Schertler, Andrea; Stolpe, Michael

Working Paper

Venture mania in Europe: Its causes and consequences

Kieler Diskussionsbeiträge, No. 358

Provided in cooperation with:
Institut für Weltwirtschaft (IfW)

Suggested citation: Schertler, Andrea; Stolpe, Michael (2000) : Venture mania in Europe: Its causes and consequences, Kieler Diskussionsbeiträge, No. 358, http://hdl.handle.net/10419/2357

KIELER DISKUSSIONSBEITRÄGE

KIEL DISCUSSION PAPERS

358

Venture Mania in Europe: Its Causes and Consequences

by Andrea Schertler and Michael Stolpe

CONTENTS

- Behind Europe's current venture mania lie unique developments of the 1990s, which include massive subsidies from several European governments. Proponents of these subsidies seem to expect that domestic venture capital industries will generate productivity effects and welfare gains on the same scale as those seen in the US, where venture capital has spurred the formation and growth of Silicon Valley and other successful clusters of innovative activity. But European governments will be able to design efficient support policies only if they understand that venture capital is necessarily linked to specialization and cannot be expected to play the same role in any two economies whose place, and contribution, within the international division of labour differ.
- Venture capital investment patterns in the US, the UK, Germany and the Netherlands show persistent differences, not only with respect to size, but also with respect to the concentration across fields of technology and development stages of target firms. Venture capital investments in the US are more heavily concentrated in the biotechnology and computer-related industries and in the earlier stages of firm development than those in Europe.
- The main differences between national venture capital markets can be explained by a theory of competition among venture capitalists which emphasizes the role of reputation in their race for capital commitments and promising investment opportunities in new technology-based firms. Reputation helps to overcome information asymmetries between outside investors and technological innovators and is primarily built through a track record of successful initial public offerings of common stock in young technology-based firms. Historically, US venture capitalists have enjoyed a more favourable market environment, including large stock markets and a fragmented banking system, and thus have had more time and opportunity to build a reputation.
- The technological specialization, which venture capitalists choose to reduce risk by active control of individual investments instead of mere diversification across many passive financings, is a learning process which mainly improves venture capitalists' proficiency in handling the particular information asymmetries and incentive problems in the early stage of new technology ventures. And since the social benefits from successful early-stage investments tend to be particularly large, venture capitalists' learning raises the social and private returns to financial intermediation. But policymakers must understand that the learning process takes time and cannot simply be accelerated through policies which merely increase the quantity of inflowing funds without improving their quality.
- As a catalyst for the learning process, there may be a role for public subsidies if an emerging venture capital market initially lacks the critical size and liquidity. However, subsidies would be a waste of resources if policy-induced barriers, embedded in tax laws, capital market regulations and other institutions, artificially inflate venture capital's user cost, or if structural conditions, partly determined by an economy's factor endowments, ultimately prevent a viable venture capital industry. In Germany and other European countries, specific policy barriers to venture capital and serious impediments to structural change are calling for a coherent policy strategy which must go beyond simple subsidy schemes.
- In their choice of policy instruments, governments face a dilemma in that only some of the more activist subsidy schemes seem to yield measurable results, but governments in countries without an established venture capital industry lack the technological and market knowledge required to design and execute such schemes effectively. In any case, guarantee schemes, like those tried in the Netherlands, are to be rejected because instead of solving the incentive problems, they may even aggravate them. However, loan schemes, like those implemented in the US and Germany, fare somewhat better on theoretical grounds but are still difficult to evaluate empirically.
- The removal of the remaining policy barriers, and not the continued subsidization of venture capital, should be the priority in Europe. Efficiency, and not quantitative targets for capital inflows, must be the objective. Yet, efficiency is intimately linked to specialization — implying investments that are highly concentrated not just in a narrow subset of high technologies, but also in a few European regions and countries only. Policymakers will have to accept that not even the removal of all policy barriers can create a vibrant venture capital industry everywhere.

INSTITUT FÜR WELTWIRTSCHAFT KIEL · FEBRUAR 2000

ISSN 0455-0420

Contents

Generous financial support by the Alfried Krupp von Bohlen und Halbach-Stiftung and the research assistance of Ulrich Stark are gratefully acknowledged.

Die Deutsche Bibliothek – CIP Cataloguing-in-Publication-Data

A catalogue record for this publication is available from Die Deutsche Bibliothek

http://www.ddb.de

ISBN 3–89456–206–4

Printed in Germany

ISSN 0455-0420

Overview

Over the course of the past twenty years, venture capital has fuelled an entrepreneurial revolution — first in the United States and now in Europe's common market —, which has opened new opportunities for technological innovation, capital investment and employment growth. Some of the most promising opportunities are in science-based industries, like software and biotechnology, which are often seen as driving the transformation to an increasingly knowledge-based economy. Indeed, this transformation would hardly be conceivable without the innovative contributions of business start-ups that rely on *venture capital* to finance their early stages of growth. So what, if anything, should governments do to support venture capital and help this transformation along? This paper will argue that governments must understand that venture capital is necessarily linked to specialization and therefore cannot be expected to play the same role in any two economies whose place, and contribution, within the international division of labour differ.

The essence of venture capital is a combination of temporary equity participation in a privately held firm and of management services provided by a specialized financial intermediary who usually seeks to exit, and profit, via an initial public offering or a trade sale once the firm has established a track record in the market place. This definition excludes buyout financing for established firms, which is often mislabelled as venture capital in Europe. In the 1990s, governments in many countries have tried to actively promote the development of venture capital, sometimes lavishly spending taxpayers' money. This policy is, often explicitly, based on the assumption that venture capital provides an *efficient* financing solution for young technology-based firms when credit markets fail to make sufficient external funds available. But the evident success of venture capital in a subset of high-tech industries and in a small number of 'fortunate' regions and countries need *not* imply that governments' role is to bring this form of financial intermediation to life everywhere.

It is the economics of venture capital which implies an intimate link with technological and industrial specialization. Venture capital strictly defined is offered only to innovators in the subset of high technologies requiring a disproportionate amount of *intangible* investment, like software and biotechnology. In addition to this macro-dimension, there is an equally important micro-dimension to specialization. Because individual venture capitalists learn from experience, they tend to become more proficient over time in screening, selecting and supporting new firms from the — often rather narrow — area of technology in which the bulk of their specific experiences falls. This increasing proficiency allows the experienced venture capitalist to carve out a technological niche for himself and to raise the returns on his investments by progressively becoming involved in start-up firms at ever earlier, and riskier, stages of business formation and growth. Incidentally, this process of specialization, which is undertaken to reduce risk by active control of each individual investment instead of mere diversification across a multitude of collateralized financings, raises the social as well as the private returns to financial intermediation.

In *open* economies, specialization in both the macro- and micro-dimension may create additional welfare gains by enhancing the international division of labour. Of course, only in the short term does the quantity and quality of venture capital supply constitute an exogenous endowment and thus a potential source of comparative advantage for an economy in the sense suggested by Nelson (1995). In the long term, both the quality and quantity are endogenous, so that venture capital specialization, and its concomitantly uneven distribution, ultimately leads to trade-related welfare gains mainly from exploiting increasing returns to scale. This hypothesis is based on the idea that dynamic scale economies are relevant in the venture capitalist's own learning as well as in the creation and application of knowledge in those new

high-tech firms whose formation is facilitated by venture capital.

In any event, the emergence of venture capital in one country can bring welfare gains not only to the domestic economy, but via specialization also to its trading partners. Consequently, policies to support and expand an *existing*, yet underdeveloped venture capital industry at home may generate positive *international* externalities. On the other hand, governments seeking to establish a domestic venture capital industry for the first time, and at any price, risk making their own country worse off even if they succeed. The reason is that they may thwart an international division of labour more in line with fundamental comparative advantages or countries' different potential to realize economies of scale.

An effective and efficient policy strategy must therefore build on a theory that explains the linkages between an economy's financial sector, the governance of innovative ventures in different industries and economy-wide patterns of specialization. Although no comprehensive and widely accepted theory is as yet available, this paper spells out what appear to be the essential elements of such a theory and discusses some casual empirical support. Its implications for policy suggest that governments should make their support for venture capital contingent on the domestic *potential* relative to other countries with which the economy is linked through trade and capital flows.

Public *subsidies* for venture capital investments can probably serve as a useful catalyst when an emerging venture capital market merely lacks the critical size and liquidity to be viable in the long term. In this case, subsidies can be thought of as supporting an economy-wide learning process akin to learning-by-doing in infant-industry models of international trade. However, a subsidy programme would be wasting resources if at least one of the following two conditions holds: first, if policy-induced *barriers*, embedded in tax laws, capital market regulations and other institutions, artificially inflate the *user cost* of venture capital; and second, if *structural conditions*, in large part determined by an economy's factor endowments or persistent patterns of inherited specialization, ultimately prevent the emergence of a *viable* venture capital industry altogether. While it remains to be seen how persistent or flexible the current structures of European economies really are, policy-induced barriers certainly play an important role in Germany and other European countries. In these countries, both specific barriers to venture capital and serious impediments to structural change, prominently due to rigid labour markets, are calling for a more coherent policy response.

A coherent policy must primarily tackle the barriers, provided the economy possesses the potential to benefit from a self-sustaining venture capital industry in the long term. Governments must therefore look beyond the *microeconomic* evidence for market failure in credit markets. They must first of all assess the home country's *macroeconomic* potential to sustain a competitive venture capital market and a corresponding pattern of specialization in industries with sufficient demand for venture capital in the long term. This potential may be constrained by *internal* conditions, like the supply of skilled scientists, engineers and managers or the size, liquidity and institutional sophistication of domestic financial markets, as well as by *external* conditions, like inherited patterns of industrial and technological specialization, determined by the economy's role within the international division of labour. Because the demand for venture capital obviously depends on an economy's macroeconomic potential to be competitive in industries with a demand for venture capital, the policy environment is determined by a mixture of internal and external conditions, only some of which also affect the supply of venture capital. Especially with respect to the external conditions, the government may be either unable or unwilling to induce sufficient change within a given time frame.

It is *after* the potential for a viable venture capital market has been established, that the government must identify the barriers, the conditions which *can* and *have* to be changed in order to unleash venture capital's full potential. These barriers may constrain either the supply

of *or* the demand for venture capital. Their removal may require general policy reforms to improve incentives as well as the adoption of appropriate instruments to address specific market failures in the allocation of capital. Needless to say that both the identification of barriers and the assessment of venture capital's macroeconomic potential require a sound understanding of the *microeconomics* of venture capital and of the overall incentives that laws and regulations imply for *intangible* investments. In the remainder of this paper, we will sketch the relevant theory (Section 1), present some evidence (Section 2) and discuss policy options (Section 3), before drawing our conclusions (Section 4) on the questions raised in this introduction.

1 Venture Capital and Specialization: Towards a Comprehensive Theory

The key to understanding venture capital is specialization. The two most basic dimensions are specialization in the formation and expansion of fast-growing firms and specialization in a subset of high technologies. Indeed, this double focus is what distinguishes genuine venture capital and yields macroeconomic implications. We shall argue below that the degree of specialization by individual venture capitalists is related to their efficiency as financial intermediaries. But chiefly, the macroeconomic relevance of venture capital is related to the special importance of *new* firms as driving forces of innovation in certain areas of high technology, an explanation of which must therefore be the *first* step in any comprehensive theory of venture capital. The *second* step must be to explain the special *problems* which innovators in these areas of technology face in the market for commercial bank credit. Only thereafter can the *comparative advantage* of venture capital vis-à-vis other forms of financial intermediation be fully appreciated. The *third* step then is to explain how open economies' endowment with venture capital can be, at least in the short term, a source of comparative advantage in those areas of high technology where efficiency requires that a decentralized industrial organization of innovation is matched with the appropriate institution of financial intermediation. Our discussion of policy implications, which largely derive from the hypothesis that countries' endowment with venture capital is endogenous in the long term, is deferred until after the review of empirical evidence.

1.1 The Role of New Firms in Technological Innovation

The hypothesis that market structure and technological innovation are interdependent goes back at least to Joseph Schumpeter (1942). Economists have long recognized non-rivalry in *using* knowledge and the difficulties of fully appropriating the returns to *new* knowledge as distinguishing economic features of innovation. With full appropriability, it would be surprising that not all industrial research and development (R&D) is carried out by technology-specific monopolies, internalizing the increasing returns to scale which the creation and application of knowledge entails. Schumpeter thought that capitalism would evolve towards an increasing monopolization of technology-based industries, and hence would ultimately adopt a form of industrial organization closely resembling central planning, as in socialist economies. But this has not happened, and the process of innovation in some of the most dynamic fields of high technology today appears to be more decentralized than ever.

New thinking about the industrial organization of innovation, which this observation has prompted, builds on the paradigm of *incomplete contracts*, formally introduced by Grossman and Hart (1986). It emphasizes the problem of incentives in a world of fundamental uncertainty. According to this view, innovation is inevitably governed by incomplete contracts because neither the characteristics, nor the timing of genuine innovations can be specified in advance. It is simply beyond the human capacity for information processing to describe all possible outcomes in advance and estimate probabilities for their occurrence. Relative to

the complexity of the decision problem, human rationality is clearly bounded.

The salient economic features of incomplete contracts are the assignment of ownership rights and decision-making authority to the various parties in the innovation process (Aghion and Howitt 1998). If *complete* contracts were available, there would be no need for discretionary decision-making after closing the contract, and the allocation of ownership would be irrelevant for efficiency (Coase 1960). Complete contracts would simply specify in advance what the defining features of the innovation were to be, how it were to be used and how the revenues were to be shared among the contracting parties in all possible states of nature. Under *incomplete* contracts, the optimal assignment of ownership and decision rights partly depends on attitudes towards risk and on the relative efficiency of the agents' efforts to find the innovation, as in the principal-agent literature. Beyond that, the assignment also depends on technology-specific factors, like the role of complementary investments and systemic innovations, as well as on the conditions of transmitting proprietary information to the producers and users of the innovation without letting too much knowledge spill over to competitors. The nature of *optimal* contracts governing innovation in a second-best world of fundamental uncertainty varies with these conditions, thus minimizing the overall costs of achieving commercial success.

These incomplete contracts typically involve the creators of new ideas, often specialists with the necessary skills to do pertinent research, as one party, and the manufacturers or the users of an innovation as the other party. Ideally, the contracts distribute the private incentives so that each party makes the socially optimal effort. For example, in software and biotechnology, two of the currently most dynamic areas of high technology, many ideas are *radical* in the sense that they threaten to make proprietary technologies of established firms obsolete. This is one reason why the incentives to pursue innovations may be stronger in independent *new* firms than in large established firms, and why new firms have indeed been the preferred venue for many of the most noticeable and profitable innovations in these areas of technology.

Put differently, the optimal industrial organization of innovation should be consistent with a distribution of incentives according to the comparative advantages of the parties involved. Because *ownership* is normally the best arrangement to incite effort, property rights should be assigned to the party whose input, including knowledge, is more important for successful innovation. Yet, the most important input need not always be creativity or research; instead, product development and production capabilities are probably more important for the ultimate success of innovations in manufacturing industries like automobiles and aircraft. Innovations in these industries typically have their origin within the integrated R&D departments of large corporations possessing the relevant capabilities for rapid product development, manufacturing and marketing. Economies of scale in these latter activities, in turn, are the main reason for the highly concentrated market structure which characterizes in particular the automobile and aircraft industry. It is when knowledge and ideas are the most important inputs that the innovation process is more likely to be dominated by independent new firms which are, at least partly, owned by the creative talent itself. This may include researchers with special skills as well as the originator of the basic business idea. Both software and biotechnology are prototypes of an industry with many independent owner-innovators, where indeed capital requirements in manufacturing and distribution are often negligible.

On the other hand, the optimal industrial organization must not be detrimental to the transmission of new knowledge between the various participants in the innovation process. It therefore matters that the costs of transmitting specific, often tacit knowledge needed to produce or use an innovation tend to be lower when the innovator is integrated into a large manufacturing firm or user organization. For example, the benefits of lower information costs to users can explain why many large firms have their own consulting and software development units providing customized solutions

for firm-specific problems. In similar vein, the transmission of tacit knowledge plays an important role in setting up the production of complex manufacturing goods, which can explain the prevalence of in-house R&D departments in the chemical and machinery industries. In the case of software, however, the production and distribution of copies does not require any understanding of its content so that integration of the developer with an experienced manufacturer is unnecessary. And while users, who often incur substantial learning costs upon the adoption of new software, should be able to benefit from the transfer of the developer's tacit knowledge, they are usually too dispersed to make integration feasible. Because software innovations primarily generate *codified* knowledge, which is easy to distribute, the specific costs of transmitting *tacit* knowledge do not appear to be a relevant constraint on the industrial organization of software development. Similar reasoning may apply to large parts of the biotechnology industry.

On the whole then, economic theory predicts that the importance of new firms in technological innovation is contingent on economic characteristics of the respective area of technology. But there is also reason to believe that the optimal industrial organization may be prevented from developing by certain constraints, in particular on the supply of external finance for new technology-based firms. Financial constraints do not only show up in terms of quantitative restrictions, but also in a restricted empirical variety of external financing instruments, including standard *credit* contracts, public and private *equity* issues as well as financial innovations like convertible debt and preferred stock which are rarely used in Europe.

1.2 Financial Constraints in Technological Innovation

Financial constraints interfere with technological innovation both quantitatively and qualitatively. Not only do they *restrain* an economy's overall innovation effort, they also *distort* its industrial organization and the governance of individual innovations. On balance, the distortions are likely to be towards too much integration in large corporations, which tend to have lower costs of raising external funds than small firms in general and technology-based new firms in particular. Moreover, because the optimal industrial organization varies across technologies and industries, so does the impact of financial constraints — which in turn implies that they may even distort the structural composition of the entire economy. By partially relieving technology-based business start-ups of their specific financial constraints, venture capital can support a less integrated organization. It may thus enhance efficiency when economic properties of the respective technology render a more decentralized industrial organization optimal than would, ceteris paribus, emerge in the absence of venture capital. But for reasons related to the management of innovation by incomplete contracts, venture capital will usually remain a second-best solution, implying persistent financial constraints.

The *quantitative* constraints on technological innovation are best understood in the context of theoretical models of bank lending with equilibrium credit rationing, based on Stiglitz and Weiss (1981). These models suggest that innovative ventures in high technology are relatively unattractive for bank lending not merely because the expected future returns are more risky than those in conventional investment projects. Instead, what matters most is that the distribution of information about future returns is more asymmetric between the innovator and outside financiers in high technology, and that a larger part of the financial investment goes into *intangible* capital which cannot serve as collateral. Informational asymmetry is important with respect to both the behaviour and the quality of the young, often inexperienced, owner-managers in new technology-based firms, who have neither established a track record in terms of financial information on their new venture, nor built a pertinent reputation in previous job assignments.

When a wealth-constrained entrepreneur seeks debt financing, asymmetry of information may create the two well-known incentive problems of *moral hazard*, in which a borrower

— after the contract is closed — changes her investment plan and thereby harms the creditor, and of *adverse selection*, in which self-selection raises the average riskiness of borrowers whose individual riskiness is determined by exogenous hidden characteristics. Agency costs tend to increase as assets become less tangible and more specific. And since a higher rate of interest on bank credit tends to aggravate the incentive problems, banks cannot freely adjust the rate of interest to equilibrate credit supply and demand. Instead, the optimal rate of interest is associated with a second-best equilibrium in which either each individual borrower is rationed (moral hazard) or rationing excludes a subset of loan applicants (adverse selection).

Gale and Hellwig (1985) have shown that the standard credit contract indeed solves the incentive problems optimally when the observation of the borrower's investment behaviour and outcome is costly to the creditor. The standard credit contract minimizes the solvency risk by stipulating a fixed rate of interest, minimizes the creditor's total expected loss by demanding collateral and minimizes the creditor's costs because the borrower's behaviour is scrutinized only in case of default. However, the standard contract breaks down when the borrower cannot offer sufficient collateral because she invests predominantly in intangible assets to realize her innovation. Moreover, innovation in high technology usually precludes that banks use other strategies of overcoming information asymmetry, in particular by inferring expected returns to specific investment projects from past observations of similar projects and by judging the management quality from an established track record. Instead, many banks simply refuse to lend to any new technology-based firm altogether.

The absence of banks creates the niche which venture capitalists fill by specializing on financing the early stages of young technology-based firms, typically including their start-up and initial expansion phase. But there is a caveat: Because venture capital itself is a highly selective form of financial intermediation, it may introduce distortions of its own. It is not indiscriminately offered to all technology-based start-ups which are shunned by banks. Moreover, the absence of banks alone cannot explain why venture capitalists typically seek to *divest* their private equity shares soon after the investee firm has attained the ability to attract more conventional forms of external finance, through a trade sale or an initial public offering of shares. This desire for divestment, timed to realize the expected supernormal returns within a period of five to seven years (Gorman and Sahlman 1989), tends to exclude all those start-ups which, in spite of their intangible investments, are not expected to match the growth rates observed in the most dynamic sectors of high technology.

Like a credit contract, venture capital establishes a financing relationship that is long-term, yet intended to be temporary from the outset. In many other ways, however, the solution that venture capital provides is the exact opposite of bank lending, fully in line with the fundamental dichotomy of debt versus equity finance. Whereas the standard credit contract offered by banks seeks to minimize the incentive problem through collateral and a fixed rate of interest, venture capital seeks to pre-empt the incentive problem through ongoing managerial support, monitoring and control of the new venture. Instead of reducing risk through portfolio diversification and demanding collateral, venture capitalists seek to actively control the risk of individual investments and to share individual risks in syndicated financing. Their comparative advantage in controlling risk derives from technological specialization. Being technologically specialized, they can actually exercise control more cost effective than commercial banks could. In fact, successful venture capital firms are often led by veterans of the industry, who built their own technology-based firm and have become rich by selling it off in the stock market. A typical venture capitalist in the United States, whose firm is structured as a limited partnership, invests some of his own money as well as that of other private investors and large pension funds.

By focusing investments on technologies within his own area of professional expertise, the venture capitalists can directly reduce in-

formational asymmetries. First of all, this mitigates the adverse selection problem. Better screening of potential investee firms forces new entrepreneurs to offer projects with higher expected returns on average and thus, indeed, helps to bring about a more efficient allocation of resources from a social point of view (Chan 1983). Secondly, reduced information asymmetry also helps to mitigate moral hazard by reducing the costs of shifting a large share of entrepreneurial control to the venture capitalist within a long-term financing relationship using convertible securities, syndication and staging of investments as control mechanisms in an essentially incomplete contract.

The staging of capital infusions is the most powerful control mechanism at the venture capitalist's disposal. By creating the option to abandon the project, staging can serve as an effective monitoring and screening device helping to reduce moral hazard as well as adverse selection (Sahlman 1990; Gompers 1995). With respect to adverse selection, periodic monitoring can be considered as repeated screening, yielding an increasingly accurate picture of the entrepreneur's true skill as her venture progresses. With respect to moral hazard, staging sets strong incentives for the entrepreneur to align her behaviour with the interests of the venture capitalist: In order to win continued financial support, she will avoid strategies with high personal returns at the expense of outside shareholders or with an excessive variance of returns. Because monitoring is costly, the venture capitalist will check the status of the project only periodically, each time preserving the option to abandon it during the next round. The frequency of project evaluations and capital infusions will depend on the relative size of agency and monitoring costs: The larger the agency costs, the shorter will be the duration of funding intervals, implying a stronger overall intensity of monitoring (Gompers 1995).

Syndication and covenants are used to limit opportunistic behaviour to which repeated bargaining might be vulnerable. Hart and Moore (1994) have shown that the option of the entrepreneur to repudiate her financial obligations limits the feasible amount of outsider claims. Syndication lowers the value of the repudiation option by making it difficult, or even impossible, for the entrepreneur to obtain succession financing from competing venture capitalists. Like syndication, covenants can make the threat of liquidation more real for the entrepreneur, should she be abandoned by her venture capitalist (Lerner 1994a; Gompers and Lerner 1996). Syndication, however, raises the question of contract robustness, which appears to require that the lead venture capitalist, who is usually better informed, maintains a fixed fraction of the firm's equity over time (Admati and Pfleiderer 1994).

Convertible securities can be interpreted as yet another means to limit opportunistic behaviour, such as "window-dressing", which aims at short-term success in the next round of stage financing. Cornelli and Yosha (1997) have shown that the incentives to engage in short-termism instead of long-term value creation are endemic in stage financing, but can be attenuated by using convertible debt or convertible preferred equity in addition to straight debt and equity financing. Convertible securities can improve incentives by threatening to transfer control if certain profit, sales or performance milestones are not attained. Preferred equity differs from common stock primarily through a higher level of protection in the event of liquidation and through postponement of dividend payments in the event of a loss. The special variant of no-load convertible preferred stock, which never pays any dividend, has a liquidation preference and may be converted to common stock at the behest of the holder, is often used for financing the start-up and early expansion stages in the United States. Young firms that are more established tend to be financed by debt with warrants, options to buy common stock at a prespecified price in the future. Since the creditor will thus share the firm's success if it grows strongly, he will initially be willing to accept a lower rate of interest and less restrictive covenants on the entrepreneur's management, in the hope of reducing the probability of a liquidity crisis. The payoff structure of all these convertible securities essentially seeks to

preserve liquidity within the start-up business and to improve incentives relative to common stock by turning the entrepreneur's stake into the equivalent of a call option. The potential transition of control rights to the venture capitalist does not only serve as a disciplinary threat *ex ante*, but also effectively relieves the entrepreneur of responsibility, should her management skills turn out to be inadequate for the venture's later stages of product development and market entry.

To make the transition of control *credible* as a disciplinary threat, the venture capitalist must of course possess the technological expertise which can usually be acquired only via specialization and learning. Credibility of staging is also reinforced by the preannounced *temporary* nature of all venture capital investments which seek to profit from realizing capital gains upon exit. However, the ability of the venture capitalist to exit *successfully* within the anticipated time frame may be impaired by the same sort of information asymmetries that provided an opportunity for venture capital in the first place. Although venture capitalists will ideally seek to sell off their shares in the stock market via an initial public offering (IPO), this may be difficult to achieve when most outside investors are poorly informed. The public may be willing to buy the shares only at a substantial discount (Amit et al. 1998). A trade sale to an informed outside investor, such as an established firm in the industry, or to the venture's own managers or its founding entrepreneur may be a more attractive alternative, unless the venture capitalist can accurately signal the true value of his venture shares to the public by building a reputation for presenting high quality ventures in public offerings. Amit et al. (1998) have therefore proposed that exits via IPOs would be chosen for the better-performing ventures, trade sales for the rest.

It thus appears that the intentionally *temporary* nature of venture capital is determined by the nature of competition among venture capitalists themselves. They tend to compete for the best investment opportunities under increasing returns to reputation, which in turn is based on actual ability and past experience. Reputation matters both in attracting new technology-based firms as investees, who do not want to fail as a result of incompetent management support, and in persuading outside investors to supply capital, which is typically locked in for several years. It is this double challenge which forces venture capitalists to concentrate their investments, and that not only in those areas of *technology* where they already excel, but more generally in those areas of *business* where unique experiences feed back into higher ability through learning-by-doing. Put differently, it pays to build a reputation for excellence where it matters most, namely in screening, monitoring and supporting the management of new ventures. As the investee firm matures, the special combination of financial and non-financial services loses its efficiency relative to more traditional forms of financial intermediation.

It is thus a sign of a highly competitive venture capital industry when individual venture capitalists cannot afford to extend their services beyond their particular area of comparative, and often absolute, advantage without jeopardizing their most valuable asset, namely their reputation. As a corollary, venture capitalists time the divestment of their private equity shares so as to maximize the returns to their reputation. These returns are increasing in the number as well as in the quality of business start-ups brought to market (Gompers 1996). Moreover, venture capitalists will seek to contract young firms as early as their ability of assessing the specific risks and expected returns of prospective investees allows without lowering the expected returns. This ability can be enhanced by maintaining a rather narrow focus on a small range of closely related technology over time. Technological specialization of venture capitalists is the more important, the earlier the stage at which they get involved with business start-ups, because the riskiness tends to decrease over the lifetime of new firms.

Summing up, technological specialization of individual venture capitalists is not merely the result of arbitrary learning from any new investments and the active involvement in the management of concomitant innovations. And

the process of specialization does not simply reinforce *any* initial technological expertise. Instead, technological specialization is mainly an implication of strategic choices calculated to enhance competitiveness vis-à-vis other venture capitalists in the race for the most profitable investment opportunities. Moreover, technological specialization and the specialization on the early stages of new firms are really two sides of the same coin. Not only are they interdependent, but both enhance efficiency in the investment process of innovating economies. Put differently, venture capital combines two dimensions of financial intermediation, namely the provision of outside finance in case of failing credit markets and the transition of new technology-based firms to maturity, with the latter including the recycling of excess profits from successful divestments.

1.3 Venture Capital and Changing Comparative Advantages in Open Economies

Economists have traditionally attributed the comparative advantages of an economy to immutable structural conditions, like the economy's *exogenous* endowment with primary factors of production. Since existing venture capitalists are not only technologically specialized, but also geographically bounded in their ability to monitor and support the management of portfolio firms effectively, they too can be interpreted as an endowment of locations and as a potential source of a comparative advantage, at least in the short term. Moreover, since many of the high-tech goods and services brought to market with the support of venture capital are traded globally, the comparative advantage from an endowment with venture capital is rarely confined to individual regions and their interregional trade, but often extends to the economy at large. Consequently, the spatial distribution of venture capital can help explain international as well as regional patterns of trade.

Bank credit, by contrast, benefits from an effective interbank market which spurs the mobility of credit finance across regions and countries. The differential impact of credit market constraints on new ventures in different areas of technology determines how important a substitute for bank credit really is for industrial innovation in those areas, and, consequently, how important venture capital can be as a source of comparative advantage for different categories of tradeables. In general, the impact is greater when investments are riskier and when they result in a higher share of intangible capital. An abundant supply of venture capital thus gives a *broad* comparative advantage in risky technologies requiring a high share of intangible investments, software being the prime example.

But there are several reasons why an economy's comparative advantage from venture capital may actually lie in a more narrow subset of high technologies. One, of course, is that venture capitalists' competitiveness in screening potential investee firms as well as in monitoring and supporting their management presupposes that they themselves are technologically specialized. Another reason is that the impact of credit constraints may also depend on an industry's specific need for external finance in general. Returning to the example of software, network externalities, scale economies and rapid product cycles all imply that competition among new entrants to this industry is rather like the winner-takes-all variety. *External* financing is then often crucial to help business start-ups gain a dominant market position sufficiently fast in order to win against competing firms at home or abroad and against alternative technological paradigms. Industries, by contrast, where expansion of young firms is largely financed from retained earnings may never develop a demand for venture capital.

In the long term, an economy's supply of venture capital is of course endogenous, and the static notion of comparative advantage must be complemented by a dynamic perspective, in which localization advantages may be self-reinforcing. The recent literature on endogenous growth in open economies (Grossman and Helpman 1991) has noted that private profit-seeking investments can have the effect of changing an economy's factor endowment over

time, with the relevant factors being non-tradeable private and public inputs for the production of tradeable goods. Examples are the pool of engineers who acquire new skills from learning-by-doing in high-tech industries and the knowledge spillovers from innovative activities in private firms, which often appear to be localized (Jaffe et al. 1993). In line with this theory of dynamic comparative advantages, we argue that also the specialized business services supplied by venture capitalists comprise non-tradeable private and public inputs, whose accumulation may change the comparative advantages of an open economy.

Thus, our explanation of venture capital's role in shaping an economy's comparative advantages is a systemic one. It does not simply rest on the premise that individual venture capitalists hold a comparative advantage vis-à-vis banks in financing certain subsets of high technology. Nor is the condition sufficient that venture capital must be immobile internationally as a factor of production. This tends to be so because intensive monitoring and control of management in investee firms require geographic proximity, and venture capitalists therefore restrict their services not only to domestic start-ups, but often even to start-ups within their own home region. More important for our explanation is the hypothesis that a viable venture capital industry both creates and relies on a variety of local public goods, making the emergence of a new venture capital industry, or the further development of an established one, a systemic event at the national or at the regional level.

The first instance of a local public good is related to venture capitalists' desire for *syndicated* financing contracts. When each individual venture capitalist is specialized, syndication presupposes the existence of other venture capitalists who have developed a profile of technological specialization similar to the respective lead venture capitalist. Bygrave (1987, 1988) has suggested that syndication is valued by venture capitalists primarily because it helps to establish networks of business contacts serving to recruit specialists, managers and engineers into client firms as well as to informally trade information about best management practices and technological opportunities among the participating venture capitalists. Missing out on that insider knowledge would deprive a venture capitalist of a critical resource. In a competitive environment, venture capitalists often cannot afford to stay out of a syndicated network and hence must alternate between taking the lead and taking a complementary role in co-financing the new technology-based firms which fall into the cross-section of a venture capitalist's geographic neighbourhood and technological domain. Some degree of synchronizing investments and of implicitly co-ordinating their technological specialization may thus benefit groups of venture capitalists within a regional or national economy. In theoretical work, Kopp (1999) explores the private and social benefits of informal communication and co-ordination through networking of innovators in a patent race model.

The second local public good is a large and liquid stock market, which provides the opportunity for initial public offerings (IPOs) of common stock, the preferred exit channel for venture capitalists competing under increasing returns to their reputation. Besides liquidity in the stock market, the efficiency of the IPO process is enhanced by the contributions of intermediaries, like investment banks, and of professionals, like accountants and lawyers, whose location decisions seem to depend on agglomeration economies related to the size of stock markets. Black and Gilson (1998) have argued that IPOs are critical for an efficient venture capital industry for two main reasons: On the one hand, IPOs offer the best opportunity for venture capitalists to build reputational capital which subsequently helps to attract new funds from outside investors and start-ups as candidates for screening. On the other hand, even more important may be that the prospect of exiting through an IPO improves the entrepreneur's incentives by allowing the entrepreneur of the start-up and the venture capitalist to enter into a self-enforcing implicit contract over control, which provides for the return of control from the venture capitalist to a successful entrepreneur upon exit through an IPO.

Without a liquid stock market, exit could only be accomplished via a trade sale, with the corporate purchaser acquiring the controlling stake which the venture capitalist has held in the start-up business. It is hence only the prospect of an IPO that can give the *entrepreneur* the call option on control which she can choose to exercise in the event of success (Black and Gilson 1998: 261). Because an IPO usually results in a dispersed ownership structure, and because most venture capitalists agree ex ante to the termination of their special control rights at the time of the IPO, even if they retain some shares for a later sale, the entrepreneur can often reassume much of the control she originally ceded to the venture capitalist in exchange for his financial and non-financial support. It is in this sense that a liquid stock market, offering the prospect of raising capital at relatively low costs through an IPO, facilitates contracting between venture capitalists and start-up businesses right from their beginning.

The costs of an IPO to the entrepreneur tend to decrease with the reputation which the venture capitalist has already acquired through his track record of past IPOs. And often, the venture capitalist's reputational capital benefits his portfolio firms well before their IPO, namely by lending credibility when they deal with third parties, for example in the recruitment of personnel or with suppliers. As for outside investors, the publicly observable exit price of an IPO provides a more reliable measure of the venture capitalist's skills than could be obtained from a record of trade sales. Moreover, a regular exit and reinvestment cycle gives outside investors the opportunity to withdraw capital from those venture capitalists who turn out to be less skilled or whose industry-specific expertise and technological specialization may have become obsolete through technological change.

A third local public good is a local job market in which venture capital funds can find the right people to screen, support, develop and finally divest of high-tech ventures successfully. These people must be experts in their respective area of technology and at the same time possess the sophisticated management skills and the specialized knowledge of financial markets which can only be acquired through learning-by-doing. It is in this sense that an emerging venture capital industry cannot simply rely on, but must build a supportive local job market itself. This is a cause of localization familiar from the very high-tech industries which venture capital primarily supports, whose entrepreneurs often base their own localization choices on the availability of a pool of specialized research and engineering skills. There are thus several theoretical grounds to expect that an open economy's comparative advantage from venture capital lies in high-tech industries whose firms tend to cluster together geographically. Moreover, venture capital itself is likely to be one of the centripetal forces in this clustering, because its active involvement in investee's management limits the geographic space within which each individual venture capitalist can operate, and because the strategic choices of competing venture capitalists are interdependent.

What we have sketched here is a multidimensional explanation of venture capital's role in shaping an economy's comparative advantages in specific high-technology industries. This explanation effectively links the dynamics of venture capital and specialization to a historical process driven by dynamic scale economies akin to learning-by-doing in infant-industry models of international trade (Schertler 1999). And this, of course, implies that there may be scope in principle to enhance an economy's welfare through targeted support for venture capital.

2 The Specialization of Venture Capitalists: Evidence

In this section, we check the available data from four major venture capital markets for evidence on our hypotheses linking technological specialization to the efficiency of venture capitalists. In comparing the US, British, Dutch and German venture capital markets, we also seek to identify empirical determinants of different national patterns of technological specialization

in the venture capital industry. The European data are from the European Venture Capital Association (EVCA 1991–96), which assembles data from the member statistics of the various national venture capital associations; because reputation is paramount in the venture capital industry, members should normally have strong incentives to provide accurate data. The United States has the oldest, largest and most deeply developed venture capital market of all. In proportion to GDP, however, the British venture capital market has nominally reached an even larger size, but much of it is in fact devoted to management buyouts (MBOs) and buyins (MBIs) and does not fall under our restricted definition of venture capital. Both MBOs and MBIs enable managers to acquire an established business, but in an MBO, these managers are from within the firm whereas in an MBI, they come in from outside. The German and Dutch venture capital markets are still relatively small, after growing steadily only since the early 1990s.

Compared to Europe, US venture capitalists concentrate a larger share of their investments on high-tech industries where young firms primarily invest in intangible capital, and where we expect credit restrictions to be of particular importance. The higher degree of specialization by US venture capitalists should result not only in a higher total rate of return, adjusted for risk, but also in a higher risk-adjusted rate of return at each financing stage. Unfortunately, the ex ante risks that venture capitalists face cannot be observed, and data on rates of return are available only at a fairly aggregate level. Moreover, country-specific patterns of venture capitalists' specialization need not be entirely due to the hypotheses discussed above. In Europe, and particularly in Germany, many venture capitalists are subsidiaries of a parent company, either a bank or an industrial firm, nurturing spin-offs from in-house research or cultivating external innovations that complement the firm's own line of products. These dependent or semi-dependent venture capitalists (also called captives and semi-captives, respectively) may enjoy neither the discretion nor the incentive to specialize on a narrow subset of high technology in the same way as fully independent venture capitalists do. For only the independent venture capitalists can expect to appropriate the returns to reputational capital which they may gain from technological specialization.

2.1 Financing Constraints

Our theoretical discussion has pointed out that *without* financing constraints in credit markets, venture capital would find it very difficult to recommend itself as a financial intermediary for new technology-based firms. After all, why should any young entrepreneur agree to share her profits with a venture capitalist if she could easily obtain a bank credit and keep the profits to herself? Despite their general plausibility, however, it is far from self-evident that credit constraints are more important for small firms than for large firms and particularly important for high-tech start-ups. Yet, it is this asymmetry of credit constraints on which our specialization hypothesis for venture capital depends. Moreover, since we are addressing the specialization of venture capital in open economies, we must also ask: What is the comparative evidence for credit constraints in different countries? And: Have economists identified characteristics of national financial systems that can help explain the variance of financing constraints, of which we suppose that they exist?

Empirical studies of the existence and consequences of credit constraints usually resort to indirect methods, because data on rejected or withheld loan applications are rarely available. But survey evidence clearly supports the presumption that high-tech start-ups face particular financing constraints (Moore 1994; Westhead and Storey 1997). The same conclusion is suggested by econometric studies which have shown that the use of external debt increases with the tangibility of a firm's assets (Friend and Lang 1988; Rajan and Zingales 1995). In order to find more precise and more specific evidence, the literature has pursued two main strategies. One of these assumes that a positive impact of a firm's cash flow on R&D and other investment decisions indicates credit constraints. The argument is that without credit

constraints, these investment decisions would only be determined by market prospects and opportunity costs, factors which are largely external to the individual firm. The other empirical strategy assumes that an above-average use of trade credit indicates credit constraints, because trade credit tends to be the most expensive form of external finance and would be avoided if cheaper and longer-term credits were available from banks.

Based on the incidence of trade credit, Petersen and Rajan (1994) find evidence that small firms in the United States are indeed credit-constrained, and that these constraints decline with a firm's age and with a stable relationship to a small number of banks. For German data, Harhoff and Körting (1998) find that older firms use relatively less trade credit than younger firms, confirming the presumption that credit constraints decrease with firm age in Germany. Moreover, they also provide evidence that the cost of credit tend to be higher for fast-growing small firms than for more stable firms in Germany. As for Britain, Hughes (1997) confirms that small firms make relatively more use of trade credits than large firms.

Based on the impact of cash flow on investment, Fazzari et al. (1988) also find evidence of credit constraints, but for large as well as small firms. Himmelberg and Petersen (1994) find cash flow to be a significant determinant of R&D investments in a panel of 179 small high-tech firms in the United States. For Germany, Harhoff (1998) uses basically the same approach to show that R&D decisions in small German firms are also sensitive to cash flow. In a comparative study of British and German firms, Bond et al. (1999) find that fixed investment in British firms is sensitive to cash flow, but not in German firms. However, they do not find evidence that firms' R&D is sensitive to cash flow in either country.

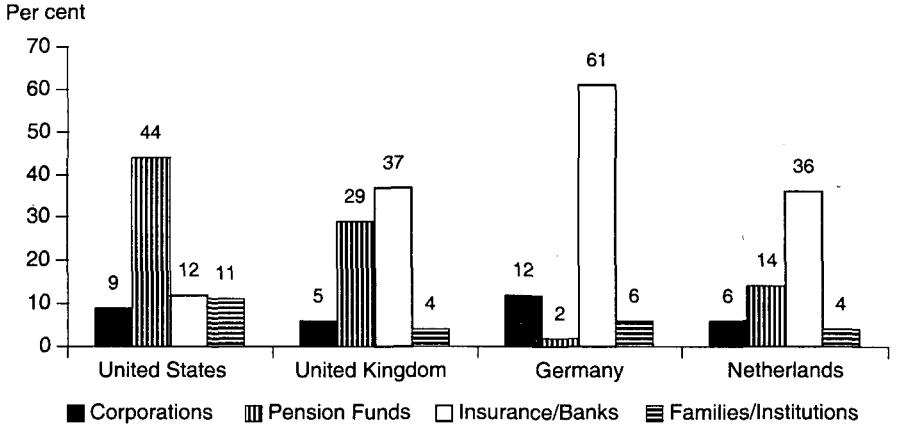
Differential credit constraints for small and large firms are consistent with the incidence of venture capital in the different countries we have looked at. In the United States, there are not only evident credit constraints for high-tech start-ups, but also great opportunities for venture capitalists who can rely on a highly productive investment banking industry to serve as underwriters for IPOs on the world's largest and most liquid stock market. In Germany, on the other hand, the stock market is much less developed, domestic investment banks are still in their infancy, and due to state banking and the wide spread of public saving and loan institutions, credit constraints appear to be less severe than in Britain, for example. Britain's financial system lacks the municipal saving and loan institutions which largely finance the German "Mittelstand" and, despite its liquid stock market, also differs from the US system because Britain lacks a domestic investment banking industry of the same quality as that in the United States. This may provide a partial explanation of why the attention and resources of British venture capitalists have been diverted from their natural domain of nurturing high-tech start-ups and are instead largely devoted to late-stage deals, including MBOs and MBIs, which are the domain of investment banks in the United States.

Finally, there is evidence that even a well-developed venture capital industry, like that in the United States, cannot provide a first-best solution and remove all the financing constraints which are due to the high uncertainty and asymmetric distribution of information characterizing technological innovation. In particular, empirical proxies for typical agency problems remain significant explanatory variables for the differential use of contractual covenants in venture capital relationships even when proxies for supply and demand conditions are taken into account (Gompers and Lerner 1999).

2.2 Specialization: An International Comparison

As a reflection of the different financial systems in which venture capitalists operate, there are sharp differences in their main sources of capital. And since a venture capital fund's main source of capital usually determines whether it is a dependent or an independent fund, it also determines venture capitalists' incentives to pursue a strategy of technological specializa-

Figure 1: Capital Commitments by Type of Investor (percentage shares 1986–1995)



Note: Volumes are deflated with the GDP (expenditure) price indices (1990=100). — Capital commitments by type of investor are summed up over the years 1986 to 1995 and divided by the total capital commitments.

Source: NVCA 1996; EVCA 1992, 1994a, 1996. GDP price indices are from OECD (1999).

tion. Besides corporations, it is banks which predominantly invest in dependent funds, so that there is a significant difference between a venture capital system dominated by banks and one dominated by pension funds. The main investors can only be identified on the basis of *new* funding activity, because data on main investors based on total cumulative funds' volumes are not available. Capital commitments in each category of investors are summed up over the years 1986 to 1995 and divided by the total sum of new funds (Figure 1).

Corporate investors often intend to participate in innovative firms in order to acquire new technologies, to enter new markets or to diversify their product range; unlike pension fund investors, they are not primarily concerned with the financial returns to their venture investments, but rather with optimizing their overall technology portfolio. For example, many German banks holding private equity shares are motivated by a desire to offer a full range of financing opportunities to firms and to raise the joint revenue from all bank services together. In order to separate credit transactions and equity transactions, many German banks have started subsidiaries managing portfolios of equity shares in unlisted firms.

In the United States, pension funds' capital became a significant factor in the growth of the venture capital market after a revision of the Employee Retirement Income Security Act (ERISA) in 1979 allowed US pension funds to invest substantial amounts of capital into risky funds, including venture capital. Pension funds have also been an important source of venture capital in the United Kingdom; in 1995, they provided almost 45 per cent of all new funds. In Germany and in the Netherlands, pension funds have played a smaller role. The activity of pension funds has been very volatile in the Netherlands, and in Germany, pension funds committed capital only in 1987/88 and 1995. In Germany, the major sources of venture capital have been banks followed by corporations. Over the 1986–1995 period, about 51 per cent of new funds were committed by banks, more than in any of the other three economies considered here. Families and non-profit institutions have never been major participants in the European venture capital markets, whereas about 10 per cent of the new funds have been raised from this source in the United States.

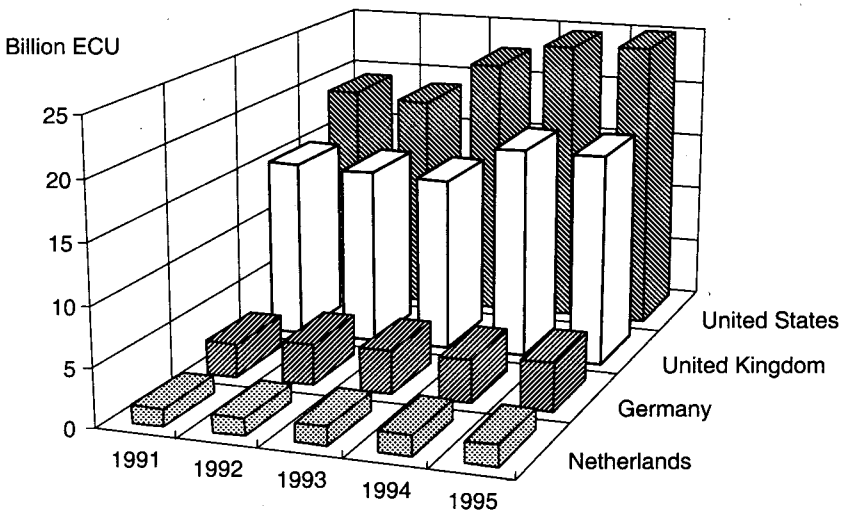
Summing up, venture capital commitments are dominated by banks in Germany and to a lesser degree also in the Netherlands. In the United States, pension funds have established themselves as the main source of capital, a trend which appears to have caught pension funds in the United Kingdom in recent years. In

fact, pensions funds in the United Kingdom may even become the dominant source of UK venture capital in the near future.

Cumulative Funds

Since the early 1990s, the total volume of cumulative funds, the sum of inflows of funds without any adjustment for divestments, has grown in all four venture capital markets examined here (Figure 2). However, their size relative to gross domestic products (GDP) and stock market capitalization (SMC) still differs sharply (Table 1).

Figure 2: Volumes of Cumulative Funds



Note: Volumes, in million local currency, are deflated with the GDP (expenditure) price indices (1990=100) and thereafter converted into ECU using year-average exchange rates.

Source: EVCA 1991–1995; NVCA 1991–1995. Exchange rates are from IMF (1999). GDP price indices are from OECD (1999).

Table 1: Volumes of Cumulative Funds as Per Cent of GDP and Stock Market Capitalization (SMC)

	United States	United Kingdom	Germany	Netherlands
1991				
GDP	0.42	1.96	0.22	0.65
SMC	0.61	2.17	1.03	1.50
1992				
GDP	0.41	2.03	0.26	0.63
SMC	0.58	2.01	1.40	1.46
1993				
GDP	0.44	2.08	0.26	0.64
SMC	0.56	1.70	1.03	1.05
1994				
GDP	0.47	2.41	0.25	0.65
SMC	0.64	2.10	1.13	0.81
1995				
GDP	0.51	2.50	0.27	0.63
SMC	0.54	1.95	1.12	0.70

Note: SMCs are year-end values given in US dollars and converted into local currency using year-end exchange rates.

Source: Volumes of cumulative funds are from EVCA 1991–1995 and NVCA 1991–1995. SMC data are from World Bank (1999). Exchange rates are from IMF (1999). GDP data are from OECD (1999).

Relative to GDP, the British venture capital market is the biggest at around 2 per cent, and the German market the smallest at only a tenth of the relative size of the British market, while the Dutch venture capital market occupies an intermediate position. Notice, however, that the Dutch market has failed to grow in terms of relative size from 1991 to 1995, while the other three have increased their relative size by a quarter during this period. It may seem surprising that the US venture capital market's relative size is only about a quarter of the British market, but this is largely due to different definitions of venture capital. Our US figures only cover independent private funds, excluding capital commitments to portfolio companies working under the Small Business Investment Company (SBIC) act, family groups and corporate affiliates. Independent funds are not legally linked to a parent company; they are mostly structured as limited partnerships, where the limited partners provide only capital, leaving the management to the general partner. Among the limited partners, insurance companies, pension funds, corporations and wealthy individuals are predominant. The European figures comprise independent, captive and semi-captive funds.

An important difference between dependent and independent funds lies in the different quality of their management support services. While the managers of independent funds are often former entrepreneurs with hands-on experience of starting their own high-technology venture, the managers of dependent funds mostly have a background in banking. Compared to these, the typical manager of an independent fund comes with many more personal contacts to other venture capitalists, financial agents and technologists both in the venture capital industry and in its client firms. We therefore believe that the non-financial services provided by independent fund managers tend to be of a higher quality than those provided by dependent fund managers. Moreover, not only the initial reputation, but also the incentive to build reputational capital will be higher for managers of independent funds.

The cumulative funds' relative size with respect to national stock market capitalization (SMC) captures the significance of venture capital for an economy's financial market. According to this measure, venture capital again appears to play a much more significant role in the British financial system than in the US system. Since the Dutch and, especially, the German stock markets are still small relative to the size of these economies, it is not surprising that their venture capital industries, too, appear to play a larger role in the equity markets of these countries than venture capital plays in the United States.

A look at annual venture capital investments and divestments during the 1991–1995 period, which is given in Table 2, confirms the general impression that relative to the size of the economy, venture capital plays a smaller role in the two largest economies, the United States and Germany, with the Netherlands occupying an intermediate position. The United Kingdom, with its broader definition of venture capital and its particularly large stock market, again stands out. Annual divestment rates, which are only given for the three European countries, do not show any great surprises. They have always remained well below the annual investments rates, confirming the strong growth of the venture capital industry in all these countries. Graphic illustrations of these trends are given in Figures 3 and 4.

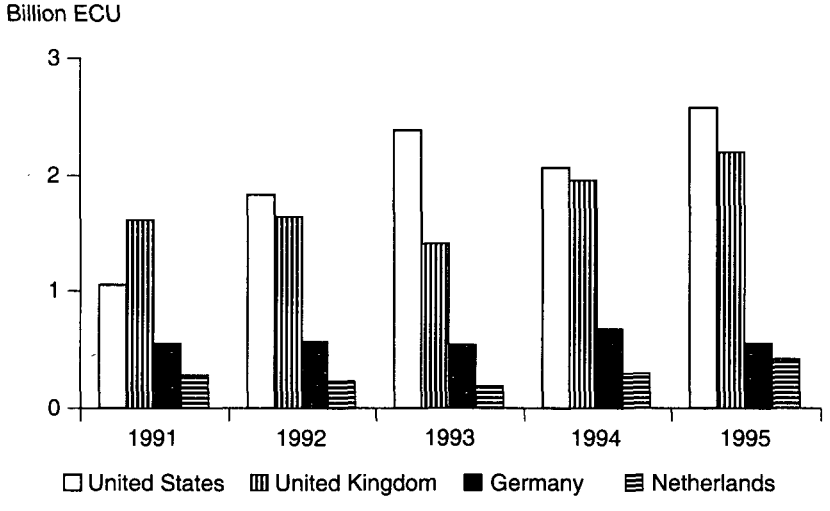
In general, however, these statistical assessments of the importance of venture capital markets have to be interpreted with some caution, because mere volumes of cumulative funds and annual investment rates provide no information about the success or failure of venture capital in financing fast-growing high-tech business start-ups, i.e. no information about the efficiency of venture capital. But there is other evidence to which we now turn.

Table 2: Annual Venture Capital Investments and Divestments as Percentage of GDP

	United States	United Kingdom	Germany	Netherlands
1991				
Investment	0.023	0.207	0.042	0.124
Divestment	—	0.080	—	0.074
1992				
Investment	0.041	0.223	0.042	0.096
Divestment	—	0.121	0.013	0.082
1993				
Investment	0.047	0.199	0.038	0.077
Divestment	—	0.166	0.021	0.069
1994				
Investment	0.039	0.261	0.047	0.114
Divestment	—	0.155	0.023	0.065
1995				
Investment	0.053	0.306	0.036	0.153
Divestment	—	0.192	0.026	0.075

Source: Volumes of investments and divestments are from EVCA 1991–1995 and NVCA 1991–1995. GDP data are from OECD (1999).

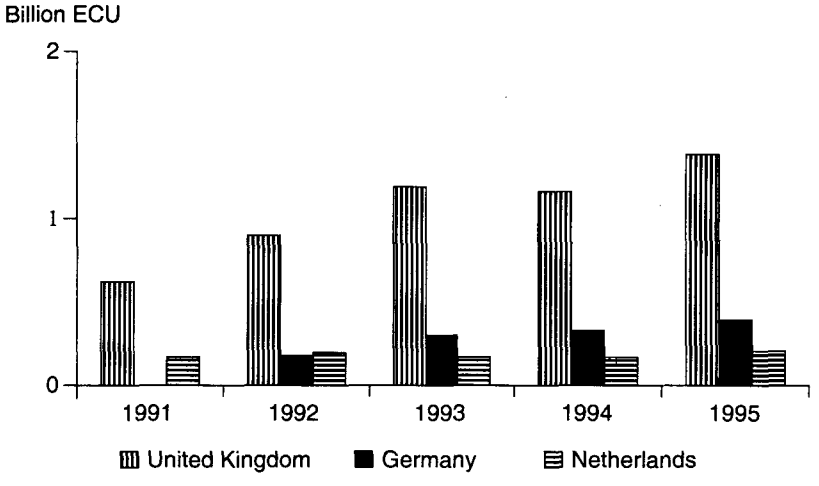
Figure 3: Annual Volumes of Investments



Note: Volumes, in million local currency, are deflated with the GDP (expenditure) price indices (1990=100) and thereafter converted into ECU using year-average exchange rates.

Source: Volumes of investments are from EVCA 1991–1995 and NVCA 1991–1995. Exchange rates are from IMF (1999). GDP price indices are from OECD (1999).

Figure 4: Annual Volumes of Divestments



Note: Volumes, in million local currency, are deflated with the GDP (expenditure) price indices (1990=100) and thereafter converted into ECU using year-average exchange rates.

Source: Volumes of divestments are from EVCA 1991–1995. Exchange rates are from IMF (1999). GDP price indices are from OECD (1999).

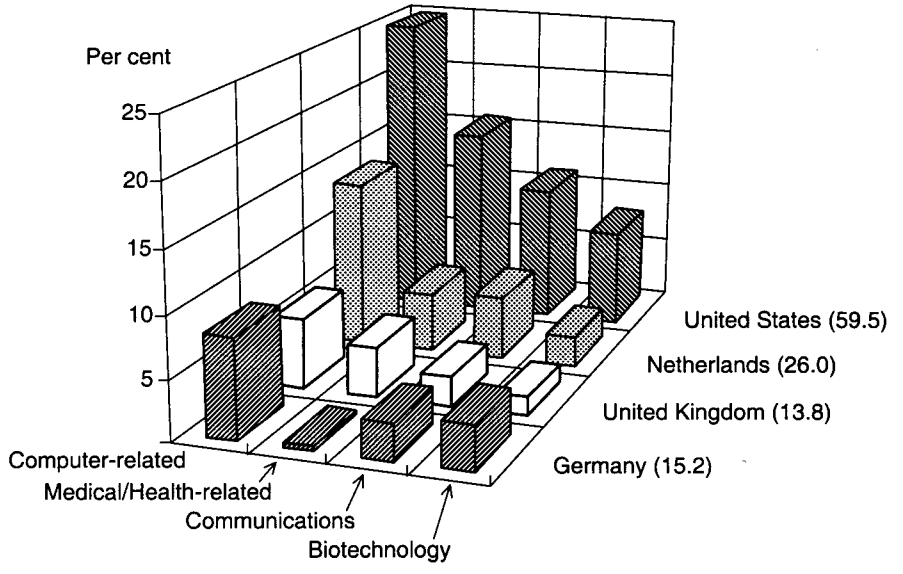
Venture Capital Investments: Characteristics and Stages

Our central hypothesis that venture capitalists tend to specialize on industries with a high share of intangible investments is supported by a variety of empirical indicators. Over the ten-year period from 1986 to 1995, the bulk of the world's venture capital investments has flown into four industries which are distinguished by a particularly high share of intangible capital and have seen strong growth in output, namely computer-related software and hardware, bio-technology, communication technologies and the medical and health-related industry. For the total 1986–1995 period, the percentage distribution of venture capital disbursements to these industries in the United States, the Netherlands, Britain and Germany is summarized in Figure 5. The differences between countries are striking.

In the United States, approximately 60 per cent of total venture capital investments went into the four high-tech industries mentioned, in the European economies only a quarter. Although investments into the computer-related industry held the largest share in all countries, the size of this share varied widely, between a quarter of total venture capital investments in the United States and only about 5 per cent in the United Kingdom. None of the European economies come even close to the high information technology and science orientation of the United States. Moreover, recent disbursement trends suggest that the European venture capital industry is developing its own distinct profile of specialization. In the United Kingdom, for example, the proportion of investments into the medical and health-related industry has increased over the observation period and reached more than 8 per cent in 1995.

In the German data, there is a marked break after the unification in 1990. Before unification, the computer-related industry accounted for about a quarter of all venture capital investments, the volume of which was still relatively small. From 1990 onwards, the volume of total venture capital investments increased sharply, but the share which went into the computer-related industry decreased to 4 per cent. In fact, the computer-related industry has seen a decline after unification even in terms of absolute values, which has begun to be reversed only five years later, at an 8 per cent share in 1995. This sequence of events is consistent with our

Figure 5: Venture Capital Disbursements by Industries (percentage shares 1986–1995)



Note: Values are deflated with the GDP (expenditure) price indices (1990=100), and thereafter disbursements by industries are summed up over the years 1986 to 1995 and divided by the respective total disbursement.

Source: NVCA 1996; EVCA 1992, 1994a, 1996. GDP price indices are from OECD (1999).

interpretation in the sense that unification, in addition to the creation of the single European market and the prospect of European Monetary Union, opened many new investment opportunities, which in turn attracted new people to the venture capital industry. Only as some of these people have succeeded in accumulating reputational capital have they become ready to specialize on investments into those subsets of *high* technology, like the computer-related industry, where financing constraints are presumed to be most important. Thus, the change of technological targeting observed for German venture capitalists after unification provides a vivid illustration of our main theme.

Our data also contains evidence on venture capitalists' specialization across the stages in the life of portfolio firms. Of course, specialization is not the only reason that venture capitalists' support varies across the development stages of the recipient firms. The most basic reason is the firms' stage-dependent demand for external finance. For statistical purposes, the following three financing stages are often distinguished:

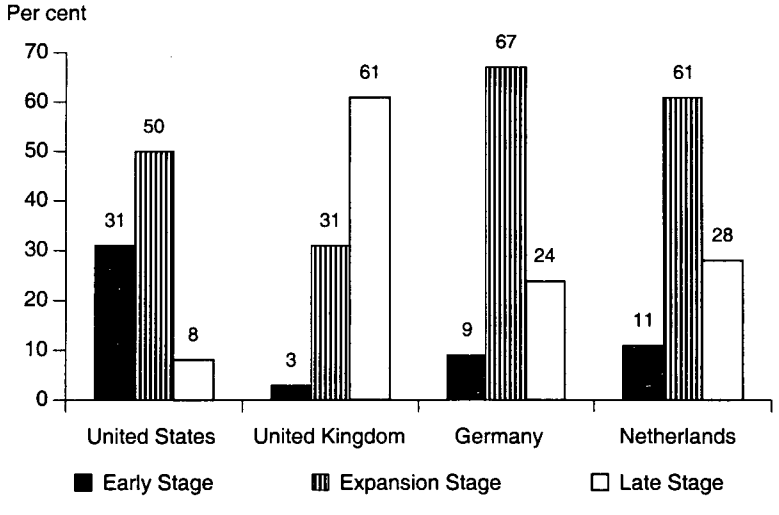
- *Early-stage financing:* The early stage, which can last between six months and five years, depending on the industry, comprises the seed stage and the start-up stage of a new business. In the seed stage, typically lasting less than one year, the initial business concept is formed and prototypes of the new product are developed and compared with competing products in the market. In the start-up stage, production is set up and a first marketing campaign is launched, to which the market reaction is carefully analyzed. Funding in the start-up stage is particularly risky and requires larger amounts of capital than in the seed stage; it is in the start-up stage that venture capitalists come into their own.
- *Expansion-stage financing:* The expansion stage often requires very large amounts of external funding, because sales do not yet generate enough liquidity for a full internal financing of the firm's growth. Venture capital is usually provided in several rounds.
- *Late-stage financing:* This category comprises a number of distinct cases of capital injections for established firms: Turnaround

financing, management buyouts (MBO), management buyins (MBI) and leveraged buyouts (LBO). These are for firms in crisis, for the acquisition of an existing business by its own management and for the takeover of privately held firms. At this stage, venture capitalists often provide debt finance, mostly in the form of convertible debentures, instead of equity only.

Figure 6 shows the distribution of venture capital investments across these three financing stages. In the United States, almost one third of investments went into the early stage and a further 50 per cent into the expansion stage. This is in sharp contrast to the UK market, where more than 60 per cent of investments went into the late stage, with a particular emphasis on MBOs, and only 3 per cent into the early stage. The venture capital markets in Germany and the Netherlands held an intermediate position, allocating most of their investments to the expansion stage. These data clearly highlight the different quality of venture capital in the different countries. Even if the MBO/MBI-funding activities of British venture capitalists were excluded, because most of them are not devoted to *new* technology-based firms, only 29 per cent of the British venture capital investments went into high-tech industries in 1991, compared to 83 per cent in the United States (Murray and Lott 1995). It appears that British venture capitalists have taken on financings which are normally done by other intermediaries in most economies.

Compared to Britain, a larger share of Dutch and German venture capital actually finds its way into high-tech start-ups. Compared to the United States, however, the much smaller Dutch and German shares of venture capital investments into the early stage are striking. These relatively small shares are consistent with our theoretical suggestion that the Dutch and German venture capitalists still need time to learn and build the reputational capital that will enhance their efficiency and make them competitive as early-stage investors without further subsidies. According to our theory, the high share of early-stage investments in the United States is evidence of the US venture capital industry's maturity. For a similar view, see

Figure 6: Stage Distributions of Venture Capital (percentage shares 1990–1995)



Note: Values are deflated with the GDP (expenditure) price indices (1990= 100), and thereafter stage investments are summed up over the years 1990 to 1995 and divided by the total investments.

Early stage includes seed and start-up (European economies) or seed, start-up and other early-stage investments (United States). Late stage includes LBO (United States) or MBO/MBI (European economies).

Source: NVCA 1996; EVCA 1992, 1994a, 1996. GDP price indices are from OECD (1999).

Gompers and Lerner (1999), who report internationally comparable figures for early-stage investments of venture capital in 1995, based on Jeng and Wells (1998). These figures indicate a volume of US$ 3,374 million in prices of 1997 for the United States, of 116 million for Germany, of 100 million for the Netherlands and of only 36 million for the United Kingdom.

2.3 Performance Measurement and Divestment Opportunities

Our theoretical discussion has suggested that a higher degree of technological specialization by individual venture capitalists should not only lead to a higher total rate of return as well as a higher rate of return at each of the different financing stages in general, but to a more pronounced efficiency gain at the early financing stages in particular. Because many US venture capitalists are already more experienced and more strongly specialized on narrow subsets of high technology, we expect that they have realized both a higher total rate of return and a higher rate of return to early-stage investments.

The most common performance measure for venture capital investments is the internal rate of return (IRR). It is defined as the discounting rate for which the present value of all future outflows equals the present value of all future inflows which a venture capitalist generates over time. This measure expresses the annual rate of return as a simple percentage and makes it easy to compare investments. But because the measure is unidimensional, it gives no information about the ex ante risk or the ex post volatility of the returns to a specific investment. Ideally, the IRR should be calculated only after a venture capitalist has exited from *all* his equity participations, because the capital gains upon exit through a trade sale or an IPO are usually the main return to his investments. But at any point in time, many participations are still in the venture capitalist's portfolio, and there are even recent entrants to the venture capital industry who have not yet exited from any of their investments. At a practical level, three variants of the ex post IRR are distinguished: The gross return on realized investments, the gross return on all investments and the net return to the outside investor (EVCA 1994b)[1]. Both gross levels of the IRR are calculated before the deduction of management fees, carried interests and other charges. The gross return on all investments even includes the entire unrealized portion of investments, the value of which has to be estimated. However, a comparison of the gross return on all investments and the net return to outside investors gives only a vague indication of the cost-effectiveness of venture capitalists but reveals little information about the efficiency of venture capitalists as financial intermediaries. Table 3 gives the total IRR on venture capital investments and the IRR on investments in different financing stages for the United States, the United Kingdom and the Netherlands.

Even at this aggregate level, the data on IRR lend support to our hypothesis that the more technologically specialized venture capitalists, who are prominent in the United States, achieve a better performance with early-stage investments. Funds which have invested in the early stage in the United States have realized a higher IRR than comparable funds in the United Kingdom and, for that matter, in the Netherlands, where the IRR has even been negative. However, the Dutch IRR for early-stage investments is not directly comparable, because, unlike the

---

1 The EVCA (1994a) bases its calculation of the IRR on the following equation:

$$\sum_{i=0}^{N} OUT_i \Big/ (1+IRR)^i = NAV_N \Big/ (1+IRR)^N + \sum_{i=0}^{N} IN_i \Big/ (1+IRR)^i ,$$

where IRR denotes the yearly internal rate of return, OUT_i represents the yearly outflow, NAV_N is the net asset value of the unrealized portfolio in the year N, and IN_i denotes the yearly inflow. This equation can be simplified, if

$$\frac{NAV_N}{(1+IRR)^N}$$

is treated as part of the financial cash inflow. Using the net cash flow, which is defined as $NCF_i = IN_i - OUT_i$, the equation takes the following form:

$$\sum_{i=0}^{N} \frac{NCF_i}{(1+IRR)^i} = 0 .$$

Table 3: Average Annual Internal Rate of Return over 1987–1996 (in per cent)[a]

	Netherlands	United Kingdom	United States[b]
Total	13	15.7	14.2
Early stage	–1	7.7	16.5
Late stage	13	—	22.1
Mid-sized MBOs	—	15.7	—
Large MBOs	—	25.8	—
Balanced[c]	—	—	14.1
Generalist[d]	—	10.9	—
Buyout	22	—	18.0

[a]Not all stages are represented. — [b]The US total IRR does not include buyouts. — [c]"Balanced" denotes funds which invest in the early as well as in the late stage. — [d]"Generalists" are funds which do not specialize on a financing stage.

Source: NVP (1997).

US and UK IRRs, it is not based on the total net IRRs of funds investing predominantly in the early stage, but on the IRRs of early-stage investments by mixed funds. Likewise, the Dutch IRR for late-stage investments includes also all investments in the expansion stage. A breakdown of the time series shows that the negative Dutch IRR in the early stage is based on a period of unsuccessful venture capital financing from 1986 to 1992 with an IRR of –8 % and a period of somewhat more successful, but still disappointing, venture capital financing from 1993 to 1996 with an IRR of 3 %. Intriguingly, the unsuccessful period was a time of heavy-handed government support for venture capital through the "Particuliere Participatiemaatschappijen" (PPM) guarantee scheme, which will be discussed below. Although the US and the UK total IRRs are net of management fees and other charges, they are still higher than the total gross IRR for the Netherlands. The total UK IRR would be less than the US IRR if management buyouts were not included in the IRR calculation.

For Germany, only a gross return on a number of individual investments made during the 1970s and 1980s is available (Schefczyk 1998). In this survey with 88 observations, the most successful venture capital investment had an average annual IRR of 111 %, while the least successful venture capital investment realized a negative IRR of –22.5 %. Altogether, an average IRR of 18.5 % was realized, while the median IRR was only 15 %.

Our hypothesis, that the exit of venture capitalists via an IPO is their best strategy to build reputational capital, is supported by the observation that IRRs vary systematically across exit channels. For example, Dutch venture capitalists realized an IRR of 32 % through IPOs, 16 % through trade sales and only 7 % through buybacks by the portfolio firms' founders.

Moreover, a variety of empirical observations support our theoretical suggestion that venture capitalists choose the exit channel strategically, and that they build their reputation primarily through successful IPOs. In the United States, for example, young venture capitalists tend to raise capital sooner after a successful IPO, the amount of capital raised depends more strongly on the number of previously backed IPOs, and at their IPO, the firms backed by a young venture capitalist tend to be younger themselves than those backed by established venture capitalists (Gompers and Lerner 1999). But within a given economy, venture capitalists' choice may be constrained by a limited set of available exit opportunities and by prevailing market conditions. An IPO presupposes a large, liquid and prudently regulated stock market, while a trade sale presupposes the existence of a corporate purchaser, with deep pockets, wishing to acquire the newly developed technology from a venture as a strategic asset. This usually means that a related industry must already be established.

The literature indeed provides evidence that an exit via IPO is chosen with greater probabil-

Table 4: Divestments by Channels (volumes in million ECU and percentage shares 1991–1995)

		United Kingdom	Germany[a]	Netherlands
Total Divestments	Volume	5,238.1	1,207.0	911.9
	Number	6,389	1,588	1,343
Sales	Volume	4,109.1	998.2	771.0
	Number	4,325	1,144	1,009
Trade sales as a percentage of	Sale volume	40.6	35.8	43.5
	Sale number	44.3	24.6	32.4
IPOs as a percentage of	Sale volume	48.0	12.3	11.6
	Sale number	16.7	4.6	6.6

[a]1991 is not included. Trade sales and IPO shares are based on a sample of observations comprising a total exit volume of 791 million ECU and a total exit number of 944.

Note: Volumes, in million local currency, have been deflated with the GDP (expenditure) price indices (1990=100), converted into ECU using year-average exchange rates and thereafter summed up over the years 1991 to 1995. — For percentage shares, volumes are deflated with the GDP (expenditure) price indices (1990=100), summed up for each divestment channel over the years 1991 to 1995 and then divided by the aggregate volume for all channels.

Source: EVCA 1992, 1994a, 1996; BVK 1992–1995. Exchange rates are from IMF (1999). GDP price indices are from OECD (1999).

ity when the liquidity in the stock market is high (Lerner 1994b), that a larger venture capital share in the ownership of a firm prior to its IPO leads to lower underpricing (Megginson and Weiss 1991) and that common stock from venture capital-backed IPOs outperforms stock from non-venture capital-backed IPOs in the long term (Brav and Gompers 1997). Barry et al. (1990) provide evidence that a higher quality of monitoring, measured by the age of the lead venture capitalist, the length of time served on the board of his portfolio firm and the number of his prior IPOs, explains lower underpricing.

On the basis of these econometric findings, we can draw some tentative conclusions on the quality of European venture capital by looking at data on divestments by channel during the 1991–1995 period, which are summarized in Table 4. The total divestments can be separated into divestments by write-off, in case of partial or total failure, and divestments by elected exit channels, in case of success. Furthermore, the proportion of the two exit channels mainly elected in case of success, trade sales and IPOs, are given.

By volume, German total divestments were about a quarter of British total divestments. In the United Kingdom, the total value of divestments was approximately five billion ECU over the period 1991 to 1995. But in the Netherlands, the total value was much lower at 911 million ECU. In the United Kingdom, almost 90 per cent of the total divestments were realized by trade sale and IPO. In the Netherlands, only 55 per cent of the total divestments were realized by these channels, in Germany 48 per cent. In Germany, a significant proportion was divested via a buyback and a secondary purchase, the purchase of shares by another venture capitalist or any other private shareholder.

In the United States (NVCA 1996), capital worth ECU 17.141 billion was raised by venture capital-backed IPOs over the period 1991–1995 with 783 firms sold over this period. About 722 enterprises went public in the United Kingdom over the period 1991–1995, and the volume of IPOs was ECU 1.972 billion. Compared with the United States, the capital raised through a venture capital-backed IPO was much lower in the United Kingdom.

3 Government Policy Towards Venture Capital

3.1 Policy Implications of Venture Capital Theory

The policy implications of our theoretical discussion can be summarized as follows. Efficiency requires that venture capitalists compete on the basis of reputational capital which they seek to build through a record of successful divestments of portfolio firms in the stock market. Helping venture capitalists to build reputational capital in the domestic market should be the government's primary concern. A higher reputation of individual venture capitalists and of the domestic venture capital industry as a whole will have two beneficial effects: First, it will encourage new technology-based firms to seek the financial and non-financial support offered by venture capitalists, and second, it will entice domestic and foreign capital providers to inject funds into the domestic venture capital industry.

Empirically, the efficiency of a venture capital industry is captured by the speed with which the accumulation of reputational capital lowers the degree of underpricing in IPOs of young technology-based firms. Underpricing refers to the difference between the price at which the IPO is offered and the (usually higher) price at which the stock is subsequently quoted publicly for the first time. Underpricing occurs when outside investors demand a discount for taking the risk of buying new stock for which no price history can be observed. Lower underpricing means that venture capitalists and owner entrepreneurs can appropriate a larger share of the social returns to their original investment. A reputable venture capitalist will thus become a more attractive partner for future start-ups in his area of technological expertise. And he may leverage some of his enhanced reputation to begin screening and investing at an earlier stage of firm formation where both the risks and the potential returns are larger. Ultimately, this raises the social efficiency of venture capital because promising new ventures will be sped along sooner while some of the wasteful adventures of entrepreneurial hypocrites may be terminated earlier.

The least controversial way of helping venture capitalists in their effort to build a reputation is to encourage and promote the prudent regulation of special stock market segments for young technology-based firms. Because these firms pose special valuation problems beyond those that bedevil the IPOs of more conventional firms, regulations should be particularly stringent with respect to accounting requirements for intangible assets, disclosure rules and insider behaviour. The goal must be to minimize the risk that an isolated case of bankruptcy soon after an IPO would frighten outside investors away by making them prejudiced against all domestic IPOs with a venture capital backing. It is because informational asymmetries are endemic and because syndication is the rule in venture financing that outside investors may not be able to discriminate efficiently between those venture capitalists who share responsibility for a failure and those who do not. Even if triggered by one or a few spectacular failures only, a loss of confidence may be persistent and may jeopardize the prospects of raising capital through an IPO for all domestic players thereafter, whether they are young technology-based firms or venture capitalists.

As a consequence, the government must first and foremost avoid all policies that might hinder the build-up of reputational capital. For example, discriminatory taxation of capital gains realized through an IPO or a trade sale should be avoided. In particular, if stock options were not taxed as income or as a capital gain before the underlying stock is eventually sold, holders would not be forced into a premature exercise of their options. And this would preserve stock options' unique value for start-ups, which primarily stems from the fact that it provides an affordable means to attract highly qualified specialists and, once they are employed, to motivate them and align their personal pecuniary interests with the long-term objectives of the firm. In similar vein, all labour market regulations that hinder the free flow of skilled specialists into and among high-tech start-ups should be relaxed, since bringing the right people into

the right place is an important part of venture capitalists' non-financial services. In many countries, the removal of labour market constraints on the venture capital industry should include the removal of barriers to the immigration of foreign specialists in areas of technology held back by a domestic shortage of skills. Moreover, bankruptcy laws in many countries will have to be reformed to make it easier for failed entrepreneurs to get a second chance, denial of which has all too often wasted their learning from experience in the past. Finally, the ability of the domestic venture capital industry to establish a reputation for high-quality IPOs may be adversely affected by overly generous subsidies or public investment guarantees.

Although subsidies may initially increase the volume of funds that an emerging venture capital industry can invest during its infancy, they are likely to discourage venture capitalists from fully taking into account the effects of their investment decisions and other activities on their own long-term reputation. For example, investment guarantees may encourage venture capitalists to be less careful in their monitoring of investment decisions in portfolio firms, and this may increase the moral hazard in these decisions. In similar vein, subsidies and investment guarantees may discourage venture capitalists from screening new technology-based firms as carefully as they can, thus increasing the risk of adverse selection in their choice of portfolio firms. Moreover, many venture capitalists will be able to expand the number of their investments only by taking on board less qualified personnel, thus further compromising their reputation for high-quality non-financial services. Ad valorem subsidies, in particular, may entice venture capitalists to provide a larger volume of finance up front so as to obtain a larger subsidy, but this will undermine the strategy of staging which has been shown to reduce moral hazard and adverse selection effectively (Gompers 1995). Thus, even if subsidies raise the overall volume of funds flowing into the domestic venture capital industry, they may be dynamically inefficient because they may hinder the build-up of reputation and may actually lower the quality of the non-financial services proffered by venture capitalists. These non-financial services, however, are crucial for the efficiency of venture capital as an institution of financial intermediation.

Most government subsidies for venture capital are awarded either as a subsidized loan or as an investment guarantee. The distinction between these two subsidy schemes matters because of their different incentive effects. In order to rank these in terms of efficiency, we must not only assess how the different schemes affect the investment behaviour of start-ups; but also how the different schemes affect the venture capitalist's efforts to screen candidates for investment and to subsequently monitor and control his portfolio firms. The start-up firm will be directly affected only if it is the recipient of the subsidy. For example, if it directly receives a subsidized loan and if this means that the start-up can do with a reduced share of venture capital in its external capital, incentives for the start-up may actually improve, because its capital structure will move away from equity-only towards a mix of debt and equity, which is more likely to lower the total agency cost of both debt and equity (Jensen and Meckling 1976). With partial debt finance, the entrepreneur's profit share in case of success will be higher than with all external finance in the form of equity or equivalent financial instruments. On the other hand, the incentives for the venture capitalist to provide managerial support may be correspondingly reduced. Moreover, even the venture capitalist's incentives for screening may be reduced if he knows that a public creditor will step in and share the risk of failure. This, in turn, may tempt the venture capitalist to seek additional ventures in which a relatively small stake held by his fund is complemented by a government loan. However, the wider spread and lower quality of the venture capitalist's non-financial services, which this may imply, will likely result in slower learning and in a slower build-up of reputational capital, which may be dynamically inefficient.

By contrast, if the loan is given to the venture capitalist and is used to increase the volume of his equity shares in each of a given number of new ventures, his incentives for screening and monitoring may even improve. Not only is his stake in each venture now higher, but so are his private costs should an individual venture fail, because he remains liable for serving his debt to the government unless his entire fund fails. Only if the venture capitalist has special insider knowledge about correlations between the prospective returns from different ventures, can he deliberately choose a combination of projects which raises the variance of their combined returns at the expense of the government's expected return on its credit. On the other hand, the additional capital from a government loan may tempt the venture capitalist to participate in additional ventures, leaving the size of each venture constant. The additional ventures would then most likely have risk-return prospects inferior to those ventures he would finance without government help. Moreover, the venture capitalist would have to spread his limited monitoring capacity over a larger number of ventures, resulting in a lower quality of monitoring and control of each individual venture. But, of course, the venture capitalist may also choose to increase the number of ventures under contract and at the same time raise his screening and monitoring efforts, which would best serve the government's goal to increase the size of the venture capital industry and to enhance a dynamically efficient learning process.

Unfortunately, there is much less reason to believe in such a lucky outcome if the government extends its support for the venture capital industry via investment guarantees for individual ventures. Under such a guarantee scheme, the venture capitalist's incentives for screening and monitoring will almost certainly be reduced, even if the guarantee covers only part of the venture capitalist's investment. For in the case of success, the venture capitalist will share in the venture's profits, but in the case of failure, he will not fully bear the losses. Hence, he will care less about potential failures which the entrepreneur herself risks by choosing to invest in a manner that promises a particularly high expected return to herself at the expense of a higher variance of returns and a higher probability of failure. The government guarantee, perversely, helps to align the venture capitalist's interest with that of his investee without solving the adverse selection and moral hazard problems. In the short term, the venture capitalist may even be able to increase the volume of his investments by luring additional outside investors into the guaranteed profit opportunity. In the long term, however, the lack of learning by the venture capitalist will deter future contributions by outside investors and will likely result in a dynamically inefficient development of the venture capital industry.

Because guarantees directly reduce the weight given to potential losses in the venture capitalist's allocation decision, the moral hazard created by a government guarantee tends to be worse than that created by a loan scheme. A loan scheme is likely to create the same sort of moral hazard only if the loans are given directly to the portfolio firm, but then the moral hazard is likely to be partially offset by improved incentives for the entrepreneur. These come about because loans given directly to the portfolio firm tend to reduce the total agency costs by moving the portfolio firm's capital structure towards one which rewards the entrepreneur's own effort more generously. Finally, under a loan scheme in which the venture capitalist is the recipient, the incentive effect may well be efficiency-enhancing if the venture capitalist himself remains responsible for serving the loan even after individual ventures have failed.

However, there always remains a problem of adverse selection in the sense that both government guarantees and loans may attract new entrants into the venture capital industry who lack the sophisticated skills and experiences needed for successful screening and monitoring of high-tech business start-ups. The reason for this is that governments are unlikely to know how to screen out the hypocrites among venture capitalists, which is particularly difficult when the venture capitalists are technologically specialized and when there are many new entrants who have not had any prior opportunity to build a pertinent reputation. The dire consequence of

a lower quality of management support offered by the average venture capitalists may not only be that outside investors are deterred from committing capital, but also that the founders of high-tech firms may become hesitant about accepting venture capital and the partial loss of control this entails. Hence, if the lower quality of management support is properly taken into account, an ill-conceived scheme of government subsidies or investment guarantees may even raise the effective costs of capital to new technology-based firms.

As a macroeconomic implication, our theoretical discussion suggests that venture capitalists may seek less technological specialization than they should in order to fully capture dynamic economies of scale if subsidies reduce the relative importance placed on venture capitalists' non-financial services. The consequence of reduced technological specialization is not only a direct efficiency loss, which is due to the key role played by specialization in reducing the adverse selection and moral hazard of financing unknown and untested young entrepreneurs: Like reputational capital, a strong technological specialization enables the venture capitalist to get involved with new technology-based firms at an earlier stage in their development. But there is also an indirect efficiency loss: Since the strategic choices of competing venture capitalists are interdependent, reduced specialization by individual venture capitalists implies that the venture capital industry as a whole will be less specialized as well. And this may leave the international division of labour at a suboptimal level.

The political economy of subsidies suggests that policymakers may wish to target them at those subsets of high technology where foreign competitors have attained a technological lead. For example, much of the official rhetoric about Germany's recent initiatives to support start-ups in biotechnology reveals this kind of motivation. But our theoretical discussion of venture capital suggests that such targeting would be a mistake. In the event of scale economies in the production of tradeables, whether static or dynamic, world welfare is maximized if all related activities are concentrated in one region or country, which therefore specializes on the respective industry so as to realize the maximum scale compatible with world demand. If another country then uses targeted subsidies for its domestic venture capital industry in order to shift the established comparative advantages in its own "favour", world welfare will inevitably be reduced, at least during a transitional period, to the extent that the subsidies lead to a less concentrated allocation of the activities that are subject to scale economies. A better policy strategy for a country seeking to establish a domestic venture capital industry for the first time may be to target subsidies so as to seek entry through its own window of opportunity. The window of opportunity will usually lie in newly emerging high technologies for which no other country has already developed a comparative advantage.

But our theoretical discussion suggests that public support for venture capital need not be targeted at particular subsets of high technology in order to initiate a process of learning-by-doing and technological specialization by venture capitalists. Such a process will be self-reinforcing when the opportunity is there and the conditions are right. Nor should governments, by the same token, require as a condition for public support that venture capitalists hold *diversified* portfolios of firms specializing on different subsets of high technology, because this would slow down the process of technological specialization which has been shown to be an efficient market response to the informational and incentive problems that bedevil the external financing of technological innovation.

Instead, policymakers must be aware that not only the specialization of individual venture capitalists comes at the price of foregone diversification of risk (Norton and Tenenbaum 1993). When an individual venture capitalist chooses to specialize on one particular technology in order to build reputational capital, this will normally imply a high degree of specialization with respect to geographic location, industrial affiliation and development stages of portfolio firms as well. But also a highly specialized venture capital industry as a whole may

lead to a less diversified industrial structure than would be supported by a bank-centred system in a small open economy. The economy's pool of entrepreneurial talent may simply be too limited to reap technological opportunities in more than one area of specialization. But with fully liberalized capital accounts, consumers will nevertheless be able to hold diversified, and therefore less risky, portfolios of capital, including domestic and foreign venture capital investments, no matter how specialized the domestic venture capital market actually is. So it need not necessarily be a concern for policymakers if the emergence of a domestic venture capital industry creates new comparative advantages which may appear to increase the riskiness of the economy's profile of technological and industrial specialization.

3.2 Policy Experiences

The comparative evaluation of actual policies in different countries is complicated by the fact that not only structural conditions but also the mix of policy-induced barriers to the development of venture capital may differ significantly between countries and, indeed, have been changing rapidly in some European countries. For example, the large and highly liquid stock markets of the United States and the United Kingdom have traditionally provided more favourable exit opportunities than the bank-dominated financial systems of continental Europe (Black and Gilson 1998). Recently of course, several European countries, seeking to emulate the success of the NASDAQ stock exchange in the United States, have made strides in establishing their own stock market segments for new technology-based firms, using a mixture of public and private initiatives. In addition, some of the other conditions which we have called policy-induced barriers to venture capital have also changed in presumably significant ways. But we shall not attempt a comprehensive evaluation here. Instead, we shall merely glance at the specific experiences with fiscal subsidies for venture capital which the United Kingdom, the United States, the Netherlands and Germany have made. While all four have indeed used public subsidies to stimulate the supply of venture capital to new technology-based firms in their early and expansion stages, the details have differed and so have the outcomes, as far as they can be evaluated on the basis of the limited data that is publicly available.

Indirect policies promoting individual investments through tax incentives have been particularly popular in the United Kingdom. As early as 1981, the British government launched the Business Start-up Scheme in order to encourage private investments into early-stage or other small, privately held firms. In 1983, this scheme became the Business Expansion Scheme (BES), under which up to £ 40,000 of an individual's eligible equity investment could be deducted from taxable income. Although the scheme initially restricted the tax incentives to direct equity investments in new firms, it was later modified with the result that the bulk of subsidized investments actually went into special funds which were set up and run under the BES. In 1993/94, the BES was replaced by the Enterprise Investment Scheme (EIS), granting 20 per cent tax relief to investors who invest up to £ 100,000 a year in small firms. In addition, the more general Capital Gains Tax Re-Investment Relief and the Venture Capital Trusts were introduced (*Venture Capital in the UK* 1996). These venture capital trusts are intended to stimulate investments by individuals in small unquoted firms by granting 20 per cent tax relief on investments of up to £ 100,000 in any one year and by exempting all returns from capital gains and income tax, but eligible trusts can only invest their capital in firms with gross assets of less than £ 10 million.

According to the OECD (1996), the BES has been successful in raising substantial *amounts* of capital. But the *efficiency* of subsidizing venture capital through tax incentives has been questioned on a number of counts. First and foremost, by requiring that individuals invest directly in privately held firms or via special new funds, the BES has largely bypassed established intermediaries, like pension funds and life insurers, and wasted their expertise in dealing with venture capitalists. Moreover, the special new funds set up and run under the BES

have probably crowded out fully private venture capitalists who might have played a larger role in the absence of the BES. On the other hand, it must be said that making all venture investments through established intermediaries eligible for tax relief would have been in conflict with the intended targeting of the subsidies at the early and expansion stages of new technology-based firms. Secondly, by tying tax incentives to the amount invested, they become more expensive than tax relief on capital gains, which only rewards the winners and hence better strengthens the incentives for venture capitalists to build a reputation for cultivating winning firms. And thirdly, because the fiscal incidence of tax incentives depends on the endogenous response of investors, it is hard to predict their subsidy equivalent ex ante, which in turn makes it very difficult to base the decision about the size of the tax incentives on the desired level of support for venture capital. For example, the amounts raised through Venture Capital Trusts have disappointed policymakers in the United Kingdom (Taylor 1997).

Direct policies promoting investments in the early and expansion stages of new technology-based firms have been adopted with varying success in the United States, the Netherlands and Germany. The first direct support policy, a loan scheme, was established in the United States with the Small Business Investment Act of 1958, which channelled low-interest government credits through so-called Small Business Investment Companies (SBICs) into small and medium-sized growth firms. SBICs are federally sponsored, yet privately owned and managed, profit-oriented investment funds which make debt and equity investments in their portfolio firms and are regulated by the US Small Business Administration (SBA). During their heyday in the 1960s, SBICs were often able to obtain four low-interest government dollars in debt, guaranteed by the SBA, for each dollar of own equity invested. Between 1958 and 1969 alone, the SBIC programme provided more than three times the total private venture capital investments in the United States (Noone and Rubel 1970). According to the SBA (1996), the costs of the scheme have been more than covered by the tax revenues generated each year from successful investments. However, a declining stock market led to the venture capital draught of the 1970s, when venture capital almost vanished. Regulation was tightened and SBICs became almost non-existent.

Today's venture capital firms in the United States take a variety of legal forms. SBICs, whose government funding no longer comes as loans but as preferred equity, and the so-called captives, which are owned by either banks or industrial corporations, have lost market shares to the ten-year private limited partnership, a self-liquidating fund, which has emerged as the dominant organizational form during the 1980s and which already controlled four fifth of US venture capital in 1989. The strict separation between limited and general partners, which this legal form affords, appears to have special advantages for the management of venture capital and for the acquisition of outside funds: It grants limited liability status to the limited partners and does not jeopardize pension funds' non-taxable status. Moreover, there is no corporate taxation, only the income of individual partners is taxable at the time of realizing the capital gains upon the preagreed termination of the fund. Taken together, it appears that these indirect tax incentives, which the ten-year private limited partnership is designed to exploit, have effectively crowded out the old SBICs whose every existence depended on government loans.

However, through a variety of support schemes, the US federal government and numerous state governments have continued to subsidize young technology-based firms. The largest such programme to date has been the Small Business Innovation Research (SBIR) programme, which between 1983 and 1995 provided over US$ 6 billion worth of public research contracts to small businesses in the United States. Lerner (1996) has calculated that SBIR awards, reaching a total volume of US$ 847 million in 1995, have become comparable in size to the annual volume of early-stage investments by private venture capital funds in the United States. In his empirical assessment of the SBIR programmes' long-term impact,

Lerner (1996) finds that the growth rates of employment and sales in recipient firms substantially exceed those of a set of matching firms, but these positive effects appear to have been confined to geographic areas which already had significant private venture capital industries before receiving SBIR awards. Thus, instead of crowding out private venture capital, government awards made under the SBIR programme actually appear to complement it. Lerner (1996) tentatively attributes this surprising result to a liquidity and a signalling effect, which the SBIR awards appear to have in the financing of innovations. With respect to liquidity, receipt of an SBIR award often helps young firms to extend the length of time until refinancing must be sought from a private venture capitalist. And with respect to signalling, potential venture capital providers and customers may interpret the award as a signal of superior quality of the firm's technology. Unfortunately, the geographic confinement of positive growth effects from SBIR awards raises doubts about the usefulness of this and similar subsidy schemes as a catalyst for the emergence of venture capital in hitherto unendowed regions or countries.

This point is reinforced by the policy experience of the Netherlands during the 1980s and early 1990s, when massive public subsidies resulted in widespread disappointment. Drawing on a detailed comparison with the US market, Brouwer and Hendrix (1998) have argued that, despite massive public support, the Dutch venture capital industry failed to build a reputation among outside investors for high-quality IPOs from early-stage investments. As a consequence of many years of disappointing performance and scandals which had surrounded stocks from venture capital-backed IPOs, the Dutch "Parallelmarket" (PM), which had been founded in 1982, was even closed down in 1993. In search for a proximate explanation, Brouwer and Hendrix (1998) have attributed the failure of Dutch venture capitalists to build a reputation to their lack of a long-term strategy which resulted in the overpricing of IPOs and in the sale of too many shares from the venture capitalist's portfolio at the time of the IPO. With hindsight, the IPO market was overheating during the 1984–1986 period. Brouwer and Hendrix (1998) report estimates, according to which the initial rate of return (underpricing) of IPOs on the PM was 28.4 %, which is not dramatically higher than the average of 8.4 % on the official market. PM turnover and the number of IPOs declined after the general stock market crash of 1987 until the PM's closure in 1993. The scandals that further tainted venture capitalists' reputation included fraudulent dealings around bankruptcies. More fundamental, however, may have been the indeterminate length of life of Dutch venture capital funds, which Brouwer and Hendrix (1998) see as providing insufficient incentives for venture capitalists to build a reputation because, unlike US venture capitalists, they need not worry about refinancing after a set date. This, in turn, may have contributed to a loss of public trust in early-stage Dutch IPOs and may thus have made further early-stage investments unattractive to venture capitalists seeking to exit via the Dutch stock market.

The rise of Dutch venture capital during the 1980s had been supported by regulatory reform, e.g. by the partial lifting of the ban on equity investments by Dutch banks in 1980, and by fiscal subsidies. Of particular importance was the introduction of the "Garantieregeling Particuliere Participatiemaatschappijen" (Guarantee Settlement Private Participation Societies) by the Dutch government in 1981, which gave qualified venture capital firms (PPMs) up to a 50 per cent retribution of losses suffered on individual venture capital investments. The full 50 per cent compensation, up to a maximum of 50 million guilders, was only paid if the venture capitalist exited within ten years after foundation. Brouwer and Hendrix (1998) report that the popularity of the "Garantieregeling" increased sharply when the maximum guarantee was raised to four million guilders of investment per deal in 1986. Private investors then swarmed to start PPMs, whereas regional and captive PPMs (mainly owned by banks) had been the main beneficiaries of the guarantees before. But compensation payments also increased sharply. Quick exiting, which had become rampant, was prohibited in 1988. Al-

though a quarter of all new venture capital investments still fell under the PPM scheme in 1990, there was rising disappointment about venture capitalists' search for quick profits instead of long-term reputation, and efforts were made to concentrate the subsidies on the start-up stage of new technology-based firms. The "Garantieregeling" was limited to an investment of 75 million guilders in 1990, and to 50 million guilders in 1991, with a maximum guarantee of 25 million guilders per portfolio firm. The "Garantieregeling" was terminated at the end of 1995, amid disappointment about its failure to stimulate early-stage investment.

The German policy experience of support for venture capital includes elements of both loan and guarantee schemes. In 1998, as in other recent years, the most important subsidy scheme has been the "KfW-Technologiebeteiligungsprogramm" (Technology Participation Scheme; BTU), in which the "Kreditanstalt für Wiederaufbau" (KfW), Germany's state development bank, committed DM 223 million in subsidized loans to venture capitalists and banks which themselves committed a minimum of DM 1 million. These loans are intended to refinance 75 per cent, up to a maximum of ECU 1.5 million, of venture capitalists' holdings of private equity in qualified high-tech start-ups. In order to become eligible, the venture capitalist must present a portfolio firm less than ten years old, with fewer than 50 employees and with annual sales below ECU 7 million. While the duration of each credit cannot exceed ten years, the KfW bears the risk for its share in the respective venture.

The second largest subsidy scheme in 1998 has been the "KfW-Risikokapitalprogramm" (Risk Capital Programme; RKP), in which the KfW committed DM 65 million in guarantees and DM 147 million in subsidized loans of up to ECU 5 million to venture capitalists and banks holding private equity in small and medium-sized firms with annual sales of less than ECU 500 million. Guarantees are for up to 40 per cent of the default risk to the venture capitalist, and the duration of both loans and guarantees is again 10 years. The explicit primary purpose of this scheme is to support bridge financing for young privately held firms planning an initial public offering of shares (IPO) in addition to a general expansion of their business activities. The third largest subsidy scheme in 1998 has been the "ERP-Beteiligungsprogramm" (ERP-Participation Programme), in which the KfW committed almost DM 180 million to small and medium-sized firms with less than 500 employees and annual sales below ECU 50 million. Although the conditions of this scheme are similar to the BTU programme, the "ERP-Beteiligungsprogramm" explicitly excludes any guarantees in case of default or bankruptcy of the respective venture.

In addition, the federal and state governments have launched numerous other subsidy schemes to support high-tech start-ups. For example, the "Technologie-Beteiligungs-Gesellschaft" (Technology Participation Society; tbg), an affiliate of the "Deutsche Ausgleichsbank", offers equity to small high-tech firms whose sales are still below ECU 14 million and which have secured a matching equity participation from a private venture capitalist. Moreover, special subsidy schemes have been set up for small and medium-sized firms located in Eastern Germany, notably the "KfW-Beteiligungsfonds Ost" with commitments of DM 192 million in 1998 alone. Under this scheme, the KfW grants subsidized loans to venture capitalists, banks, industrial corporations or even individuals holding private equity in firms with less than ECU 500 million in annual sales. The loan ceiling is set at 100 per cent of the supported equity stake, whose maximum size is ECU 10 million, and 50 per cent of the default risk to the investor is guaranteed by the KfW. Some schemes can even be employed cumulatively in some parts of Germany.

Given this multitude of subsidy schemes for private equity participations in small and medium-sized firms, many observers have noted that, contrary to the persistent popular belief of a venture capital draught in Germany, the country is now actually awash with venture capital. Not only does a young German entrepreneur in the late 1990s have easier access to venture capital than his counterpart in the United States, where 99 per cent of applicants

for venture capital are routinely rejected. But also the monetary user costs of venture capital to the entrepreneur may well be lower in Germany than in the United States. Unfortunately, these quantitative measures say little about the *quality* of venture capitalists' non-financial services. Insiders openly talk about the dangers of moral hazard and adverse selection, one sign of which is the fact that the high valuations on Germany's "Neuer Markt" stock market segment are beginning to attract young firms from abroad, including the United States, which apparently anticipate lower costs of raising equity capital on Germany's relatively young "Neuer Markt" than even on America's booming NASDAQ. This sign may indicate that the German venture capital cycle may well be approaching its peak quite soon. Hence, it is probably too early to judge the success of the various German policy initiatives whose intention has been to stimulate the supply of venture capital. The ultimate test of venture capital's resilience will only come during the next bear market for stocks, which is likely to be followed by a recession in the very high-tech industries whose expansion has hitherto been fuelled by heavily subsidized venture capital. This test will reveal how many new technology-based firms actually fit the description by an insider quoted in *The Economist* (1999: 30), characterizing Germany's emerging biotechnology industry as consisting of "scientific projects in a business wrapper, with a narrow product pipeline and a critical lack of managerial expertise".

Summing up, there is some evidence that the different schemes of support for venture capital have had the mixed success which we had predicted in our theoretical discussion. In particular, loan schemes like those in the United States appear to have had fewer and less serious negative side-effects in terms of supporting the wrong sort of ventures and the wrong sort of actors in the venture capital industry. By contrast, the Dutch PPM guarantee scheme of the 1980s and early 1990s must probably be considered a failure. The German policies may well prove hardest to evaluate, not only because many are of recent vintage, but also because many of them mix elements of a loan scheme with elements of a guarantee scheme. The problems encountered by the indirect policy approach of the UK government are of a somewhat different nature because tax incentives on their own seem to lack the necessary focus to lure venture capitalists into early-stage deals. Hence, there is a genuine dilemma for policy-makers in that only some of the more direct and more activist subsidy schemes seem to yield measurable results soon enough to be attributable to these support policies, but governments in countries without venture capital generally lack the specific technological expertise and knowledge of market conditions to execute such direct policies efficiently.

4 Conclusions

While Europe in the 1990s has seen spectacular growth in venture capital, ironically, this may have made governments more complacent about the many remaining barriers. Europe's current venture mania is only partly due to the internal and external liberalization of capital markets; possibly in larger part, it must be attributed to several unique developments in the 1990s, namely the stock market boom in anticipation of monetary union, the inflow of surplus funds for venture capital investments from the United States and, last but not least, the massive subsidies that several European governments have extended. These favourable developments are partly one-time events (like monetary union), partly cyclical developments (like the inflow of US capital) and partly politically motivated subsidies. Thus, it will remain unclear whether conditions have changed *fundamentally* enough to permit a self-sustaining venture capital market in all EU countries until the current boom has reached its peak and subsidies have been phased out.

There are then two possible outcomes, either continued growth or decline of what are still fragile venture capital markets in several European countries. A decline would suggest that fundamental conditions do not favour venture capital in the respective economy and that sub-

sidization has been in vain. Given Europe's less favourable structural conditions, however, the removal of the remaining *barriers* may or may not change the overall picture very much. Continued growth, on the other hand, would suggest that temporary subsidies may have been helpful in kicking off a venture capital market that would be viable in the long term. In this case, the removal of the remaining barriers would further improve the efficiency of the venture capital market. Neither outcome, however, would call for continued subsidies.

And there is another lesson for policymakers: Besides being ineffective (in the face of adverse fundamentals) or superfluous (after the market has surpassed its infant-industry stage), subsidies may even be *counter-productive*. Subsidies which are channelled through private venture capital intermediaries, of which public guarantees are a special example, carry the risk of new distortions, because they tend to make outside investors and fund managers less careful about weighing the risks of their investment decisions (moral hazard). Moreover, subsidies may attract people to the venture capital business who are poorly qualified to assess the prospects and risks of specific new technologies (adverse selection). When subsidies thereby lead to a waste of human capital as well as to an unwarranted change in technological priorities, an open economy might move to a pattern of specialization at odds with fundamental comparative advantages. The welfare loss to an open economy could then indeed be substantial.

References

Admati, A.R., and P. Pfleiderer (1994). Robust Financial Contracting and the Role of Venture Capitalists. *Journal of Finance* 49 (2): 371–402.

Aghion, P., and P. Howitt (1998). *Endogenous Growth Theory*. Cambridge, Mass.

Amit, R., J. Brander, and C. Zott (1998). Why Do Venture Capital Firms Exist? Theory and Canadian Evidence. *Journal of Business Venturing* 13 (6): 441–466.

Barry, C.B., C.J. Muscarella, J.W. Peavy III, and M.R. Vetsuypens (1990). The Role of Venture Capital in the Creation of Public Companies. Evidence from the Going-Public Process. *Journal of Financial Economics* 27: 447–471.

Black, B., and R. Gilson (1998). Venture Capital and the Structure of Capital Markets: Banks Versus Stock Markets. *Journal of Financial Economics* 47 (3): 243–277.

Bond, S., D. Harhoff, and J. van Reenen (1999). Investment, R&D and Financial Constraints in Britain and Germany. Working Paper Series 99/5. The Institute for Fiscal Studies, London.

Brav, A., and P. Gompers (1997). Myth or Reality? The Long-Run Underperformance of Initial Public Offerings: Evidence from Venture and Nonventure Capital-Backed Companies. *The Journal of Finance* 52 (5): 1791–1821.

Brouwer, M., and B. Hendrix (1998). Two Worlds of Venture Capital: What Happened to US and Dutch Early Stage Investment? *Small Business Economics* 10 (4): 333–348.

BVK (Bundesverband Deutscher Kapitalbeteiligungsgesellschaften) (1992). *BVK-Statistik*. Berlin.

— (1993). *BVK-Statistik*. Berlin.

— (1994). *BVK-Statistik*. Berlin.

— (1995). *BVK-Statistik*. Berlin.

Bygrave, W.D. (1987). Syndicated Investments by Venture Capital Firms: A Networking Perspective. *Journal of Business Venturing* 2 (2): 139–154.

— (1988). The Structure of the Investment Networks of Venture Capital Firms. *Journal of Business Venturing* 3 (2): 137–157.

Chan, Y. (1983). On the Positive Role of Financial Intermediation in Allocations of Venture Capital in a Market with Imperfect Information. *The Journal of Finance* 38 (5): 1543–1561.

Coase, R. (1960). The Problem of Social Cost. *Journal of Law and Economics* 3: 1–44.

Cornelli, F., and O. Yosha (1997). Stage Financing and the Role of Convertible Debt. CEPR Discussion Paper 1735. Centre for Economic Policy Research, London.

The Economist (1999). Biotechnology: Ripe for Picking. August 7th: 30.

EVCA (European Venture Capital Association) (1991). *Yearbook.* Zaventem, Belgium.

— (1992). *Yearbook.* Zaventem, Belgium.

— (1993). *Yearbook.* Zaventem, Belgium.

— (1994a). *Yearbook.* Zaventem, Belgium.

— (1994b). *The EVCA Performance Measurement Principles.* Zaventem, Belgium.

— (1995). *Yearbook.* Zaventem, Belgium.

— (1996). *Yearbook.* Zaventem, Belgium.

Fazzari, S.M., R.G. Hubbard, and B.C. Petersen (1988). Financing Constraints and Corporate Investment. *Brookings Papers on Economic Activity* (1): 141–195.

Friend, I., and L.H.P. Lang (1988). An Empirical Test of the Impact of Managerial Self-Interest on Corporate Capital Structure. *The Journal of Finance* 43 (2): 271–281.

Gale, D., and M. Hellwig (1985). Incentive-Compatible Debt Contracts: The One-Period Problem. *Review of Economic Studies* 52 (4): 647–663.

Gompers, P.A. (1995). Optimal Investment, Monitoring, and the Staging of Venture Capital. *The Journal of Finance* 50 (5): 1461–1489

— (1996). Grandstanding in the Venture Capital Industry. *Journal of Financial Economics* 42 (1): 133–156.

Gompers, P.A., and J. Lerner (1996). The Use of Covenants: An Empirical Analysis of Venture Partnership Agreements. *The Journal of Law & Economics* 39 (2): 443–498.

— (1999). *The Venture Capital Cycle.* Cambridge, Mass.

Gorman, M., and W. Sahlman (1989). What Do Venture Capitalists Do? *Journal of Business Venturing* 4 (4): 231–248.

Grossman, G.M., and E. Helpman (1991). *Innovation and Growth in the Global Economy.* Cambridge, Mass.

Grossman, S., and O.D. Hart (1986). The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *Journal of Political Economy* 94 (4): 691–719.

Harhoff, D. (1998). Are There Financing Constraints for R&D and Investment in German Manufacturing Firms? *Annales d'Économie et de Statistique* 49/50: 421–456.

Harhoff, D., and T. Körting (1998). Lending Relationships in Germany — Empirical Evidence from Survey Data. *Journal of Banking & Finance* 22 (10): 1317–1353.

Hart, O., and J. Moore (1994). A Theory of Debt Based on the Inalienability of Human Capital. *Quarterly Journal of Economics* 109 (4): 842–879.

Himmelberg, C.P., and B.C. Petersen (1994). R&D and Internal Finance: A Panel Study of Small Firms in the High-Tech Industries. *The Review of Economics and Statistics* 76 (1): 38–51.

Hughes, A. (1997). Finance for SMEs: A U.K. Perspective. *Small Business Economics* 9 (2): 151–166.

IMF (International Monetary Fund) (1999). *International Financial Statistics.* CD-ROM. Washington, D.C.

Jaffe, A.B., R. Henderson, and M. Trajtenberg (1993). Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations. *The Quarterly Journal of Economics* 108 (3): 577–598.

Jeng, L.K.A., and P.C. Wells (1998). The Determinants of Venture Capital Funding: An Empirical Analysis. Harvard University. Cambridge, Mass. Mimeo.

Jensen, M.C., and W.I. Meckling (1976). Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure. *Journal of Financial Economics* 3 (4): 305-360.

Kopp, A. (1999). Direct Communication, Costs of Networking and Localization of Technical Knowledge. Kiel Working Papers 903. Institute of World Economics, Kiel.

Lerner, J. (1994a). The Syndication of Venture Capital Investments. *Financial Management* 23 (3): 305–360.

— (1994b). Venture Capitalists and the Decision to Go Public. *Journal of Financial Economics* 35 (3): 293–316.

— (1996). The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program. NBER Working Paper 5753. National Bureau of Economic Research, Cambridge, Mass.

Megginson, W.L., and K.A. Weiss (1991). Venture Capitalist Certification in Initial Public Offerings. *The Journal of Finance* 46 (3): 879–903.

Moore, B. (1994). Financial Constraints to the Growth and Development of Small High Technology Firms. In A. Hughes and D.J. Storey (Eds.), *Finance and the Small Firm.* London.

Murray, G.C., and J. Lott (1995). Have UK Venture Capitalists a Bias against Investment in New Technology Based Firms? *Research Policy* 24 (2):283–299.

Nelson, R.R. (1995). Co-Evolution of Industry, Structure, Technology and Supporting Institutions, and the Making of Comparative Advantages. *International Journal of the Economics of Business* 2 (2): 171–184.

Noone, C.M., and S.M. Rubel (1970). *SBICs: Pioneers in Organized Venture Capital.* Chicago.

Norton, E., and B. Tenenbaum (1993). Specialization versus Diversification as a Venture Capital Investment Strategy. *Journal of Business Venturing* 8 (5): 431–442.

NVP (Nederlandse Verenigung van Participatiemaatschappijen) (1997). *Rentabiliteit en Venture Capital. Rapport NVP-Onderzoek Over de Periode 1987/1996.* Den Haag.

NVCA (National Venture Capital Association) (1991). *Yearbook.* Arlington, Va.

— (1992). *Yearbook.* Arlington, Va.

— (1993). *Yearbook.* Arlington, Va.

— (1994). *Yearbook.* Arlington, Va.

— (1995). *Yearbook.* Arlington, Va.

— (1996). *Yearbook.* Arlington, Va.

OECD (1996). Venture Capital and Innovation. OECD Working Papers IV (98). OECD, Paris.

— (1999). *National Accounts.* Vol. 1. CD-ROM. Paris.

Petersen, M.A., and R.G. Rajan (1994). The Benefits of Lending Relationships: Evidence from Small Business Data. *The Journal of Finance* 49 (1): 3–37.

Rajan, R.G., and L. Zingales (1995). What do we Know about Capital Structure? Some Evidence from International Data. *The Journal of Finance* 50 (5): 1421–1460.

Sahlman, W.A. (1990). The Structure and Governance of Venture-Capital Organizations. *Journal of Financial Economics* 28 (2): 473–521.

SBA (Small Business Administration) (1996). *Overview. Small Business Investment Companies 2/96.* Access on January 18th 1999 via: http:\\www.sba.gov/INV/overview.html

Schefczyk, M. (1998). *Erfolgsstrategien deutscher Venture Capital-Gesellschaften.* Stuttgart.

Schertler, A. (1999). Venture Capital and Asymmetric Information in an Evolutionary Framework. Kiel Working Paper 939. Institute of World Economics, Kiel.

Schumpeter, J. (1942). *Capitalism, Socialism and Democracy.* New York.

Stiglitz, J.E., and A. Weiss (1981). Credit Rationing in Markets with Imperfect Information. *American Economic Review* 71 (3): 393–410.

Taylor, R. (1997). Venture Capital Trusts: Tax Breaks Tempt Backers. *Financial Times*, Survey (Management Buy-Outs), May 30th: V.

Venture Capital in the UK. A Report and Guide to the Venture Capital Industry (1996). HMSO, London.

Westhead, P., and D.J. Storey (1997). Financial Constraints on the Growth of High Technology Small Firms in the United Kingdom. *Applied Financial Economics* 7 (2): 197–201.

World Bank (1999). *Emerging Stock Markets Factbook*. Vol. 13. Washington, D.C.