the generation of a reputation for solid investments (a *window dressing* of the portfolio);
- Managerial hubris: more established managers may believe that they can invest across sectors given a successful history of private equity investing (on such see Shepherd, Zacharakis and Baron, 2003)
- Enhanced returns to investing as opportunities change over time;
- Enhanced value of real options associated with strategic investments, such as the aggregate value of income streams derived from investee companies through cross-selling of products.

There are, however, potentially significant costs of style drifting to a GP, including:

- Potential litigation for breach of a limited partnership contract;

- A loss of reputational capital (particularly where the deviations have unsuccessful outcomes), which potentially inhibits a manager's ability to raise follow-on capital, as well as potentially harming deal flow and syndication alliances with other fund managers concerned about spillover of damaged reputational capital;
- An increase in the risk profile of a fund, where managers are not investing in their areas of expertise, and a consequential misallocation of attention by fund managers

As a related point, style drifts are of course also potentially costly to institutional investor LPs as they result in a change in the risk/return profile of their exposure to private equity.

The tradeoff in terms of costs and benefits to private equity style drift is the focus of our theoretical and empirical analyses. With respect to private equity, the most important cost/benefits seem to be the reputational aspects, increased investment opportunities and diversification benefits. Using these ingredients, we generate a set of hypotheses on style drift in private equity that encompass the proclivity of VCs to style drift and the propensity of LPs to accept style drift. Using principal-agent literature we argue that style drifts are expected to be less likely for younger VC funds, as the costs of drifts are more pronounced in terms of damage to reputational capital since they have shorter track records compared to established funds.[27] We also conjecture that style drifts are less likely in boom periods when the scope of valuable projects within the fund's stated objectives are more robust. Similarly, we predict that changes in market conditions from time of fundraising to time of investment affect the propensity to style drift due to changes in investment opportunities.[28]

We test the new theory developed herein with a sample of 11,871 private equity investments (including early stage venture capital investments, and late stage private equity investments) from the Venture Economics database. First, we show that an increase in the age of the VC investor's organization by 5 years increases the probability of style drift by 1%, and similarly, each successive VC fund within an organization is 0.5% more likely to style drift. These robust and statistically significant effects are economically meaningful because many VC organizations in the Venture Economics database were established in the 1960s, while others were formed only in the late 1990s. Similarly, some VC organizations in the Venture Economics database have as many as 41 funds, while others have only operated 1 fund. The propensity of VC funds to style drift therefore significantly depends on fund characteristics. In conjunction with our companion empirical results, discussed immediately below, this shows style drift is thus an important concern for institutional investors seeking a specific exposure to certain forms of venture capital and private equity.

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27 Further, younger funds are also more likely to have more onerous contractual limited partnership covenants imposed on their investment activities (Gompers and Lerner, 1996, 1999).

28 Ritter and Welch (2002) provide an extensive analysis of the overall IPO activities in the US, which documents how market conditions for VC divestments have changed over time. See also Loughran and Ritter (2004) and Jenkinson and Ljungqvist (2001).

Second, we show that market conditions significantly affect the propensity to style drift. Specifically, a 20% increase in NASDAQ from the time of fundraising to the time of investment gives rise to a 4% reduction in the probability of a style drift by funds committed to early stage investments, but a 5% increase in the probability of a style drift by funds committed to later-stage investments. These effects are very economically meaningful, given the context that the average change in NASDAQ from time of fundraising to time of investment in the Venture Economics database is more than 60%. The intuition underlying these results is that for VC funds that committed to early stage investments such a commitment is easier to adhere to in more favorable economic conditions with greater investment opportunities. By contrast, funds that commit to focus on later stage investments are more likely 'drift down' to riskier early stage investments as such investments appear comparatively more attractive when economic conditions are favorable. In support of these results, we also show that the Internet bubble period was associated with a 4% lower probability of a style drift among funds committed to an earlier stage focus, and a 0.5% higher probability of a style drift among funds committed to a later stage focus.

Third, we consider whether style drift affects the performance of venture capital and private equity investments. The data indicate style drifts are associated with a 4% increase in the probability of an IPO exit, controlling for other factors that might affect exit outcomes. This suggests, due to the potential reputation costs associated with style drifts discussed above, VC and private equity funds will style drift only for investments that are more likely to yield favorable realizations. The overall impact on limited partners (fund providers) is unclear, since this would require an assessment of risk and return of their portfolio (our data are suggestive that stage drifts have been associated with higher risk and return over the period examined). However, given that limited partners aim at controlling their portfolio risk by allocating amount to different asset classes, most style drifts by VC funds inevitably mean undesirable effects on the limited partners' portfolios.

This paper is organized as follows. Section 2.2 very briefly reviews the related research, and introduces a new model to derive testable hypotheses. Section 2.3 introduces the data and provides descriptive statistics. Multivariate tests are carried out in section 2.4. Limitations and future research are discussed in section 2.5. The last section concludes.

2.2 Theory

Only a few recent papers have examined style consistency of mutual fund managers and their impact on performance (Wermers, 2002, Brown and Harlow, 2004, Barberis and Shleifer, 2003, and Chan, Chen and Lakonishok, 2002). Barberis and Shleifer (2003) rationalize the behavior of *style investing* (the allocation of funds among asset classes instead of individual securities) by institutional investors (e.g. fund providers of VC funds).[29]

29 Benefits of style investing (i.e. classifying assets) (Barberis and Shleifer, 2003, and Chan, Chen, and Lakonishok, 2002) include: (a) it simplifies the selection of problems and the processing of information, (b) it increases control of overall risk for institutional investors, and (c) it helps investors to better assess the performance of portfolio managers.

Brown and Harlow (2004) show that for mutual fund investments, style-consistent funds outperform style-drifting funds. Wermers (2002) show that in institutional portfolios, style drifts are more common among managers that trade more but that they also achieve higher returns. They also conclude that managers do not seem to be worried about style drift. Interestingly, when controlling for style drifts, the higher performance outcome disappears.

This paper extends the concept of style drift to the context of venture capital and private equity funds. Within the venture capital literature, our central research question is related to analyses of VC fund managers vis-à-vis institutional investors. One direct area on topic considered in prior work has been the analysis of covenants between institutional investors and venture capital fund managers, as analyzed by Gompers and Lerner (1999) and Lerner and Schoar (2004). Private equity and venture capital limited partnership agreements are established between institutional investors (the limited partners) and fund managers (the general partners) such that all investment decisions are carried out by the fund managers. These limited partnerships are the most common way in which private equity and venture capital funds are structured in the US and many other countries around the world. The limited partnership agreement typically lasts for 10-13 years. Gompers and Lerner (1996) show less well established VC managers are more likely to face restrictive covenants from institutional investors in terms of the types of investments that they consider, such as the exclusion of buyout transactions and transactions in certain types of industries, among other things. In related work, Lerner and Schoar (2004) show VCs invest in comparatively illiquid investee companies in order to screen richer investors. Our analyses in this paper also focus on the relationship between institutional investors and venture capital fund managers; however, our focus is different in that we study the committed objective of the VC fund when the limited partnership agreement was established, and study the propensity to deviate from that committed objective. We also study the impact of such style drifts on investment performance. This issue of style drift is important because an institutional investor's exposure to risk associated with investments in private entrepreneurial firms at different stages of development will change if the VC fund manager does not adhere to the committed investment objectives.

Our analysis of style drift in venture capital and private equity is also related to seminal work on grandstanding by venture capital fund managers (Gompers, 1996). Gompers shows that young VC firms are more likely to exit their better investments earlier than that which would otherwise be optimal for the entrepreneurial firm, in order to signal quality ('grandstand') to institutional investors for the purpose of raising capital for a new fund. Gompers' analysis of grandstanding is consistent with evidence in Barry *et al.* (1990) and Megginson and Weiss (1991) that younger VC funds underprice more their investees at the IPO due to a lack of reputation, and theoretical work (Neus and Walz, 2005) that model this phenomenon of large underpricing by younger VC funds as a commitment device for acquiring reputation. Our analysis of style drift in private equity and venture capital involves a similar notion of signaling behavior of VC managers to their institutional investors, but our focus is on the commitment to invest in entrepreneurial firms at particular stages of development (i.e., our focus is on investment behavior instead of exit behavior).

Finally, it is worth mentioning the recent study by Jones and Rhodes-Kropf (2003), which is complementary to ours. Their focus is on the fund level, and examine the effect of undiversified portfolios for venture capitalists on fund returns. Our analysis is on the individual investment level and focuses on drivers of style drifts. Moreover, our paper can be related in a larger perspective to the results of Chevalier and Ellison (1999) on career concerns.

Our theoretical analysis of style drifts by private equity and venture capital funds in this section proceeds as follows. Section 2.2.1 presents the elements of a theoretical model to highlight certain costs and benefits of style drifts. Section 2.2.2 derives the model in an environment without signaling, while section 2.2.3 presents an outcome with signaling. Section 2.2.4 considers alternative explanations not explicitly modeled. Section 2.2.5 outlines empirical predictions. Sections 2.3 and 2.4 thereafter present data and empirical tests of the model introduced in this section.

2.2.1 *Theoretical Model*

Fund Providers: Suppose that fund providers have exogenously given preferences in a specific asset class when investing in private equity. In our case, this corresponds to a particular stage of development. Suppose further that there are only two pools of projects available, where pool 1 corresponds to the fund provider's preference. In other words, the fund provider hopes that the VC will invest all the funds in this pool. We model this by assuming a discount of $1\text{-}\delta$ for investments made in pool 2, where $0 < \delta < 1$. The expected present value of each valuable project is given by $V > 0$, and is realized at time $t = 1$. There is perfect competition among fund providers of private equity for both pools. Also, we assume that market conditions (investment opportunities of each pool) have not changed between the time the VC raised the fund and the time of actual investment.[30]

Venture Capitalists: At time $t = 0$, VC funds raise the amount $I > 0$, which we set equal to exactly the required amount for one project. The full amount is then invested. For simplicity, suppose the VC finds a valuable project in pool 1 with some positive probability only (that will depend on the VC's screening ability). We further assume that VCs get private benefits of managerial hubris for financing a valuable project in pool 2. Let us denote these benefits by $\Pi > 0$. This may induce VCs to style-drift.[31] They also differ in their ability to screen projects in which they can add value. In particular, if a VC fund

30 In the empirical analysis, we will control for changes in market conditions.

31 Another source of benefits from style-drifting is risk diversification. Our model can easily extended to include this rationale (but with some additional notation) and would yield very similar empirical predictions. Of course, one would need to consider portfolios of more than one project, but this is merely a simplifying assumptions in our model.

has good ability in screening projects in its given investment focus, then she will find a profitable project in pool 1 with probability P, otherwise with probability p. By definition, $0 < p < P < 1$. In pool 2, a VC fund has probability p of finding a profitable project regardless of her/her ability in pool 1. Half of the VCs are skilled and the other half not. Suppose fund providers have no information about the true ability of VC fund managers. We also suppose that VCs only raise two funds in their lifetime, one so-called first fund and one follow-on fund. [32] VCs are said to be "young" if they are in their first fund, and "old" (or "more established") if already managing their second (and last) fund. The second fund is raised at time $t = ½$, prior to the realization of the first fund's outcome. Finally, to simplify the analysis we shall assume that no drift takes place if no valuable project is found; in this case, the next best project is one in pool 1 with a present value of zero.[33]

Delegation of Investment Decisions: Similar in spirit as in Aghion and Tirole (1997) on the delegation of tasks[34], we make the assumption that parties do not contract upon VC's investment decisions, although observable. We motivate this assumption by the fact that fund providers only observe the projects proposed by the venture capitalist but not the full outcome of the screening. The latter may therefore claim that she could not find a valuable project in pool 1 but instead one in pool 2. While it is possible for LPs to inspect whether the VC invested the funds in the committed asset class, they still have to rely on the VC's judgment in selecting investments. In other words, LPs also have to delegate the decision of project selection to the VC and need to trust her.[35]

2.2.2 *Outcome without Signaling*

If a VC has no interest in signaling her screening ability, then style-drifting always takes place in the first and second funds whenever a valuable project is identified in pool 2. There is no information content from investment decisions made in the first fund. To see this, consider first a young VC who wants to raise her first fund. Let us denote by $0 \leq \alpha \leq 1$ the proportion of fund profits retained by the VC. In this case, fund provider's expected profits are given by the following condition:

$$\left[\frac{1}{2}(P(1-p)+p\delta)+\frac{1}{2}(p(1-p)+p\delta)\right]\cdot(1-\alpha^*)V = I$$

and they cannot infer any information from investment decisions of VCs. There is no information content so that both types of VCs will obtain the same conditions on their follow-up fund, regardless their investment decisions in their first fund.

32 This is similar to Lerner and Schoar (2004). While analyzing another issue, Neus and Walz (2004) provide a useful framework for how our setting could be modeled in a multi-period analysis.

33 This is merely a simplification to avoid more complex analysis. Our argument holds for a large number of alternative assumptions of the "next best project", e.g., if we assume that it has a return of zero (NPV = 0).

34 See Tirole (1999) for a survey of the incomplete contract literature.

35 Given this delegation issue, punishing a VC manager for drifting away from the may not be sensible if the latter also has to provide assistance to the portfolio companies as it would reduce her incentives. In the case of venture capital investments, assisting companies is an essential part of VC's activities.

In this case, there is a gain for VC funds to signal their ability if they are better project screeners. One way is to avoid drifting in early funds so that fund providers can infer the ability of VC funds from investments done by previous funds. A fund that did not drift in her first fund will receive better terms in her second fund compared to a VC that did style-drift. By not drifting, a VC forgoes the diversification benefits but will get better conditions in her follow-up fund.

Note that if signaling were not an issue (e.g. suppose that the screening quality of any VC would be revealed after the first fund), there would be no difference between young and older VCs. A venture capitalist with good screening skills would be given $[(P(1-p)+p\delta)]\cdot(1-\alpha_{good})V=I$ in her follow-up fund, while a VC with bad screening skills would get $[(p(1-p)+p\delta)]\cdot(1-\alpha_{bad})V=I$. It is easy to show that any style-drift behavior in the first fund would have no impact on the raising of a follow-on fund if quality of VCs were revealed between t = 0 and t = ½, since there is no need for the VC to signal her screening ability when managing the first fund. In this case, VCs would style-drift in the first fund as much as in their second fund and thus no difference in investment behavior would be expected. Only when the screening ability of VCs need to be inferred from investment decisions in the first fund is the signaling rationale of importance.

2.2.3 *Outcome with Signaling Incentives by Skilled Venture Capitalists*

Consider now the case where skilled VCs will not drift if they find a project in pool 1. When raising a second fund, such a VC will face a fund provider with the following participation constraint if she did not drift in the first fund:

$$\left[\frac{P+(1-P)(1-p)}{P+(1-P)(1-p)+(1-p)}(P(1-p)+p\delta)+\frac{(1-p)}{P+(1-P)(1-p)+(1-p)}(p(1-p)+p\delta)\right]\cdot(1-\alpha_{no})V=I$$

The fact that a style-drift has occurred in the first round gives an imprecise signal of the VC's ability to screen projects in the promised asset class (pool 1). If the VC did not style-drift previously, then fund providers will think she has good screening abilities with probability $\frac{P+(1-P)(1-p)}{P+(1-P)(1-p)+(1-p)}$, instead of ½ (as in the first fund.[36]

In contrast, a VC who did drift in the first fund will face a fund provider with the following participation constraint:

$$\left[\frac{(1-P)p}{(1-P)p+p}(p(1-p)+p\delta)+\frac{p}{(1-P)p+p}(P(1-p)+p\delta)\right]\cdot(1-\alpha_{d})V=I$$

It is straightforward to show that $\alpha_d < \alpha_{no}$.[37] Thus, VCs will be penalized for having style-drifted in their first fund. When possible (i.e. when a VC identified valuable projects in

36 Note that this probability is strictly greater than ½ for $P > p > 0$. This is always the case here, by assumption.

37 This condition requires that the signaling VC is more likely to be associated with being as skilled VC than under no signaling. This is the case iff $\frac{P+(1-P)(1-p)}{P+(1-P)(1-p)+(1-p)}>\frac{p(1-p)}{p+p(1-p)}$. After some basic algebraic transformations, it is straightforward to show that this is always the case.

both pools for her second investment), a VC may therefore prefer not to style-drift in her first fund if the gains derived from her follow-on fund (through better financing conditions) are greater than the gains from style-drifting in her first fund. Less skilled VCs may not mimic, since these better terms in the second fund do not translate to the same expected benefits to them. This is because they are less likely to identify a valuable project (regardless the pool). This separating equilibrium is more likely when Π is low, V is large, and the difference in skills between good and bad VCs is important. A skilled VC will prefer to signal her screening ability iff

$$[(p\delta + (1-p)P)](\alpha_{no} - \alpha^{*})V > \Pi$$

It is straightforward to show that $\alpha_{no} > \alpha^{*}$. Since an unskilled VC faces a more stringent condition, her threshold is higher and thus she is less likely not to style-drift. But for certain parameter values, unskilled VCs may also prefer not to style-drift in their first fund (and thus to mimic skilled VCs) to limit the signaling capability of skilled VCs.[38]

2.2.4 *Alternative Explanation*

An alternative story to the signaling one and that yields similar empirical predictions is one based on learning by younger VCs in their first fund. Suppose that younger VCs are only skilled in identifying valuable projects in pool 1 but not in pool 2 and that they *learn* to identify valuable projects in pool 2 while managing their first fund. In this case, more established VCs are also more likely to style-drift as they are more skilled. In the empirical analysis, we include control variables that enable distinctions between the learning rationale and signaling rationale associated with style drifts. These controls are discussed in Section 2.1 and ensuing empirical tests.

2.2.5 *Empirical Predictions*

The theoretical framework developed above enables a concise statement of the central empirical predictions pertaining to the effect of VC reputation on the propensity to style drift. Limited partnership VCs with an incentive to raise new funds in the future face reputation costs associated with style drift, and this cost is greater for less well-established VC managers. By not style-drifting, young VCs derive greater benefits from signaling their ability to find entrepreneurial firms within their stated fund objective, and are thus more likely to obtain new capital for follow-on funds and capital on more attractive terms in the future from their institutional investors. In short, we therefore expect less experienced VCs to style-drift less often as a way to signal their screening ability to fund providers.

While examining this prediction empirically, one needs to carefully control for market conditions. We note that a variable for market conditions could be added to the model; however, that variable (and/or others) does not impact the analysis with respect to central elements of the theory we have modeled. In our empirical analyses, market conditions may have several effects on the incentives and capability of venture capitalists to style drift. First

38 A complete analysis of the different outcomes (including pooling equilibria) is available upon request.

of all, when market conditions are particularly good (e.g. during the Internet boom), it is easier to find valuable projects. While this makes style drifting easier, it also makes it easier not to style drift. This is the case if all private equity asset classes have good conditions. The total effect in this case is unclear a priori but needs to be controlled.

Moreover, a crucial aspect is the possible change in market conditions between the time the funds were raised and the time the funds are invested. This may also drive VC's incentives to style drift. If market conditions have changed since the VC raised his/her fund, the latter may "naturally" drift, sometimes even at the benefit of fund providers. For instance, suppose that the VC committed to invest the money in early stage projects and that at the meantime market conditions have dramatically changed so that there are only very few profitable early stage projects anymore. Then, both, the VC and fund providers, would be better off with style-drifts towards other stages of developments. What really matters is the relative change of market conditions (i.e., relative to other pools). We discuss this further in the next section.

2.3 Data and Descriptive Statistics

2.3.1 Data Description

Along the definitions provided by Wermers (2002), our analysis focuses on *active* style-drifting, i.e., style-drifting at time of investment and not due to a lack of portfolio rebalancing over time. We control for this by examining only deal initiations, i.e., first-round investments. This is further motivated by a value-adding rationale. Suppose a VC fund is specialized in later stage deals. Given that VCs are active investors and add value in their portfolio companies, it is better for this fund to invest in promising companies that are already in the later stage than in promising early stage companies. The latter may still fail and never enter the later stage of development, in which case the given VC fund will not be able to add value.

We selected all the U.S. VC-backed companies from the Venture Economics database, and collected all available information on the VC funds that financed the first round of investment and that are not generalist funds. The data cover investments done during the period 1/1/1985 to 12/31/2003. The information included for each investment is provided below together with the definition of variables. To avoid strategic investment considerations of VC funds from round to round, we limit our analysis to deal origination (i.e., first-round investments). Overall, the data set comprises 11,871 first round investments (only) by limited partnership VCs (only) (to focus on the reputation costs vis-à-vis

39 Besides stage focus, the dataset also comprises some information on industry and geographical focus. Unfortunately, only stage focus is available on the fund level. The two others are on the firm level. Also, a significant number are generalists (especially with respect to geographical focus). Importantly, note that the funds in our data set have not changed their stated stage focus on the Venture Economics reporting (generally, such changes almost never happen on Venture Economics, according to our discussions with the database managers at Venture Economics). As well, our discussions with institutional investors indicate stage drift is a much more important concern relative to industry or geography drift, so that the focus on stage drift is more meaningful in practical terms. See section 2.5 below for further details.

institutional investors), and excludes VC funds that categorize themselves as 'generalists' (because style drift is undefined for such funds).[39] Note that the fund stated stage focus is for the VC fund, and not for the VC organization (which itself may collectively comprise more than one fund). We control for VC organizations that operate (or have operated) more than one fund (among other things) in our empirical analyses below.

Table 8 provides an overview of all the variables.[40] The variables considered in our analysis are described immediately below.

Table 8: Variable definitions

Variable	Definition
Fund Stage Drift	Dummy variable equal to one if the VC fund did a style drift in terms of stage of development, and zero otherwise
Fund Large Stage Drift	Dummy variable equal to one if the VC fund did a style drift by more than one stage of development, and zero otherwise
VC Fund / Firm Characteristics:	
VC Fund Age	Age of the VC fund at time of investment (in years); i.e., time elapsed between the fund was closed and the date of investment
Fund Size	Total amount of funds raised (in million US$)
Fund Sequence	Number of VC funds raised by the firm; i.e., whether the given fund is the first of the VC firm, second fund …
VC Firm Age	Age of the VC firm at time of investment (in years)
Non-US Fund	Dummy variable equal to one if the VC fund is not US-based
New Fund Raised	Dummy variable equal to one if the VC firm raised a follow-on fund already, and zero otherwise
Investment / Company Characteristics:	
Amount of Investment	Total amount invested (in million US$) by the VC syndicate
Company Age	Age of the portfolio company at time of investment
Industry dummies	We include industry dummies for the following industries: biotech, communication and media, medical, computer, non-high tech
Stage of Development dummies	We include stage dummies for the following stages of development at time of investment: early stage, expansion stage, later stage, other stages
Market Conditions:	
Bubble Dummy	Dummy variable equal to one if the investment was made in the years 1998 to 2000 (inclusive), and zero otherwise
% Change Nasdaq	Percentage change in the Nasdaq Composite Index between the time the fund was closed and the time of investment

40 For most of these variables, we use definitions and classifications from Venture Economics.

Stage Drift: We define two variables to measure style drift. The first one is a dummy variable equal to one if the VC fund did a style drift in terms of stage of development ("*Fund Stage Drift*"), and zero otherwise. In this case, a VC fund style-drifts if it does not invest in the asset class it committed to; e.g. an early-stage fund investing in an expansion stage or later stage company. The other one, which we denote by "*Fund Large Stage Drift*", defines a style drift in a more stringent way. We only consider drifts that are more than one stage difference; e.g., an early-stage fund investing in an expansion stage company would not be a style-drift while investing in a later stage company would (similarly a later-stage fund investing in an expansion stage would not be a large drift but investing in an early-stage would).

VC Fund / Firm Characteristics: One variable is the age of the VC fund at time of investment ("*Fund Age*"); it represents the time elapsed between the fund was closed and date of investment. Another variable is the size of the fund ("*Fund Size*"), which gives the total amount of funds raised (in million US$).[41] To measure the age of the VC fund, we use two different measures:

- "*Fund Sequence*": the number of VC funds raised by the firm (i.e., whether the given fund is the first of the VC firm, second fund…).
- "*Firm Age*": the age of VC firm at time of investment (in years).

In addition, we include in some regression specifications a dummy variable equal to 1 if the VC firm raised a follow-up fund already at the time of investment ("*New Fund Raised*"), and zero otherwise. For instance, suppose a VC firm uses its first fund ever raised to finance a new start-up. Then, this dummy variable will have the value of one if at the meantime the VC firm raised a second fund (but uses the first fund to finance this new investment) and zero if no second fund was raised yet. As we shall see later, this variable is intended to separate between the signaling and the learning rationale discussed in Section 2.2.

Investment / Company Characteristics: We control for the total amount invested (in million US$) by the VC syndicate (labeled as "*Amount of Investment*") and the age of portfolio company (in years) at time of investment ("*Company Age*"). Finally, we also include industry dummies (biotech, communication and media, medical, computer, non-high tech)[42] and dummies for the stage of development at time of investment (early stage, expansion stage, later stage, other stages) in all the regressions.

Market Conditions: To control for market conditions at the time of investment and changes in market conditions between the time the venture capitalist raise the fund

41 We also considered a dummy for whether the VC firm and/or VC fund is located in the US. Since this variable is never significant and over 95% of the firms/funds are from the US in the Venture Economics data, we do not explicitly provide this information.

42 We used the sub-group 1 classification of Venture Economics. Note that it is not explicitly distinguish Internet companies; they are included in either computer sector (software and hardware) or communication and media, depending on the specificity of the Internet company.

and the time the investment took place, we include in the regression analyses several macroeconomic variables. The first one is a dummy variable equal to 1 if the investment was made in the years 1998 to 2000 (inclusive), and zero otherwise ("*Bubble Dummy*"). It is intended to capture the time period of the Internet bubble. The other market conditions variable gives the percentage change in the Nasdaq Composite Index between the Index value at time the fund was closed and the time of investment *("% Change Nasdaq*"). This variable measures changes in market conditions between the time funds were raised (and thus investment focus/commitment was set) and the actual time of investment. If this variable is different from zero, then the pool of projects may have changed. Along the line of earlier work (Cumming, Fleming and Schwienbacher, 2003), we should expect an increase in the Nasdaq Index to positively affect the likelihood of investing in new early stage projects as compared to all new investments. Thus, an increase in the Nasdaq Index should have a negative impact on style-drifts if the VC fund focus is in early stage and a positive impact if the VC fund had another investment focus. Given that this requires certain assumptions on the relative impact of stock market valuations on early-stage versus later-stage investments, results may also be the opposite (but less likely). Since this is not a variable of interest for testing our predictions but rather a control variable, the actual sign of it is more of an empirical issue here.

2.3.2 Descriptive Statistics

Table 9 gives the frequency of the stage focus of VC funds and the actual development stage of entrepreneurial firms included in the dataset. Panel A provide statistics in absolute number, while Panel B in percentage. It indicates that style drift is common among first-round investments along all stages of development. While most observations are in early-stage companies (since we focus on deal initiations), the dataset also comprises a number of investments in other stages of developments. Interestingly, most VC funds have either an early-stage or later-stage commitment.

Table 9: Fund stage focus and stage of development of entrepreneurial firms
This table presents the frequency of stage drifts (and non-drifts) among the limited partnership venture capital funds in the Venture Economics dataset for the period 1 January 1985 – 31 December 2003. The sample includes all funds that indicated a focus on a particular stage of entrepreneurial development (and excludes those funds that are self-proclaimed "generalists" that do not focus on any stage of development).

		PANEL A: IN ABSOLUTE VALUES				
		Stage of Development of Entrepreneurial Firms				
		Early-Stage	Expansion-Stage	Later-Stage	Other Stages	Total
Stage Focus of VC Funds	Early-Stage	4721	663	78	199	5661
	Expansion-Stage	287	193	26	31	537
	Later-Stage	2929	1058	281	758	5026
	Other Stages	325	276	33	13	647
	Total	8262	2190	418	1001	11871

		PANEL B: IN PERCENTAGES				
		Stage of Development of Entrepreneurial Firms				
		Early-Stage	Expansion-Stage	Later-Stage	Other Stages	Total
Stage Focus of VC Funds	Early-Stage	39.8%	5.6%	0.7%	1.7%	47.7%
	Expansion-Stage	2.4%	1.6%	0.2%	0.3%	4.5%
	Later-Stage	24.7%	8.9%	2.4%	6.4%	42.3%
	Other Stages	2.7%	2.3%	0.3%	0.1%	5.5%
	Total	69.6%	18.4%	3.5%	8.4%	100.0%

Table 10 shows summary statistics of our sample of fund stage drifts. The first column gives the statistics of the full sample, while the other columns the statistics of several sub-samples. Given the large number of observations, most of the tests of differences in mean between sub-samples turn out to be statistically significant. Overall, it indicates that style drifts were more likely outside the period of the Internet bubble, in non-high tech companies, in older portfolio companies, and by more established VC funds. Non-US fund do not seem to behave differently. Most of these results remain valid for Large Drifts (columns (5) to (7)).

Table 11 provides a correlation matrix of selected variables. Given the large number of observations, most of the correlations are statistically significant at the 1% level (all greater than 0.024). The correlations are consistent with comparison tests described above, and provide insight into potential areas of collinearity problems in the multivariate analyses (described in the next section).

Table 10: Summary statistics for fund stage drifts by private vc funds

This table presents comparison test statistics of the explanatory variables in the data (defined in Table 1) for Fund Stage Drifts and Fund Large Stage Drifts (also defined in Table 1). *, **, *** Significant at the 10%, 5% and 1% levels, respectively.

Variable	(1) Mean of Full Sample	Standard Deviation	Stage Drift (2) With Drift	Stage Drift (3) No Drift	Stage Drift (4) Difference (2) - (3)		Large Drift (5) Large Drift	Large Drift (6) No Drift	Large Drift (7) Difference (5) - (6)	
Number of Observations	11871	—	6663	5208			3838	8033		
Fund Stage Drift	0.561	0.496	1.000	0.000	—		1.000	0.352	—	
Fund Large Drift	0.323	0.468	0.576	0.000	—		1.000	0.000	—	
Bubble Dummy	0.325	0.468	0.297	0.360	-7.255	***	0.307	0.334	-2.928	***
Nasdaq Composite Index	1600	1260.9	1488	1744	-11.053	***	1532	1633	-4.049	***
% change Nasdaq Index	0.699	2.283	0.805	0.563	5.843	***	0.840	0.632	4.257	***
Amount of Investment	8.009	30.162	9.498	6.103	6.764	***	8.573	7.739	1.473	
Company Age (years)	4.017	8.197	5.071	2.669	16.949	***	3.773	4.134	-2.252	**
Early Stage	0.696	0.460	0.531	0.906	-51.200	***	0.848	0.623	28.306	***
Expansion Stage	0.184	0.388	0.300	0.037	42.409	***	0.072	0.238	-26.306	***
Later Stage	0.035	0.184	0.021	0.054	-9.324	***	0.020	0.042	-6.877	***
Other Stages	0.084	0.278	0.148	0.002	33.069	***	0.060	0.096	-7.141	**
Communication & Media	0.172	0.378	0.167	0.179	-1.651	*	0.180	0.169	1.434	
Computer related	0.378	0.485	0.347	0.417	-7.782	***	0.344	0.394	-5.280	***
Semi-Conductor	0.078	0.268	0.073	0.084	-2.272	**	0.079	0.077	0.433	
Biotechnology	0.065	0.246	0.050	0.083	-7.144	***	0.064	0.065	-0.319	
Medical/Health	0.127	0.333	0.121	0.134	-1.977	**	0.131	0.125	1.019	
Non-High Tech	0.181	0.385	0.241	0.103	20.585	***	0.202	0.170	4.081	***
VC Fund Age	3.251	3.743	3.614	2.787	12.461	***	3.593	3.088	6.584	***
Non-US Fund	0.037	0.188	0.038	0.035	0.932		0.037	0.036	0.279	
Fund Size	160	280.1	167	152	3.052	***	183	149	5.329	***
Fund Sequence	4.987	5.112	5.142	4.789	3.860	***	5.088	4.939	1.461	
VC Firm Age	11.020	8.578	11.441	10.482	6.102	***	11.572	10.757	4.759	***
New Fund Raised Dummy	0.574	0.495	0.588	0.555	3.591	***	0.586	0.568	1.906	*

Tabel 11: Correlation matrix of the main variables

	Fund Stage Drift	Fund Large Drift	Bubble Dummy	Nasdaq Composite Index	% Change Nasdaq Index	Amount of Investment	Company Age	Early Stage Dummy	Expansion Stage Dummy	Later Stage Dummy	Other Stages Dummy	COMMEDIA	COMPUTER	SEMICOND	BIOTECH	MEDICAL	NONHIGHTECH	Fund Age	Non-US Fund	Fund Size	Fund Sequence	Firm Age	New Fund Raised Dummy
Fund Stage Drift	1.000																						
Fund Large Drift	0.611	1.000																					
Bubble Dummy	-0.067	-0.027	1.000																				
Nasdaq Composite Index	-0.101	-0.038	0.767	1.000																			
% Change Nasdaq Index	0.053	0.043	0.168	0.137	1.000																		
Amount of Investment	0.056	0.013	0.094	0.118	0.024	1.000																	
Company Age	0.145	-0.021	-0.060	-0.057	0.023	0.115	1.000																
Early Stage Dummy	-0.405	0.228	0.077	0.108	-0.024	-0.084	-0.314	1.000															
Expansion Stage Dummy	0.336	-0.201	0.022	0.026	0.027	0.032	0.158	-0.720	1.000														
Later Stage Dummy	-0.090	-0.056	-0.060	-0.079	-0.004	0.004	0.169	-0.289	-0.091	1.000													
Other Stages Dummy	0.260	-0.061	-0.118	-0.162	0.004	0.091	0.187	-0.459	-0.144	-0.058	1.000												
COMMEDIA	-0.015	0.013	0.104	0.120	0.003	0.034	-0.073	0.047	-0.030	-0.033	-0.014	1.000											
COMPUTER	-0.072	-0.048	0.203	0.209	0.047	-0.021	-0.056	0.070	0.024	-0.024	-0.133	-0.355	1.000										
SEMICOND	-0.021	0.004	-0.051	-0.018	-0.016	0.000	-0.035	0.036	-0.039	-0.001	-0.005	-0.133	-0.227	1.000									
BIOTECH	-0.067	-0.003	-0.089	-0.072	-0.028	-0.026	-0.062	0.100	-0.068	-0.033	-0.048	-0.120	-0.205	-0.076	1.000								
MEDICAL	-0.018	0.009	-0.116	-0.113	-0.033	-0.022	-0.039	0.038	-0.020	-0.005	-0.031	-0.174	-0.297	-0.111	-0.100	1.000							
NONHIGHTECH	0.179	0.038	-0.166	-0.226	-0.005	0.029	0.240	-0.255	0.087	0.090	0.241	-0.214	-0.366	-0.136	-0.123	-0.179	1.000						
Fund Age	0.110	0.063	-0.131	-0.170	0.661	-0.010	0.054	-0.071	0.020	0.025	0.073	-0.037	-0.032	0.016	-0.007	-0.006	0.074	1.000					
Non-US Fund	0.009	0.003	0.056	0.089	0.055	-0.003	-0.012	-0.015	0.039	-0.006	-0.027	0.013	0.003	0.024	0.002	-0.001	-0.033	0.021	1.000				
Fund Size	0.027	0.055	0.179	0.311	-0.080	0.116	0.009	-0.008	0.037	-0.017	-0.028	0.048	0.058	-0.001	-0.029	-0.049	-0.059	-0.145	-0.037	1.000			
Fund Sequence	0.034	0.014	0.079	0.138	-0.121	0.085	0.020	-0.039	-0.013	0.070	0.037	0.027	0.045	0.006	-0.011	-0.010	-0.072	-0.200	-0.066	0.362	1.000		
Firm Age	0.055	0.044	0.011	0.038	0.134	0.049	0.033	-0.037	-0.003	0.036	0.042	0.022	-0.001	0.013	-0.007	-0.014	-0.012	0.164	-0.051	0.248	0.609	1.000	
New Fund Raised Dummy	0.033	0.017	0.044	0.036	0.126	-0.001	0.001	-0.018	0.004	0.010	0.018	0.002	0.018	0.009	-0.002	-0.014	-0.017	0.224	0.007	-0.027	-0.009	-0.009	1.000

2.4 Regression Analysis

Our multivariate empirical analyses of the hypotheses developed above in section 2.2 proceeds as follows. In section 2.4.1 we study the role of VC fund and entrepreneurial firm characteristics and market conditions on the VC's propensity to style drift to any stage that is not in the focus of the VC. We also consider the factors that lead to large style drifts (such as an early stage fund drifting to a late stage company, instead of drifting only to an expansion stage company). Section 2.4.2 studies the relation between style drifts and subsequent investment performance. Thereafter, limitations and future research are considered in Section 2.5.

2.4.1 *Analysis of When VCs Style Drift*

This subsection examines the impact of investment and fund characteristics on stage drifts. Table 12 provides regression results for *Fund Stage Drifts*. Nine alternative specifications are provided to show robustness. Table 12 (and all of the subsequent regression tables) presents the Logit coefficients; but we also describe in the text the economic significance of the results based on the partial derivatives. Given the strong correlation between *Fund Size* and our measures of fund experience (*Fund Sequence* and *Firm Age*) (as indicated in Table 11), we examine these variables separately. Regression (1) therefore only includes *Fund Size*, while regressions (2) – (5) examine the effect of fund experience. In regressions (6) – (9), we include a dummy that helps us to distinguish between the signaling and the learning rationale. This dummy is equal to one if the VC fund had raised a follow-on fund prior to the actual investment (but the investment was done with the previous fund). In all the regression specifications, we include controls for entrepreneurial firm characteristics (*Amount of Investment*, *Company Age* as well as stage and industry dummies).

Table 12 presents a first set of informative results pertaining to the incentives for a VC fund to style drift. Proxies for fund experience are significant in various specifications. In particular, an increase in the age of the VC investor's organization by 5 years increases the probability of stage drift by 1%, and similarly, each successive VC fund within an organization is 0.5% more likely to stage drift. The results are generally consistent with the signaling hypothesis derived in section 2.2, that a less well-established VC fund has a less pronounced propensity to drift in order to signal ability to institutional investors through being able to identify profitable projects within their committed investment focus. That is, the reputation costs of drifting for a less well-established VC fund are greater, as drifting alters the risk return profile of the institutional investor, and a failed investment that was not within the scope of the stated fund objective is thereby much more costly for a VC fund without a track record. It is important to nevertheless acknowledge that the data do not indicate a statistical relation between fund size and propensity to style drift, but the size variable is likely a less precise indicator of VC reputation (i.e., size could be related to a number of other factors identified in Gompers and Lerner, 1998) compared to VC age and the number of prior funds operated by the VC.

Table 12: Regression results for stage drifts by private vc funds

This table presents logit regression analyses of the determinants of stage drifts. In all the regressions, the dependent variable (denoted "Fund Stage Drift" in the paper) is a dummy equal to one if the investment involved a stage drift, and zero otherwise. Explanatory variables are explained in Section 3.1 and in Table 1. All the regressions are binary Logit regressions and are done with QML (Huber/White) standard errors and covariances. Significance levels: *, **, *** for 10%, 5%, and 1%, respectively.

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Amount of Investment	0.0044 *	0.0031	0.0031	0.0105 ***	0.0108 ***	0.0031	0.0038	0.0104 ***	0.0107 ***
Company Age	0.0143 ***	0.0131 ***	0.0120 ***	0.0187 ***	0.0185 ***	0.0134 ***	0.0138 ***	0.0187 ***	0.0185 ***
Fund Size	0.0001								
New Fund Raised Dummy						0.1623 ***	0.1705 ***	0.1521 ***	0.1514 ***
Fund Sequence		0.0184 ***		0.0171 ***		0.0181 ***		0.0176 ***	
Firm Age			0.0095 ***		0.0124 ***		0.0106 ***		0.0126 ***
Bubble Dummy				-0.2404 ***	-0.2316 ***			-0.2480 ***	-0.2388 ***
"% change Nasdaq" * "Early Focus"	-0.6317 ***	-0.5756 ***	-0.6946 ***			-0.6111 ***	-0.6547 ***		
"% change Nasdaq" * "Non-Early Focus"	0.5211 **	0.5364 **	0.5449 ***			0.5429 ***	0.5428 ***		
Stage Dummies (account for constant)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean dependent Variable	0.5613	0.5613	0.5613	0.5613	0.5613	0.5613	0.5613	0.5613	0.5613
Nbr. Observations	11871	11871	11871	11871	11871	11871	11871	11871	11871
Log likelihood	-5957.1	-5972.3	-5944.8	-6547.2	-6542.1	-5956.2	-5947.0	-6540.8	-6535.7
Pseudo R^2	0.2701	0.2707	0.2709	0.1956	0.1962	0.2734	0.2736	0.1984	0.1989

Interestingly, the dummy *New Fund Raised* is positive and significant in all the specifications (regressions (6) to (9)). Specifically, the data indicate a 3% increase in the probability of drifting if the VC had already secured a follow-on fund. This is in line with the notion that venture capitalists drift more often once they have secured a follow-on fund. This goes against the learning rationale and favors the signaling rationale.

Regarding market conditions, the results with respect to changed market conditions ("*% Change Nasdaq*Early Focus*" and "*% Change Nasdaq*Non-Early Focus*") are in line with our predictions described in section 2.2. In particular, a 20% increase in NASDAQ from the time of fundraising to the time of investment gives rise to a 4% reduction in the probability of a stage drift by early stage funds but to a 5% increase in the probability of a stage drift by funds with later-stage commitments. This difference between early and late stage focus is important, as our theory predicts that a commitment to focus on earlier stage investments is easier to adhere to in more favorable economic conditions. By contrast, our theory predicts funds that commit to focus on later stage investments are more likely to believe 'down drifts' to riskier early stage investments are comparatively more attractive in favorable economic conditions. This supports the idea that in favorable market conditions, VC funds are less likely to drift since proportionately it is easier to find profitable projects than in bad times.

As with the NASDAQ market variables, the *Bubble Dummy* variable has a significantly negative impact of stage drifts. In particular, the Internet bubble period was associated with an approximately 4% lower probability of a stage drift (regressions (4), (5), (8) and (9)). Note, however, that this result pertains more directly to the funds that had committed to an earlier stage focus (consistent with the NASDAQ variables discussed immediately above), as 4908 of the drifts were down (late stage funds investing in early stage companies), while 1755 were up drifts (early stage funds investing in late stage companies) (see Table 9 for details). When we separated the dependent variable into up versus down drifts (two dependent variables for two different regressions; not explicitly reported for reasons of conciseness), the results reported in Table 12 were consistent for the down drifts, but there was a 0.5% higher probability of a stage drift in the bubble period among funds committed to a later stage focus.[43]

In Table 13, we run the same regressions as in Table 12 but with the alternative definition of style drift, namely *Fund Large Stage Drift.* The results are very similar to those already reported in Table 12, and therefore not discussed in detail. In short, the predictions derived in section 2.2 continue to be supported.

43 We also used the Nasdaq Composite Index as alternative measure for market conditions at time of investment. The results were qualitatively not different.

Table 13: Regression results for large stage drifts by private vc funds

This table presents logit regression analyses of the determinants of stage drifts In all the regressions, the dependent variable (denoted "Fund Large Stage Drift" in the paper) is a dummy equal to one if the investment involved a "large" stage drift, and zero otherwise. Explanatory variables are explained in Section 3.1 and in Table 1. All the regressions are binary Logit regressions and are done with QML (Huber/White) standard errors and covariances. Significance levels: *, **, *** for 10%, 5%, and 1%, respectively.

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Amount of Investment	0.0012	0.0016	0.0016	0.0038	0.0037	0.0016	0.0016	0.0038	0.0036
Company Age	0.0103 ***	0.0103 ***	0.0102 ***	0.0125 ***	0.0123 ***	0.0104 ***	0.0103 ***	0.0126 ***	0.0124 ***
Fund Size	0.0003 ***								
New Fund Raised Dummy						0.2010 ***	0.2095 ***	0.1126 ***	0.1135 ***
Fund Sequence		0.0087 **		0.0112 **		0.0082 *		0.0115 **	
Firm Age			0.0097 ***		0.0130 ***		0.0101 ***		0.0131 ***
Bubble Dummy				-0.1635 ***	-0.1569 ***			-0.1690 ***	-0.1623 ***
"% change Nasdaq" * "Early Focus"	-1.1814 ***	-1.2082 ***	-1.2181 ***			-1.2466 ***	-1.2571 ***		
"% change Nasdaq" * "Non-Early Focus"	0.2749 ***	0.2745 ***	0.2607 ***			0.2595 ***	0.2455 ***		
Stage Dummies (account for constant)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean dependent Variable	0.3233	0.3233	0.3233	0.3233	0.3233	0.3233	0.3233	0.3233	0.3233
Nbr. Observations	11871	11871	11871	11871	11871	11871	11871	11871	11871
Log likelihood	-6576.0	-6582.1	-6576.5	-7036.4	-7025.0	-6571.4	-6564.9	-7032.7	-7021.2
Pseudo R^2	0.1277	0.1270	0.1283	0.0582	0.0597	0.1306	0.1308	0.0634	0.0642

Note that we considered other specifications, but did not report for reasons of conciseness. For example, we considered an ordered Logit model for the degree of drift. Because the results were quite similar to those already reported, they are not explicitly reported for reasons of conciseness. Further, we also considered separately the determinants of up drifts versus down drifts, and the results are generally consistent with the reported differences for early versus non-early focus, as discussed immediately above. These and other specifications not explicitly presented are available upon request.

2.4.2 Analysis of the Effect of Style Drift on Performance

In Table 14 Panels A and B we examine the effect of style drift on the risk and performance of investments. Panel A presents summary statistics pertaining to risk and performance, in relation to *Fund Stage Drift* and *Fund Large Stage Drift*. Panel B then presents multivariate regressions of the relation between style drift and performance, which we measure by the type of exit. In line with the literature (e.g. Gompers, 1996; Gompers and Lerner, 1999a, 2001), we define exits via an IPO as most successful investments. We also consider an alternative definition in which we treat exit via either IPO or trade sale/acquisition as success (and exit via liquidation (write-off) as measure for bad performance). Our dataset comprises 4434 exited investments, and the remainder 7437 investments were unexited (as at December 2003).

Note that this performance measure is investment-specific and may therefore differ from the risk-return effect on limited partners (fund providers) as we only look at investments individually and not portfolio effects. The impact on limited partners (fund providers) is partial from this analysis, since this would require an assessment of risk and return of their portfolio. However, given that limited partners aim at controlling their portfolio risk by allocating amount to different asset classes, any style drift by VC funds inevitably means some undesirable effects on the limited partners' portfolios (except if increase in investment performance were particularly important).

Table 14 Panel A indicates a greater proportion of exits were by IPOs (and a smaller proportion were by write-offs) for *Fund Stage Drifts* compared to no stage drift (Test 1). Similar results are observed for *Fund Large Stage Drift* versus no stage drift (Test 2), and insignificant differences are observed between *Fund Stage Drift* versus *Fund Large Stage Drift* (Test 3) in respect of exit outcomes.

Table 14 – Panel A: Summary statistics on the relation between stage drift and performance

This table presents summary statistics with respect to different exit routes and self-reported valuations at time of investment. The total sample is divided into three groups for no stage drift, stage drift, and large stage drift. The number of observations for which valuations are available is less than the number of observations for exited companies because the only subsample of exits is considered, and some of the valuations were unknown for the exited investments. Significance level for test statistics: *, **, *** for 10%, 5%, and 1%, respectively.

Test #	Description of Sample Considered	# Companies Exited	Proportion of Companies Exited by IPO	Proportion of Companies Exited by Acquisition	Proportion of Companies Exited by Write-off	Number of Valuations	Average (Post Money Value - Invest Value) / Invest Value	Variance of Valuation Returns	Median (Post Money Value - Invest Value) / Invest Value	Average (Post Money Value - Total Value) / Total Value	Median (Post Money Value - Total Value) / Total Value
	Full Sample	5223	0.345	0.470	0.166	4165	2.649	99.472	1.400	2.572	1.381
	No Stage Drift	2142	0.308	0.478	0.202	2185	2.208	22.053	1.360	2.113	1.333
1	Stage Drift	3081	0.371	0.465	0.141	1980	3.135	184.509	1.478	3.078	1.440
	Difference Test Statistic		-4.479***	0.887	4.336***		-0.117	8.367***	p <= 0.0556*	-0.122	p <= 0.0282**
	No Stage Drift	2142	0.308	0.478	0.202	2185	2.208	22.053	1.360	2.113	1.333
2	Large Stage Drift	1781	0.362	0.456	0.159	1169	2.860	229.992	1.400	2.831	1.383
	Difference Test Statistic		-3.399***	1.351	2.663***		-0.063	10.429***	p <= 0.455		p <= 0.181
	Stage Drift	3081	0.371	0.465	0.141	1980	3.135	184.509	1.478	3.078	1.440
3	Large Stage Drift	1781	0.362	0.456	0.159	1169	2.860	229.992	1.400	2.831	1.383
	Difference Test Statistic		0.571	0.617	-1.228		0.027	1.247	p <= 0.339	0.024	p <= 0.261

Table 14 – Panel B: Effect of style drift on investment performance

This table presents binary logit estimates and two-step sample selection corrected estimates of the exit outcome. The variables are explained in Section 3.1 and in Table 1. Regression (1) is a binary Logit regressions and are done with QML (Huber/White) standard errors & covariances, and uses the sample of all investments that were exited at the end of 2003. Regressions (2) - (5) are two-step Heckman-like sample selection models, where the first step considers the probability of an exit, and the second step estimates the probability of success taking into account the non-randomness of an exit (step 1). Significance levels: *, **, *** for 10%, 5%, and 1%, respectively.

	(1)	(2)		(3)		(4)		(5)	
Explanatory Variables	Dep. Var.=1 for IPO Exit (for Subsample of Exited Investments Only)	Step 1: Dep. Var.=1 for Exit	Step 2: Dep. Var.=1 for IPO	Step 1: Dep. Var.=1 for Exit	Step 2: Dep. Var.=1 for IPO	Step 1: Dep. Var.=1 for Exit	Step 2: Dep. Var.=1 for IPO	Step 1: Dep. Var.=1 for Exit	Step 2: Dep. Var.=1 for IPO or Acquisition
Amount of Investment	0.00001 ***		0.00001 ***		0.00001 ***		0.00001 ***		0.000002
Company Age at Investment	0.0140 ***		0.0072 ***		0.0076 ***		0.0080 ***		0.0196 ***
Fund Sequence	0.0185 **		0.0082 **		0.0085 **				
VC Firm Age							0.0152 ***		0.0021
Fund Stage Drift Dummy	0.1490 *		0.0897 **				0.0774 *		-0.0167
Fund Large Stage Drift Dummy					0.0409				
Nasdaq Return 3 Months Prior to Exit	0.7027 **		0.3031 **		0.3050 **		0.3214 **		-0.2674
Nasdaq Return Over Investment Period		0.0664 ***		0.0677 ***		0.0631 ***		0.0659 ***	
Constant	NO	1.2152 ***	NO	1.2080 ***	NO	1.2019 ***	NO	1.1857 ***	NO
Investment Year Dummies	NO	YES	NO	YES	NO	YES	NO	YES	NO
Exit Year Dummies	YES	NO	YES	NO	YES	NO	YES	NO	YES
Stage Fixed Effects	YES	NO	YES	NO	YES	NO	YES	NO	YES
Industry Dummies	YES	NO	YES	NO	YES	NO	YES	NO	YES
Mean dependent Variable	0.3836	0.4399	0.3836	0.4399	0.3836	0.4399	0.3836	0.4399	0.9098
Nbr. Observations	4434	11871	4434	11871	4434	11871	4434	11871	4434
Log likelihood	-2556.539	-4132.078		-4133.142		-4127.232		-2726.296	
Pseudo R^2	0.134	Not applicable		Not applicable		Not applicable		Not applicable	

Table 14 Panel A also provides comparison tests for pre-money and post-money valuations, in order to consider the effect of style drift on performance and risk. The consideration of pre- and post money valuations are not exact measures of performance and risk, but are nevertheless informative proxies. The pre-money valuation is the VC's assessment of the value of the company prior to their investment (as mentioned, we only consider 1st round investments). The post-money valuation is the VC's assessment of the value of the company after the investment, given their contribution to the venture. The results generally indicate that stage drifts are associated with greater post-money valuations, and greater variance is associated with investments that were drifts.[44] As with the exit results, note that similar results are observed for *Fund Stage Drift* and *Fund Large Stage Drift* versus no stage drift (Tests 1 and 2), and insignificant differences are observed between *Fund Stage Drift* versus *Fund Large Stage Drift* (Test 3). In short, the data are therefore consistent with the view that drifts are more common among investment opportunities that are potentially more profitable, and where the VC perceives greater value can be added to the venture.

While Table 14 Panel A reports summary statistics for both exit outcomes and valuations, note that the regression analyses in Table 14 Panel B only consider exit outcomes. The main reason is that we believe we have a fairly complete set of variables to explain investment performance, but not valuations. The valuations at the time of investment are likely influenced by numerous project-specific factors that are unobservable. Exit performance, by contrast, has been more frequently studied in the literature (see, e.g., Gompers and Lerner, 1999; Cochrane, 2005; Schwienbacher, 2002; Das et al., 2002; Cumming and MacIntosh, 2003; Fleming, 2004). Below, we describe the variables we can and cannot consider to explain alternative exit outcomes, with reference to the prior literature on topic.

Table 14 Panel B presents 5 alternative regressions to show the robustness of alternative specifications on the effect of style drift on exit outcomes. Regression (1) provides an analysis of IPO exits on the subsample of exited investments (as mentioned, our dataset comprises 4434 exited investments, and the remainder 7437 investments were unexited as at December 2003). Regressions (2) – (5) consider two-step sample selection corrected estimates that account for the non-randomness of observing any exit. In the two-step models, the first step explains the existence of an exit as a function of investment year dummy variables, the NASDAQ return over the investment horizon (from the time of first investment to the time of exit (or to December 2003 in the case of no exit). The second step then considers the specific exit outcome that resulted, taking into account the first step as to whether or not there has been an exit. The second step regressions use proxies for VC skill (such as VC firm age and fund sequence), the size of the investment, the stage of the entrepreneurial firm at time of investment, the NASDAQ return 3-months prior

44 This is not attributable to the difference investment sizes, as most drifts were down drifts (to smaller earlier-stage companies), as discussed.

to exit (as in Lerner, 1994), exit year dummy variables, and industry dummy variables. In section 2.5 we discuss limitations of alternative variables that we might have included if we had additional information.

The specifications for the data are consistent with the notion that style drift affects investment performance: *Fund Stage Drift* is positively related to the probability of an IPO, although the effect of a *Fund Large Stage Drift* is statistically unrelated to the probability of an IPO. In particular, the data indicate a *Fund Stage Drift* is associated with an approximately 4% increase in the probability of an IPO exit (i.e., the data are suggestive that stage drifts are associated with higher risks and returns), controlling for other factors that might affect exit outcomes. These results also suggest, due to the potential reputation costs of deviation, style drifts are more common for investments that are more likely to yield favorable realizations.

Note that we also considered up drifts (early stage committed funds investing in late stage companies) versus down drifts (late stage committed funds investing in early stage companies), but do not report those results for reasons of conciseness. In brief, those results show up drifts are statistically unrelated to exit outcomes, whereas down drifts are positively related to exit outcomes (and the economic significance is approximately the same as above at 4%).

A concern with our specifications is that the propensity to stage drift might be greater when expected performance is better; in other words, stage drifts might be endogenous to exit outcomes. Our specifications consider stage drifts as a right-hand-side variable, and exits as a left-hand-side variable. The main reason for this is that exits occur subsequent to the stage drift, and the exit outcome cannot be completely certain at the time of investment (stage drift) given that at least a few years typically pass from time of investment to time of exit. We nevertheless did consider various instrumental variables to control for potential endogeneity (such as geographic location, for example); however, the results from such specifications were not materially different (although it was difficult to find convincing instruments that would affect style drift and not exit outcomes).

Finally, note that other results in Table 14 Panel B are quite intuitive. For instance, larger investments are more likely to go public. This is expected, as firms typically must meet minimum capitalization requirements before they can be listed on a stock exchange (although this minimum amount tends to vary over time, and decreases in periods like the Internet bubble period). Firms that were older at the time of VC investment were also more likely to go public, which is likely related to the fact that VCs make better investment decisions from the firm's longer track record from which due diligence can be carried out. VC organizations that have a longer history (by age in years and by fund sequence) were more likely to have IPOs in our sample, indicating that experienced VCs add more value to their investees than less-experienced VCs (consistent with Hsu, 2004, for example). Finally, the data indicate that VC-backed companies are more likely to go public in times of rising markets, and VCs are particular skilled at timing the NASDAQ market (consistent with Lerner, 1994).

2.5 Limitations and Future Research

This paper is the first to address the question of style drift in private equity, and the issue of whether style drift affects performance. A new model was introduced to develop testable predictions, and data were used to test the predictions. Our data comprised first-round investments carried out by limited partnership VC funds. Our focus on style drift was limited to the stage of development of the entrepreneurial firm at the time of first investment. As such, the scope of our empirical work and economic question considered could be expanded in various dimensions, and more detailed datasets could be assembled. Suggestions are provided below.

We have only considered independent VC funds because these are the funds that rely on follow-on funds and therefore need to establish reputation with institutional investors through signaling. Other possible types include corporate and bank-affiliated funds. These funds may have very different investment objectives and are not funds with limited durations. Our hypotheses would not apply in this case. Therefore, their exclusion was necessary in our empirical analyses. Future theoretical research may develop hypotheses pertaining to drifts among captive funds, and empirical tests could be carried out for captives.

We further note that there are other ways in which we may have specified our empirical tests. For example, instead of specifying each observation as an investment round, we could have used each fund as a different observation. One would then measure style drift on the fund level as a proportion of all investments done. Our specifications with each observation as an investment round enables controls for syndication on specific deals, which is a big advantage over the specifications which performs a fund-level analysis of style drift. The effect of style drifts on investment performance also controls for fund size and fund sequence, among other control variables. But most importantly, an analysis on the fund level does not allow to control for changes in market conditions between the time the fund was raised and the actual investment. Given the importance of changed market conditions for explaining significant parts of style drift (as evidenced in our analysis on the investment round level here), a fund level analysis would have had important drawbacks.

Another potential interesting extension would be to examine other dimensions of style drift, like industry and geographical focus. While our dataset does not allow us to do so in a satisfactory way (*cf.* Footnote 39), it would present a more complete picture of style drift as far as VC funds typically also make commitments along these other dimensions. We did make a preliminary investigation of these issues within the confines that the Venture Economics dataset does not record a fund stated industry focus. That is, we compared the most industry investment for a fund with the outlier industry investments. Our preliminary analysis of industry drifts on a reduced sample size did not yield conclusions on incentives to style drift that were materially different than that for stage focus. We do note, however, that this empirical strategy is imperfect since some funds may have drifted more often than not, and therefore we do not report these results. Future research on topic is warranted with other data. Our data are the only industry-wide US data that enables examination of the topic of style drift in private equity, with particular attention to stage drifts.[45]

We also considered examining downward and upward drifts separately. The problem with this alternative specification is that downward drifts are not specified for early-stage funds. Expansion-stage funds can drift in both directions. This means that the probability distribution of the dependent variable is not the same for each observation, which makes such an analysis impossible to perform. Similar reasons apply to upward drifts.

It would be interesting to examine the issue of style drift in other countries. As mentioned in Footnote 41, a dummy was added for non-US funds to examine if their incentives were different when investing in US companies. We did not find any difference with this respect and thus did not present these results in the tables; however, only 434 investments were carried out by non-US funds (Canadian and European) in our sample. Further work could consider this issue with a more well-rounded international sample.

Finally, our analysis of the effect of style drift on investment performance is perhaps incomplete and could deserve additional research. For instance, variables pertaining to contractual governance of the VC may impact subsequent exit outcomes (as considered in prior work referenced above in subsection 2.4.2). Our evidence of the relation between style drift and performance is therefore only suggestive. While full consideration of this issue is limited by the available data from Venture Economics, further work may provide new interesting insights on the relation between style drifts and performance. Likewise, it would be interesting to know whether style drifts give rise to different contracts among VCs and entrepreneurial firms. It may be the case that style drifts do in fact invoke a different degree of VC control rights, which could in turn affect investment performance. Furthermore, our data do not enable precise IRRs to be computed for exited investments, and therefore we cannot assess performance based on IRRs. Further research examining each of these issues is warranted.

45 The data are of course subject to potential measurement error, as in all other papers that use data from Venture Economics (see, e.g., Gompers and Lerner, 1999). On average, we have no reason to believe that measurement error skews the direction of stage drift. We independently investigated a large random sample of funds in the data, and did not find discrepancies between their stated fund focus and actual investments relative to that reported in the Venture Economics data.

3 General Conclusions

Both studies included in this booklet evidence the crucial impact of market conditions on the outcome of venture capital investments. These conditions seem to affect venture capitalists decisions in a number of ways, which also have relevance for fund providers.

The first study puts forth a theoretical model whereby VCs time their investments according to exit opportunities. When exit markets become less liquid, VCs invest proportionately more in new early-stage projects (relative to new projects in other stages of development) in order to postpone exit requirements and thus invest in riskier projects. As such, VCs tradeoff liquidity risk with technological risk when exit markets lack liquidity. In contrast, when liquidity is high VCs invest more in expansion-stage and later-stage projects where time until exit (investment duration) is reduced.

The U.S. data examined provide very strong support for the theory. We found a strong negative relationship between liquidity of exit markets and the likelihood of investing in new early-stage projects. Furthermore, we found that the liquidity of exit markets significantly affects the decision to invest in new projects, as well as the size of the investment syndicate. An increase of liquidity by 100 IPOs in a year reduces the likelihood of investing in new early-stage projects by approximately 1.5% - 2.3%, increases the probability of investment in a new project (as opposed to a follow-on project) by approximately 1.2% – 4.1%, and gives rise to approximately 0.2 fewer syndicated partners. These marginal effects are economically meaningful, due to the massive swings in IPO market cycles (see, e.g., Lowry, 2003; Ritter and Welch, 2002; Loughran and Ritter, 2004, 2004). We explained in this paper the fact that our findings are remarkably consistent with related empirical and theoretical work in venture capital finance over boom and bust periods (see, e.g., Kortum and Lerner, 2000; Kanniainen and Keuschnigg, 2004), and suggested a number of avenues for future research on this topic.

The second study introduced the concept of style drift to private equity investment. We presented theory and evidence pertaining to style drifts in terms of a fund's stated focus on particular stages of entrepreneurial development. Our model derived conditions under which style drifts are less likely among younger funds, in order to signal ability and commitment to stated objectives for the purpose of raising follow-on funds. We also demonstrated that changes in market conditions can affect style drifts, and showed differences for funds committed to early stage investments versus funds committed to late stage investments.

The empirical analysis of drifts from a sample of 11,871 investments in the Venture Economics database provided strong support for our theoretical predictions. In a variety of multivariate specifications, the data consistently indicated that an increase in the age of the VC investor's organization by 5 years increases the probability of stage drift by 1%, and similarly, each successive VC fund within an organization is 0.5% more likely to stage drift. We further show that market conditions significantly affect the propensity to style drift, whereby a 20% increase in NASDAQ from the time of fundraising to the time of investment gives rise to a 4% reduction in the probability of a stage drift by early stage funds but to a 5% increase in the probability of a stage drift by funds with later-stage commitments. We also showed that the Internet bubble period was associated with a 4% lower probability of a stage drift among funds committed to an earlier stage focus, and a 0.5% higher probability of a stage drift among funds committed to a later stage focus.

This paper then provided evidence of a positive relation between style drifting and investment performance. In particular, we showed that a stage drift is associated with a 4% increase in the probability of an IPO exit, controlling for other factors that might affect exit outcomes within the scope of detailed data that are available in the Venture Economics database. These results suggests, due to the potential reputation costs of deviation, style drifts are more common for investments that are more likely to yield favorable realizations.

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