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Learning and Signalling in the French and German Venture Capital Industries

by

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Abstract:
This paper analyses the efficiency of venture capital and its impact on primary equity markets in France and Germany. It shows that venture capital operates according to the signalling model in France and according to the learning model in Germany. Only the learning model can serve as a rationale for government subsidies. In the signalling model, many young venture capital firms succeed without a protected learning period because they already excel in the screening, monitoring and management supporting services they provide. They will seek to signal their quality to outsiders by taking portfolio firms public early. A variety of empirical tests and policy implications are discussed.

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Contents

List of Tables

1. Motivation

Government support for venture capital has been a top priority in Europe's strategy for innovation and growth since the mid-1990s (see European Commission 1999). Various investment subsidies have been provided both at the national level and at the supranational level, where the European Investment Fund (EIF) became a major investor in venture capital in the late 1990s. But was this actually a prudent choice of policy? Was the money well spent?

In terms of economic theory, subsidies can be rationalized by a variant of the old infant industry argument in which a learning process enhances the productivity of domestic resources over time. In the case of venture capital, learning may entail a variety of external economies, in particular the training of a pool of specialized professionals whose ability to screen, monitor and control entrepreneurial start-ups is often decisive. With labour mobility, this training cannot be fully appropriated by the firm providing it. Moreover, the learning process may entail dynamic returns to scale that private firms are too shortsighted to realize, even if localized external economies are absent. For both of these reasons, subsidies hold the promise to establish a domestic venture capital industry that eventually becomes self-sustaining and internationally competitive. This would solve a genuine market failure and the subsidies would have a positive payoff to society. Indeed, they could be considered a far-sighted investment to enlarge an economy's capacity for technological innovation.

Learning, however, must be sufficiently strong. The right policy choice therefore depends on empirical evidence of learning in the domestic venture capital industry: Is learning present and how large is its contribution to the evolving efficiency of venture capital investments? This paper sets out to provide this evidence and uses a new hand-picked dataset of initial public

offerings (IPO), including characteristics of issuing companies and their venture capital shareholders, observed on France's Nouveau Marché and Germany's Neuer Markt in the period from 1996 to 2000.

The structure is as follows. Section 2 reviews existing evidence on the development of venture capital and introduces the learning model. Section 3 discusses the testable implications of the learning model and compares them with those of the signalling hypothesis. Section 4 introduces and describes the dataset. Section 5 presents empirical tests of the signalling and learning hypotheses. Section 6 discusses theses findings in the context of related literature. Section 7 concludes by summarizing the implications for policy and suggests directions for future research.

2. Economic significance and development of venture capital

For the purpose of this study, venture capital does not simply equal private equity since this includes passive share holdings in unlisted firms. Instead, venture capital is understood to be only the subset of private equity that combines temporary equity participation in a privately held start-up with active monitoring and control. Venture capitalists are specialized financial intermediaries that raise capital mainly from institutional investors and seek to exit from their investments via an IPO or a trade sale as soon as the start-up has established a track record in the market place. An efficient venture capital sector thus provides two sorts of benefits to society: it helps to overcome financing constraints for high-tech start ups, when they are shunned in credit markets, and it serves as a filter for untested technology ventures seeking to attract expansion finance in primary equity markets.

There is a strong case that this new form of financial intermediation indeed spurs technological innovation in the US. Headline underpricing tends to be significantly lower if an IPO is backed by venture capital so that a larger share of a venture's social returns is privately appropriated by the original investors (Barry et al. 1990). Moreover, Gompers and Lerner (1999), p. 210, provide evidence that the long-term performance of IPOs backed by venture capital in the US is significantly better than the performance of IPOs without such backing. And in more direct evidence of technological innovation, venture-backed firms appear to pursue more radical product and process innovations (Hellmann and Puri 2000), resulting in a higher propensity to patent and in patents of a higher average value (Kortum and Lerner 2000).

Europe's lag. Although European venture capital investments reached an all time high in early 2000 (Arundale 2001), Europe's venture capital industry is still way behind its US counterpart – both in terms of size and efficiency. Total investments of private equity and venture capital in 1999 exceeded 25 billion Euro, after 14.5 billion Euro in 1998, but only 43 percent of the 1999 total was real venture capital, targeted at start-ups and fast growing young companies; the larger part was devoted to management buy-outs, replacement finance and other late-stage deals. Bottazzi and Da Rin (2002) point out that policy makers' great efforts to increase the flow of funds have not prevented Europe's venture capital industry from falling further behind that of the US over the last decade. For the period from 1995 to 2000, Bottazi et al. (2001) estimate that the flow of venture capital investments has increased by a factor of 6 in Europe, but by a factor of 24 in the US. Moreover, in terms of the quality of the corporate governance and other services they provide, many European venture capitalists are still learning their trade. By looking at venture capital's role in the recent IPO wave on Europe's new stock market segments for high growth companies, Bottazi and Da Rin (2002) find evidence that venture capital is alleviating credit constraints. But

they also find that Europe's venture capital has only had a limited effect on the ability of young firms to raise equity capital, to grow, and to create jobs. They conclude that both growth and maturation should be the objective of public support for the European venture capital industry.

Without a mature venture capital industry that identifies and nurtures promising ideas, many European countries have not been able to exploit their science resources and potential for innovation as efficiently as the US economy has done. Bottazzi et al. (2001) argue that in the production of valuable patents, Europe is lagging behind the US neither because of an insufficient quality of European research, as measured by scientific citations, nor because of lower R&D expenditure per worker employed in R&D, but rather because of a lower stock of accumulated knowledge and R&D productivity. Moreover, Europe's productivity in the R&D sector, its share of valuable patents in the high-tech sectors, seems to be falling further behind, as Bottazi et al. (2001) argue, because the number and the innovativeness of start-ups is limited. Regulatory impediments and the dominance of banks in Europe's venture capital industry appear to have imposed a form of industrial organization where too many high-tech start-ups are not really independent, but operate within the boundaries of large established companies. Almost 40 percent of all funds raised by Europe's private equity and venture capital industry in 1999 came from banks and industrial corporations, and only 18.7 percent from pension funds (Arundale 2001), the most important long-term investors in the US. In Germany, the share of banks alone was around 50 percent in 1998. The outcome, according to Bottazi et al. (2001), is that quoted venture-backed companies do not grow faster than non-venture-backed ones in Europe. This finding, however, leaves open whether Europe is now getting the kind of learning experience that propelled the US venture capital industry in the 1980s.

The US venture capital cycle. The US example has demonstrated that an efficient venture capital industry — with a track record of successful investments on public display in the stock market – will attract further capital inflows and create a self-sustaining investment cycle. Europe's venture capital industry, by contrast, is still too dependent on subsidies and – without substantial gains in efficiency – it may remain so for quite some time. Based on the US experience, Gompers and Lerner (1999), p. 205, argue that successful exits are critical to ensuring attractive returns for investors and to raising new capital. They point out that the European venture capital industry during the early 1990s remained depressed because, in contrast to the US, Europe's stock markets performed poorly and thus did not offer an attractive exit route. IPOs are attractive for several reasons, including the opportunity for the founder to regain managerial control over his firm – a point first made by Black and Gilson (1998). This opportunity lowers contracting costs between the entrepreneur and the venture capitalist in a way that the prospect of a trade sale cannot match since a trade sale would result in concentrated ownership by a large strategic investor, not in the dispersed shareholder structure that usually emerges from an IPO and is preferred by the founder.

Exiting via the stock market also provides outside investors and venture capital managers with information about the valuation of portfolio firms, as documented in their headline underpricing at the time of the IPO and in their subsequent performance in the secondary market. IPOs are thus an important element in a two-way learning process that informs both the investing public and the venture capitalists about the quality of their skills at screening, selecting and controlling portfolio firms. This sort of information helps outside investors to decide on which venture capitalist to place their bets, and it helps the venture capitalist to reassess her strategic orientation and business practice in the selection, monitoring and support of portfolio firms. The learning hypothesis

thus provides an additional rationale for the importance of primary equity markets as an exit channel for venture capital investments. And the planned closure of the Neuer Markt by Deutsche Börse before the end of 2003, less than seven years after its inception, might be an ominous sign for the future of venture capital in Germany.

Policy implications. The rationale for government subsidies, implied by the learning hypothesis, depends on social benefits of learning that venture capital firms can only partially appropriate. At the macro-level, these social benefits may derive simply from having, as opposed to not having, a domestic venture capital industry. At the micro-level there are a variety of more specific social benefits which are related to learning: Not only does learning generate a pool of trained venture capital professionals, but it also lowers the underpricing of IPOs in primary equity markets and, by increasing the privately appropriable portion of the social returns from technology investments, supports innovations that would not otherwise reach the market place. In addition, there may be indirect externalities such as knowledge spillovers from the R&D activities of venture capital-backed companies. The social benefits of course must be large enough to outweigh the social costs of government subsidies, including the distortionary taxation to raise the funds as well as distortions in the selection, monitoring and control of portfolio firms that may result from the moral hazard of subsidies (see Schertler and Stolpe 2000). It is important to note that other explanations of the venture capital cycle may imply many of the same indirect social benefits from venture capital, but do not imply the same direct social benefits from subsidising venture capital.

The most prominent alternative explanation is the signalling model in which each venture capital firm knows its abilities ex ante. Those with high-ability have incentives to take costly action which signals their quality to potential

investors in order to raise new capital. This model does not allow for learning in any economically meaningful way. Signalling is an efficient strategy, in terms of the second best, to reduce asymmetric information, and its benefits are appropriated by those with high ability. Signalling thus provides no rationale for government subsidies. Instead, the signalling model may provide a rationale to reform accounting rules and disclosure regulation so as to increase the transparency of IPO candidates, reduce informational asymmetries and ultimately eliminate the need for costly signalling. Because these policy implications are so different, empirical research must be careful to distinguish the learning from the signalling model and to focus on the testing of empirical predictions that are unique to either of the two models.

Empirical implications. US experience suggests that venture capital backing does affect the valuation of IPOs in the primary market and their long-term performance in the secondary market in a predictable way. Several studies have confirmed the observation of Barry et al. (1990) that venture capital backing lowers the widely observed underpricing and thus provides a kind of certification for IPOs. According to Megginson and Weiss (1991), the first authors to rigorously test the certification hypothesis, it is taking firms public repeatedly that enables venture capitalists to credibly stake their reputation on the issuer's quality and certify that it is not overvalued at the IPO. Venture capital thus enhances the efficiency of primary equity markets.

However, the few studies that have examined the certification hypothesis with European data, have tended to reject it. De Maeseneire and Manigart (2002), for example, study 300 IPOs on the Easdaq and the EuroNM group of stock exchanges, of which 43 percent were backed by venture capital, but they do not find a significant effect of venture capital backing on the level of underpricing. For the Neuer Markt, a former member of EuroNM, Franzke (2001) finds that

the underpricing of IPOs was even higher when they were backed by venture capital. Unless this finding is due to selection bias, or constitutes a merely temporary phenomenon, it would suggest that venture capital is not only less efficient in Germany than in the US, but that it may even be damaging to a firm's growth prospects.

Both the learning model and the signalling model can reconcile this empirical puzzle, but do so in different ways. As Gompers and Lerner (1999), p. 259, point out, certification by venture capitalists is potentially consistent with grandstanding, as implied by the signalling model. Young venture capitalists of high ability may have incentives to bring their portfolio firms to market early in order to establish a track record and raise capital for new ventures. Certification would hence lower underpricing only on average. The certification effect would be noticeable in the premature IPOs of young venture capitalists only after taking into account the firms' age and other pertinent characteristics, if at all. The average certification effect would mainly stem from the lower underpricing of IPOs backed by old venture capitalists whose ability is assumed to be public knowledge.

In the learning model, too, certification is mainly provided by old and experienced venture capitalists. Outside investors know about the limited ability of young venture capitalists to select and support portfolio firms and therefore demand a higher level of underpricing to compensate them for taking the additional risk. The reason for the greater certification effectiveness of venture capitalists is thus different from the grandstanding model, in which all venture capitalists know their individual ability ex ante. Genuine learning rather implies that young venture capital firms are initially uncertain not only about their current ability, but also about their potential to hone their skills through experience. None of them has any special incentive to rush her portfolio firms to

market. On the contrary, the market valuation of a portfolio firm at the time of an IPO can only provide accurate feedback on the ability of a venture capitalist if she has taken the same effort to support and prepare the IPO candidate as any other venture capitalist would have done. Bringing a portfolio firm to market early would deprive a young venture capitalist of a potentially valuable learning opportunity. With both the venture capitalist and outside investors learning to better judge her ability – from the revealed valuation of portfolio firms in primary equity markets – underpricing is gradually reduced through a sequence of IPOs in which a particular venture capital firm is involved.

3. Testable implications of the learning and signalling models

3.1 Baseline comparisons

A formal model of learning in venture capital, based on the compensation model of Gibbons and Murphy (1992), is developed in Gompers and Lerner (1999), pp. 82. Formal models of signalling in primary equity markets were first developed by Allen and Faulhaber (1989), and others around the same time. Gompers (1996) extends the signalling model to the case of a venture capital firm seeking to establish a reputation for quality. The learning and signalling models are based on a common assumption: Venture capitalists work until their marginal share of the expected increase in return equals their marginal effort cost. A large part of the return comes in the form of reputation, which enhances the ability to attract promising portfolio firms and to raise new funds from outside investors. Both models emphasize the need to exit investments through an IPO so that returns can be observed by potential investors, not just by current investors. But the models differ in their assumption about the distribution of information. While initial uncertainty about the ability of the venture capitalist is symmetric in the learning model, the venture capitalist is better informed than outside

investors in the signalling model. In the learning model, investors as well as venture capitalists will revise their beliefs about the venture capitalist's ability after observing the returns on her current investments. In the signalling model, by contrast, investors revise their beliefs about young venture capitalists after observing IPOs of their portfolio firms, but they do not do so with regard to old venture capitalists.

Both learning and signalling has a variety of empirical implications not only for the choice of exit strategy, but also for the design of compensation schemes, as Gompers and Lerner (1999) point out. In this paper, I only examine those with regard to exiting via the stock market, the area on which I have assembled a comprehensive dataset covering almost all IPOs on France's Nouveau Marché and Germany's Neuer Markt from 1996 through 2000. A number of testable implications regarding exit can help to discriminate between the two models. In a nutshell, the signalling model predicts different behaviour of young and old venture capital firms, whereas the learning model predicts basically the same exit strategy for all venture capital firms. As in the signalling model, the efficiency of individual venture capital firms may differ in the learning model, but underpricing declines in response to accumulated experience, not in response to a strategic choice on the timing of the IPOs of portfolio firms. Six major empirical implications which distinguish the learning model from the signalling model are summarized in Table 1 and more fully explained as follows.

First, with respect to the choice of portfolio companies brought to market, the signalling hypothesis predicts that these firms should be less mature than those brought to market by older venture capitalists. Although the signal is to take a company public, not the level of underpricing per se, there is the second-order implication that the effect of recent performance in the IPO market on the

amount of capital raised is stronger for young venture capitalists than for the old. Indeed, the more elastic market response provides the incentive to rush portfolio firms to market. In the learning model, by contrast, the expectation of a positive market response does not lure the young venture capitalist to rush her portfolio firms to market. Rather like in a real option model, the young venture capitalist may have incentives to wait until she is more certain that the performance of her portfolio firm in the primary equity market will be good enough to trigger a positive market response and help raise new capital from outside investors. In line with the certification hypothesis, the learning model predicts that IPOs backed by older venture capitalists come earlier than the IPOs backed by younger venture capitalists, since the monitoring and control of portfolio firms and the certification by old venture capitalists is expected to be more effective. An old venture capitalist may even use her reputation as a partial substitute for time and effort in nurturing portfolio firms, for example when negotiating deals with suppliers, creditors and other strategic partners.

Second, with respect to capital inflows to the venture capitalist, the learning model predicts that the ability to raise capital depends on total accumulated experience, the number of all successful prior IPOs backed by the venture capitalist. Since a high level of underpricing in the IPOs backed by a particular venture capitalist would be considered as a sign of incomplete learning and poor appropriation of investment returns, underpricing should have a negative impact on new capital inflows, after controlling for the number of prior IPOs. In the signalling model, by contrast, the size of newly raised funds should increase more strongly in response to the size of the observed underpricing when the venture capitalist is young. Moreover, the market response for old venture capitalists should not only be weaker, but also inelastic to the further accumulation of experience; the marginal effect of bringing additional firms to market should be minimal.

Third, in the signalling model young venture capitalists have smaller percentage equity stakes at the time of the IPO which means they are willing to pay higher valuations. One reason is that an earlier IPO leaves less time to increase the typically staged capital infusions as much as an older venture capitalist would. Moreover, an older venture capitalist has incentives to hold a larger percentage equity stake at the IPO because she can expect a better performance in the primary equity markets, so that the opportunity costs of the larger participation are lower, and the immediate IPO reward for a given effort to support the portfolio firm is larger. Finally, the IPO backed by a young venture capitalist comes earlier, yet it must yield an overall return to the portfolio company's other pre-IPO shareholders, in particular to its founding entrepreneur, that is competitive with the higher rate of IPO return that an old venture capitalist would provide. For a given level of management support, the entrepreneur will therefore demand a larger equity stake for himself if he is to contract with a young venture capitalist. Indeed, a larger stake will be demanded even if the venture capitalist has already signalled her high ability to the entrepreneur through characteristics of the pre-IPO compensation contract, as predicted by Gompers and Lerner (1999).

In the learning model, by contrast, young venture capitalists hold *larger* percentage equity stakes at the time of IPO – not only because they tend to wait longer before bringing a firm public und thus have more pre-IPO financing rounds, but also because larger capital infusions and the corresponding higher share in the portfolio firm's risk can serve as a partial substitute for the lower quality of managerial support that a young venture capitalist offers. She may need this substitute to attract promising start-ups into her portfolio if these would otherwise seek the more effective support from a more experienced old venture capitalist. The larger equity stake thus corresponds to the less valuable management support provided by a young venture capitalist in the learning

model. In essence, the larger pre-IPO capital input from the young venture capitalist finances a part of the company's growth that would otherwise be financed through the proceeds from the IPO. As a corollary, the venture capitalist's larger equity stake should improve her incentives and lead to a greater effort in supporting and controlling the portfolio firm, fully in line with the idea of learning by doing.

Fourth, the learning model has static and dynamic implications for underpricing. It predicts, ceteris paribus, a higher level of underpricing for young venture capitalists which reflects the greater uncertainty about their ability. But the learning model also predicts that the level of underpricing in a venture-backed IPO is partially dependent on the lagged underpricing observed in previous IPOs backed by the same venture capitalist. There should be regression towards the mean in the sense that the influence of past underpricing on current underpricing is positive, but below one for each particular venture capitalists. The reason is that both venture capitalists and investors continuously improve their judgement on the venture capitalist's ability and her portfolio firms' quality. In the signalling model, by contrast, underpricing is independent of the venture capitalist's age and experience after controlling for the issuer's lack of maturity and other relevant characteristics of the IPO. With regard to other determinants of underpricing, learning and signalling have largely similar implications. For example, board service of the venture capitalist in the IPO firm, an indicator of the intensity of managerial support, should reduce underpricing in both models because a better informed venture capitalist should be able to provide more credible certification.

Fifth, the learning model is consistent with information spillovers in underpricing, including hot issue markets – the temporal clustering of IPOs from particular industries or specific areas of technology. The observed success or

failure of one IPO may not only influence investors' demand for further IPOs from that field, but also the exit strategy of venture capitalists who are still uncertain of their own ability. These venture capitalists would use the observed valuations of recent IPOs as relevant information to assess the maturity of their own portfolio firms, especially in those cases where these firms are from the same field of technology. Moreover, venture capitalists would have incentives to take similar portfolio firms public when the revealed valuations are high. They would then be able to learn something from the relative performance of their own portfolio firms under a given set of conditions in the primary equity market. The signalling model, by contrast, is not consistent with information spillovers. Their presence would dilute the informativeness of timing a particular IPO and would thus reduce the effectiveness of premature IPOs as a signalling device for young venture capitalists of high ability. With information spillovers, observers of IPO timing would have reason to suspect that the desire to signal was only one of several considerations in the timing decision for an IPO. Signalling would therefore cease to be a viable strategy.

Sixth, the learning model also has implications for the long-term performance of IPOs. Empirical studies have shown that IPOs of small firms typically underperform in the stock market, yet this underperformance is less pronounced if the IPO was backed by a venture capitalist (Gompers and Lerner 1999). Assuming that improved monitoring and control increases the value added by a venture capitalist to her portfolio firms, the learning process should actually be accompanied by a gradual reduction in the long-term underperformance of the IPOs she supports. The signalling model, by contrast, is consistent only with the static implication that venture capital-backed IPOs perform better than non-venture-backed IPOs of similar size, age and technology focus, both in the short and in the long term. There is no gradual reduction in the long-term

underperformance, because the ability of venture capitalists taking portfolio firms public does not change, and everybody knows this.

Testing these implications will provide evidence on the empirical question whether Europe's national venture capital industries are still in learning mode, or whether they have already reached the level of maturity seen in the US market. The evidence from the US indicates that young venture capitalists, who know their superior ability, seek to build their reputation through signalling (Gompers 1996). Only in a mature market can they do so because young venture capital firms' awareness of their own ability presupposes that they draw on a local pool of experienced professionals who know what it takes and how to rate themselves. Today's level of maturity in the US venture capital industry is itself the outcome of a long learning process, beginning soon after World War II and lasting until well into the 1980s, when government-backed Small Business Investment Companies (SBIC) were still the dominant form of venture capital and served as a training ground for professional managers. It was probably during the 1980s that the US made the transition from learning to signalling mode; a large number of independent venture capitalists came into existence and took advantage of the rapidly rising investment volume which pension funds allocated to venture capital after the prudent man rule was introduced in 1979.

The transition may prove to be less smooth in Europe. One reason for scepticism is the presence of a large number of captives, venture capital firms that are majority-owned and refinanced by an established corporation. Compared with independent venture capital firms, captives tend to have weaker incentives to build their reputation with outside investors and may therefore have a higher propensity to try to time the market in order to maximize the immediate returns from each individual IPO, which would be inconsistent with signalling.

3.2 Predictions for captive venture capital firms

Evidence on captives in the US is provided by Gompers and Lerner (2000). They show that captives tend to pay higher valuations, resulting in smaller equity stakes at the IPO. However, the premium disappears when only corporate venture investments with a strong strategic fit are compared to the average investments made by independent venture capitalists. This suggests the presence of complementarities which add value to portfolio firms and may serve as a substitute for management support. Deliberate choices can be responsible for such complementarities, for example, when a captive makes them a criterion in her selection of portfolio firms or when the captive supports entrepreneurial talent from within the parent company, such as a young R&D worker with a brilliant, but risky idea that does not quite fit into the corporation's production plan and is therefore spun off into a start-up.

The empirical predictions, which I use to discriminate between the signalling and learning model, must partially be reformulated to take the specific behaviour of captives into account. The predictions do not change uniformly for all captive venture capitalists. In a first pass, I will distinguish between captives owned by industrial corporations and those owned by commercial banks. Both of these differ from independent venture capitalists because they pursue strategic objectives in addition to the direct financial gains from each investment. And in both cases, signalling is likely to be of little importance as a strategy to raise new funds, although it may play a role in attracting portfolio firms. It is the nature of their strategic objective that makes these two kinds of captives distinct. The industrial captive will seek to maximize the value of an asset that is affected by the venture through a complementarity or a substitutional relationship mediated via the product market. By contrast, the bank-owned captive will rather use equity participations as a loss leader for other financial services or as

a corporate governance instrument to reduce agency costs in lending to start-up firms.

With regard to the testable implications of learning vis-à-vis signalling, this means that the main difference between bank and industrial captives lies in their potential for learning. The potential is limited in the case of captives owned by banks since these lack technological focus, and typically set weaker incentives for their managers than independent venture capital firms do. If the bank captives therefore provide management support of lower value, they can be expected to compensate this through larger equity stakes. Moreover, pre-IPO lending by a bank means that the IPO can often be postponed relative to IPOs backed by independent venture capitalist. The timing of IPOs is then mainly determined by the desire to maximize proceeds. By the same token, the performance impact on bank-owned venture capitalists' ability to raise new funds is expected to be relatively weak, regardless of their age. And the decline of underpricing with experience is limited, as is the impact of learning on long-term underperformance. However, information spillovers may have a larger impact on the level of underpricing than in the case of IPOs backed by independent venture capitalists.

The potential for learning is greater for industrial captives, especially when they target their investments at ventures which are complements to the parent company's product range and technologies. In the presence of complementarities, industrial captives may even have incentives to provide more valuable managerial support, and to pay higher valuations resulting in smaller equity stakes, than would be observed for independent venture capitalist. Focused industrial captives may hence be even better learners than independent venture capitalists, although the performance impact on their fund-raising can be expected to be more limited. Overall, the empirical predictions of the learning

model may have even greater validity in the case of industrial captives focused on the development of complements.

The opposite, however, should hold if the captive invests in a venture that produces a *substitute* to the parent company's product range (see Hellmann 2002). Such an investment may be part of a hedging strategy, and the captive would have relatively little incentive to provide management support. Since the entrepreneur would then prefer to contract with an independent venture capitalist, and obtain more valuable management support, the captive must compensate by holding a larger equity stake. Moreover, since a trade sale is a relatively more attractive exit option for captives, the timing of an IPO, when the captive does choose to take a portfolio firm public, should be geared more towards maximizing the direct financial returns. The portfolio firms chosen for IPO are not expected to be the best performers and, due to greater uncertainty about their prospects, underpricing may be higher than for IPOs backed by independent venture capitalists. In general, the predictions of the learning model should have relatively little validity for IPOs backed by industrial captives which do not have a strong focus on technologies that complement the parent company's core competencies.

It is clear, then, that empirical tests of learning and signalling must control for the influence of captives, especially on the size of the equity stake at IPO, but also for the strength of the learning effect and the timing of IPOs in relation to market conditions. The unique role of captives in Europe is emphasized in the next section which provides a detailed description of venture capital activity in France and Germany.

4. Venture Capital in France and Germany: a description of the industry

4.1 Institutional background

The French and German venture capital industries that emerged in the 1980s and 1990s faced rather different gaps in the two countries' financial systems. In France, a general financing gap for small firms had opened up with the revolution in the French financial system of the mid-1980s (Cieply 2001). In Germany, by contrast, only high-tech start-ups were hampered by a serious financing gap and the venture capital industry grew mainly in response to new technological opportunities in the 1990s. Although the French and the German financial systems are often portrayed as similar, especially in comparison to the Anglo-American market-based system, they did in fact provide quite different initial conditions for the emergence of domestic venture capital industries in the 1980s and early 1990s. Even today, the French banking system offers small and medium sized enterprises far fewer opportunities to obtain credit finance than is the case in Germany. Against this much broader gap in the French financial system, venture capital can be expected to be less specialized, less focused on high technology. The German banking system, by contrast, served the country's numerous collateralised Mittelstand firms, which form the backbone of the German economy, quite well; and the financing gap that did require attention was mainly due to a lack of equity finance for high-tech start-ups. Venture capital in Germany can thus be expected to focus on the latter. In the future, the implementation of new capital adequacy requirements (Basle II) by German banks may create new financing gaps for German Mittelstand firms.

In a comparative study, Friderichs and Paranque (2001) have described the German financial system as a prototype of the commitment-based banking

model originally developed by Rivaud-Danset and Saleis (1992) and the French financial system as a prototype of the auto-economy model proposed by Hicks (1975). In this latter model, firms' own funds, their cash flow and reserves are the principal source of finance for small firms. They are kept at arms' length by French banks with their characteristic emphasis on procedure-based relationships with corporate clients. French firms have therefore traditionally sought to maintain their financial autonomy. Disintermediation in the 1990s has further diminished the role of the banking sector, while equity markets have continued to play only a limited role for small and medium sized firms. Cieply (2001) points out that the French government has adopted a number of new policies since 1996 to promote the financing of small and medium sized enterprises in line with the general move from a credit-based economy towards an equity oriented system. In 1997, for example, it established the B.D.P.M.E. (Banque de Développement des Petites et Moyennes Entreprises), a state-owned financial institution dedicated to small and medium sized firms. Moreover, a variety of new public funds have been created to subsidize venture capital organizations.

In Germany, by contrast, small firms have traditionally enjoyed very little financial autonomy, due to their heavy dependence on bank debt as a source of finance. Until well into the 1990s, the role of the banking sector has even been increasing, while the stock market continues to play no role at all for most Mittelstand firms.[1] An important explanatory factor in this appears to be Germany's bankruptcy legislation which guarantees comprehensive protection of creditors' interests and substantially limits the insolvency costs that might be incurred by banks, as Friderichs and Paranque (2001) point out. Collateral therefore provides the vast majority of small firms in Germany with a cheap way

of covering credit risks, so that there is little need to earmark liquidity for this purpose. The financing problem that became urgent in the 1990s is that start-ups in high technology usually cannot provide collateral. Germany's federal government and many state governments have therefore introduced a combined total of almost 500 different subsidy schemes to promote the development of venture capital. The most important of these programmes either require the presence of a private lead investor, such as a venture capitalist, or directly subsidize venture capitalists by providing refinancing or investment guarantees (see Schertler and Stolpe 2000; Gebhardt and Schmidt 2002).

The data assembled for this study provides evidence of the enormous growth and diversity of venture capital in France and Germany in the late 1990s, and of the progress made since the mid-1990s. At that time, the venture capital industry of most European countries was already on a course of rapid expansion. Although – according to the European Commission (1998) – the total volume of venture capital investments in the European Union was only one third of that in the U.S. in 1997 and more than 40 percent of Europe's venture capital was still invested in the United Kingdom, the European continent rapidly became the focus of expansion; cumulative funds more than doubled between 1990 and 1996. In Germany, for example, the proportion of cumulative funds to GDP rose from 0.22 percent in 1991 to 0.27 percent in 1995, and in proportion to Germany's stock market capitalization from 0.94 percent to 1.11 percent, a trend that has since accelerated.

Both France and Germany have seen very rapid growth of venture capital and private equity investments in the second half of the 1990s. From 1997 to 1999 alone, total investments grew from 1248 Mio. Euro to 2817 Mio. Euro in

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[1] See Audretsch and Elston (1997) for an introduction.

France, and from 1326 Mio. Euro to 3159 Mio. Euro in Germany (Arundale 2001, p. 46). Seed and start-up investments surged to 32 percent in Germany and 18 percent in France. According to Fiedler and Hellmann (2001), Figure 2, seed and start-up investments grew by 1262 percent in Germany from 1995 to 1999. Evidence on the quality of venture capital is more difficult to obtain. Bascha and Walz (2002) describe the financing practices of German venture capitalists in some detail. They find that venture capital tends to take the form of a silent partnership, which is not very different from debt finance, when agency problems are low and a buy-out is expected as the exit route. Convertible securities, by contrast, are used more frequently when agency problems are severe and venture capitalists expect to exit via an IPO, as in the case of high-tech ventures.

According to the European Commission (1998), only 19 percent of European venture capital investments supported firms in their early stage compared with 35 percent of US venture capital. Another hint at variations in management quality is the stark difference between the US and European venture capital markets in the degree of sectoral concentration of venture capital investments. In the US, it is common for specialized venture capital firms to focus on rather narrow fields of technology that promise supernormal rates of growth in the near future. Whereas in the US, more than 60 percent of investments went to innovators of computer hardware and software, communications and medical technologies as well as biotechnology, these fast changing areas of high technology have apparently been much less the focus of European venture capital investments. Most European venture capital has been targeted at general investment goods, consumer goods and service industries. In Germany, for example, more than 25 percent of venture capital investments in 1994 went into mechanical engineering, a traditional strength of the German economy, and a further 15 percent into trade (Pfirrmann et al., 1997, p. 51).

These structural differences did have an influence on performance. According to the European Commission (1998), the internal rate of return to early stage investments in Europe was 5.7 percent in 1996, less than half the internal rate of return realized in the United States (14.2 percent) and even further below the average internal rate of return to all European venture capital investments (19.4 percent). This strongly suggests that the quality of venture capital firms specialized on early stage financing was much higher in the US than in Europe.

4.2 Quantitative evidence

Table 2 provides evidence from in-depth interviews with 6 French and 12 German venture capital firms about their management practice. These interviews were made primarily to check whether the data sources I used to quantify venture capital activity in France and Germany correctly identify genuine venture capital firms among the numerous private equity investors participating in the IPOs on Europe's stock exchanges. The procedure to identify venture capital firms was to include all member firms of the two national venture capital associations in France and Germany as well as any additional members of the European Venture Capital Association. Other private equity participants in the sample were counted as venture capitalist if they declared themselves as such. A list of all venture capital firms thus identified is contained in appendix A.

The survey responses in Table 2 suggest that an active involvement in the management of portfolio firms is not uncommon for both French and German venture capitalists. The respondents were fairly small in terms of funds under management and young of age, with an average period of venture capital activity in the respective host country of less than two years. In the interviews, they were asked to relate their prior activity to specific IPOs of their portfolio firms. The total cumulative number of portfolio firms was more than twice as large for the French venture capitalists, and they also had more exits than their

German counterparts. Board membership prior to the IPO was less than one year on average, and between 50 and 90 percent of board memberships were maintained for more at least one year after the IPO. Business contacts with portfolio firms were frequent, with monthly checks on performance. However, less than 8 percent of business contacts of the French venture capitalists related to new financings and more than 60 percent to business strategy, while the contacts of German venture capitalists appear to be more evenly spread, with more than 40 percent related to new financing rounds.

Table 3 documents differences in the size and growth of 184 French and 61 German venture capitalist that backed the 446 IPOs on the Nouveau Marché and Neuer Markt between 1996 and 2000 that are contained in our dataset. Prima facie, the French venture capital industry appears to operate with more efficiency than its German counterpart. With a smaller team of professionals, the average French venture capital firm manages more than twice the investment volume and more than three times the number of portfolio firms. However, German venture capital firms concentrate their investments more heavily in the early stage of their portfolio firms' development, in which the risks and benefits of financial support are greatest.

The early stage is the period during which the initial business plan is worked out, prototypes are built and the market potential is explored. Infusions of venture capital are usually quite limited during the early stage and financing rounds are made contingent on progress towards certain milestones in business development. Much larger capital infusions are required during the expansion stage, in which the production and distribution are set up on a large scale and a big marketing effort is made. The late stage refers to private equity investments that are related to management buy-outs and buy-ins and other forms of financial engineering for established firms, not for fast-growing start-ups.

Most of the differences in the average characteristics of French and German venture capital firms are highly significant if tested either using a conventional a t-test for differences in means or the two non-parametric tests reported in Table 3. Many of the variables are not exactly normally distributed so that the non-parametric tests may be more reliable. Taken together, this evidence tends to confirm that French venture capital indeed fills a broader gap in the financial system, as described in section 4.1, while German venture capital is more focused on the specific financing problems of fast-growing start-ups.

Table 4 documents differences between venture capital firms operating with and without government support in France. Such support can take a variety of different forms in practice: for example, subsidized loans, tax-financed equity participation schemes or government guarantees to cover part of the financial losses that eligible private equity investors may suffer. Most of these government schemes have conditions attached so that not all venture capitalists will want to apply for these subsidies. Some authors have also stressed the distinction between subsidised and non-subsidised venture capital. Bascha and Walz (2002) note that public-private partnerships, a common organizational form in Germany, often require significantly lower returns on capital than fully independent venture capital firms do, especially when they are young. Most of the latter seem to follow the US model of refinancing their investments through closed-end funds.

The survey did not seek to quantify the support which a particular venture capitalist or her portfolio investments received from the government, but simply asked for yes or no. In France, those receiving government support have significantly smaller teams of professionals and manage smaller investment volumes, although the number of portfolio firms does not appear to differ much between these two groups of venture capitalists. Moreover, those without

government support seem to concentrate their portfolio investments more on start-ups in high technology, which includes information technology and biomedical technology.[2] But there do not seem to be any significant differences in the stage distribution of the investments made by these two groups of venture capital firms in France.

Table 5 documents the German situation where the differences between venture capital firms operating with government support and those without are generally smaller than in France. It is noteworthy, however, that the number of professional employees and the number of portfolio investments have been growing much more rapidly in venture capital firms with government support. This differential is shown to be significant by all three tests reported. But no significant difference is recorded for the average annual growth rate of the investment volume and for the stage distribution of the portfolio investments made by German venture capital firms with and without government support.

Table 6 documents differences between captives, or dependent, and independent venture capital firms in France. Not only do independent venture capitalists concentrate more of their investment in high technology, but they also employ larger teams of professionals, manage a greater number of portfolio firms and have much larger overall volumes of investments, on average. Perhaps surprisingly, they concentrate a larger share of their investments in the late stage of their portfolio firms' development. The captives' greater reliance on government subsidies is a further element of distinction from their independent counterpart.

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[2] Respondents were asked to state in which of the following 7 areas their portfolio investments were primarily concentrated: information and communications technology, biotechnology and medical care, manufacturing and services, financial services, other sectors, regional focus, no particular

Table 7 documents the differences between dependent and independent venture capital firms in Germany. Here the strong focus of independent venture capitalists on high technology and the expansion stage of portfolio firms are particularly striking. In terms of their number of professional employees, independent venture capitalists were not only larger than their dependent counterparts, but also grew twice as fast in 1997 to 2000. The average volume of investments grew much more rapidly than the number of portfolio firms, which is consistent with the idea of a short-run demand curve for venture capital that was inelastic relative to the rapidly expanding supply during those years. The fact that the average number of portfolio firms stayed constant, in spite of an average annual growth rate of the number of investments above 80 percent, is attributable to a wave of entries by small venture capital firms.

Table 8 compares IPOs on Germany's Neuer Markt with those on France's Nouveau Marché. The main difference seems to be that underpricing was significantly lower in the sample of 130 French IPOs than among the 325 IPOs in the German sample. As a consequence, the average amount of money left on the table was seven times larger on the Neuer Markt. On this count, the French venture capital market looks more mature and appears to provide a setting in which the signalling model naturally applies, while the German venture capital industry looks more like a learning experiment.

Another significant difference between the two countries was the higher participation intensity of venture capital firms in the German primary equity market. The shares held by venture capitalists before the IPO averaged 12.6 percent, and still 7.1 percent after the IPO, against 8.2 and 5.7 percent in France.

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sectoral or regional focus. The first two categories count as high technology for the purpose of this study.

These figures are averages for all IPOs, including those without any participation by a venture capitalist. Insiders, such as owner managers and founders of start-up firms, and strategic investors both held larger shares of the firms going public on the Nouveau Marché and continued to do so also after their partial unwinding during the IPO. By implication, the percentage free float after the average IPO was significantly higher on the Neuer Markt. In terms of employment growth, the evidence reveals that firms going public on the Nouveau Marché had experienced a significantly higher rate of employment growth in the two years prior to their IPO.

Table 9 compares IPOs from high technology and low technology firms on Germany's Neuer Markt, while Table 10 does the same for the Nouveau Marché. What is most striking in Germany's case is that the venture capital share in these IPOs was actually lower in the high-tech sectors, biomedical and information technology, than in other sectors. This confirms the persistence of the initial conditions in the mid-1990s, when many inexperienced newcomers to Germany's venture capital industry shied away from too risky investments in high-tech start-ups and instead chose to invest in relatively safe small firms with a more traditional business and industry background. Some private equity investors even seem to increase their shares in traditional firms at the time of the IPO, instead of unwinding them. The average age of low tech firms was larger at the time of IPO, yet this did not translate into a lower rate of underpricing, compared to biomedical firms. In the longer term, over six and twelve months, the average rate of return was even higher for IPOs of low tech firms than for information technology IPOs. Moreover, low tech firms going public also had faster employment growth in the run-up to the IPO.

Table 10 compares IPOs from high technology and low technology firms on France's Nouveau Marché. In contrast to the German case, the venture capital

share is higher in the high-tech sectors than in low-tech companies. And so is the employment growth rate, the underpricing and the rate of return in the first year after the IPO. In many ways, the empirical picture of the French IPO market confirms our theoretical expectations more than Germany's Neuer Markt does.

Table 11 provides a comparison of venture capital-backed and non-venture capital backed IPOs over time; it is based on annual data. The table highlights the influence of market conditions on the size of the underpricing, which appears to fluctuate greatly even over the course of only four years. In line with theoretical considerations, German venture capital-backed IPOs came earlier in the life of issuing firms than those without venture capital backing. However, the opposite seems to hold in France. Sales and employment in portfolio firms were not systematically higher than the corresponding averages for issuers without venture capital backing. Moreover, the book-to-market ratio, which is often considered a measure of the relative importance of human or intangible capital in a firm, was not systematically lower among IPO firms backed by venture capitalists. Except for the case of German IPOs in 1998 and 2000, the book-to-market ratio was even higher among venture-backed IPO firms, in contrast to theoretical expectations. In terms of equity values, venture-backed firms going public on the Nouveau Marché were larger than non-venture-backed firms in all years since 1998. But the opposite holds for firms that went public on Germany's Neuer Markt. In terms of employment, venture-backed firms have tended to grow slower, in both countries, when compared to IPO firms not backed by venture capital. This summary evidence is broadly in line with the decription of Europe's venture capital industry in Bottazi et al. (2001).

5. Evidence on learning and signalling in France and Germany

5.1 Characteristics of venture-backed firms and venture capitalists' fund raising

Tables 12 to 23 provide evidence on the first three empirical predictions of the learning and signalling models that I discussed above. These tables distinguish between key characteristics of IPO firms backed by young and old venture capitalists in France and Germany. I define young venture capitalists as all those founded after 1990, and old venture capitalists as all those founded before 1991. Venture capitalists thus defined as young are those for whom the booming stock market of the late 1990s provided their first real learning opportunity at exiting into primary equity markets. Most of the older venture capital firms, by contrast, would probably have gathered some experience during the 1980s.

First, I make these comparisons for all IPOs backed by venture capital, and then I check the robustness of the findings by repeating the comparisons for various subgroups of venture capitalists: dependents versus independents, technologically specialized versus generalists, and small versus large venture capitalists. For each comparison, standard t-statistics and two non-parametric tests are used.

Overall, there is evidence in support of the signalling model in France (Table 12), where young venture capitalists tend to bring their portfolio firms to market earlier and on average seem to incur higher levels of underpricing although the latter is not significant at any conventional level. Moreover, book-to-market ratios tend to be lower for the IPO firms backed by young French venture capitalists, suggesting the presence of a relatively high share of intangibles, for example knowledge capital and patents. According to the signalling model, a young venture capitalist who knows his superior ability would be willing to make risky investments in human capital-intensive companies, but a young and

inexperienced venture capitalist would refrain from the most risky investments in the learning model. Table 12 reveals that IPOs are used to lower the equity share of insiders by approximately one third from a 50 percent average starting share. However, it must be noted that the relatively large shareholdings by young French venture capitalists before and after the IPO, 31 and 19.1 percent – with no significant difference to the shareholdings of old venture capitalists, are contrary to the theoretical predictions of the signalling model.

In Germany, by contrast, there is evidence in favour of the learning model (Table 13). Not only are the book-to-market ratios of IPO firms backed by young venture capitalists higher, which indicates that their portfolio firms are less technology-intensive and less risky. But young German venture capitalists also do not bring their portfolio firms to market earlier than their old compatriots, and are rewarded with a significantly lower level of underpricing than the old. The case for the learning model is strengthened by the fact that the predictions of the learning model are mainly supported by the behaviour of independent venture capitalists not by dependent venture capitalists, as shown in Tables 16 and 17. Recall that many of captive venture capital firms in Germany are subsidiaries of banks which neither have a great potential to learn, nor a strong incentive to signal their hidden quality to outside investors. Learning is therefore expected to be a more important characteristic of independent venture capitalist. In line with this, Table 17 also shows that young independent venture capitalists do not on average hold smaller equity shares before an IPO.

Captives in France, however, appear to behave in line with the signalling hypothesis: young dependent venture capital firms bring their portfolio firms to market earlier, invest in firms with a lower book-to-market ratio and experience a much higher level of underpricing at the IPO (Table 14). French independents, by contrast, present a puzzling case (Table 15). While young independents

appear to back firms with a lower book-to-market ratio and bring portfolio firms to market slightly earlier than old independents do, the young also hold significantly larger equity stakes before and after the IPO and enjoy a much lower level of underpricing at the IPO. This probably means that most young independents in France already operate with great efficiency and are perceived in this way by outside investors, who apparently accept their certification of portfolio firms in the IPO process.

Comparative evidence for the behaviour of specialized venture capital firms, with a focus on high technology, and non-specialized venture capitalists is provided in Tables 18 and 19 for the Nouveau Marché and Tables 20 and 21 for the Neuer Markt. Both the specialists and the non-specialists operate in line with the signalling hypothesis in France: young members of these two groups back firms with a lower book-to-market ratio, bring their portfolio firms to market early and suffer a higher level of underpricing as a consequence. Young specialists, however, also hold relatively large equity stakes in their portfolio firms, which is contrary to the predictions of the signalling model. Among German non-specialists (Table 20), there is some evidence in favour of the learning model: the young do not only appear to back firms with a higher book-to-market ratio, but they also wait as long as the old before bringing their portfolio firms to market, and they are rewarded with a relatively low level of underpricing for making these safe choices. On some counts, German specialists also appear to be operating according to the learning model, although there is evidence of significantly smaller equity stakes held by young German specialists at the time of IPO, which is difficult to reconcile with the learning hypothesis.

Further support for the signalling model in France is provided by the comparative behaviour of young and old venture capital firms which are small, employing fewer than ten professionals to manage their portfolio (Table 22).

The young among the small French venture capital firms back firms with a lower book-to-market ratio and rush their portfolio firms to market, but the increase in underpricing that might be expected from this behaviour is not significant. The German case of small venture capital firms is less clear. The observation of earlier IPOs backed by the young among the class of small venture capitalists (Table 23) may *prima facie* look like support for the signalling model. But this observation need not necessarily be inconsistent with the learning model since old venture capitalists that have stayed small may simply have been poor learners and may therefore show an abnormally low productivity in nurturing their portfolio firms. In fact, they take above average time to bring firms to market.

How does the differential behaviour of young venture capitalists in France and Germany affect their opportunities to raise follow-on funds and to grow? The preliminary evidence reported in the last row of Tables 12 to 23 provides no more than a few hints. In both countries, the rate of capital growth tends to be higher for young venture capitalists than for the old in the late 1990s. But due to the limited number of observations, the recorded difference is statistically significant only in the case of French independents (Table 15). In line with the signalling model, this may mean that young independent venture capitalists have been able to persuade outside investors to infuse more capital in response to successful prior IPOs.

5.2 Venture capital's impact on underwriter choice

When the impact of venture capital on the level of underpricing in an IPO is examined by means of multiple regression analysis to control for other potential determinants of underpricing, two specific endogeneity problems may arise. The first is related to the choice of underwriter: the mere presence of a venture capitalist may broaden the opportunities and negotiating power of the issuer,

thus making it more likely that a top-quality underwriter is contracted for a planned IPO. The underwriter in turn can be expected to have an impact on the level of underpricing by helping to certify the quality of an IPO firm, and the size of this impact is likely to depend on the reputation the underwriter enjoys with potential investors. See Carter et al. (1998) for US evidence. The coefficient of venture capital's impact on underpricing may therefore be distorted even if a control variable for underwriter quality is included in the regression.

In their seminal paper on the certification hypothesis, Megginson and Weiss (1991) found that venture-backed issuers in the US were able to attract more prestigious underwriters than non-venture-backed issuers. This finding implies that the true influence of venture capital backing on the level of underpricing may be under- or overestimated if the venture capitalist's influence on the quality of the underwriter is ignored. Moreover, the mere inclusion of a control variable for underwriter quality may not suffice to identify the true impact of venture capital on underpricing. Megginson and Weiss (1991) argued that the certification provided by venture capitalists in the US was both a partial substitute and a complement to the certification provided by prestigious investment banks. Identification may therefore require a separate model to explain the quality of underwriters that is chosen in the presence and absence of venture capital backing in an IPO.

The second potential endogeneity problem is caused by the information spillovers from prior IPOs which are implied by the learning hypothesis (see Table 1). More specifically, the true impact of venture capital on underpricing may be underestimated if the learning from prior IPOs backed by a particular venture capitalist is ignored. This second problem will later be addressed within a dynamic panel analysis, which uses instruments for the endogenous regressors

and employs a system estimator based on the Generalized Method of Moments (GMM) to increase econometric efficiency.

First, however, I will examine how relevant the endogeneity of underwriter choice is with respect to the presence of venture capital. Table 24 provides evidence from an ordered logit model on the influence of venture capital backing and other exogenous variables on the underwriter choices made by the firms that went public on the Neuer Markt and Nouveau Marché. In this model, underwriters' quality had to be measured on the basis of extraneous information, that is independent from the other explanatory variables of underpricing and underwriter choice in the dataset. I therefore use a rank order scale from 1 to 4 and a simple quality-related classification scheme. An ordered logit thus provides the appropriate econometric model of issuers' propensity to choose an underwriter from one of these four quality levels.

International evidence provided by Ljungqvist and Wilhelm (2001) shows that US-based investment banks are the most prestigious underwriters in the sense that they possess the highest ability to attract outside investors and to lower the level of underpricing in an IPO, especially outside the US. A rank indicator value of 1 is therefore assigned to all US investment banks and other US underwriters. The value 2 is assigned to large domestic investment banks in France or Germany. In the German case, evidence from Franzke (2001) is used to determine the ten most prestigious domestic underwriters in Germany. In the case of France, the top ten domestic underwriters were picked on the basis of their overall strength in terms of balance sheets and investment banking activity. A value of 3 is assigned to other domestic underwriters in France or Germany. Lastly, a value of 4 is assigned to all foreign underwriters other than those from the US. A list of all German and French underwriters with rank 2 is provided in appendix A.

As explanatories, the ordered logit model includes three groups of variables: *first*, two measures of venture capital's influence – a dummy for the presence of venture capital backing and the relative size of venture capital's stake in the IPO firm —, *second*, the log of gross proceeds as a measure of issue size, and *third*, several firm characteristics which may bear on the optimal choice of underwriter quality: dummy variables for firms belonging to the information technology or biotechnology sector, the log of employment as a measure of firm size, the log of the market-to-book value as a measure of the firm's human capital intensity, the log of leverage as a measure of firm-specific credit constraints and the log of age as a measure of the length of the firm's track record.

Not all firms going public will want to choose the highest quality of underwriter services since these come at a cost. There are two types of costs to consider: First, there are the direct costs of going public, including underwriting fees which European underwriters usually set at three percent and US underwriters at seven percent of gross proceeds. This so-called gross spread seems to be roughly constant across the business cycle and across cycles in the demand for underwriting services. Second, there is the underwriter's market power, his discretion in share allocations and his hidden influence on the issue price. Even if an underwriter of high quality reduces underpricing on average, his market power may allow him to make a suboptimal marketing effort in individual IPOs whose volume is small relative to the IPOs where his reputation is at stake. Market Power can often be attributed to economies of scale where „scale" refers to the number of IPOs that a particular underwriter serves within a given period of time. Benveniste et al. (2002) have emphasised the role of information externalities as an explanation for the clustering of IPOs through time that is often brought about by investment banks' bundling of IPOs from a given industry. This, they argue, serves to resolve the externality problem and improves investment incentives by enforcing a more suitable distribution of the

costs of producing information that a pioneering IPO reveals to the benefit of any followers.

The willingness of IPO candidates to incur the costs of contracting a high-quality underwriter will increase with the expected benefits, above all with the increase in gross proceeds which results from a lower rate of underpricing. It follows that the quality of the underwriter's certification services is more important, the larger the size of the firm and the size of the stock market issue as well as the higher the share of intangible capital in the firm's total stock of capital. Outside investors will find a human capital intensive firm, with a high market-to-book value, inherently more difficult to evaluate so that underpricing – as a compensation for risk taking – would be more pronounced without certification. The observed quality of the underwriter should therefore be positively correlated with the ratio of the market-to-book value as well as with dummy variables for a high tech focus of the issuing firm's line of business. But underwriter quality should be negatively correlated with the firm's leverage and age, since a high leverage would indicate the availability of credit as a substitute for outside equity and a long track record would indicate the availability of direct information as a substitute for the certification which the underwriter may provide.

Table 24 provides the evidence on the determinants of underwriter choice, as revealed in the IPOs on the Neuer Markt (Model 1 to 4), on the Nouveau Marché (column 5) and in a combined sample (column 6). In contrast to the US evidence (Megginson and Weiss 1991), the ordered logit model of underwriter choice suggests that venture capital backing actually lowers underwriter quality in Germany, although the dummy coefficient is significant only at the 10 percent level (Model 3 and 4) and the size of the venture capital stake in the IPO firm is insignificant (Model 1). Note that this is not inconsistent with the learning

model of venture capitalists' behaviour if most German venture capital firms still have a rather low standing vis-à-vis reputable investment banks.

In line with expectations, a more prestigious underwriter is chosen by larger issuers, with the log of employment measuring firm size, by issuers seeking to raise a larger volume of capital, included as the log of gross proceeds, and by relatively young IPO candidates, included as the log of 1 plus the firm's age. The older an issuer, the lower the quality of the underwriter. Other potential determinants of underwriter choice, the market-to-book value and the issuer's leverage, turned out to be insignificant in the Neuer Markt sample, as shown in Model 1. Models 2 and 3 successively eliminate the insignificant variables. The preferred equation is reestimated as Model 4, using the complete set of 259 IPOs for which all the significant explanatory variables are observed.

On France's Nouveau Marché, the effect of venture capital backing on the choice of underwriter quality has the expected negative sign, shown in column 5, but it is significant only at a level of almost 25 percent. Taking Model 4 as a benchmark, column 5 includes only those explanatories that were statistically significant in the Neuer Markt sample. As in Germany, a more prestigious underwriter is chosen by larger firms, in terms of the number of employees, and by issuers seeking to raise a large volume of capital. In contrast to Germany, the age of the IPO firm does not have a significant impact in France.

In the combined sample, the influence of the more numerous German observations dominates, but the coefficient for venture capital backing is clearly insignificant. Instead, the positive coefficient for the log of leverage is now highly significant, Privately held firms with relatively easy access to credit are less dependent on an IPO to finance their expansion. These issuers will hence be less willing to incur the high cost of contracting a top-rated underwriter. It is interesting that this prediction finds support in the combined sample and, at a

much lower level of significance, also in the German sample, but not in the French data alone. The most likely reason is that the French credit market tends to be dry for *all* small firms, not just for high-tech firms, so that leverage cannot be a good indicator of firm-specific credit constraints.

Table 25 helps to further clarify the pattern of correlation between underwriters' rank and the presence of venture capital backing. It provides evidence on the distribution of venture- and non-venture backed IPOs across the four quality-related classes of underwriters. Moreover, it provides univariate evidence on the impact of underwriter quality on the level of underpricing and on the amount of money-left-on-the-table relative to the gross proceeds of an IPO. Compared to the prevalence of venture backing among all IPOs, those with foreign underwriters, including both US and European underwriters, are more likely to be backed by venture capital, both in Germany (top panel) and France (bottom panel). The evidence from the Nouveau Marché moreover shows that more prestigious domestic underwriters tend to have a larger venture-backed share of IPOs than less prestigious domestic underwriters in France.

In Germany, by contrast, the most prestigious underwriters, whether US-based or domestic, have relatively fewer IPOs with venture capital backing than less prestigious underwriters. This casts doubt on the assumption that venture capitalists always help in selecting more prestigious underwriters, although it does not deny that venture capital backing is related in some way to the quality of underwriters. The finding thus confirms that underwriter quality should be a control variable in multiple regression analyses of underpricing seeking to assess the effectiveness of venture capital in certifying IPO quality. However, the descriptive evidence does not point to a large endogeneity bias.

Table 25 also provides a first look as to how underwriters' quality affects the level of underpricing and the associated wealth loss, the amount of money an

issuer leaves on the table relative to gross proceeds. Whereas the percentage underpricing and wealth loss are much greater when an IPO is underwritten by a less prestigious investment bank in Germany, the opposite seems to hold in France. There, US-based underwriters are associated with the highest underpricing and the greatest average wealth loss, while they appear to be the most efficient class of underwriters in Germany. Surprisingly, Germany's own ten most prestigious underwriters (rank 2) do not beat other domestic underwriters (rank 3).

Univariate comparisons, however, cannot adequately control for other determinants of underpricing implied by asymmetric information in the IPO process. As long as the information asymmetry is not fully resolved through the certification which underwriters and venture capitalists are supposed to provide, the winner's curse will continue to bedevil any IPO allocation that is based exclusively on investors' willingness to pay. In order to identify the marginal impact of different explanatory variables on underpricing, the full set of theoretical determinants must be studied within a multiple regression model.

5.3 Venture capital's impact on underpricing

Table 26 reports the results from underpricing regressions that do consider the full set of explanatories. These include *first* characteristics of the issuer, such as its age, size, sales per employee, leverage, market-to-book ratio and industry affiliation, *second* measures of uncertainty surrounding an IPO, such as the aftermarket standard deviation of stock returns and two variables that try to capture insiders' incentives to exploit privileged information, the log of gross

proceeds and the dilution factor as measures of absolute and relative issue size[3], *third* the role of intermediaries in the IPO process, a dummy for venture capital backing, the underwriter rank and the intensity of venture capitalists' selling at the IPO, and *fourth* market conditions at the time of the IPO, such as the index trend of the market segment in which the IPO is listed, a dummy for the bubble years 1999 and 2000 and the calendar day of any given year to capture seasonal influences.

The choice of these regressors is motivated by theoretical considerations which emphasize the size of uncertainty and the private incentives to exploit privileged information, when information is asymmetrically distributed among investors, as the fundamental determinants of underpricing. The underpricing is seen as an insurance against the winner's curse, which may arise when the true value of an IPO candidate is unknown and investors' individual estimates are randomly distributed around the true value. If shares are then allocated to the highest bidder in order to maximize gross proceeds, the winner of the bidding will most likely pay more than the true value. Underpricing should therefore be larger, the larger the uncertainty about the true value of an issuer's shares and the less symmetric the distribution of relevant information is. Underpricing regressions will thus have to include, above all, variables that capture the ex ante uncertainty about a firm's prospects, such as the market-to-book value and the innovativeness of its technology, and the uncertainty revealed ex post, such as the aftermarket standard deviations. Other variables are included to control for the certification provided by underwriters and venture capitalists, and the incentives of insiders to exploit privileged information at the expense of outside investors.

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[3] The gross proceeds are defined as the number of shares issued multiplied by the offer price, the

The results for Germany's Neuer Markt are largely in line with theoretical expectations. The IPO candidate's log of leverage and the presence of venture capital backing (VC dummy) both have a significant negative impact on the percentage underpricing. Several measures of firm-specific uncertainty, such as the log of market-to-book value, the dummy for biomedical start-ups and the aftermarket standard deviation, are clearly associated with higher levels of underpricing. It is surprising, however, that also firm size, measured by the log of employment, and an indicator of marketing success or maturity, the log of sales per employee, have significant positive coefficients. In line with the winner's curse, one would expect that uncertainty is lower and relevant information more evenly distributed, the larger and the more mature an IPO candidate. A further surprise is the negative, but insignificant dummy coefficient for the bubble years of 1999 and 2000, which suggests that underpricing was lower in this period after controlling for other relevant determinants. However, this finding may be consistent with the learning hypothesis which views cycles in IPO activity and pricing as an endogenous implication of information spillovers, and not as an exogenous aberration.

With regard to the certification hypothesis, the evidence is mixed. While the underwriter rank is insignificant, the presence of venture capital backing has a substantial and significant negative impact on the level of underpricing on the Neuer Markt. Moreover, the selling intensity of venture capitalists at the IPO (VC sales dummy) also has the expected sign, the effect being positive and significant. This suggests, in line with theoretical predictions, that the credibility and effectiveness of certification is reduced when a venture capitalist sells a large part of her stake at the time of the IPO.

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dilution factor is the number of primary shares issued divided by the total number of outstanding shares prior to the IPO.

With regard to the learning hypothesis, more detailed information is provided by Model 2. In this regression, the VC dummy is replaced by variables that distinguish between IPOs where several, not mutually exclusive categories of venture capitalists are involved, such as those with a self-reported focus on information technology and biomedical ventures (high-tech focus), those receiving some form of government subsidies (public support), those operating as independent firms (independent VC) and those with more than 9 professional employees (large VC). In the latter case, the dummy captures the *average* size of the venture capital firms involved, while the other three dummies take the value one already when only one venture capital firms of those participating in the IPO meets the criterion. In addition, the variable "average VC age" is added to estimate the impact of the average age of the venture capital firms involved in an IPO at that time.

Prima facie, the significant positive coefficient of "average VC age" seems to contradict the prediction of the learning model that younger venture capitalists experience higher levels of underpricing. Moreover, the increase due to a relatively *large VC* size is at odds with the learning model, although the latter is significant only at the unconventional 17 percent level. Even so, this evidence cannot count as an unqualified rejection of the learning hypothesis since the dummy for independent venture capital firms has a highly significant *negative* impact on underpricing. Given the fact that independent venture capital firms tend to be younger on average than the captives involved in the Neuer Markt IPOs, multicollinearity may explain why the "average VC age" has a small positive impact on underpricing after controlling for the presence of independent venture capital backing. Moreover, also the highly significant increase in underpricing due to a *high-tech focus* may be consistent with the learning model if these are IPOs backed by venture capitalists still learning their trade. In a similar vein, the learning hypothesis can reconcile the observation that the VC

sales dummy, which now does not capture selling intensity by only the fact that some venture capital shares are sold at the IPO is negative, at the 15 percent level of significance: because of their more valuable management support, only the older and more experienced venture capital firms may be in a position to afford selling shares at the IPO without unduly damaging their reputation.

The rather limited sample from the Nouveau Marché, in which only a subset of the potential explanatories are observed without serious multicollinearity, allows no more than tentative inferences to be made. Only the most important explanatory variables were included in the regressions reported as Model 3 to 5. Once again, the log of market-to-book value, an ex ante indicator of firm-specific uncertainty due to unobservable human capital, and the aftermarket standard deviation, the ex post indicator of firm-specific uncertainty, have significant positive coefficients. Moreover, market conditions, such as market trend and the calendar day have a similarly large influence as in the Neuer Markt sample. The age of an IPO candidate has no significant impact on underpricing.

Surprising is the finding in Model 3 that the presence of venture capital backing increases underpricing, instead of reducing it, although the level of significance is only 13 percent. This observation may be consistent with the signalling hypothesis if most of the French venture capitalists are still young and hence in signalling mode, bringing premature portfolio firms to market. In this case, the positive coefficient for the age of IPO firms could – in part – be due to a negative correlation between venture capital backing and age, so that a relatively large proportion of old firms are without venture capital backing and without the limited certification effect that is consistent with the signalling hypothesis for young venture capitalists bringing premature firms to market.

Models 4 and 5 show that, due to the small sample from the Nouveau Marché, it is not possible to analyse in detail what determines the positive impact of the VC

dummy on underpricing. Model 4 shows that the impact of the VC sales dummy is not significant when other dummies related to the presence of different categories of venture capital firms are included. Moreover, neither the binary dummy for a young average age of venture capital firms involved in the IPO, nor the "average VC age" included in Model 5 have a significant impact on underpricing. This finding, however, is consistent with the prediction of the signalling model that the age of a venture capitalist has no influence on underpricing after controlling for all the relevant determinants. The last column of Table 26 reports a combined regression, in which the more numerous IPOs on the Neuer Markt dominate, but in contrast to the Neuer Markt models, the dummy variables for VC presence and VC sales are no longer significant.

To study the second endogeneity problem, I will now focus on the most likely channel of information spillovers in IPO underpricing consistent with the learning hypothesis: the accumulation of venture capitalists' reputation through their success in certifying the quality of a series of IPOs in which they participate as a private equity investor. Learning may affect the valuation of future IPOs backed by a particular venture capitalist in two ways. First, a large underpricing in prior IPOs may persuade outside investors that the venture capitalists backing them have more certification power than expected so that less underpricing is required to compensate investors for the risk of participating in future IPOs. Second, the venture capitalists themselves may learn how to value their portfolio firms more accurately, how to select the most promising ones for an IPO and how to bargain with underwriters about the conditions and the pricing of a forthcoming issue. In principle, there may be other relevant channels for information spillovers, such as those linking sequential IPOs from a particular field of technology, regardless of the underwriter or venture capitalist backing them. But I will ignore them here because there is no obvious

econometric framework in which a multitude of spillover channels can be studied simultaneously.

5.4 A dynamic panel model

My framework to test for information spillovers from the prior IPOs backed by a particular venture capitalist is a dynamic panel model. The IPOs observed for the portfolio firms of different venture capitalists are assembled in temporal sequence for each of the associated venture capitalists. A maximum of four time series observations is used in each cross section unit of this panel dataset; new cross section units are created if a particular venture capitalist has backed more than four different IPOs during the sample period since the asymptotic efficiency of the estimator primarily depends on the size of the cross section. To allow for information spillovers, the set of explanatories is augmented by a lagged endogenous regressor that measures the underpricing observed in the latest prior IPO backed by a particular venture capitalist. The learning hypothesis, in contrast to the signalling model, implies that lagged underpricing influences the performance of the current IPO in such a way that the underpricing associated with less experienced venture capitalists gradually declines towards the long-term mean observed for all venture-backed IPOs over time. The coefficient on lagged underpricing should fall into the interval (0,1) if the learning hypothesis is true.

Stated formally, I estimate an autoregressive-distributed lag model of the form

$$Y_{it} = \gamma + \alpha Y_{i,t-1} + \beta x_{it} + (\eta_i + \vartheta_{it})$$

with index i = 1, 2, …, N for different venture capitalists and a time index t = 2, 3, …,T counting the number of IPOs backed by a particular venture capitalist. Y_{it} denotes the underpricing observed for the t^{th} IPO backed by venture capitalist

i. In line with the random effects model, η_i is an unobserved individual-specific time-invariant effect which allows for heterogeneity in the means of the Y_{it} series across individuals, and ϑ_{it} is a disturbance term, assumed to be independent across individuals. Under the further assumption that η_i and ϑ_{it} have the usual error component structure with $E(\eta_i)=0$, $E(\vartheta_{it})=0$, $E(\vartheta_{it}\eta_i)=0$ for i=1, …, N and t=2, …, T and $E(\vartheta_{it}\vartheta_{is})=0$ for I=1, …, N and $\forall t \neq s$, there will be sufficient moment restrictions to identify and estimate α for $T \geq 3$, using the General Method of Moments (GMM). Since the individual effects are stochastic, they are inevitably correlated with the lagged dependent variable $Y_{i,t-1}$. The vector of exogenous explanatory variables is denoted x_{it} and is assumed to be uncorrelated with the disturbance term, so that $E(X_{is}\vartheta_{it})=0$ for S=1, … T and t=2, …T.

The presence of information spillovers formally implies that α is significantly different from zero, although not necessarily positive as long as $|\alpha|<1$. If α is positive, the adjustment of expectations in response to information revealed in the underpricing of prior IPOs backed by a particular venture capitalist is smooth and convergence to the long-term mean level of underpricing is monotonic on average. A monotonic decline in underpricing can be attributed to the accumulation of experience in bringing firms to market, fully in line with the learning hypothesis.

If α is negative, the adjustment is oscillating, with above average underpricing followed by below average underpricing, and vice versa. In this case, there is no long-term improvement in the certification provided by the venture capitalists. Nor is there a long-term decline in the compensation – through underpricing – that outside investors require to buy the shares from new IPOs in a series of IPOs backed by a particular venture capitalist. Instead, the oscillating adjustment suggests that venture capitalists are trying to adjust to some average – and

perhaps optimal – level of underpricing through a process of trial and error. While this is clearly at odds with symmetric learning, the notion of an optimal level of underpricing is not necessarily inconsistent with the signalling hypothesis, in which young venture capitalists take portfolio firms public prematurely to signal their own quality as specialized financial intermediaries.

In principle, one can estimate a dynamic panel in levels, and results for the IPOs backed by venture capitalists on France's Nouveau Marché are reported in Table 27, column 1.[4] This regression is not directly comparable with the regressions reported in Table 26 since the panel of Table 27 includes only IPOs that are backed by identified venture capitalists, and none without such backing. Even so, the results reported in Table 27 do confirm most of the coefficients for the exogenous variables that are reported to be significant in the best fit of Table 26, column 5: in particular, the positive impact of age, of the market-to-book-ratio and of the market trend. Moreever, also the coefficient for aftermarket standard deviation is estimated to be large and positive, in line with theoretical expectation.

However, the coefficient of interest in the panel model, the influence of lagged underpricing on the current underpricing of IPOs backed by a particular venture capitalist turns out to be insignificant. This need not yet invalidate the spillover hypothesis, of course, since the inclusion of a lagged endogenous regressor implies an asymptotic bias when the model is estimated in levels and by OLS.

The econometric literature makes several suggestions how to avoid this bias. An early suggestion has been to transform the model by taking first differences and to use an instrumental variable estimator. However, Alonso-Borrego and

Arellano (1999) show that the preferred instruments in the difference panel estimator, the lagged levels of the endogenous regressor, are usually too weak to avoid a bias in finite samples, especially in the case of persistent explanatory variables. Blundell and Bond (1998) therefore suggest a system panel estimator that simultaneously uses both the difference panel data and the data from the original level specification. They show that using the lagged differences of the endogenous regressor variables as instruments for the regression in levels generates large increases in consistency and efficiency. These instruments for the level equations are appropriate as long as the differences are uncorrelated with the individual-specific effects ϑ_{it}, although there may by correlation between the lagged levels and ϑ_{it}.The lagged levels of the endogenous regressor continue to serve as instruments for the equation in differences.

Table 27, columns 2 to 4, reports the results from the system GMM estimator, including two specification tests. In line with Arellano and Bover (1995) as well as Blundell and Bond (1998), the Sargan test of over-identifying restrictions is reported as a test of the overall validity of the instruments employed in the estimator. This test is based on the sample analogue of the moment conditions used in the estimation process and shows that the over-identifying restrictions cannot be rejected, so that the instruments can be assumed to be valid in all of the regressions reported. The second tests examines the hypothesis that the error term is not serially correlated. This implies that there should be significant negative first-order serial correlation in the differenced residuals and no second-order serial correlation. The evidence of first-order serial correlation in the first-differenced error terms is consistent with the requirements of the dynamic panel

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[4] All the dynamic panel regressions reported in Tables 27 and 28 have been done with DPD98 for GAUSS, as described in Bond (2002) and Arellano and Bond (1998).

model. However, evidence on second-order serial correlation is unavailable since the time series in the dynamic panel of columns 2 to 4 are too short.

Looking at the coefficients of the best fit, reported in column 4, the positive impact of the market-to-book value, the aftermarket standard deviation, the market trend, and the bubble dummy is confirmed. However, neither the impact of age, nor of size, measured by the log of employment, are significant. The impact of lagged underpricing is now estimated as highly significant, yet negative. This finding thus provides further support for the signalling hypothesis and against the learning hypothesis for France's Nouveau Marché.

Two further regressions are reported in columns 5 and 6 of Table 27. These use an augmented dataset in which all cross-section units with have been augmented by including one of the nearest preceding IPOs that was backed by a different venture capitalist. The fact that the coefficient for lagged underpricing is now insignificant, while the coefficients on the exogenous regressors are merely changed in size, suggests that the coefficients for the lagged underpricing in Models 2 to 4 does indeed capture a salient information spillover, something related to the presence of prior experience of each individual venture capital firm, and not to chance alone. It is noteworthy that Models 5 and 6 also pass the specification tests, including the absence of second-order series correlation, which is now available because the augmented panel has an extra observation in each time series.

Table 28 reports the results for Germany's Neuer Markt. Again, many of the explanatory variables that were significant in the static regressions reported in Table 26, are confirmed in the panel estimates, both when using OLS (Model 1) and the system GMM estimator (Models 2 to 4). Moreover, the specification tests are acceptable in Models 2 and 3: There is significant negative first-order serial correlation and the Sargan test of overidentifying restrictions confirms the

appropiateness of the instruments. Model 4 reports the results from an extended panel that was augmented to include an additional observation in the time series that did not relate to the particular venture capitalist defining each cross section, as described for the Nouveau Marché above.[5] It does not change the basic picture, nor does it render lagged underpricing a significant influence on current underpricing.

Model 3, the preferred specification, does not only confirm that a higher market-to-book value and a greater aftermarket standard deviation tend to increase the percentage underpricing, but also that the log of leverage and the log of sales per employee have the expected negative influence. However, the impact of lagged underpricing is not significant. This casts some doubt on the validity of the learning model for Germany's Neuer Markt.

This negative finding is further confirmed when the panel is re-estimated by different econometric methods, for example in terms of orthogonal deviations and levels, as reported in Table 28, column 6. In the within-groups model, reported in column 5, the coefficient on lagged underpricing even appears to turn negative, but this estimate is too small and insignificant to alter the conclusion: no information spillovers can be detected that would lend support to the learning hypothesis for the venture capitalists who divest their portfolio firms on Germany's Neuer Markt. Although the within groups model is likely to be biased under the assumptions made here, it can provide useful insights if interpreted in conjunction with the levels regression (Model 1). As Blundell et al. (2000) point out, the within-groups model and the levels regression have asymptotic biases in opposite directions, downwards in the case of the former

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[5] Note that Model 4 in Table 28 does not pass the specification test for no serial correlation in the error term since the differenced errors exhibit second-order serial correlation, but no first-order serial correlation.

and upwards in the case of the latter if the true coefficient on the lagged endogenous regressor is positive. The overall impression of zero information spillover is thus confirmed.

As a final piece of evidence, one can look at the results from a dynamic panel regression that includes lagged underpricing as the only explanatory variable: $Y = 44.41\,[3.01] + 0.09\,[0.34]\,Y_{t-1}$, with t-statistics in brackets. The specification tests for this model reveal first-order serial correlation in the errors in first differences – 0.12 [1] with p=0.73 – and a Sargan test of overidentifying restrictions of 2.70 [4] and p=0.61. The regression is based on 72 observations distributed across 31 cross section units.

6. Related literature

Determinants of underpricing. The findings of the present paper are broadly in line with previous studies that have provided evidence on the determinants of underpricing. The bulk of the evidence lends support to the winner's curse hypothesis by corroborating the importance of uncertainty and asymmetric information as well as the role of financial intermediaries in certifying the unobservable qualities of issuers and lowering the level of underpricing. For example, Ljungqvist (1997) found that the stock market trend, the macroeconomic climate, inside retention rates and an issue's inverse offer size affect underpricing positively on Germany's primary equity market even before the 1990s' boom. Over longer horizons, however, he showed German IPOs to be poor investments loosing more than 12 per cent over the first three years of trading relative to the market, exclusive of the initial underpricing return. A qualitatively similar picture now emerges from the bubble years of the Neuer Markt.

For the French primary market, by contrast, there is some evidence in favour of the signalling model of underpricing: Faugeron-Crouzet et al. (2001) show that the degree of underpricing varies with the type of subsequent securities issued within a four-year period after an IPO on France's second-tier market between 1983 and 1994. Underpricing averaged 31 percent for firms that issued further equity shares, but only 13 percent for those that subsequently issued convertible bonds or securities with warrants attached. However, this evidence was mainly driven by IPOs that were introduced at fixed prices, not by auction methods like the bookbuilding procedures now popular in most countries. With this qualification in mind, the authors suggest that market feedback also plays a role in explaining issuing behaviour after a successful IPO.

Habib and Ljungqvist (2001) provide a more general test of optimising behaviour as a determinant of underpricing. In their model, the owners of IPO candidates seek to solve a multidimensional problem in which the level of underpricing is influenced by deliberate choices about the effort to promote an issue, such as the expenses incurred by choosing a reputable underwriter and a suitable exchange for the listing. The authors argue that the extent to which owners trade off underpricing and promotional effort is determined by the minimization of their own expected wealth losses and therefore depends on the owner's participation in the offering and the magnitude of the dilution they will suffer on retain shares. Evidence from a sample of IPOs in the US confirms this empirical prediction.

Other evidence suggests that it is not only reputable underwriters, but also venture capital firms that can lower underpricing through their certification of IPO quality. The participation of a reputable venture capitalist may therefore help to improve the trade off that an IPO candidate faces. Lerner (1994) provides one of the pioneering empirical studies of how the decision to go

public is influenced by venture capitalists. It examines the timing of initial public offerings and private financings by venture capitalists in a sample of 350 venture backed new technology-based firms between 1978 and 1992 and shows that firms tend to go public when equity valuations are high, employing private financings when values are low. Seasoned venture capitalists are shown to be the most successful at timing IPOs to coincide with market peaks. While this finding supports the hypothesis that venture capitalists are learning by doing, it also raises the question whether venture capital's influence on the timing of IPOs may be detrimental to the welfare of outside investors by luring them into over-valued issues during a market bubble.

Learning and bubbles. The relationship between investor learning and hot issue markets, or bubbles, has been a focus of several theoretical and empirical studies. On the empirical side, Lowry and Schwert (2002) have sought to determine whether IPO market cycles are bubbles or evidence of sequential learning. Based on US data from the strong cycles in the number of IPOs and in the average initial returns from 1960 to 1997, they find that initial returns are predictably related to past initial returns and also to future IPO volumes at the aggregate level. In more detailed results, the authors show that aggregate IPO cycles occur because of the time it takes to complete an IPO, because similar types of IPOs cluster in time, and because information spillovers are important.

In a theoretical model, Hoffmann-Burchardi (2001) shows how information revelation and underpricing can explain the temporal clustering of IPOs. By analysing sequential going-public decisions, Hoffmann-Burchardi derives conditions under which the likelihood of a second initial public offering increases after a first firm has gone public and hot issue markets arise – with a higher degree of underpricing than in cold issue markets. Asymmetric and costly information about firm quality and industry prospects are driving the result. The

owners of privately held firms may want to sell because they are risk averse and respond to an increased uncertainty of industry prospects conveyed by a first IPO. At the same time, investors can free ride on the industry news and increase their valuation of the second IPO by abstaining from further costly information production.

The presence of information externalities makes room for financial intermediaries to play a useful role in coordinating the timing of IPOs, which may help to improve the overall efficiency of going public for an industry with many start-ups. Benveniste et al. (2002) argue that firms going public reveal information that influences the production decisions of rivals as well as their own and that market failures can occur when the information production costs are borne primarily by pioneering firms. Both pioneers and their followers may remain private for too long and make ill-informed investment decisions as a consequence. Solving this coordination problem, the authors argue, requires a transfer between pioneers and followers that leads to a more equitable distribution of information production costs. In their model, underwriters can enforce such a transfer by bundling IPOs within an industry.

It is conceivable that venture capital firms can play a similar role. In doing so, they are even better placed to take industry prospects into account if they are technologically specialized and actively involved in the management of their portfolio firms. Where the learning model applies, government subsidies can therefore not only enhance the efficiency of venture capital, but also help to solve the coordination problems that often arise when private investment

decisions create informational externalities in fast growing industries whose expansion typically relies on equity finance.[6]

Divergence of opinion. The particular relevance of the learning hypothesis for fast growing technology-based industries stems from the observation that investors will in many cases hold widely diverging opinions about the long-term prospects of radical new technologies. Miller (1977) argued that greater divergence of opinion or uncertainty about an initial public offering can generate both short-run overvaluation and long-term underperformance. In support of this suggestion, Houge et al. (2001) find that a wide opening spread and a high flipping ratio tend to be associated with poor long-term returns in the US.

Allen (1993) and others have argued that a large divergence of investors' opinions about the prospects of new technologies would lead to suboptimal levels of investment if only bank credit were available, because creditors base their capital allocation on expected returns, with a risk premium depending on the degree of ex ante uncertainty. Not surprisingly, large cycles in IPO activity have historically played a crucial role in facilitating radical technological change in the economy. Jovanovic and Rousseau (2001) observe that firms entered the stock market in the 1990s at a younger age than any earlier cohort since the close of the 19th century. They argue that the electrification era and the era of information technology shortened the life span of firms before going public because these technologies were so productive that they did not require a long learning period to convince investors of their potential. The better an idea, the higher is the opportunity cost of delaying its implementation, and the earlier will the firm have its IPO, say Jovanovic and Rousseau.

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[6] More general policy implications of bubbles in primary equity markets are discussed in Ploog and Stolpe (2003).

However, there is another side to the story. While IPO cycles with temporary overvaluation may serve a useful purpose in resolving technological uncertainty, they may also increase the social costs of going public by making issuers complacent about leaving money on the table. In this vein, Loughran and Ritter (2002) have argued that issuers from the most dynamic areas of high technology may care less about latent agency problems vis-à-vis underwriters as the valuation of shares from these areas in primary equity markets heats up. In the US, for example, the average first day return was less than 15 percent during 1990 to 1998, but then jumped to 65 percent during the bubble years of 1999 and 2000. If the complacency about leaving money on the table is part of the social costs of going public, then venture capital firms may have a role to play in reducing these costs by helping to overcome the agency problems and by lowering underpricing through their part in certifying issuers' long-term prospects.

Overinvestment and learning. In the learning model, venture capital firms may of course not immediately be able to mitigate the social costs of IPO cycles. Indeed, when the supply of high-quality venture capital – with the ability to screen, nurture and certify the quality of technology-based start-ups – is inelastic in the short run, venture capital's involvement may even exacerbate the cycles. In this case, the unwinding of venture capital investments in primary equity markets may have adverse welfare implications. Hot issue markets that are confined to narrow areas of technology, such as biotechnology or multimedia applications, may lead to overinvestment in the technologies that enjoy a temporary bonanza. At the same time, other technologies might not be developed simply because they are out of fashion in the stock market.

In the US, Gompers and Lerner (1999), p. 136, have indeed found a strong relationship between the pre-IPO valuation of venture capital investments and

prior capital inflows and estimate that a doubling of inflows triggers an increase in valuation levels between 7 and 21 percent. As a result, the investment portfolios of different venture capitalists may become too similar, so that opportunities in other areas of technology are missed and the performance is depressed. In the longer term, such an impasse may be resolved provided that venture capital firms are in learning mode, setting them on different paths of technological specialization so that herding will become less of a problem in their investment choices as the industry matures.

Learning, of course, requires that not only the more successful portfolio investments – those that venture capitalists take public – are evaluated, but also the less successful investments that are exited through bankruptcy or a trade sale. As an example, Cochrane (2001) provides a detailed empirical study of risks and returns of venture capital that encompasses all three types of exits to avoid selection bias. Using a maximum likelihood estimator that corrects for any remaining selection bias, he finds a mean log return of only 7 percent against 100 percent before the correction. The arithmetic average returns in his sample are much higher, around 700 before selection bias correction and still 53 percent after the correction. On this basis, venture capitalists still have plenty to learn even in the US, where Cochrane's data was collected. The more elastic the supply of high quality venture capital, the stronger should be its mitigating impact on some of the socially wasteful aspects of IPO cycles.

7. Concluding remarks

Public support for venture capital in Europe has been substantial during the 1990s and continues to be so. This paper has asked whether generous subsidies can be expected to improve the industry's efficiency, and not merely its size. Caution may be in order because subsidies can create a variety of incentive

problems of their own. For example, subsidies may attract poor managers into venture capital firms and may thus reduce the quality of screening, monitoring, control and ongoing management support for venture-backed firms. In this case, it is even conceivable that subsidies raise the total user costs of venture capital for all those technology-based start-ups that primarily want to benefit from solid management support or from the advertisement and certification effect of having won venture capital backing. For these start-ups, the direct financial resources that a venture capitalist provides may be much less important than the effective support in going public.

The present paper provides the first evidence that venture capital in France operates according to the signalling model, and venture capital in Germany according to the learning model. The latter finding helps to solve the empirical puzzle in previous studies that found venture capital backing to result in higher, not lower levels of underpricing on Germany's Neuer Markt. In the signalling model, new entrants into the venture capital business may already possess a high quality of screening, monitoring and management supporting services and will seek to signal their quality to outsiders by taking portfolio firms public early so that underpricing of these IPOs is inevitably higher. In the learning model, young venture capital firms do not take their portfolio firms public at a premature stage, but they also experience higher levels underpricing because the screening, monitoring and management supporting services of the young is of lower quality than the services provided by older, more experienced venture capital firms. Given the different nature of financing gaps for small firms in France and Germany, as described in section 4.1, it is not surprising to find substantial differences in the behaviour and strategies of venture capital investors.

Only the learning model can serve as a theoretical rationale for government subsidies. The present findings therefore do suggest that policies of fiscal support for venture capital need not and should not be uniform within Europe's common market. Instead, the principle of subsidiarity should apply. Moreover, my findings also suggest that regulations play a crucial role in facilitating the efficient operation of venture capital and other financial intermediaries in primary equity markets. Full information disclosure can in principle serve as a substitute for a long track record of profitability. Indeed, many analysts in the early and mid-1990s thought that this would permanently reduce access barriers to primary equity markets for those fast growing start-ups that develop large capital requirements long before they become profitable. It was generally overlooked that in the fastest growing areas of high technology, intellectual property rights are often incomplete and difficult to secure without undue delay in the legal system, especially outside the US, so that stringent disclosure is a two-edged sword. On the one hand, it can reduce the need for IPO candidates with the better long-term business prospects to signal their quality by means of underpricing or to use underpricing as an implicit insurance promise for poorly informed outside investors. On the other hand, too much information disclosure about new technologies and business strategies may help imitators and other competitors and may thus reduce the part of the social returns from an innovation that the innovator can privately appropriate. The incentives to innovate are then mitigated.

Regulators must be aware that the extent and stringency of disclosure requirements affects a trade-off between the need for IPO candidates to signal their quality through underpricing and the opportunities of venture capital firms and other financial intermediaries to use premature IPOs as a signalling device to support their own entry and competitive position in the IPO market. In practice, regulations may, for example, set rules for the discriminatory allocation

and pricing of shares by underwriters in primary equity markets. Such rules can help to set incentives for the revelation of dispersed valuation information that outside investors may hold so that underpricing is reduced and the signalling strategy in which a young venture capitalist brings premature portfolio firms to market becomes less risky and costly in terms of money left on the table. Across countries, there continues to exist a great diversity in the rules that affect underwriter behaviour and the production and dissemination of information in the IPO process. Recent efforts by the European Commission to harmonize merely the formal requirements of IPO prospectuses are unlikely on their own to raise the number of Pan-European issues to a level that would initiate a common primary market for equities.

While a policy emphasis on underwriting and disclosure regulations is implied primarily by the signalling hypothesis, its importance should not be underestimated when there is a role for subsidies because a country's venture capital industry is in learning mode. This point has been highlighted by the demise of Germany's Neuer Markt in the years after 2000. Regulators must recognize that the specialized financial intermediaries that take young firms public have another role to play as information brokers. They often use underpricing and the discriminatory allocation of shares as a means to extract valuation information from outside investors as well as to attract additional investors and reduce the problem of the winner's curse in primary equity markets. They can achieve both of these objectives with a lower level of underpricing, the higher their reputation with outside investors, based on a track record of successful IPOs. They can use their reputation to certify the quality of firms going public. This role as an information broker can be played by investment banks as well as by venture capital firms. Venture capital firms have the advantage of a long-term relationship and active involvement in the management of their portfolio firms. In the long term, venture capital firms may

therefore be more efficient in certifying the quality of high-tech start-ups going public.

However, the interaction between venture capital and underwriters and its implications for the efficiency of primary equity markets remains an under-researched area in financial economics. One specific area of future empirical research is to examine how the ability of venture capital firms to raise new capital from outside investors responds to the success of portfolio firms in the IPO market. A further area that was not exhausted in the present paper is the long-term performance of venture backed IPOs relative to similar IPOs without such backing.

In the meantime, policy makers must be careful that they do not inhibit the functioning of information brokers in primary equity markets through unnecessary regulation. This is especially important in an underdeveloped primary equity market where underpricing tends to be higher. The objective of economic policy must be to support the emergence of a sufficiently diversified range of specialised financial intermediaries, which may require a long period of learning by doing. More research will be needed to understand the causes of the divergent experiences of venture capital in France and Germany, before comprehensive conclusions can be drawn as to how diversified the system of financial intermediation should be and what combination of government policies and regulations is optimal within a given country.

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Appendix A: Data sources

The sample includes initial public offerings on the Neuer Markt from the period 1997 through 2000 and from the Nouveau Marché during the period from 1996 through 2000. Data on the all share index was provided by Deutsche Börse and the Bourse de Paris. Daily share prices of individual stock from the Neuer Markt were provided by the Institut für Entscheidungstheorie und Unternehmensforschung Karlsruhe. Daily share prices of stock from the Nouveau Marché were provided by the Bourse de Paris. Firm specific data is from the IPO prospectuses of the firms, from their web sites, or from annual reports, as well as from telephone interviews. The data on characteristics of venture capital firms in France and Germany initially was collected from the annual reports of the Bundesverband Deutscher Kapitalbeteiligungs-gesellschaften (BVK), of the Association Francaise des Investisseurs en Capital (AFIC) and of the European Venture Capital Association (EVCA). This information was supplemented with data from Plötz (2001) on the Neuer Markt IPOs, from Hamel and Hugot (1998) and Hugot (2000) on the Nouveau Marché IPOs and from two electronic surveys and telephone interviews in both countries. The Bourse de Paris also provided information on the offer prices, gross proceeds, offer price ranges, number of shares sold and the names of the underwriters for all firms going public on the Nouveau Marché. The same information was obtained from the prospectuses of firms going public on the Neuer Markt.

The venture capitalists involved in IPOs on France's Nouveau Marché from 1996 through 2000 are as follows: 21 Société centrale, 3i, ABN-AMRO Capital France, Access2Net, Acland, ACTIDEV, Advent International, AGF Private Equity, AGRO Plus, Air Liquide Ventures, Alliance Entreprendre, Alpha, Asace Création, Alta, Berkeley Associates, Alternative Ventures, Apax Partners & Cie,

Apollo Invest, Aquitaine Création Innovation – ACI, Ardèche Participation, Argos Soditic, Astorg, Atlas Venture, Atria Capital Partenaires, Auriga, Avenir Entreprises Gestion, Avenir Tourisme, Axa Investment Managers Private Equity Europe, AZEO, Banexi Ventures, Banque de Vizille, Barclays Private Equity, Baring Private Equity Partners, BBS Finance, BC Partners, BIOAM, BNP Paribas Développement, BNP Private Equity, Brantley Venture Partners II L.P., Bretagne Investissements, Bretagne Participations, Bretagne Jeunes Entreprises, Bridgepoint Capital, Butler Capital Partners, Capital Investissement Franche-Comté, Capital Privé, Carlyle Group, CDC Innovation, CDC-Equity Capital, CDC-Services Industrie Electropar France, Environmental Investment Partners, CDC-Valeurs de Croissance, Centre Capital Développement, Charterhouse, Chevrillon-Candover, CICLAD, CINIDEV, CINVEN, CITA, Clam Private Equità, COFINEP, Compagnie Financière du midi Toulousain, Compagnie Financiére Edmond de Rothschild, Croissance Nord Pas-de-Calais, CVC, Capital Partners, Dassault Développement, ELECTRA Partners Europe SA, EMERTEC, EPF Partners, EPICEA, ESFIN Gestion, EUREFI, EURO Capital, EuropaWeb, Expanso, FEMU QUÌ, FILTARN, Finadvance, Finama Private Equity, Finances & Stratégies, Financière d'Aquitaine et du Grand Sud-Ouest, Financière de Brienne, Financière Galliéra, Financière Natexis Banques Populaires, Financière Tuileries, Financiére Voltaire, Finexplus, FINORPA,Fonds Partenaires, FRFI-ALSACE, Galileo, GIMV NV, Group LMBO, Herrikoa, IDEB, IDI Euridi, IDI Kairos Ventures, IDPC, Ile-de-France Développement, Industries & Finances, Initiative & Finance, Innovacom, Innoven Partenaires, Institut Lorrain de Participation – ILP, Intuitucapital, Investir en Provence, IPBM, IPO-Institut de Participtions de l'Quest, IRDI Midi-Pyrénées, IRPAC Champagne-Ardennes, Croissance, I-Source, Jafco Investment (UK) Limited, Johnson&Johnson Development Corp., Kairos Partners, LBO France – LTI, Lebon Développement, Legal & General Ventures, Limousin Participations, Lion Expansion, LORIENT Développement, MIDI-Pyrénées

Création, Multicroissance, Natexis Industrie, Naxexis Investissement, Nord Création, Nord Innovation, Normandie PME Gestion, Océan Participations, Oppenheim Beteiligungs AG, OUEST Croissance, OUEST Développement, P.A.I. Management, Parconexi, PART'COM IN-COM Médiatel, Partech International, Participex, Pays de la Loire Développement, Pechel Industries, Picardie Avenir, Poitou Charentes Expansion, Poitou Charentes Innovation, Prime Technology Ventures NV, Privast Capital Partner, Quilvest Capital France, R.E.L., Régions Expansion, Rhône Dauphiné Développement, Rhône-Alpes Création, Robertsau Gestion, SADEPAR, Samenar, Schroder Ventures, Sebadour, Seeft Venture, SGAM Private Equity, SIPAREX Ingénierie et Finance, SNVB Participations, SOCADIF, Société Régionale de Participations, SOCRI, SODERO Participations, Sofi Paca, Sofilaro, Sofilaro Participations, SOFIMAC, SOFININDEX, Sofinnova Partners, SOFIREM, SOFRED, Sopromec, Soridec, SPEF, SPTF, SUD CAPITAL Gestion, SUDINNOVA, Synerfi S.A., Synergie, Finance Sobrepar, TCR Europe SA, Tertiaire Développement, Thomson-CSF Ventures, Tofinso, TURENNE Capital Partenaires, T-Venture, UI - Agrinova Dynamust IDIA, Uni Expansion Ouest, Unigrains, Union Européenne de cic Finance, VAUBAN Partenaires, VENTECH, and Viventures.

The venture capitalists involved in IPOs on Germany's Neuer Markt from 1997 through 2000 are as follows: 3i Gesellschaft für Industriebeteiligungen mbH, ABN AMRO Capital Gesellschaft für Beteiligungsberatung mbH, Accura Technologie Holding AG, Adir Group, AET, Alafi Capital Corp., Alpha Beteiligungsberatung mbH, Alpinvest Int. B.V., Apax, Atlas Venture GmbH, ATRIUM Private Equity GmbH, Baaderbank, BAG Aktiengesellschaft für Industriebeteiligungen, Bayern Kapital Risikokapitalbeteiligungs GmbH, BB-Kapitalbeteiligungsgesellschaft mbH (now Capiton AG), Berlin Capital Fund GmbH, Beteiligungsgesellschaft für die deutsche Wirtschaft mbH, BioMed

Venture AG, bmp AG, BWK GmbH - Baden-Württembergische Kapitalbeteiligungsges., BW-Venture Capital GmbH, Capital Management Wolpers, capiton AG, Cavendish, CEA Capital Partners GmbH&Co. Beteiligungs KG, CEA Interactive GmbH, Centro Internationale Handelsbank AG, Commerz Unternehmensbeteiligungs-AG, Croissance Discovery FCPR, DBF III, Deutsche Beteiligungs AG – Unternehmensbeteiligungsgesellschaft, Deutsche Effecten- und Wechsel-Beteiligungsgesellschaft AG, DG PRIVATE EQUITY GmbH (now DZ Equity Partner, after merger with DZ Capital Partner in 2000), DVCG Deutsche Venture Capital Gesellschaft mbH, Econa AG, equi-net Venture Partners AG, ETF Group, Evergreen Group, GAN Avenir FCPR, German Equity Partner B.V., German European Venture Capital Partners, Gold-Zack AG, GUB Unternehmensbeteiligungen AG, HANNOVER Finanz GmbH (Commerzunternehmensbeteiligungs GmbH), HASPA Beteiligungsgesellschaft für den Mittelstand, HSBC Private Equity Deutschland GmbH, HVB Beteiligungsgesellschaft mbH, IBB Beteiligungsgesellschaft mbH, IKB Beteiligungsgesellschaft mbH, Innovacom, Invesco Asset Management, IVC Venture Capital AG, Jakob Falkner, Julius Bär Kapitalanlage AG, Kapitalbeteiligungsgesellschaft der Deutschen Versicherungswirtschaft AG (KDV), KB LUX Venture Capital Fund-Biotechnology, Knorr Capital Partner AG, Lavinia, LBB –Beteiligungsgesellschaft, LBBW, Mittelständische Beteiligungsgesellschaft Baden-Württemberg GmbH, MVC Mitteldeutsche Venture Capital AG, NIB Norddeutsche Innovations- und Beteiligungsgesellschaft mbH, NORD Holding Unternehmensbeteiligungsgesellschaft mbH, Pari Capital AG , Pegasus, PINE Finanz Private Investition &Equity GmbH, Plug in Equity, pre-IPO Aktiengesellschaft, PRICAP Venture Partners AG, Prime Asset Management AG, RBS Kapitalbeteiligungsgesellschaft Rheinisch Bergischer Sparkassen mbH, Sachsen LB Corporate Finance Holding GmbH, SBG-Sparkassen-Beteiligungsgesellschaft mbH & Co. KG, Siemens Venture Capital GmbH,

Sparkassenbeteiligungsgesellschaft Heilbronn-Franken & Co. KG, Sparta, S-REFIT Regionaler Finanzierungsfonds für Innovationen u. Technologieunternehmen, Stargroup, Strategic European Technologies N.V., SüdKB Süd-Kapitalbeteiligungs-Gesellschaft mbH, S-Unternehmensbeteiligungsgesellschaft der Sparkasse Leipzig mbH, Tamar Technology Investors L.P., tbg Technologie-Beteiligungsgesellschaft mbH der Deutschen Ausgleichsbank, TCB, Technologieholding Fonds VC, TechnoStart Beratungsgesellschaft für Beteiligungsfonds mbH, TFG Venture Capital AG & Co, KGaA Unternehmensbeteiligungsgesellschaft, T-Venture Telematik Venture Holding GmbH, TVM Techno Venture Management GmbH, U.C.A. Aktiengesellschaft, Vertex, VMR Luxembourg, wellington partners venture capital gmbH, and WestKB - Westdeutsche Kapitalbeteiligungsgesellschaft mbH.

The 10 underwriters with rank 2 on Germany's Neuer Markt are the following (see Frantzke 2001): Bankgesellschaft Berlin, BHF-Bank, Commerzbank, Deutsche Bank, Deutsche MorganGrenfell, DG Bank, Dresdner Bank, HSBC Trinkaus & Burkhardt, HypoVereinsbank, Nord/LB and WestLB Panmure.

The 10 underwriters with rank 2 on France's Nouveau Marché are the following: ABN AMRO Rothschild, BNP Paribas, CCBP, CCF (Crédit Commercial de France), Charterhouse (wholly owned subsidiary of HSBC Holdings), CNCA (Credit Agricole Indosuez), Crédit Lyonnais, Natexis Capital, Société Générale and Spef Technology. The first two of these merged during the observation period.

Appendix B: Tables

Table 1 – Empirical implications of the learning and signalling models

	Signalling	Learning
Maturity of IPO firms	Young VCs have earlier IPOs.	Young VCs have later IPOs.
Performance impact on venture capitalists' ability to raise new funds	The impact is larger for young VCs.	The impact is cumulative, and not larger for young VCs.
Equity stake at IPO	Young VCs have smaller equity stakes.	Young VCs have larger equity stakes.
Level and dynamics of underpricing	Young VCs incur higher underpricing, but only because their IPO firms are younger. The age of the VC has no influence on underpricing when all other factors are controlled for.	Young VCs face higher underpricing even after controlling for age and other characteristics of IPO firms. Underpricing declines with experience, at all age groups. Technologically specialized VCs have smaller underpricing.
Information spillovers in underpricing	No	Yes
Long-term performance	No impact	Learning gradually reduces underperfor-mance of IPOs backed by a particular VC.

Table 2 – Survey answers from four French and four German venture capitalists on their support of 18 initial public offerings on the Neuer Markt and Nouveau Marché

	6 French cases	12 German cases
Board membership	4	9
thereof:		
supervisory board	1	9
Average duration of board membership prior to IPO (months)	10	9
Average age of VC's board members (years)	35–40	35–40
Percentage of board membership retained one year after the IPO	50	90
Average number of prior		
exits	2.6	3.3
via IPO	2.7	1.3
via trade sale	2.5	0.5
via bankruptcy		
Total cumulative number of portfolio firms prior to the IPO	49	22
Frequency of business		
contacts	monthly	monthly
to control performance		
to review financing stages and advise or decide on further investments	every two weeks	quarterly
Percentage of contacts related to		
business crises	12	3
routine business	17	20
business strategy	63	34
new financings	8	44
Total funds under management when the IPO firm was added to portfolio (Mio. Euro)	66	76
Prior time of venture capital activity in the country (months)	19	18

Source: Author's data set.

Table 3 – Differences between 184 French and 61 German Venture Capitalists

		French VCs		German VCs		Tests for equality of means and medians					
		Av.	Obs.	Av.	Obs.	t-test	prob.	Wilc.	Prob.	VdW	prob.
Public support (in percent)		51	153	44	57	0.92	0.36	0.91	0.36	0.84	0.36
Year of foundation		1986	180	1990	61	1.67**	0.10	2.37***	0.02	5.72***	0.02
Professional employees	1997	6.4	72	7.3	46	0.67	0.50	0.81	0.42	0.08	0.77
	1998	8.1	81	8.6	49	0.26	0.79	1.11	0.26	0.20	0.65
	1999	6.3	146	11.4	51	3.30***	0.00	3.77***	0.00	12.12***	0.00
	2000	6.8	179	14.6	56	4.58***	0.00	4.37***	0.00	18.74***	0.00
Average annual growth (in percent)		15	145	28	47	1.93**	0.05	3.25***	0.00	8.96***	0.00
Number of portfolio firms	1997	73	64	13	27	1.57*	0.12	5.95***	0.00	32.74***	0.00
	1998	82	75	13	34	2.10***	0.04	6.46***	0.00	39.45***	0.00
	1999	75	135	21	44	2.06***	0.04	5.94***	0.00	32.16***	0.00
	2000	66	169	22	51	1.91**	0.06	5.84***	0.00	33.46***	0.00
Average annual growth (in percent)		17	133	46	44	1.95**	0.05	3.04***	0.00	9.33***	0.00
Volume of investments	1997	96	69	20	23	2.55***	0.01	4.61***	0.00	22.77***	0.00
(in Mio. Euro)	1998	217	78	24	28	1.80**	0.07	4.86***	0.00	25.07***	0.00
	1999	202	137	74	38	1.48*	0.14	2.71***	0.01	6.40***	0.01
	2000	342	171	172	45	1.19	0.24	2.63***	0.01	6.15***	0.01
Average annual growth (in percent)		39	135	76	35	2.12***	0.04	0.52	0.60	0.58	0.45
Stage distribution of investments											
(in percent)	early stage	28	184	40	60	2.26***	0.02	2.58***	0.01	6.38***	0.01
	expansion	35	184	34	60	0.26	0.80	0.32	0.75	0.21	0.65
	late stage	34	184	25	60	1.82**	0.07	1.91**	0.06	3.76***	0.05

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Table 4– Differences between Venture Capitalists operating with and without government support in France

		without support		with support		Tests for equality of means and medians					
		Av.	Obs.	Av.	Obs.	t-test	Prob.	Wilc.	Prob.	VdW	Prob.
Year of foundation		1987	75	1988	78	0.16	0.87	0.43	0.66	0.11	0.74
Dependent VC's in percent		25	75	21	75						
Specialization in percent											
high-tech		21	75	13	75						
industry and services		13	75	8	75						
None		65	75	79	75						
Professional employees	1997	7.1	32	4.7	32	1.78**	0.08	1.71**	0.09	3.48***	0.06
	1998	10.2	37	5.3	35	2.02***	0.05	1.72**	0.08	3.95***	0.05
	1999	8.6	62	4.4	61	2.76***	0.01	2.93***	0.00	10.27***	0.00
	2000	8.7	75	5.5	76	2.41***	0.02	2.30***	0.02	6.44***	0.01
Average annual growth (in percent)		12	62	15	60						
Number of portfolio firms	1997	42	30	54	31	1.09	0.28	0.95	0.34	0.99	0.32
	1998	69	35	52	35	1.09	0.28	0.07	0.94	0.01	0.94
	1999	74	59	52	59	1.43	0.15	0.08	0.94	0.00	0.99
	2000	61	72	48	75	1.15	0.25	0.56	0.58	0.23	0.63
Average annual growth (in percent)		12.7	58	22.8	59	0.62	0.54	0.30	0.77	0.19	0.66
Volume of investments	1997	136	34	59	33	2.27***	0.03	1.68**	0.09	2.48***	0.12
(in Mio. Euro)	1998	355	40	67	35	2.23***	0.03	1.99**	0.05	3.60***	0.06
	1999	370	61	71	60	3.18***	0.00	4.47***	0.00	19.49***	0.00
	2000	671	73	96	77	3.88***	0.00	4.13***	0.00	16.90***	0.00
Average annual growth (in percent)		41	59	33	60	0.60	0.55	0.15	0.88	0.00	0.96
Stage distribution of investments											
(in percent)	early stage	26	75	28	77	0.37	0.71	0.32	0.75	0.49	0.48
	expansion	33	75	36	77	0.66	0.51	0.67	0.50	0.44	0.51
	late stage	40	75	34	78	1.07	0.28	0.75	0.45	0.93	0.33

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Table 5 – Differences between Venture Capitalists operating with and without government support in Germany

		without support		with support		Tests for equality of means and medians					
		Av.	Obs.	Av.	Obs.	t-test	prob.	Wilc.	Prob.	VdW	Prob.
Year of foundation		1990	32	1991	25	0.73	0.47	0.85	0.40	0.51	0.48
Dependent VC's in percent		24	75	32	75						
Specialization in percent	high-tech	18	75	24	75						
	industry and services	6	75	8	75						
	none	69	75	68	75						
Professional employees	1997	8.3	26	6	19	0.92	0.36	0.02	0.98	0.07	0.78
	1998	9.1	27	7.9	21	0.44	0.66	0.57	0.57	0.08	0.77
	1999	11	27	11.9	23	0.26	0.80	0.96	0.34	0.74	0.39
	2000	14	30	15	24	0.20	0.84	1.28	0.20	1.15	0.28
Average annual growth (in percent)		16	25	43	21	2.10***	0.04	1.52*	0.13	3.15***	0.08
Number of portfolio firms	1997	7.6	17	22.4	9	1.37*	0.18	1.03	0.30	1.45*	0.23
	1998	8.2	19	19.8	14	1.13	0.27	1.10	0.27	1.45*	0.23
	1999	23.5	24	19.1	19	0.29	0.78	1.32*	0.19	1.38*	0.24
	2000	20.3	28	22	21	0.12	0.90	2.61***	0.01	6.15***	0.01
Average annual growth (in percent)		23	24	72	18	2.08***	0.04	3.00***	0.00	8.36***	0.00
Volume of investments in Mio. Euro	1997	23	14	16	9	0.52	0.61	0.25	0.80	0.11	0.74
	1998	26	14	21	14	0.39	0.70	0.74	0.46	0.49	0.49
	1999	113	20	32	18	0.86	0.40	1.55*	0.12	1.58*	0.21
	2000	258	26	54	19	1.01	0.32	2.23***	0.03	3.74***	0.05
Average annual growth (in percent)		82	19	70	16	0.24	0.82	0.71	0.48	0.41	0.52
Stage distribution of investments (in percent)											
early stage		39	31	39	25	0.08	0.94	0.41	0.68	0.09	0.77
expansion		33	31	36	25	0.40	0.69	0.76	0.45	0.29	0.59
late stage		24	31	25	25	0.09	0.93	0.40	0.69	0.21	0.65

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Table 6 – Differences between dependent and independent venture capitalists in France

		Dependent VCs		Independent VCs		Tests for equality of means and medians					
		Av.	Obs.	Av.	Obs.	t-test	prob.	Wilc.	Prob.	VdW	Prob.
Year of foundation		1986	133	1985	47	0.15	0.88	0.95	0.34	0.73	0.39
Public support (in percent)		52	115	47	38						
Specialization (in percent)	high-tech	17	133	22	50						
	industry and services	12	133	6	50						
	none	71	133	72	50						
Professional employees	1997	5.1	49	9.1	23	2.43***	0.02	3.16***	0.00	8.80***	0.00
	1998	7.9	54	8.4	27	0.20	0.84	2.29***	0.02	4.18***	0.04
	1999	6.2	108	6.6	38	0.26	0.80	2.41***	0.02	4.13***	0.04
	2000	6.7	130	7	49	0.24	0.81	2.02***	0.04	3.13***	0.08
Average annual growth (in percent)		42	107	14	38	2.76***	0.01	2.97***	0.00	9.23***	0.00
Number of portfolio firms	1997	50	48	142.2	16	1.63*	0.11	0.22	0.83	0.16	0.69
	1998	63.2	54	129.1	21	1.37*	0.18	0.06	0.95	0.04	0.85
	1999	67.1	102	98.1	33	0.92	0.36	0.68	0.50	0.22	0.64
	2000	59.6	124	84.4	45	0.87	0.39	1.50*	0.13	2.09***	0.15
Average annual growth (in percent)		19	100	13	33	0.33	0.74	0.85	0.39	0.25	0.62
Volume of investments in Mio. Euro	1997	76	52	159	17	2.18***	0.03	3.16***	0.00	9.54***	0.00
	1998	161	58	379	20	1.50*	0.14	3.41***	0.00	10.74***	0.00
	1999	144	107	406	30	2.54***	0.01	2.70***	0.01	6.68***	0.01
	2000	202	129	772	42	3.71***	0.00	2.39***	0.02	6.09***	0.01
Average annual growth (in percent)		33	104	61	31	1.93**	0.06	2.07***	0.04	3.19***	0.07
Stage distribution of investments (in percent)											
early stage		29	131	28	50	0.21	0.83	0.50	0.62	0.55	0.46
expansion		39	131	27	50	2.71***	0.01	2.63***	0.01	7.00***	0.01
late stage		32	131	39	50	1.33*	0.18	0.73	0.46	0.92	0.34

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Table 7 – Differences between dependent and independent venture capitalists in Germany

		Dependent VCs		Independent VCs		Tests for equality of means and medians					
		Av.	Obs.	Av.	Obs.	t-test	prob.	Wilc.	Prob.	VdW	Prob.
Year of foundation		1990	38	1992	14	0.56	0.58	0.24	0.81	0.09	0.77
Public support (in percent)		43	37	62	13						
Specialization (in percent)	high-tech	17	41	47	15						
	industry and services	7	41	0	15						
	none	76	41	53	15						
Professional employees	1997	6.2	30	11.4	11	1.76**	0.09	1.35*	0.18	1.98***	0.16
	1998	7.8	31	12.5	12	1.52*	0.14	0.91	0.36	0.97	0.33
	1999	10.4	32	16.5	13	1.51*	0.14	0.80	0.42	1.09	0.30
	2000	12.4	37	24.3	13	2.01***	0.05	1.26	0.21	2.05***	0.15
Average annual growth (in percent)		23	30	46	12	1.42*	0.16	0.37	0.71	0.38	0.54
Number of portfolio firms	1997	5.8	17	32.1	7	2.26***	0.03	3.05***	0.00	9.60***	0.00
	1998	7.3	22	30	9	2.01***	0.05	1.53*	0.13	2.89***	0.09
	1999	20.9	26	24.5	13	0.20	0.84	0.58	0.56	0.50	0.48
	2000	20.5	32	30.6	13	0.60	0.55	1.72**	0.09	3.07***	0.08
Average annual growth (in percent)		36	26	85	13	1.63*	0.11	0.36	0.72	0.53	0.47
Volume of investments in Mio. Euro	1997	19	17	39	3	0.92	0.37	1.64*	0.10	2.63***	0.11
	1998	23	20	30	5	0.36	0.72	0.68	0.50	0.58	0.45
	1999	30	25	247	8	1.78**	0.08	0.76	0.45	0.81	0.37
	2000	73	30	582	9	1.94**	0.06	2.22	0.03	5.26***	0.02
Average annual growth (in percent)		44	23	216	7	2.85***	0.01	2.02***	0.04	5.00***	0.03
Stage distribution of investments (in percent)											
early stage		38	37	36	14	0.18	0.86	0.04	0.97	0.01	0.91
expansion		31	37	42	14	1.18	0.24	1.44*	0.15	2.26***	0.13
late stage		31	37	15	14	1.61*	0.11	1.24	0.21	1.83**	0.18

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Table 8 – A comparison of initial public offerings on Germany's Neuer Markt and France's Nouveau Marché

	Neuer Markt		Nouveau Marché		t-test
	A	O	A	O	
Percentage of firms belonging to the					
IT industry	63.7	325	73.6	129	
biomedical industry	9.2	325	9.3	129	
other manufacturing and services	24.9	325	14.0	129	
financial services	2.2	325	3.1	129	
Sales growth in the two years prior to IPO (in per cent)	172	322	227	121	-0.74
Employment growth in the two years prior to IPO (in per cent)	95	310	141	109	-2.07
Underpricing (in per cent) rate of return					
at first day opening price	50.5	325	13.1	130	5.45
at first day closing price	122.1	325	8.8	114	2.67
Medium term performance annual rate of return from first day closing price (in per cent)					
after six months	91.6	266	98.5	100	-0.19
after twelve months	86.3	186	163.9	63	-1.61
Money left on the table (Mio. Euro)	38.6	134	5.1	134	3.41
Free float (in per cent)					
before IPO	2.3	303	2.5	131	-0.19
after IPO	33.5	303	29.4	131	3.40
Shares held by insiders (in per cent)					
before IPO	51.0	325	58.4	131	-1.99
after IPO	38.9	325	43.2	131	-1.66
Shares held by strategic investors (in per cent)					
before IPO	11.4	325	34.6	82	-7.49
after IPO	8.2	325	24.2	81	-7.03
Shares held by venture capitalists (in per cent)					
before IPO	12.6	289	8.2	134	2.31
after IPO	7.1	291	5.7	134	1.33

Notes: A = Averages; O= Observations.

Source: Author's data set.

Table 9 – A comparison of High-Tech and Low-Tech initial public offerings on Germany's Neuer Markt

	Low Tech		Biomedical		IT	
	A	O	A	O	A	O
Sales growth in the two years prior to IPO (in per cent)						
Employment growth in the two years prior to IPO (in per cent)						
Age (years	12.7	77	7.8	26	9.2	200
First day opening price rate of return (in per cent)	46.5	88	43.1	30	53.2	207
First day closing price rate of return (in per cent)	192	88	77	30	99	207
Six monthly rate of return from first day closing price (in per cent)	149	61	213	12	39	113
Twelve monthly rate of return from first day closing price (in per cent)	162	74	73	21	63	171
Sales growth (in per cent)						
Employment growth (in per cent)	214	88	106	29	164	204
Market to book value						
Debt equity ratio						
Issue volume (Mio Euro)	64.0	86	65.1	30	83.2	205
Money left on table (Mio Euro)	41.1	88	26.9	30	43.0	207
Free float						
prior to IPO	2.8	80	5.2	25	1.8	198
after IPO	35.6	80	33.2	25	32.8	198
Insider shares						
prior to IPO	41.4	88	41.4	30	56.5	207
after IPO	31.8	88	28.8	30	43.3	207
Strategic holdings (in per cent)						
prior to IPO	8.1	88	13.8	30	12.4	207
after IPO	6.4	88	9.7	30	8.8	207
VC share (in per cent)						
prior to IPO	14.1	64	9.7	198	4.8	22
after IPO	29.7	27	6.0	198	2.8	22

Notes: A = Averages; O= Observations.

Source: Author's data set.

Table 10 – A comparison of High-Tech and Low-Tech initial public offerings on the French Nouveau Marché

	Low-Tech		Biomedical		IT	
	A	O	A	O	A	O
Sales growth in the two years prior to IPO (in per cent)						
Employment growth in the two years prior to IPO (in per cent)						
Age (years	11.1	22	9.4	12	9.3	92
First day opening price rate of return (in per cent)	3.4	22	6.9	12	17.3	95
First day closing price rate of return (in per cent)	5	20	6	11	11	80
Six monthly rate of return from first day closing price (in per cent)	102	18	39	10	110	69
Twelve monthly rate of return from first day closing price (in per cent)	37	12	22	10	253	38
Sales growth (in per cent)						
Employment growth (in per cent)	71	20	166	11	276	86
Market to book value						
Debt equity ratio						
Issue volume (Mio Euro)	0.72	15	2.73	11	2.64	53
Money left on table (Mio Euro)	1.03	22	2.59	12	5.64	95
Free float						
prior to IPO	1.13	21	7.1	12	2.2	94
after IPO	32.4	21	25.9	12	29.3	94
Insider shares						
prior to IPO	69.6	21	42.6	12	58.8	94
after IPO	48.5	21	32.5	12	44.1	94
Strategic holdings (in per cent)	31.3	61	34.8	7	53.1	11
prior to IPO	21.6	61	28.7	7	34.0	10
after IPO						
VC share (in per cent)						
prior to IPO	4.8	22	11.5	12	8.9	95
after IPO	2.7	22	9.9	12	6.0	95

Notes: A = Averages; O= Observations.

Source: Author's data set.

Table 11 – The distribution of VC-backed and non-VC-backed IPOs in France and Germany, based on yearly data

	O	Age in years	IaC	BaM	IaS	FiS	IR	YR	Sales	Employ-ment	Debt/ equity	BMR	Equity	MLOT
			– percent –								– ratio –		(Mio. €)	(Mio. €)
Before 1998														
France VC-backed	10	12.5	50	37.5	12.5	0	-4.2	26.7	83	66	1.4	5.0	4.9	8.1
Non-VC-backed	14	11.2	46	15.4	30.1	7.7	-3.2	74.7	85	316	1.7	2.7	5.0	0.3
Germany VC-backed	5	6.3	40	0	60	0	62.1	136.0	42	35	6.2	6.8	7.8	1.9
Non-VC-backed	5	23.7	20	20	60	0	49.4	780	359	50	4.4	2.8	2.7	11.8
1998														
France VC-backed	12	7.8	69	15	15	0	10.4	26.9	403	69	3.9	7.8	5.1	0.7
Non-VC-backed	17	7.2	56	6	33	6	4.0	112.0	474	75	7.2	4.7	2.8	7.8
Germany VC-backed	49	12.7	69	8	23	0	85.2	-5.0	119	65	3.3	1.8	6.1	54.6
Non-VC-backed	82	15.3	48	0	52	0	80.0	-18.4	96	107	3.7	9.0	9.1	60.4
1999														
France VC-backed	13	11.0	83	17	0	0	15.1	340	192	90	1.3	10.0	7.0	1.5
Non-VC-backed	19	9.9	88	6	0	6	26.5	512	128	97	2.2	6.3	4.2	2.1
Germany VC-backed	13	9.2	67	14	18	0	48.9	88.3	111	85	2.7	6.2	7.7	16.1
Non-VC-backed	31	9.8	63	4	27	6	43.5	97.3	87	98	–	3.6	7.8	20.7
2000														
France VC-backed	24	8.3	88	0	13	0	27.6	-93.3	274	172	1.2	4.8	9.0	16.1
Non-VC-backed	25	9.7	83	4	8	4	11.8	-16.1	100	176	2.8	2.8	3.8	3.2
Germany VC-backed	71	8.3	63	18	18	0	45.3	–	254	110	2.0	2.9	7.5	27.8
Non-VC-backed	65	9.6	74	8	17	2	46.0	-47.7	283	91	3.0	3.2	13.7	43.5

Notes: O = Observations; IaC = information and communications technology; BaM = biomedical technology; IaS = industry and services; FiS = financial services; IR = initial return, percentage underpricing; YR = return on offer price after one year; BMR = book-to-market ratio; MLOT = money left on table.

Source: Author's data set.

Tabelle 12 –Characteristics of initial public offerings backed by young and old venture capital firms in France's Nouveau Marché

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	80.72	100	83	84.53	100	181						
Age (years)	6.55	5.76	78	9.65	7.53	179	3.26***	0.00	2.67***	0.01	6.57***	0.01
Book to Market (percent)	4.51	2.87	72	6.73	3.25	157	1.79**	0.07	1.08	0.28	1.39*	0.24
Underpricing (percent)	43.73	12	83	35.98	6.21	180	0.81	0.42	0.91	0.36	1.12	0.29
Money left on the table (Mio. Euro)	22.96	4.50	69	21.75	4.90	136	0.58	0.56	0.79	0.43	1.23	0.27
Insider equity share before IPO (percent)	50.12	51.18	83	48.56	51	181	0.27	0.79	0.20	0.84	0.14	0.71
Insider equity share after IPO (percent)	36.17	35.88	83	35.11	35.64	181	0.21	0.83	0.11	0.91	0.07	0.79
Venture capital share before IPO (percent)	31.04	25.1	83	27.95	24.33	181	1.15	0.25	0.97	0.33	0.46	0.50
Venture Capital share after IPO (percent)	19.08	16.80	83	16.76	14.1	181	1.31	0.19	1.02	0.31	0.55	0.46
Rate of capital growth for the venture capital firm in the late 1990s (percent)	57.95	28.94	12	42.85	28.94	33	0.98	0.34	0.56	0.58	0.63	0.43

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 13 – Characteristics of initial public offerings backed by young and old venture capital firms in Germany's Neuer Markt

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	81.69	100	71	82.35	100	85						
Age (years)	9.57	6.81	70	9.06	7.53	82	0.07	0.94	0.27	0.79	0.15	0.70
Book to Market (percent)	5.93	3.00	66	4.41	2.28	77	0.99	0.32	0.76	0.45	0.46	0.50
Underpricing (percent)	36.41	10.91	71	60.89	24	85	2.38***	0.02	2.00***	0.05	4.52***	0.03
Money left on the table (Mio. Euro)	16.70	5.02	60	36.63	13.16	72	2.33***	0.02	1.51*	0.13	3.27***	0.07
Insider equity share before IPO (percent)	48.71	51	71	48.31	52	85	0.23	0.82	0.16	0.87	0.04	0.85
Insider equity share after IPO (percent)	34.37	33.19	71	34.80	35.35	85	0.02	0.98	0.10	0.92	0.00	0.99
Venture capital share before IPO (percent)	29.39	24.33	71	32.02	28.57	85	0.63	0.53	1.13	0.26	0.75	0.39
Venture Capital share after IPO (percent)	16.68	14.32	71	19.41	17.09	85	1.37*	0.17	1.76**	0.08	2.65***	0.10
Rate of capital growth for the venture capital firm in the late 1990s (percent)	122.94	51.89	14	62.08	51.89	10	0.89	0.39	0.56	0.58	0.51	0.48

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 14 – Characteristics of initial public offerings backed by young and old dependent venture capital firms in France

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	78	100	55	83	100	120						
Age (years)	6.48	5.8	53	10.50	8.5	119	3.15***	0.00	2.32***	0.02	5.28***	0.02
Book to Market (percent)	4.45	2.9	52	7.08	3.88	105	2.41***	0.02	2.46***	0.01	5.95***	0.01
Underpricing (percent)	53.12	15.6	55	28.87	4.3	120	1.94**	0.05	1.76**	0.08	3.23***	0.07
Money left on the table (Mio. Euro)	25.75	4.5	47	14.54	2.6	188	2.31***	0.02	2.49***	0.01	7.73***	0.01
Insider equity share before IPO (percent)	56.33	61.1	55	51.90	54.9	120	1.18	0.24	1.29*	0.20	1.09	0.30
Insider equity share after IPO (percent)	40.75	44.3	55	37.06	37.5	120	1.22	0.22	1.16	0.24	0.98	0.32
Venture capital share before IPO (percent)	24.65	23.6	55	26.11	22.4	120	0.58	0.56	0.27	0.79	0.32	0.57
Venture Capital share after IPO (percent)	14.37	12.9	55	14.95	11.4	120	0.54	0.59	0.07	0.94	0.27	0.60
Rate of capital growth for the venture capital firm in the late 1990s (percent)	51.75	10.0	9	39.36	10.0	22	0.00	1.00	0.84	0.40	0.36	0.55

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 15 – Characteristics of initial public offerings backed by young and old independent venture capital firms in France

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	85.71	100	28	86.89	100	61						
Age (years)	6.69	5.53	25	7.96	6.68	60	0.65	0.52	1.03	0.30	0.58	0.44
Book to Market (percent)	4.66	2.75	20	6.01	2.34	52	0.62	0.54	0.88	0.38	0.54	0.46
Underpricing (percent)	25.27	7.22	28	50.19	22.00	60	1.69**	0.10	1.49*	0.14	1.90**	0.17
Money left on the table (Mio. Euro)	17.00	4.50	22	34.96	14.12	48	1.45*	0.15	1.37*	0.17	2.10***	0.15
Insider equity share before IPO (percent)	37.94	34.44	28	42.01	45.7	61	0.73	0.47	0.66	0.51	0.11	0.74
Insider equity share after IPO (percent)	27.16	25.54	28	31.26	32.96	61	0.98	0.33	0.80	0.42	0.33	0.56
Venture capital share before IPO (percent)	43.57	45.91	28	31.57	30	61	2.37***	0.02	2.40***	0.02	3.98***	0.05
Venture Capital share after IPO (percent)	28.32	28.66	28	20.31	18.10	61	2.50***	0.01	2.30***	0.02	4.54***	0.03
Rate of capital growth for the venture capital firm in the late 1990s (percent)	76.58	80.84	3	46.85	80.84	11	2.04***	0.11	1.31*	0.19	2.36***	0.12

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 16 – Characteristics of initial public offerings backed by young and old dependent venture capital firms in Germany

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	76.92	100	39	80.0	100	55						
Age (years)	8.19	5.8	38	9.24	7.53	53	0.89	0.38	0.84	0.40	0.60	0.44
Book to Market (percent)	5.53	2.87	35	4.81	1.87	49	0.32	0.75	0.48	0.63	0.15	0.70
Underpricing (percent)	45.99	11.11	39	54.86	12	55	0.94	0.35	0.56	0.58	0.54	0.46
Money left on the table (Mio. Euro)	22.93	15.0	33	3.35	5.52	44	1.00	0.32	0.48	0.63	0.50	0.48
Insider equity share before IPO (percent)	49.55	51.18	39	41.73	37.1	55	1.29*	0.20	1.13	0.26	1.26	0.26
Insider equity share after IPO (percent)	34.70	32.29	39	29.71	28.7	55	1.12	0.27	1.03	0.30	1.20	0.27
Venture capital share before IPO (percent)	28.50	25.0	39	33.72	29.06	55	1.18	0.24	1.36*	0.17	1.60*	0.21
Venture Capital share after IPO (percent)	18.19	14.56	39	20.98	20.57	55	0.96	0.34	1.56*	0.12	2.07***	0.15
Rate of capital growth for the venture capital firm in the late 1990s (percent)	60.32	25.0	9	34.12	25.0	9	0.31	0.76	0.00	1.00	0.01	0.93

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 17 – Characteristics of initial public offerings backed by young and old independent venture capital firms in Germany

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	87.5	100	32	86.67	100	30						
Age (years)	11.21	11.09	32	8.74	7.53	29	1.03	0.31	0.65	0.52	0.33	0.57
Book to Market (percent)	6.39	3.13	31	3.71	2.40	28	0.93	0.36	0.19	0.85	0.04	0.84
Underpricing (percent)	24.73	8.38	32	71.95	68.56	30	3.33***	0.00	2.96***	0.00	8.39***	0.00
Money left on the table (Mio. Euro)	9.09	4.61	27	41.56	23.65	28	2.37***	0.02	2.37***	0.02	6.42***	0.01
Insider equity share before IPO (percent)	47.69	47.79	32	60.39	65.4	30	1.52*	0.14	1.25	0.21	1.56*	0.21
Insider equity share after IPO (percent)	33.96	34.77	32	44.18	46.41	30	1.70**	0.09	1.48*	0.14	2.18***	0.14
Venture capital share before IPO (percent)	30.47	24.12	32	28.90	25.15	30	0.47	0.64	0.09	0.93	0.07	0.79
Venture Capital share after IPO (percent)	14.85	10.8	32	16.52	13.18	30	0.60	0.55	0.59	0.55	0.30	0.58
Rate of capital growth for the venture capital firm in the late 1990s (percent)	235.65	79.46	5	313.69	79.46	1	NA	NA	0.00	1.00	1.00	0.32

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 18 – Characteristics of initial public offerings backed by young and old non-specialist venture capital firms in France

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	82.05	100	39	82.95	100	129						
Age (years)	7.03	5.76	36	9.76	7.53	127	1.93**	0.06	1.56*	0.12	2.32***	0.13
Book to Market (percent)	4.63	2.87	34	7.01	3.27	110	1.33*	0.19	1.30*	0.19	1.59*	0.21
Underpricing (percent)	49.34	15.56	39	39.02	6.25	129	0.80	0.43	0.60	0.55	0.87	0.35
Money left on the table (Mio. Euro)	21.96	4.32	34	22.21	5.52	100	0.17	0.86	0.33	0.74	0.36	0.55
Insider equity share before IPO (percent)	50.82	51.18	39	50.04	52.55	129	0.35	0.73	0.18	0.86	0.04	0.83
Insider equity share after IPO (percent)	36.61	39.69	39	36.18	37.47	129	0.31	0.76	0.23	0.82	0.00	0.96
Venture capital share before IPO (percent)	29.85	29.06	39	29.45	25.00	129	0.02	0.99	0.44	0.66	0.03	0.87
Venture Capital share after IPO (percent)	18.38	17.06	39	17.45	14.66	129	0.37	0.71	0.81	0.42	0.22	0.64
Rate of capital growth for the venture capital firm in the late 1990s (percent)	41.81	28.38	9	40.00	28.38	27	0.80	0.44	0.63	0.53	0.60	0.44

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 19 – Characteristics of initial public offerings backed by young and old high-tech specialist venture capital firms in France

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	79.5	1	44	88.5	1	52						
Age (years)	6.1	5.2	42	9.4	8.3	52	2.78***	0.01	2.33***	0.02	5.24***	0.02
Book to Market (percent)	4.4	2.4	38	6.1	2.5	47	1.33*	0.19	0.44	0.66	0.30	0.58
Underpricing (percent)	38.8	10.6	44	28.3	2.6	51	0.15	0.88	0.04	0.97	0.05	0.83
Money left on the table (Mio. Euro)	23.9	4.50	35	20.5	2.57	36	0.41	0.68	0.96	0.34	1.04	0.31
Insider equity share before IPO (percent)	49.5	51.1	44	44.9	41	52	0.64	0.52	0.64	0.52	0.45	0.50
Insider equity share after IPO (percent)	35.8	33.2	44	32.4	30.5	52	0.57	0.57	0.55	0.58	0.36	0.55
Venture capital share before IPO (percent)	32.1	24.7	44	24.2	21.4	52	1.95**	0.05	1.06	0.29	1.24	0.27
Venture Capital share after IPO (percent)	19.7	13.6	44	15	12.1	52	1.24	0.22	0.54	0.59	0.23	0.63
Rate of capital growth for the venture capital firm in the late 1990s (percent)	106.4	80.8	3	50.2	80.8	6	0.49	0.65	0.00	1.00	0.04	0.85

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 20 – Characteristics of initial public offerings backed by young and old non-specialist venture capital firms in Germany

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	78.95	100	38	81.58	100	76						
Age (years)	8.98	7.53	37	9.20	7.55	74	0.14	0.89	0.17	0.87	0.11	0.74
Book to Market (percent)	6.29	2.79	36	4.11	2.16	69	1.12	0.27	0.51	0.61	0.17	0.68
Underpricing (percent)	35.58	11.01	38	61.65	21.00	76	2.00***	0.05	1.51*	0.13	2.65***	0.10
Money left on the table (Mio. Euro)	20.23	5.80	34	38.96	13.13	63	1.62*	0.11	0.82	0.42	1.37*	0.24
Insider equity share before IPO (percent)	45.53	50.26	38	49.59	52.55	76	0.62	0.54	0.71	0.48	0.61	0.44
Insider equity share after IPO (percent)	32.32	32.56	38	35.73	35.88	76	0.75	0.46	0.87	0.39	0.75	0.39
Venture capital share before IPO (percent)	32.32	25.05	38	30.03	27.71	76	0.79	0.43	0.36	0.72	0.29	0.59
Venture Capital share after IPO (percent)	17.18	15.92	38	18.19	16.91	76	0.53	0.60	0.56	0.57	0.36	0.55
Rate of capital growth for the venture capital firm in the late 1990s (percent)	66.81	19.74	8	62.08	19.74	10	1.29*	0.25	1.01	0.31	1.10	0.29

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 21 – Characteristics of initial public offerings backed by young and old high-tech specialist venture capital firms in Germany

Young are all venture capital firms founded after 1990, old are those founded before 1991

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	84.85	100	33	88.89	100	9						
Age (years)	10.23	6.45	33	7.80	6.73	8	0.77	0.45	0.02	0.99	0.00	0.98
Book to Market (percent)	5.51	3.31	30	6.97	5.83	8	0.44	0.66	0.84	0.40	0.86	0.35
Underpricing (percent)	37.37	10	33	54.51	30.95	9	0.77	0.44	1.27	0.20	1.66**	0.20
Money left on the table (Mio. Euro)	12.08	5.02	26	20.28	22.40	9	1.41*	0.17	1.62*	0.10	2.43***	0.12
Insider equity share before IPO (percent)	52.38	51	33	37.50	27.27	9	1.67**	0.10	1.56*	0.12	2.29***	0.13
Insider equity share after IPO (percent)	36.72	33.9	33	26.94	20.37	9	1.53*	0.13	1.48*	0.14	2.12***	0.15
Venture capital share before IPO (percent)	26.02	20	33	48.84	56.74	9	2.80***	0.01	2.65***	0.01	6.03***	0.01
Venture Capital share after IPO (percent)	16.11	9.46	33	29.66	30.04	9	2.40***	0.02	2.50***	0.01	5.59***	0.02
Rate of capital growth for the venture capital firm in the late 1990s (percent)	197.78	67.15	6		67.15	1	NA	NA	NA	NA	NA	NA

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 22 – Characteristics of initial public offerings backed by small young and old venture capital firms in France's Nouveau Marché

Young are all venture capital firms founded after 1990, old are those founded before 1991. Small are those with less than 10 professional employees in 2000.

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	80.26	100	76	83.46	100	133						
Age (years)	6.53	5.76	71	9.93	8.17	131	3.16***	0.00	2.64***	0.01	6.41***	0.01
Book to Market (percent)	4.38	2.87	66	7.37	3.30	112	1.85**	0.07	1.20	0.23	1.62*	0.20
Underpricing (percent)	42.66	12	76	39.09	6.18	133	0.21	0.83	0.59	0.56	0.54	0.46
Money left on the table (Mio. Euro)	21.86	4.50	65	25.53	5.04	97	0.04	0.97	0.90	0.37	1.37	0.24
Insider equity share before IPO (percent)	49.04	51.18	76	47.83	51	133	0.25	0.80	0.26	0.79	0.11	0.74
Insider equity share after IPO (percent)	35.14	34.27	76	34.17	35.64	133	0.27	0.79	0.23	0.82	0.14	0.71
Venture capital share before IPO (percent)	31.81	25.17	76	29.93	26.12	133	0.38	0.70	0.06	0.96	0.03	0.87
Venture Capital share after IPO (percent)	19.43	16.93	76	17.36	15.05	133	0.95	0.34	0.44	0.66	0.08	0.78
Rate of capital growth for the venture capital firm in the late 1990s (percent)	53.35	28.38	11	46.41	28.38	26	0.78	0.45	0.53	0.60	0.59	0.44

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Tabelle 23 – Characteristics of initial public offerings backed by small young and old venture capital firms in Germany's Neuer Markt

Young are all venture capital firms founded after 1990, old are those founded before 1991. Small are those with less than 10 professional employees in 2000.

	Young VCs			Old VCs			Tests for equality of means and medians					
	Av.	Med.	Obs.	Av.	Med.	Obs.	t-Test	Prob.	Wilc.	Prob.	VdW	Prob.
Percent High-Tech	86.49	100	37	93.75	100	16						
Age (years)	8.22	6.03	37	10.98	8.11	16	1.22	0.23	1.33*	0.18	2.41***	0.12
Book to Market (percent)	5.05	2.82	36	7.62	1.31	15	1.20	0.24	0.13	0.89	0.11	0.74
Underpricing (percent)	30.85	10	37	53.92	14.13	16	1.47*	0.15	0.55	0.58	0.39	0.53
Money left on the table (Mio. Euro)	10.47	2.84	31	39.11	20.60	10	3.00***	0.01	1.64*	0.10	3.42***	0.06
Insider equity share before IPO (percent)	48.12	48.15	37	43.84	31.18	16	0.37	0.71	0.26	0.80	0.01	0.91
Insider equity share after IPO (percent)	34.86	33.9	37	31.43	26.00	16	0.40	0.69	0.38	0.70	0.15	0.70
Venture capital share before IPO (percent)	26.29	21.53	37	22.57	20.77	16	0.69	0.50	0.18	0.85	0.24	0.62
Venture Capital share after IPO (percent)	16.82	11.54	37	15.38	15.83	16	0.39	0.70	0.29	0.77	0.00	0.96
Rate of capital growth for the venture capital firm in the late 1990s (percent)	155.60	32.83	6	25.87	32.83	5	0.70	0.56	-0.39	0.70	0.00	1.00

Notes: Av.= Average; Obs. = Observations; Prob. = Probability; Wilc. = Wilcoxon; vdW = van der Waerden; ***, **, * represent significance at the 5, 10, 20 percent level, respectively.

Source: Author's data set.

Table 24 – The choice of underwriter: an ordered logit model

The dependent variable is	Neuer Markt				Nouveau	Combined
underwriter rank*	Model 1	Model 2	Model 3	Model 4	Marché	Sample
VC-backing	0.49	0.40	0.42	0.43	-0.92	0.18
	0.35	*0.26*	*0.26*	*0.26*	*0.76*	*0.24*
	[0.16]	[0.12]	[0.10]	[0.10]	[0.23]	[0.45]
VC stake	-0.00					
	0.01					
	[0.72]					
Log of gross proceeds	-0.66	-0.66	-0.66	-0.65	-0.13	-0.19
	0.21	*0.21*	*0.21*	*0.21*	*0.05*	*0.08*
	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.02]
Information technology dummy	0.40	0.42	0.35	0.35	0.49	0.37
	0.33	*0.32*	*0.29*	*0.28*	*0.65*	*0.25*
	[0.23]	[0.19]	[0.23]	[0.21]	[0.45]	[0.14]
Biomedical dummy	0.28	0.26				
	0.52	*0.52*				
	[0.60]	[0.62]				
Log of employment	-0.48	-0.48	-0.49	-0.49	-0.76	-0.65
	0.14	*0.13*	*0.13*	*0.13*	*0.35*	*0.12*
	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]	[0.00]
Log of market-to-book ratio	0.01					
	0.10					
	[0.96]					
Log of leverage	0.09	0.10	0.09	0.10	0.19	0.13
	0.08	*0.08*	*0.08*	*0.07*	*0.36*	*0.07*
	[0.24]	[0.20]	[0.23]	[0.20]	[0.59]	[0.08]
Log of (1+age)	0.41	0.40	0.40	0.43	0.45	0.44
	0.15	*0.14*	*0.14*	*0.14*	*0.48*	*0.14*
	[0.01]	[0.01]	[0.01]	[0.00]	[0.35]	[0.00]
Limit points :						
Limit 2: C(10)	-6.15	-6.26	-6.32	-6.26	-5.94	-5.29
	2.25	*0.93*	*0.91*	*0.87*	*1.83*	*0.64*
	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Limit 3: C(11)	-2.52	-2.63	-2.69	-2.65	-3.39	-1.99
	2.18	*0.83*	*0.80*	*0.77*	*1.72*	*0.56*
	[0.25]	[0.00]	[0.00]	[0.00]	[0.05]	[0.00]
Limit 4: C(12)	-0.51	-0.62	-0.67	-0.61	0.41	0.30
	2.13	*0.75*	*0.72*	*0.69*	*1.69*	*0.54*
	[0.81]	[0.41]	[0.35]	[0.38]	[0.81]	[0.58]
Observations	253	253	253	259	52	311
No. of ordered indicator values	4	4	4	4	4	4
Iterations until convergence	6	5	5	5	5	5
Log likelihood	-244.96	-245.04	-245.16	-251.01	-48.27	-310.95
Restr. Log likelihood	-269.00	-269.00	-269.00	-275.75	-55.02	-337.84
LR statistic (9 df)	48.07	47.92	47.68	49.49	13.49	53.77
Probability (Lrstat)	2.48e-07	3.70e-08	1.37e-08	5.96e-09	0.04	8.21e-10

Notes: Coefficients = first number. – Std. Error (QML Huber/White) = italic. – Prob. = in square brackets. – *Underwriters are ranked 1 to 4, with 1 being the highest. Rank 1 is for US investment banks. Rank 2 is for large domestic, rank 3 for other domestic and rank 4 for foreign underwriters except those from the US.

Table 25 – Underwriter rank, venture capital backing, underpricing and money left on the table

	Underwriters with rank				All underwriters
	1	2	3	4	
Neuer Markt					
Observations	27	184	82	23	319
VC backing (in percent of all IPOs)	44	40	46	61	43
Underpricing (percent) #	38.4	51.9	45.6	70.0	51.0
	(32.8)	(18.2)	(16.9)	(31.0)	(18.9)
	[37.9]	[72.9]	[71.8]	[106.0]	[74.4]
Money left on table, relative to gross proceeds (percent) #	34.8	78.3	50.9	81.8	78.7
	(20.9)	(15.3)	(11.9)	(13.0)	(22.1)
	[41]	[241]	[94]	[178]	[208]
Nouveau Marché					
Observations	16	51	59	6	132
VC backing (in percent of all IPOs)	63	53	31	67	45
Underpricing (percent) #	32.3	12.7	12.7	3.3	14.9
	(10.7)	(0.5)	(0.5)	(3.6)	(0.8)
	[65.7]	[35.1]	[32.3]	[32.3]	[38.2]
Money left on table, relative to gross proceeds (percent)6	134	4.7	1.9	2.9	19.3
	(2.0)	(0.4)	(0.1)	(2.9)	(0.4)
	[371]	[12.1]	[6.7]	[2 obs.]	[127]ə

Notes: # Entries are for means, medians (in parentheses) and standard deviations (in brackets). – 6 Limited number of observations. – ə 68 observations.

Table 26 – Least-squares underpricing regressions

Dependent variable is the	Neuer Markt		Nouveau Marché			Combined
percentage underpricing	Model 1*	Model 2	Model 3	Model 4	Model 5	Sample**
Constant	-288.37	-271.42	-140.30	-127.96	-124.39	-167.98
	94.75 [0.00]	*72.35* [0.00]	*85.09* [0.11]	*83.83* [0.13]	*79.03* [0.12]	*69.92* [0.02]
Log of (1+age)	7.28	3.28	8.57	10.19	9.50	4.47
	6.12 [0.24]	*5.73* [0.57]	*7.77* [0.28]	*9.29* [0.28]	*9.13* [0.30]	*5.43* [0.41]
Log of employment	12.82	11.18				2.33
	5.93 [0.03]	*4.75* [0.02]				*4.70* [0.62]
Log of sales per employee	14.32	14.88				
	4.88 [0.00]	*4.72* [0.00]				
Log of leverage	-13.67	-12.82				-8.46
	3.78 [0.00]	*3.59* [0.00]				*3.07* [0.01]
Log of market-to-book	16.25	15.85	7.10	6.29	6.13	10.78
ratio	*4.47* [0.00]	*3.37* [0.00]	*4.13* [0.09]	*4.32* [0.15]	*4.07* [0.14]	*3.02* [0.00]
Information technology	2.30	1.04				-3.61
dummy	*9.21* [0.80]	*9.00* [0.91]				*8.30* [0.66]
Biomedical dummy	33.47	32.85				8.91
	13.36 [0.01]	*13.33* [0.00]				*11.42* [0.44]
Aftermarket standard	479.97	590.74	465.04	459.69	453.39	508.90
deviation	*174.84* [0.01]	*141.68* [0.00]	*169.36* [0.01]	*193.52* [0.02]	*188.45* [0.02]	*135.55* [0.00]
VC sales dummy (selling	47.93	-13.28		6.76		4.80
intensity in Model 1)	*17.72* [0.01]	*9.14* [0.15]		*17.65* [0.70]		*30.23* [0.87]
VC dummy	-52.68		18.70			-10.16
	19.37 [0.01]		*11.96* [0.13]			*30.80* [0.74]
Average VC age		0.005		-3.20¶	0.001	
		0.002 [0.03]		*25.36* [0.90]	*0.002* [0.57]	
High-tech focus		42.71		14.64	14.07	
		15.77 [0.01]		*18.38* [0.43]	*13.93* [0.32]	
Public support		-16.46				
		14.39 [0.25]				
Independent VC		-39.74		-0.92		
		14.05 [0.01]		*15.73* [0.95]		
Large VC		22.01		12.84	14.56	
		16.07 [0.17]		*19.16* [0.51]	*16.56* [0.38]	
Market trend	1522.30	1692.17	2214.03	2194.62	2142.54	1666.65
	584.44 [0.01]	*512.30* [0.00]	*831.59* [0.01]	*544.28* [0.00]	*524.52* [0.00]	*458.08* [0.00]
Bubble	-19.88	-15.43				-17.86
	14.97 [0.19]	*11.73* [0.19]				*11.06* [0.11]
Calendar day	-41.62	-43.35	-44.69	-49.10	-47.23	-50.65
	20.29 [0.04]	*17.34* [0.01]	*21.38* [0.04]	*22.33* [0.03]	*21.81* [0.04]	*16.55* [0.00]
Observations	212	252	51	51	51	304
R-squared [adjusted]	0.31 [0.25]	0.35 [0.30]	0.54 [0.48]	0.55 [0.44]	0.56 [0.47]	0.28 [0.25]
S.E. of regression	62.47	62.12	36.32	37.47	36.50	60.89
Log likelihood	-1168.52	-1388.76	-251.82	-250.98	-250.88	-1673.36
Mean [S.D.] depend. Var.	47.88 [72.15]	50.86 [74.13]	23.74 [50.21]	23.74 [50.21]	23.74 [50.21]	45.64 [70.33]
F-statistic [Prob.]	5.40 [0.00]	7.26 [0.00]	8.59 [0.00]	4.97 [0.00]	6.57 [0.00]	8.79 [0.00]

Notes: Coefficients first. – White heteroskedasticity-consistent standard errors in italics. – Probabilities in brackets. – *Instead of the VC sales dummy, Model 1 includes VC selling intensity. Three additional regressors in Model 1 are insignificant: the log of gross proceeds (-3.08 with S.E. 6.64 [0.64]), the dilution factor (-2.45 with S.E. 29.35 [0.93]) and underwriter rank (5.24 with S.E. 7.66 [0.50]). – **Underwriter rank is insignificant (4.25 with S.E. 4.93 [0.39]) and the dilution factor and gross proceeds are not included in the combined sample. – ¶ A dummy for IPOs with a young average age of venture capital firms, i.e. foundation after 1990.

Table 27 – Dynamic Panel Regressions for IPO underpricing on France's Nouveau Marché

	IV, Levels	IV, First Differences+Levels				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	-267.95	-286.27	-280.03	-233.64	-129.61	-102.03
	-4.01	*-3.12*	*-3.09*	*-2.54*	*-2.08*	*-1.77*
	(0.00)	(0.00)	(0.00)	(0.04)	(0.04)	(0.08)
Log(1+age)	8.75	11.90	7.44		4.09	
	1.28	*1.72*	*1.29*		*0.60*	
	(0.20)	(0.09)	(0.20)		(0.55)	
Log of employment	0.58	1.89	0.12		2.91	
	0.10	*0.31*	*0.02*		*0.43*	
	(0.92)	(0.76)	(0.98)		(0.67)	
Log of market-to-book	11.94	12.72	13.44	11.15	3.92	3.62
ratio	*3.57*	*2.65*	*2.89*	*2.06*	*1.23*	*1.13*
	(0.00)	(0.00)	(0.00)	(0.04)	(0.22)	(0.26)
Aftermarket	442.57	447.48	351.09	446.86	426.58	454.09
standard deviation	*2.27*	*2.29*	*2.41*	*2.08*	*2.31*	*2.18*
	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.03)
Market trend	3561.30	3755.18	3750.33	3477.18	3113.55	3035.23
	7.17	*5.02*	*6.04*	*4.40*	*3.49*	*3.54*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Bubble	18.02	17.83	21.05	23.46	14.51	18.52
	1.71	*1.77*	*2.19*	*2.14*	*0.99*	*1.09*
	(0.09)	(0.08)	(0.03)	(0.03)	(0.32)	(0.28)
Calendar day	0.11	0.08	0.08	0.09	0.11	0.11
	2.19	*1.40*	*1.53*	*1.48*	*1.60*	*1.38*
	(0.03)	(0.16)	(0.13)	(0.14)	(0.11)	(0.17)
VC sales	0.69	0.71	0.90	0.78	0.65	
	0.93	*1.09*	*1.44*	*1.11*	*0.87*	
	(0.35)	(0.28)	(0.15)	(0.27)	(0.39)	
Lagged under-	-0.12	-0.24	-0.18	-0.23	0.00	0.04
pricing of the VC	*-1.17*	*-2.67*	*-3.47*	*-2.81*	*0.01*	*0.27*
	(0.24)	(0.01)	(0.00)	(0.01)	(0.99)	(0.79)
First-order serial	-1.58 [25]	-2.11 [18]	-2.27 [18]	-2.26 [18]	-2.59 [18]	-2.56 [18]
correlation*	(0.11)	(0.04)	(0.02)	(0.02)	(0.01)	(0.01)
Second-order serial	0.27 [18]				0.90 [6]	1.51 [6]
correlation*	(0.79)				(0.37)	(0.13)
Observations	68	68	68	68	72	72
Number of firms	25	25	25	25	24	24
Degrees of freedom	58	58	58	60	62	65
RSS	73590.46	76530.00	76530.00	78470.04	112755.11	113969.96
TSS	186919.54	186919.54	186919.54	186919.54	197163.65	197163.65
Est. sigma-squared	1268.80	1319.48	1319.48	1307.83	1818.63	1753.38
Wald test of joint	89.32	86.94	136.61	70.32	30.86	22.02
significance	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Sargan test		*1.51*	1.51	*0.74*	*3.87*	3.36
		(0.82)	(0.82)	(0.95)	(0.87)	(0.91)

Notes: Model 1 = One-step estimates; Model 2, 4, 5 and 6 = One-step estimates with robust test statistics; Model 3 = Two-step estimates. – t-statistics in italics. – Probabilities (p-values) in brackets. – * Number of cases for which the type of serial correlation is evaluated in squared brackets.

Table 28 – Dynamic Panel Regressions for IPO underpricing on Germany's Neuer Markt

	IV, Levels	IV, First Differences + Levels			Within groups	IV, Orthogonal Dev.+Levels
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	-456.61	-553.40	-556.92	-337.52		-560.70
	-4.04	*-8.21*	*-11.16*	*-5.14*		*-9.52*
	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)
Log(1+age)	11.57	26.58	28.07	13.17	25.00	28.78
	0.62	*2.65*	*3.34*	*1.35*	*3.42*	*3.21*
	(0.53)	(0.00)	(0.00)	(0.18)	(0.00)	(0.00)
Log of employment	8.80				6.85	
	0.98				*1.46*	
	(0.33)				(0.14)	
Log of sales per	-6.20	-12.79	-14.76		-11.28	-13.20
employee	*-1.01*	*-2.23*	*-2.50*		*-2.00*	*-2.30*
	(0.31)	(0.03)	(0.01)		(0.05)	(0.02)
Log of leverage	-17.11	-23.21	-22.41	-17.58	-25.92	-22.91
	-4.10	*-11.08*	*-15.33*	*-7.00*	*-8.68*	*-12.79*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log of market-to-	20.78	27.05	27.01	18.44	29.93	27.02
book ratio	*4.24*	*10.38*	*14.64*	*5.75*	*9.23*	*12.27*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
IT dummy	-7.81	3.41	9.89	-12.11	12.87	3.75
	-0.48	*0.23*	*0.80*	*-1.21*	*1.22*	*0.26*
	(0.63)	(0.82)	(0.42)	(0.23)	(0.22)	(0.80)
Biomedical dummy	-0.03	2.14	4.51	2.67	16.51	3.26
	-0.00	*0.13*	*0.28*	*0.25*	*1.61*	*0.17*
	(0.99)	(0.90)	(0.78)	(0.80)	(0.11)	(0.86)
Aftermarket	600.16	329.17	457.65	114.68	-19.97	559.82
standard deviation	*2.00*	*1.47*	*1.62*	*0.61*	*-0.09*	*1.79*
	(0.05)	(0.14)	(0.11)	(0.54)	(0.93)	(0.07)
Market trend	1318.81	1005.96		2038.00	-244.19	
	1.31	*1.23*		*2.60*	*-0.55*	
	(0.19)	(0.22)		(0.01)	(0.58)	
Bubble	22.84	42.28	29.96	20.10	71.35	23.95
	1.49	*3.69*	*2.95*	*1.30*	*3.59*	*1.92*
	(0.14)	(0.00)	(0.00)	(0.19)	(0.00)	(0.06)
Calendar day	0.10			0.21	-0.09	
	1.10			*3.76*	*-1.78*	
	(0.27)			(0.00)	(0.07)	
VC sales	-0.75	-1.33	-1.30	-1.15	-2.42	-1.08
	-2.32	*-3.51*	*-3.41*	*-3.35*	*-6.04*	*-3.14*
	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lagged under	0.05	0.14	0.02	0.02	-0.08	0.12
pricing of the VC	*0.57*	*0.89*	*0.23*	*0.25*	*-1.40*	*0.72*
	(0.57)	(0.37)	(0.82)	(0.80)	(0.16)	(0.47)
First-order serial	1.58 [31]	-1.90 [10]	-1.85 [10]	-0.73 [25]	-2.38 [10]	-1.97 [10]
correlation*	(0.11)	(0.06)	(0.06)	(0.46)	(0.02)	(0.05)
Second-order serial	0.45 [10]			2.05 [8]		
correlation*	(0.66)			(0.04)		
Observations	72	72	72	111	41	72
Number of firms	31	31	31	39	31	31
Degrees of freedom	58	60	61	99	28	61
RSS	124915.07	149418.44	155127.35	246945.88	16527.99	146085.51
TSS	312792.27	312792.27	312792.45	432083.23	115013.67	312792.27
Est. sigma-squared	2153.71	2490.31	2543.07	2494.40	590.29	392.43
Wald test of joint	87.23	432.29	620.66	149.14	166.89	111.02
significance	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Sargan test		2.65(0.00)	2.57 (0.77)	7.16 (0.62)		2.27 (0.69)

Notes: Model 1 to 6 = One-step estimates with robust test statistics. – t-statistics in italics. – Probabilities (p-values) in brackets. – * Number of underlying cases in squared brackets.