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Europe's Entry into the Venture Capital Business: Efficiency and Policy

by

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Abstract:

This paper provides new evidence on Europe's experience with venture capital in the 1990s. Individual countries' activity is not solely determined by country characteristics and a purely domestic history, but also by a common European experience: the interdependence of valuations in primary equity markets. Each country must seek to improve the efficiency of its venture capital sector independently. Specific policies should depend on initial conditions and on the evolution of micro-efficiency. Initial public offerings backed by venture capital provide the appropriate window to look at the relative efficiency of individual venture capital organizations and their learning process over time.

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1. Motivation

Better access of new technology-based firms to venture capital has long been at the core of Europe's policy strategy for innovation and growth. In June 1998, the Cardiff European Council adopted the five-year Risk Capital Action Plan which the European Commission (1998a) prepared to promote the development of an integrated pan-European risk capital market. Yet relatively little was known until recently about the empirical determinants and institutional requirements of an *efficient* venture capital industry.[1] To fill this gap, the EU-funded research programme on European Integration, Financial Systems and Corporate Performance (EIFC) included an empirical project on "European Financial Markets, Venture Capital and High-Tech Firms", for which field work was begun in late 2000 – right after the millennium bubble in technology stocks had burst. From this vantage point, a wealth of new empirical data has been assembled and used to study the genesis and development of Europe's venture capital since 1990. The present paper will report from this research[2] and discuss its relevance to specific policy issues, such as the merits of targeted subsidies for venture capital, the deregulation of access to primary equity markets and the appropriate level of policy making within Europe's common market – national or supranational – among others.

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1 For findings from a rare empirical study with a broad European perspective on the venture capital industry and an assessment of its impact on innovation and growth, see Bottazi et al. (2001) and Bottazi and DaRin (2002).

2 See Schertler (2001, 2002a, 2002b, 2003) and Stolpe (2003a) for other parts of this research. A closely related paper is Stolpe (2004).

A first look at the distribution of early stage venture capital investment in 13 countries and its development since 1990 is provided in Figure 1.[3] In all countries, except for the Netherlands, a strong upswing beginning in 1997 and lasting until 2000 takes the volumes of early stage venture capital investments from below 0.2 to a multiple of the initial level – in most countries to around 1.0 per mil of GDP.[4] Against this strong surge in venture capital at the *end* of the 1990s, all contemporaneous differences across countries fade into the background. Indeed, the striking co-movement of investment levels suggests that some kind of international interdependence holds the key to understanding Europe's entry and recent experience in the venture capital business. The hypothesis of international interdependence is of fundamental importance for the design of government policy and for the choice of methods that can be used to study the empirical determinants of venture capital activity. Policies, as I will explain in a moment, must target the efficiency of the venture capital industry, not the aggregate investment volume within a given country or region. And the empirical methods must not fall into the trap of treating countries' individual experiences as observations from completely separate experiments. An appropriate method must allow for some form of cross-country and intertemporal dependence so that the role of a common European experience in the development of countries' individual venture capital industries can be identified in the data.

In principle, a variety of different mechanisms may be responsible for international interdependence in venture capital, some of which would be driven by exogenous variables – such as linkages in interest rates, an important

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3 The four panels distinguish countries by their inherited affinity with legal systems thought to provide different degrees of investor protection (La Porta et al. 1997).

4 A similar picture for expansion stage investments is shown in Figure 2. The Netherlands' more gradual expansion of venture capital investments began in 1994.

determinant of the cost of raising venture capital, and linkages through inflows of surplus venture capital from outside Europe's market. In this paper, however, I will argue that the observed interdependence in European venture capital during the 1990s has mainly been due to *information spillovers* in primary equity markets, an endogenous phenomenon that creates the potential for collective expectations of a hot issue market to serve as an effective coordinating mechanism for individual investments.[5] The presence of information spillovers naturally implies that agents' individual expectations, too, are formed endogenously since they will reflect those spillovers in one way or another. And these expectations in turn can have a large impact because many investments in the early or expansion stage of new technology-based firms are motivated by expectations about future conditions in the primary equity market. Exiting via an initial public offering (IPO) tends to be much more profitable during a hot issue market, when prices are high and the promotional effort for a successful placement is low. This chain of events seems to suggest that hot issue markets initiate venture capital investments and ultimately drive the development of venture capital markets.

In the aggregate, however, one cannot rule out reverse causality: an expanding number and volume of venture capital investments may be the most important factor that causes the arrival of a hot issue market and increases its size, given

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5 For the purpose of this study, venture capital is understood to be only the subset of private equity that combines temporary equity participation in a privately held start-up with active monitoring and control so that passive share holdings in unlisted firms are excluded. Venture capitalists are specialized financial intermediaries that raise capital mainly from institutional investors and seek to exit from their investments via an IPO or a trade sale as soon as the start-up has established a track record in the market place. An efficient venture capital sector thus provides two sorts of benefits to society: it helps to overcome financing constraints for high-tech start ups, when they are shunned in credit markets, and it serves as a filter for untested technology ventures seeking to attract expansion finance in primary equity markets.

that the main purpose of venture capitalists' management services is to select and prepare suitable start-ups for an early IPO. There seem to be only two ways to avoid this circular explanation for the empirical link between the volatility of primary equity markets and the volume of venture capital investments. One is to assume that a third variable is responsible for both. The other is to allow those cyclical co-movements to be mutually self-reinforcing by invoking a theoretical model with multiple equilibria and non-deterministic adjustment paths. In this interpretation, information spillovers in primary equity markets can create *social* multipliers and lead to non-ergodic growth in the development of venture capital. The main contribution of this paper is to study the empirical implications of this latter interpretation and to discuss some of the policy issues it raises.

Because the policy implications of social multipliers may vary depending on their actual size in a given situation, it is important to identify the underlying causes empirically and to use empirical findings when the size of the relevant social multiplier must be predicted in order to assess the likely impact of a specific policy proposal. A social multiplier that is relatively small may not imply multiple equilibria. But when there *are* multiple equilibria, national and European policy objectives can easily get into conflict with each other. More precisely, if multiple equilibria are due to country-specific economies of scale that one country exploits at the expense of another, policy makers will have to deal with an irreducible zero-sum aspect in the distribution of venture capital across countries. In this case, unless countries can find a cooperative solution, the dynamics of the allocation process will be characterized by international path dependence and a country with an initial advantage can expect to enjoy a long-term lead.

However, path dependence and multiple equilibria need not always imply locational competition for venture capital in the absence of government co-operation. Instead, the international interdependence of primary equity markets

may serve to coordinate national cycles in venture capital investments and boost the overall volume of venture capital inflows, creating a positive-sum game for all. In this case, the relevant economies of scale, such as the learning-by-doing in an emerging venture capital industry, would accrue to the European economy as a whole and no government co-operation would be required: any national policy that fosters venture capital investments would automatically create benefits for the other European countries as well. It is hence clear that efficient policies towards venture capital must be based on a thorough *empirical* analysis of how the linkages between primary equity markets and national venture capital investments actually work. For this purpose, it is useful to think of venture capital investments as growth options that are exercised when a venture-backed start-up has its IPO.

Even without venture capital-backing, real options typically account for a large proportion of market value in high-tech start-ups. As Myers (1977) pointed out, the execution of these call options on a future growth opportunity typically requires a large infusion of equity capital that can only be raised through an IPO. The timing of an IPO must therefore take into account the value of the underlying growth option both to the venture capitalist and his portfolio firm. To the latter, the growth option is the option to expand operations after the IPO has raised a substantial amount of new equity. To the venture capitalist, it is the option to refinance and expand his own operations. The flexibility to exercise the option if market conditions turn out favourably can make it worthwhile for a venture capitalist to make an initial investment in portfolio firms that would be considered unprofitable on the basis of static net present value (NPV) alone. Moreover, Myers (1977) makes the important prediction that corporate borrowing will be *inversely* related to the proportion of market value accounted for by real options, because issuing risky debt reduces the present market value of a firm holding real options by inducing a suboptimal investment strategy or

by forcing the firm and its creditors to bear the costs of avoiding the suboptimal strategy. In terms of incentives, therefore, a better source of external finance for high-tech start-ups is private *equity*, such as venture capital, because the option to go public tends to align the separate strategies of an entrepreneurial start-up and its venture capitalist during the crucial phase of preparing for the IPO.

The remainder of this paper is structured as follows. Section 2 analyses the allocation of venture capital in Europe's common market within a simple dynamic model that emphasizes the role of information revelation and information spillovers in primary equity markets. Section 3 discusses empirical evidence on the determinants of cross-country variations. Section 4 describes the initial conditions and the evolution of venture capital in France and Germany during the 1990s. Section 5 provides evidence on the role of venture capital in primary equity markets, with a special focus on venture capital's effect on the relative underpricing of IPOs. Section 6 discusses related literature and policy implications. Section 7 concludes.

2. International interdependence in venture capital dynamics: the theoretical basis

The stylised facts of European venture capital. When Ooghe et al. (1991) concluded their pioneering account of venture capital's arrival in Europe stating that at the end of the 1980s, the volume of investments had caught up with the level, relative to GDP, observed in the US, they had no idea what the subsequent stock market depression would do to Europe's venture capital industry in the 1990s: During the first half of the 1990s, while the US market raced ahead, European venture capital remained sluggish, no matter what country you look at. Yet the most striking feature in all eight panels of Figure 1 and 2 is a strong upswing in venture capital investments that begins in 1997 and lasts until 2000. These stylised facts, as the introduction already pointed out, strongly suggest

that international *interdependence* has been and will be a defining feature of the European experience with venture capital.[6]

It is worth looking at countries' individual experiences in somewhat more detail. As panel A in Figure 1 shows, the evolution of early stage investments in the two sample countries with an *English* legal system, the United Kingdom and Ireland, has been very similar, with the main surge occurring only in 2000. Expansion stage investments, by contrast, have taken rather different paths, with a three times higher peak volume in the United Kingdom. In the six countries with a *French* legal system, early stage investments show one pattern for the three Northern and another pattern for the three Southern countries, with the former reaching more than twice the peak level of the latter in 2000 – from remarkably similar initial levels in the early 1990s. For expansion stage investments, the picture is more mixed – with France sharing the more modest development pattern that characterizes the Southern group of countries. Looking at the two sample countries with a *German* legal system, the upswing at the end of the 1990s has taken both early and expansion stage investments in Germany to much higher levels than in Austria, but compared to Austria's very low initial level, the growth of Austrian venture capital is also quite impressive. In the *Scandinavian* legal systems, finally, all three countries show a strong upswing of both early stage and expansion stage investments at the end of the 1990s, and in

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6 Figures 1 and 2, plotting annual data on early stage and expansion stage investment volumes per mil of GDP against time, group countries in four different panels according to each country's inherited affinity with the four generic legal systems that the literature identifies as providing different degrees of investor protection (La Porta et al. 1997). Greater investor protection is thought to lower the cost of capital by reducing the expected rate of return that investors require for bearing part of a firm's idiosyncratic risk. Apart from differences in levels, this theory might suggest different time patterns in the evolution of venture capital across legal systems, but countries' common bubble experience of the late 1990s, to which the depression of the early 1990s gave way, belies the significance of such differences.

contrast to other countries, the high level of venture capital investments does not collapse in 2001 or 2002.[7]

The nature of interdependence. To understand the specific implications of international interdependence in venture capital, one has to start with a general framework that can be used to compare different types of economic interdependence. In principle, the interdependence of individual choices in an economic system can be either negative or positive, self-reverting or self-reinforcing. *Negative* feedback tends to arise when the interdependence is mediated through the price mechanism. Since venture capitalists are intermediaries, the price mechanism works on two sides: in the allocation of funds by external investors to individual venture capital organizations and in the matching of start-ups with these organizations. With negative feedback, the price of venture capital will inexorably decline as the supply of funds is increased or as the demand for venture capital dries up, and vice versa.[8] To see this, consider the expected rate of return if a trade sale is the only exit option for individual venture capital investments. In this case, the price at which a given venture can be sold will normally depend only on the overall demand for such take-overs, the number and willingness-to-pay of potential buyers, *and* on the venture's intrinsic characteristics, including qualities acquired with the support of venture capital, but not on the terms and conditions of other trade sales. The intrinsic characteristics will vary, and to the extent that due diligence can assess the

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7 However, in Denmark's case it may be too early to draw this inference since its upswing came with a two year delay.

8 Entrepreneurs pay for venture capital in a variety of ways, including the temporary concession of control over certain aspects of the firm's management. However, the main measure of the price of venture capital is the relative size of the equity stake that is conceded to a venture capitalist in return for a given volume of financial investment and management support. The lower this stake, the lower is – ceteris paribus – the price of venture capital.

differences, all venture capitalists will first pick the more profitable investment projects so that the expected rate of return will decline as the total volume of investments is increased.

To be sure, the *new* growth theory has introduced the idea that positive investment externalities, such as knowledge spillovers from research and development (R&D) and rent spillovers from the introduction of new goods, may keep up the marginal product of capital amid a growing volume of investments. Positive externalities are indeed pervasive in the high-tech industries in which a large part of venture capital investments is concentrated. In the short run, however, there is another – overriding – reason to assume that the *external* providers of capital will face a diminishing marginal rate of return, irrespective of any externalities: the supply of experienced venture capitalists is usually fixed in the short run, as in Gompers (1998). Under such a capacity constraint, a rapidly increasing number *or* volume of investments will tend to reduce the quality of venture capitalists' selection, screening and monitoring of portfolio firms even if the *average* quality in the pool of available start-ups is constant. A declining marginal efficiency of investments is then inevitable.[9]

In Figure 3, the curve ER_{TS} has the negative slope that indicates a declining marginal efficiency of venture capital in the short term. By contrast, the supply of funds, represented by SF in Figure 3, is upward sloping because the capital providers will make more funds available only when they can expect to earn a higher rate of return. There is thus a unique static equilibrium at q_t with the implied equilibrium price ER_t.

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9 Gompers and Lerner (2000a) provide evidence that inflows of capital into venture funds have indeed increased the valuation of these funds' new investments in the US, and thus lowered the price of venture capital, even after controlling for the characteristics of portfolio firms and for fluctuations in public market valuations.

Positive feedback in venture capital tends to arise when there is some form of non-market interaction. For example, large differences between national venture capital markets can be explained by differences in the endowment with local public goods that enhance the efficiency of venture capital. A local public good is a case of non-market interaction if its supply depends on some kind of positive feedback or virtuous circle brought about by the autonomous decisions that capital providers, venture capitalists or the users of venture capital make in pursuit of their private objectives. Stolpe (2003b) discusses three such local public goods: labour market pooling, syndication and the positive impact of localized primary equity markets on the creation of reputational capital, which venture capitalists may use to attract promising start-ups, to certify their quality and to lower the costs of contracting with start-up firms and capital providers.

Labour market *pooling* is important because the professionals needed for the selection and oversight of portfolio firms must possess highly specialized skills and experiences and will therefore prefer to be in a local labour market in which many potential employers compete for these skills rather than in a labour market dominated by a single employer with monopolistic pricing power (see Krugman 1991). Labour market pooling provides a local public good when it creates a persistent competitive advantage for local firms. *Syndication* creates a local public good because the opportunities for syndication depend on the number and on the technological focus of other local venture capitalists with a propensity to syndicate.[10] *Reputation* finally is a local public good because many investors and the relevant professionals, such as analysts, accountants and lawyers, tend to specialize in local primary equity markets where they can profit from decreasing

average costs in researching, processing and selling private information about local IPO candidates; most of these are simply too small to get global recognition.[11]

It is well-known that local primary equity markets play a central role in refinancing a thriving venture capital industry because they tend to lower the costs of contracting between the entrepreneur in a start-up firm and her venture capital backers as well as the costs of attracting capital inflows into venture capital funds. The *first* effect was pointed out by Black and Gilson (1998), who argue that the prospect of the venture capitalist exiting after the start-up goes public gives the entrepreneur the call option to regain control over her firm: unlike a trade sale, an IPO will usually result in a dispersed distribution of shares so that the entrepreneur can reassume a dominant role in the firm's strategic decision making. The *second* effect is due to the unique signalling opportunity in primary equity markets: as the US example has demonstrated, a track record of successful investments on public display in the stock market will attract further capital inflows and may create a self-sustaining venture capital cycle. This is especially important for young venture capitalists of high ability who may wish to pursue a signalling strategy in order to establish a reputation and raise the inflow of funds (see Gompers 1996 and Stolpe 2003a). By the same token, reputation plays an important role in the competition among venture capitalists for the most promising investment opportunities in new technology-based firms. In either case, the public reputation cannot be built through a series of trade sales because the terms and conditions in such deals are rarely

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10 Evidence on the relative importance of national and international syndication is contained in the data on annual venture capital flows compiled by the EVCA (2003a). Throughout the 1990s Europe's different national venture capital markets have had fairly similar shares of non-syndicated investments in all venture capital investments.

11 See Stolpe (2003b), p. 10, for further details.

disclosed. Historically, US venture capitalists have enjoyed a more favourable market environment, including large and liquid stock markets, and so have had more time and opportunity to build reputational capital.

However, while the three localized feedback mechanisms just described can explain persistent long-term *differences* between countries, they cannot explain the international *interdependence* that is evident in the pan-European surge of venture capital in the late 1990s. It is to this end that I propose to think in terms of a real option hypothesis which can explain cyclical co-movements across countries as well as large differences between countries. Both the start-up firm and the venture capitalist have a growth option that can be exercised by going public. The start-up can use the IPO proceeds to expand the scale of its operations, while the venture capitalist can use the proceeds from the sale of *his* shares to finance new investments. In addition, there is the option value of the positive signal that a successful IPO sends. I have already argued that such a signal may help to attract new capital inflows from outside investors and to open new investment and growth opportunities in start-up firms.

The literature has largely overlooked the value of the IPO exit option to the venture capitalist. This is a serious shortcoming since the externalities from the information revealed through the exercise of this option are bound to trigger exactly the sort of non-market interaction that may give rise to a large social multiplier in venture capital investments. Only investment stakes in a privately held firm entail this exit option and its value does not only increase – more than proportionally – with the *level* of valuations in the primary equity market, but also increases with their volatility. Indeed, the prospect of exiting at the peak of a bubble, which may imply an overvaluation of many IPOs relative to the firms'

discounted long-term value in the secondary market, appears to be an empirically important motivation for venture capital funds to invest in start-up firms.[12]

The exit option therefore has real consequences long before it is exercised. Above all, it lets venture capital investments respond positively to the expectation of future bubbles in the primary equity market – and more so, the larger these future bubbles are likely to be. The build-up of expectations, in turn, is driven by information spillovers from individual IPOs that reveal sufficiently specific information to influence the timing and pricing of subsequent IPOs. This is an example of non-market interaction because neither the IPO firms, nor the venture capitalists that benefit from the increase in the value of their real options, can be charged a price for receiving and exploiting the information spillovers. Moreover, because information easily crosses borders, the option value to a venture capitalist of having equity stakes in privately held firms will create the kind of social multipliers that transcend national markets for venture capital and operate across all countries perceived as belonging to Europe's common market for portfolio capital.

To facilitate a more rigorous discussion of implications, I assume that the probability of a start-up going public within any given time horizon will generally increase with the backing of venture capital. This may be partly due to venture capital's certification effect in primary equity markets (see Megginson et al. 1991) and partly due to the direct impact of venture capital on the growth

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[12] See Lerner (1994) for US evidence. In a theoretical contribution, Benveniste et al. (2002) argue that dominant financial intermediaries may help to bring about a temporal clustering of IPOs in order to internalise at least parts of the information spillovers to subsequent IPOs that are subject to a common valuation factor, such as a similar business model or technology focus. However, the intermediaries they have in mind are underwriters, such as investment banks, not venture capitalists.

of start-up firms.[13] Although the marginal quality of start-ups receiving venture capital finance may *decline* as the number of such start-ups increases, the volatility of the market's valuation of their IPOs is likely to increase: The more start-ups are ready to go public, the greater will be the probability of a hot issue market – *first*, because by definition no hot issue market can arise without a critical mass of IPOs and *second*, because the size of any given hot issue market will depend on the total size of the information externalities that venture capitalists seek to exploit by rushing their portfolio firms to the IPO when a hot issue market begins to form.

Macro-implications. To illustrate the aggregate consequences of positive feedback, I will build on Becker and Murphy's (2000) simple theory of fads since fads are characterized by the same sort of dynamics that seem to have driven Europe's venture capital industry in the 1990s. Fads are often fuelled by rationing the demand for goods whose social level of demand depends primarily on their popularity, because the popularity can be boosted by the advertising effect of rationing. In a similar vein, the inelastic capacity of venture capital organizations to screen and monitor portfolio firms induces many closed-end funds to practice a form of rationing that drives up the valuation of individual venture capital stakes, while it raises the hurdle for new start-ups to obtain venture capital finance. In fact, as Gompers and Lerner 2000a show, venture capital organizations often do not seek to expand the number of portfolio firms, but increase the size of the average deal when more funds become available under conditions of a fixed management capacity constraint in the short run. They will thus pay more for a given stake in a portfolio firm and they may also

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[13] Comparing venture capital-backed with non-venture capital-backed start-ups, Hellmann and Puri (2000) find that the former are quicker to introduce new products into the market so that they can often realize first-mover advantages and grow faster.

increase the volume of investments in less risky deals, such as in the expansion stage. In both ways, they will lower the price an entrepreneurial start-up has to pay for venture capital, although in an ex ante sense, there is a prohibitive price for the start-ups that are rationed and hence the expected price of all start-ups seeking venture capital finance may actually increase.

In line with the generic model of fads set out in chapter 9 of Becker and Murphy (2000), aggregate demand by entrepreneurial start-ups for venture capital investments can be written as $q = D(ER, Z, q)$ with $D_{ER} > 0$ and $D_q > 0$, where ER is the price of venture capital, the expected rate of return required by the suppliers of funds, q is the aggregate investment volume demanded, and Z are other determinants of demand. The total response to a change in any common variable X, like the required rate of return, is given by $\frac{dq}{dX} = \frac{D_X}{1-m}$, where $m = D_q$, the derivative of the demand function with respect to the aggregate investment volume, is a kind of social multiplier. The larger the social multiplier, the larger will be the response to changes in any common determinant of venture capital demand, such as price changes in primary equity markets, with an immediate impact on the expected rate of return on venture capital investments.

In the following, I will argue that the influence of transient conditions in primary equity markets can be so strong that m exceeds unity in some intervals of price, holding other variables constant. Where m > 1, the aggregate demand for venture capital will be unstable because every initial increase in aggregate demand will trigger an even larger subsequent increase in everyone's individual demand, which in turn will further fuel the rise in aggregate demand.

Figure 3 shows the functional relationship between the aggregate demand for venture capital, q, and the expected rate of return that is required by the

suppliers of funds, denoted ER_{IPO}. In equilibrium, the marginal venture capital investment is expected to just yield the required rate of return. This rate can be interpreted as the equilibrium price of venture capital. A social multiplier below unity implies that the demand function is negatively sloped, but a positive slope prevails in the interval where m > 1. At the two turning points, the function is infinitely elastic, with m = 1. Moving from the stable competitive equilibrium at q_l to q_h involves an increase in both quantity and price although the demand function itself remains unchanged. This is brought about by a large increase in each entrepreneur's willingness to pay for venture capital finance as venture capital's stakes in other start-ups are increased. For this reason, demand is unstable in the interval, defined by m > 1, and will explode or implode in response even to small changes in its exogenous determinants, such as the market rate of interest. Moreover, also the two stable equilibria at q_l and q_h can be vulnerable to relatively small shocks that cause large changes in the willingness to pay for venture capital.

Determinants of the social multiplier. To be more specific as to how the influence of equity markets can create a social multiplier that exceeds unity in some interval of venture capital's price and aggregate demand, I will now introduce a simple set of micro-foundations that fit into the rather general analytical framework laid out in Becker and Murphy (2000), pp. 11: exogenous changes in the venture capital market alter investment behaviour, and the aggregation of all investment behaviour determines the nature of the venture capital market. Information spillovers in the primary equity market create the opportunity to go public, a form of social capital whose volume will depend on the size of the respective hot issue market. The amount of this social capital will in turn influence the individual investment behaviour of venture capitalists.

Consider the objective function of a typical risk-neutral venture capital firm that maximizes the expected rate of return on its portfolio investments:

$ER = ER(x, y; S)$. Social capital, S, will influence a certain type of investment, x, if S and x are complements, so that an increase in S raises the marginal expected return from x, even when the increase in social capital itself lowers the expected rate of return. Complementarity between S and x means that an increase in S raises the demand for x. Not only will entrepreneurial start-ups develop a greater demand for venture capital infusions, but also the venture capitalists will increase their demand for funds to be invested in start-ups that can be prepared to go public.

The total volume of a closed-end investment fund, I, has to be divided into investments in IPO candidates, x, and start-ups in line for a trade sale, y, so that the budget constraint is $x + y = I$. The first-order maximizing condition is $\frac{dx}{dS} = \frac{ER_{yS} - ER_{xS}}{DEN} > 0$ if $ER_{xS} > ER_{yS}$, since $DEN = ER_x^2 / \left((I - y)ER_y\right) < 0$; the expected marginal return on venture capital investments in start-ups in line for a trade sale will decline as the number or volume of these investments is increased. As in Becker and Murphy (2000), I assume that the stock S equals the average of the x's for all members of the relevant social group: $S = X = \frac{1}{N}\sum x^j$ with $j \in G$, comprising all start-up firms within a given region or country, or within any area from which start-up firms go public in one and the same primary equity market. Individual maximization leads to a demand function for each firm's venture capital infusion, x^j: $x^j = d^j\left(e^j, p, S = X\right)$ with j = 1, 2, …, N, where e^j captures firm-specific determinants, such as the area of technology, p is a common influence on all members of G, such as the price of venture capital, and X is the level of social capital assumed by j when choosing x^j. The equilibrium level of $X = F\left(e^i \ldots e^n, p\right)$ is found by summing over all x^j: $X = \sum \frac{x^j}{N}$ $= \sum \frac{d^j\left(e^j, p, X\right)}{N}$. Taking the total derivate, the impact of an exogenous price

change on the volume of social capital and on the equilibrium level of X can be derived as $\frac{dS}{dp} = \frac{dX}{dp} = \frac{\sum dx^j / dp}{N} = \frac{\sum \partial x^j / \partial p}{N} + \frac{\sum \left(\partial x^j / \partial S\right) / (dS/dp)}{N}$ or

$\frac{dS}{dp} = \frac{\frac{1}{N}\sum \partial x^y / \partial p}{1 - m}$ where $m = (1/N)\sum \left(\partial x^j / \partial S\right) > 0$.

The social multiplier, m, is determined by the first-order maximizing condition that an exogenous increase in S raises the demand for x if it raises the marginal rate of return on x *relative* to the marginal rate of return on y. Put differently, the build-up of social capital through the anticipation of a hot issue market must increase the demand for venture capital by start-ups seeking an IPO *more* than the demand by start-ups in line for a trade sale, which is a natural assumption. It implies that the relevant non-market interaction must operate with a sufficient degree of complementarity to make the social multiplier positive. The larger the influence of externalities – that I assume to arise from the information revealed in primary equity markets – in exercising the IPO option, the larger will be the social multiplier and the likelihood of a large response to a common change, such as an exogenous change in the price of venture capital. Becker and Murphy (2000), p. 15, point out that individual responses in fixed proportions imply m = 1 because the demand for x by each j changes by the same percentage as S does, so that $m = (1/N)\sum \left(\partial x^j / \partial S\right) = 1$, where $x^j = w^j NS$ and $\sum w^j = 1$. However, a social multiplier can also exceed one, because individual demand may increase by a greater percentage than aggregate demand.

The relevance of this analytical framework is readily apparent when the option value of having venture capital in a start-up firm raises the social multiplier above one, because the expectation of an imminent hot issue market becomes so strong that it becomes a self-fulfilling prophecy. Although the option value of venture capital investments may not be the only relevant source of non-market

interaction, it is bound to be the strongest. The increase in option value will be more than proportional to an exogenous change in the valuation of IPOs or in the price of venture capital when a subsequent hot issue market is driven by an informational cascade in which most individuals choose to ignore their own private information (see Bikhchandani et al. 1992)[14]. The essential point is that rising individual option values will in turn increase the aggregate *demand* for venture capital through three complementary channels: *First*, the expectation of a hot issue market can trigger a surge in the formation of entrepreneurial start-ups. *Second*, existing start-ups will increase their demand for venture capital in order to take advantage of the benefits of venture capital-backing before and during an IPO. *Third*, venture capital organisations will want to raise the number of portfolio firms to maximize their profits from exiting during the hot issue market.

However, as I noted above, a rapidly increasing number of portfolio firms may be difficult to accommodate if the venture capital industry has a limited pool of experienced professionals to select and control portfolio firms. In this case, venture capital organisations may seek to improve the average quality of their portfolio firms by increasing the valuation paid for a given stake in order to attract a larger number of promising start-ups as screening candidates, similar to efficiency wage theory where firms offer wages above the market clearing level in order to incite greater effort in their workers. Higher valuations of entrepreneurial start-ups can further fuel their demand for venture capital although the constraints imposed by the limited management capacity of

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[14] As Bikhchandani et al. (1992) showed, the exploitation of information spillovers can increase the expected value of individual investment decisions even if that implies investor herding in the aggregate, creating an informational cascade, a specific form of non-market interaction, that leads to information blockage and a socially suboptimal aggregation of information.

existing venture capitalists may actually reduce the probability of obtaining venture capital finance in the short term. If the fall in venture capital's price is sufficiently large, the *ex ante* expected rate of return from starting a start-up may *increase* in spite of a decreasing probability of obtaining venture capital finance.[15] Moreover, even when a lower probability implies a higher price of venture capital in an *ex ante* sense, owning an entrepreneurial start-up may entail enough of a real option value to raise the number of start-ups and the overall demand for venture capital. With an increasing variance in the cost of external finance, this option value is also increasing: while the price is – in effect – prohibitive for all start-ups that are rationed, it falls for those that win venture capital backing and benefit from the higher valuations paid by venture capitalists.

Non-market interaction through option exercise in venture capital. Because the information externalities are much larger if an IPO reveals information to everybody than if a trade sale reveals information only to the small group of agents involved in the transaction, the recent literature on primary equity markets has rightly made it a priority to understand how investors, issuers and intermediaries attempt to exploit those information externalities for private gain. For example, issuers will seek to schedule their IPO at a time when the prior IPOs of similar firms have induced a favourable assessment of the prospective rate of return to IPO investors. By the same token, venture capitalists will seek to influence the timing of their portfolio firms' IPO so that a good performance induces external investors to make new funds available for the next round of financing start-ups. In either case, the opportunity to exploit information

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15 A similar effect drives the Harris-Todaro model of migration from rural areas to the urban agglomerations in developing countries. See Harris and Todaro (1970) for details.

externalities is clearly related to an asymmetric distribution of information about the true value of the IPO.

Especially for high-tech start-ups, it is natural to assume that the entrepreneur and her managers have better information about the firm's true value than the market has, so that the market will normally infer the firm to be overvalued when an equity offering is announced. The market will shun these issues unless there is reason to believe that they are deliberately underpriced. Part of the cost of raising equity capital is thus due to an adverse selection problem which may prevent many firms with positive net present value (NPV) investment plans from raising the necessary equity to finance these plans. It may hence be rational for a privately held firm to postpone its IPO until the costs of issuing equity have declined or the demand for a capital infusion has increased to make the IPO attractive even at relatively high cost. Lowry (2003), p. 7, argues that the adverse selection costs of issuing public equity change over time, in line with Lucas and McDonald's (1990) theoretical finding that information asymmetry can explain the characteristic clustering of equity offerings.

The real option hypothesis provides a novel explanation of changes in the cost of adverse selection over time – based on the notion that private information revealed through the exercise of an option will have an impact on subsequent exercise choices when only imperfect information is available to inform option exercise strategies. Grenadier (1999) provides a formal model of sequential option exercise in which the options themselves are basically independent. He argues that in contrast to a world of only public information, where each option can be exercised in isolation, the exercise of all the options in a temporal sequence must be determined as part of a strategic equilibrium in markets with both public and private information. Grenadier (1999) shows that the equilibrium of such option exercise games with asymmetric private information may be characterized by an informational cascade so that agents choose to

ignore their own private information and jump on the exercise bandwagon. Endogenous cascades and boom-and-bust behaviour may thus result from rational underlying forces.[16]

However, these equilibrium cascades imply that information is aggregated inefficiently. Moreover, herd behaviour that is individually rational will not last forever when the underlying market conditions are allowed to change over time, instead of being static as Bikchandani et al. (1992) assumed. This is shown in Nelson (2002) who explores the relationship between a high correlation of individual actions and cascades. She offers a formal model of sequential IPOs in which the decision to go public is more likely to be associated with informational cascades than the decision to hold off – an asymmetry that arises because the size of the payoff from making the correct IPO decision depends on the prevailing market conditions. The model of Nelson (2002) thus provides one rationale why the real option value of a stake in a privately held start-up cannot grow without bound.

Another rationale is that venture capitalists will not be able to find an infinite number of start-ups in the short term – without lowering the average quality of their investments. Nonetheless, they will want to capitalize on an increasing option value by increasing the size of each deal and will therefore begin to shift the focus of their investments from early stage to expansion stage. This in turn will raise the average maturity of the firms preparing to go public so that the

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16 As a caveat, the value of the expected information spillover from other agents' choices might imply that the prospect of a hot issue market will delay the exercise of the IPO option. The advantage of delay is that one can gain information by observing the actions of others. However, Chamley and Gale (1994) provide a model in which the equilibrium is characterized by randomised strategies, but an individual investment can trigger immediate further investment by others. In the limit, a period of little investment is followed by either a sudden investment surge or a collapse.

typical pre-IPO valuation will present investors with less uncertainty and the option value of each pre-IPO stake will tend to be lower. At the same time, venture capitalists may raise the price paid per share in each portfolio firm, regardless of whether they are in the start-up or expansion stage, so that the price of acquiring the IPO option tends to increase.[17]

Contingent on the strength of the social multiplier, m, there may be one or three equilibria, as shown in Figure 3. If $m<1$ for all levels of venture capital investments, there will not be multiple equilibria. Glaeser and Scheinkman (2003) have termed this the moderate social influence condition (MSI). In Figure 3, the equilibrium volume of the venture capital investment expands from q_t to q_l when a primary equity market opens a more profitable exit route than the trade sale. Multiple equilibria may play a role if $m>1$, but they are not guaranteed: the ER_{IS+} curve, indicating the particularly high expected rate of return from IPOs in the presence of foreign information spillovers, has only one intersection with the SF curve. By contrast, the ER_{IPO} curve, indicating the absence of foreign spillovers in the domestic private equity market, has three equilibria, namely q_l, q_h and an unmarked unstable equilibrium in between, where $m>1$.

The cost of raising capital will be smaller during a hot issue market, because the high valuation of shares will enable the issuing firm to raise a given amount of capital by giving up a smaller ownership stake in itself. In general, a call option's price will depend positively on the price of the underlying asset, the

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[17] The higher valuations per se provide a motive for rushing to the IPO so that the venture capitalist can maintain the overall expected rate of return from his portfolio. This is consistent with Gompers and Lerner (2000a), who provide evidence of 'money chasing deals': Inflows into venture capital funds are associated with a higher valuation of the new investments made by these funds, but not with the ultimate success of their portfolio firms.

interest rate, the time to expiration and the volatility of the price of the underlying asset, and negatively on the exercise price. We could therefore interpret the improved opportunities to raise equity for an expansion as lowering the exercise price during the hot issue market. The option premium, the value of flexibility with respect to the decision to go public, will be higher, the more uncertainty there is, the higher the real rate of interest and the longer the duration of the investment opportunity.

To sum it up, an increasing number of start-ups prepared to go public will increase the value of the expansion option in each individual venture capital contract through three channels: *First*, it will make the realization of favourable conditions in the primary equity market, a hot issue market, more likely, thus increasing ER_{IPO}. This is because any cold issue market may end with a few isolated IPOs whose individual timing may be accidental; but the aggregate odds for a cold issue market to end within a given time horizon are clearly larger, the larger the pool of IPO candidates with an independent probability of going public during any given interval of time. *Second*, the value of the expansion option will be higher, the larger the hot issue market because the IPO can then be expected to attract a higher price for a given stake in the start-up firm. The hot issue market will increase in size with the number of IPOs because the aggregate value of information externalities will then be larger (see Welch 1992, Hoffmann-Burchardi 2001, and Nelson 2002). *Third*, if a larger number of venture capital-backed start-ups waiting to go public causes the next hot issue market to arrive earlier, this will in effect reduce the riskless rate of interest at which the expected future value of the expansion decision is discounted.

International implications. The model I have sketched can not only explain the rapid diffusion of venture capital in the second half of the 1990s, but also makes the important prediction of an increasing divergence between efficient and less efficient venture capital markets in the years after a bubble: initially, that is

before the bubble bursts, the impact of the social multiplier is *symmetric* across venture capital markets in different countries. Indeed, the model suggests that with international information spillovers[18], a high-level venture capital equilibrium is more likely to be reached, as shown in Figure 3, where the ER_{IS+} curve is above ER_{IPO} for all values of q. But during a hot issue market, systematic differences in the efficiency of venture capital across countries will be revealed through the observed certification power of local venture capitalists in the IPO market so that the impact of the social multiplier may become *asymmetric*. This may then create international divergence in venture capital investment patterns.

Temporary booms that lift all countries are thus compatible with inequality between countries in the longer term, because complementarities related to *local* public goods, such as local primary equity markets, syndication networks and labour market pools, can cause inequality between countries for reasons similar to the discussion in Becker and Murphy (2000), p. 16. In an empirical study, high levels of variance in aggregates across countries can count as an indication that multiple equilibria are present, because strong forms of social interaction often lead to different outcomes from exactly the same fundamentals.

3. Macro-evidence: Determinants of cross-country variation in venture capital activity

Preliminaries. The theoretical considerations of section 2 suggest three specific problems that must be emphasized in the interpretation of any relevant empirical

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[18] Calvo and Mendoza (2001) have analysed investors' effort to investigate individual countries when a cross section of countries is under consideration as their investment target. They find that the presence of a fixed costs of investigating each country lets the optimal amount of investigation diminish with the number of countries so that herding becomes more pronounced.

evidence: *First*, the difficulty of identifying a unique equilibrium versus multiple equilibria; *second*, the issue of potential endogeneity in explanatories; and *third*, the need to control for changing government policies in the data. The presence of social multipliers has two main implications that are in principle testable: (i) initial positions of national venture capital markets matter, whereas the specific characteristics of individual start-ups will not have much effect on their demand for venture capital as long as the overall conditions in the local market remain the same; (ii) the process is ergodic – with no long-term lock-in that might prevent individual countries from developing their own venture capital industry.[19] Instead, the next hot issue market will provide a new opportunity to reposition a failing national venture capital industry.

However, no single method on its own can solve the difficult problem of empirically distinguishing models with a unique equilibrium and a large social multiplier from models with multiple equilibria. As Glaeser and Scheinkman (2003) point out, three different approaches have been used in the literature to estimate social interactions: *First*, a comparison of the variance of group averages in settings with and without social interaction. *Second*, estimation on the basis of the covariance between individual outcomes and the average outcome within a group. And *third*, a comparison of the empirical impact of exogenous shocks on outcomes for individuals and joint outcomes for groups, wherein the ratio measures the size of social interactions.

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[19] Stolpe (2003b) provides evidence that the distribution dynamics of aggregate venture capital investment patterns in the cross-section of European countries do not imply non-ergodicity.

It is clear then that *static* cross-country analyses cannot hope to identify all the relevant determinants of national venture capital investments when social interactions induce investment patterns that may be spuriously attributed to exogenous factors, such as country-specific barriers. Nonetheless, static analyses may provide valuable insights in conjunction with complementary approaches, such as panel methods – in particular the estimation of *dynamic* panel data models[20] – to deal with interdependence in the time dimension. For example, the well-known static cross-country panel study of Jeng and Wells (2000) notes the importance of IPO volume, relative to a country's GDP, as a driving force of venture capital investments, but does not establish a clear direction of causality. Only a dynamic econometric method can hope to distinguish the influence of contemporaneous determinants from the hand of the past. On its own, however, not even the dynamic panel method, which has been especially developed to provide consistent estimates of the influence of lagged endogenous variables in panel models for data sets with a large cross-section, can detect multiple equilibria.

To obtain more insight into the endogeneity problems that social multipliers and the possibility of multiple equilibria create, regression analyses of cross-country variation must be complemented by a direct comparison of venture capital's microeconomic efficiency in each country. Primary equity markets provide the window on the performance of venture capital which this empirical research requires: venture capital organisations can be assumed to build their reputation by bringing their best portfolio firms public and their success in building a reputation can be measured by the difference in underpricing vis-à-vis IPOs not backed by venture capital. Current efficiency is the outcome of prior

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[20] See Bond (2002) for an introduction.

investments and learning-by-doing, a process in which past experiences can have a lasting influence. A research strategy that directly compares the efficiency of different national venture capital markets thus helps to overcome the limitation of cross-country regressions when contemporaneous determinants of venture capital activity are to be distinguished from the hand of the past. Moreover, it provides policy makers with a useful quantitative target for a long-term strategy to improve the efficiency of domestic venture capital.

Empirical cross-section variation. Initially, I will compare the cross-section variation in European venture capital investments to that in gross capital formation, relative to gross domestic product (GDP): How much of the cross-section variation can be explained by country fundamentals, such as the indicators of legal systems and government support compiled by the EVCA (2003)? Table 11 presents measures of early stage venture capital investments and gross capital formation per mil of GDP and various indicators of countries' tax and legal environments for the development of venture capital that were compiled by EVCA (2003) during 2002. The total EVCA score gives the average of individual scores across 10 issues, on which countries were rated 1 – the most favourable score –, 2 – an intermediate score with room for improvement – and 3 – the least favourable score.

As the first two columns in Table 11 show, the dispersion of early stage venture capital investments across countries is much larger than the dispersion of gross capital formation – which is consistent with a social multiplier in the former, but not in the latter. The largest national share of early stage venture capital investments in GDP is recorded for Finland at 1.04 per mil of GDP, which is eight times larger than the share of early stage venture capital investments in Portugal's GDP. For expansion stage investments, the dispersion is even more pronounced, namely more than tenfold. Again, this relatively large variance in the aggregate investment levels relative to countries' GDP does suggest the

presence of a social multiplier. More systematic evidence is provided in Table 12, where the standard deviation of early stage and expansion stage venture capital investments is shown to be much larger relative to the mean than in the case of gross capital formation.

Although my sample with only 13 countries in the cross-section is too small to explain these differences within a multivariate regression model, the bivariate correlations reported in Table 13 make the point that the relevant indicators have next to no explanatory power. A negative sign would be required to confirm economic predictions on the direction of the influence of the various legal and tax indicators. But for early stage venture capital investments, a negative correlation is only observed vis-à-vis the regulation of pension funds.

Previous empirical studies in the country cross-section have examined the relevance of broader theoretical determinants of venture capital activity, such as capital and labour market regulations, the liquidity of stock markets, the size of tax rates, the importance of large financial players, and the relative size of the economies. However, the results of these studies have proved sensitive to the choice of econometric methodology and to the exact delineation of venture capital. Partly for this reason, Schertler's (2003) contribution to the EIFC project has reached somewhat different conclusions than the pioneering study by Jeng and Wells (2000), which used a panel data set of 21 countries for the years 1993 to 1995 and analysed determinants of venture capital investments and new funds raised for private equity in *static* panel regressions. Building on the same basic set-up, Schertler (2003) used data from 14 Western European countries for the years 1989 to 2000 to study the determinants of venture capital investments with

the *dynamic* panel method.[21] In both studies, early stage investments are used as a narrow approximation for venture capital investments and the aggregate of early and expansion stage investments as a broader definition, and investments are scaled by GDP.[22]

The most important findings are as follows: When new funds raised for private equity investments is the dependent variable, Jeng and Wells (2000) find the wealth of private pension funds to be a significant determinant over time but not across countries. But they do not find accounting standards, as an indicator of capital market regulations, and labour market rigidities to have a significant influence. When the actual venture capital investments are the dependent variable, Jeng and Wells (2000) find the market value of IPOs to have a significant positive impact on the aggregate of early and expansion stage investments, but not on early stage investments alone. Accounting standards, by contrast, are shown to have a significant negative impact on early and expansion stage investments, but no impact on early stage investments alone, while labour market rigidities continue to have no significant impact on early and expansion stage investments. But they do appear to have a significant negative impact on early stage investments.

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[21] I note in passing that a dynamic panel regression with no more than 14 observations in the cross-section must be interpreted cautiously because the method is only asymptotically efficient and normally requires a much larger cross-section – with 100 observations or more. Remember that only the size of the cross-section, not the number of observations in the time series, determines the level of efficiency achieved in practical applications of the dynamic panel estimator. The smallest cross-section for which Judson and Owen (1999) estimate the method's actual bias by means of Monte Carlo simulations has 20 observations. They show a large negative bias whose exact size varies with the true parameter value and tends to grow as the size of the cross-section is reduced.

[22] Some might argue that the relevant size differences between countries would be better captured by scaling on gross capital formation.

Schertler (2003) confirms the positive impact of the liquidity of stock markets on venture capital investments. She finds early stage investments to depend positively on a country's stock market capitalisation, on its human capital endowment, measured by the number of R&D employees, and on the rigidities in the labour market. However, when she uses early and expansion stage investments as a broad definition of venture capital, Schertler (2003b) cannot confirm these results. As for the surprising estimate of a positive influence of labour market rigidities on early stage investments, she argues that this coefficient may be caused by the endogenity of capital-labour-ratios across countries: in an economy with a highly regulated labour market, firms may install more capital, including venture capital, per employee since they will have incentives to substitute capital for labour.

4. Micro-evidence: The development and efficiency of venture capital in France and Germany

Initial conditions. The venture capital industries of France and Germany are an interesting pair to compare for a variety of reasons; and because these two economies are of similar size, such a comparison should be able to trace the long-term influence of different initial conditions that prevailed at around the same time. When an economy's individual experience with venture capital is subject to country-specific complementarities and social multipliers, there is no strong presumption that the level of investments in economies starting from different initial conditions will converge.

An empirical assessment of the conditions in Europe's emerging venture capital industry during the second half of the 1980s is provided by Ooghe et al. (1991). They saw France already on a high growth path, and West Germany still lacking a self-sustaining venture capital industry. The small beginnings of West German venture capital were heavily dependent on foreign sources of capital, despite the

fact that the demand from entrepreneurial start-ups was quite limited because established banks already provided enough equity and debt finance for most small and medium-sized enterprises in West Germany. As a general observation, Ooghe et al. (1991, p. 390) note that the size of Europe's various national venture capital industries seemed to be correlated with the level of activity in countries' secondary stock markets that were created during the 1980s.[23] As for government incentives, Ooghe et al. (1991, p. 390) note that the United Kingdom, the Netherlands, France and Belgium were the most successful countries at creating a favourable climate by using tax incentives and loss guarantees to reduce the riskiness of venture capial investments. But in Germany, the tax and legal environment for entrepreneurial start-ups was considered one of the worst in Europe. In the following, I will provide a more detailed look at the initial conditions and institutional framework of venture capital in France and Germany.

Institutional background. To better understand how institutions shape the initial conditions of venture capital, it is useful to think in terms of systemic financing gaps – the demand for external finance that a country's inherited financial system cannot meet. Even when there is institutional inertia, these gaps may evolve – for example in response to exogenous technological change and global trends in financial markets, such as the 1990s' trend towards disintermediation, or in response to government policies that intend to close specific gaps. The French and German venture capital industries that emerged in the 1980s and 1990s faced rather different gaps in the two countries' financial systems.

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[23] To facilitate the listing of small stocks in the United Kingdom, the Unlisted Securities Market was created in 1980, to be followed by the Parallelmarkt in the Netherlands in 1982, the Second Marché in France in 1983 and in Belgium in 1985, and the Geregelter Markt in West Germany in 1988.

In France, a general financing gap for small firms had opened up with the revolution in the French financial system of the mid-1980s (Cieply 2001). In Germany, by contrast, only high-tech start-ups were hampered by a serious financing gap and the venture capital industry grew mainly in response to new technological opportunities in the 1990s. Even today, the French banking system offers small and medium sized enterprises far fewer opportunities to obtain credit finance than is the case in Germany. Against this much broader gap in the French financial system, venture capital can be expected to be less specialized, less focused on high technology. The German banking system, by contrast, served the country's numerous collateralised Mittelstand firms, which form the backbone of the German economy, quite well; and the financing gap that did require attention was mainly due to a lack of equity finance for high-tech start-ups. Venture capital in Germany can thus be expected to focus on the latter.[24]

In a comparative study, Friderichs and Paranque (2001) describe the German financial system as a prototype of Rivaud-Danset and Saleis's (1992) commitment-based banking model and the French financial system as a prototype of Hicks's (1975) auto-economy model. In this latter model, firms' own funds, their cash flow and reserves, are the principal source of finance for small firms. They are kept at arms' length by French banks with their characteristic emphasis on procedure-based relationships with corporate clients. French firms have therefore traditionally sought to maintain their financial autonomy. Disintermediation in the 1990s has further diminished the role of the banking sector, while equity markets have continued to play only a limited role for small and medium sized firms. Cieply (2001) points out that the French

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[24] In the future, the implementation of new capital adequacy requirements (Basle II) by German banks may create new financing gaps for German Mittelstand firms.

government has adopted a number of new policies since 1996 to promote the financing of small and medium sized enterprises in line with the general move from a credit-based economy towards an equity-oriented system. In 1997, for example, it established the B.D.P.M.E. (Banque de Développement des Petites et Moyennes Entreprises), a state-owned financial institution dedicated to small and medium sized firms. Moreover, a variety of new public funds have been created to subsidize venture capital organizations.

In Germany, by contrast, small firms have traditionally enjoyed very little financial autonomy, due to their heavy dependence on bank debt as a source of finance. Until well into the 1990s, the influence of the banking sector continued to increase and the stock market played no role at all for most Mittelstand firms.[25] An important explanatory factor in this appears to be Germany's bankruptcy legislation which guarantees comprehensive protection of creditors' interests and substantially limits the insolvency costs that might be incurred by banks, as Friderichs and Paranque (2001) point out. Collateral therefore provides the vast majority of small firms in Germany with a cheap way of covering credit risks, so that there is little need to earmark liquidity for this purpose. The financing problem that became urgent in the 1990s is that start-ups in high technology usually cannot provide collateral. Germany's federal government and many state governments have therefore introduced a combined total of almost 500 different subsidy schemes to promote the development of venture capital. The most important of these programmes either require the presence of a private lead investor, such as a venture capitalist, or directly subsidize venture capitalists by providing refinancing or investment guarantees (see Schertler and Stolpe 2000; Gebhardt and Schmidt 2002).

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

Quantitative evidence. Both France and Germany have seen very rapid growth of venture capital and private equity investments in the second half of the 1990s. From 1997 to 1999 alone, total investments grew from 1,248 Mio. Euro to 2,817 Mio. Euro in France, and from 1,326 Mio. Euro to 3,159 Mio. Euro in Germany (Arundale 2001, p. 46). Seed and start-up investments surged to 32 percent in Germany and 18 percent in France. According to Fiedler and Hellmann (2001), Figure 2, seed and start-up investments grew by 1,262 percent in Germany from 1995 to 1999. Evidence on the quality of venture capital is more difficult to obtain. Bascha and Walz (2002) describe the financing practices of German venture capitalists in some detail. They find that venture capital tends to take the form of a silent partnership, which is not very different from debt finance, when agency problems are low and a buy-out is expected as the exit route. Convertible securities, by contrast, are used more frequently when agency problems are severe and venture capitalists expect to exit via an IPO, as in the case of high-tech ventures.

Taking US venture capital as a benchmark, the persistent lag of European venture capital in terms of quality is particularly striking. According to the European Commission (1998c), only 19 percent of European venture capital investments supported firms in their early stage compared with 35 percent of US venture capital. Another hint at variations in management quality is the stark difference between the US and European venture capital markets in the degree of sectoral concentration of venture capital investments. In the US, it is common for specialized venture capital firms to focus on rather narrow fields of technology that promise supernormal rates of growth in the near future. Whereas in the US, more than 60 percent of investments went to innovators of computer hardware and software, communications and medical technologies as well as biotechnology, these fast changing areas of high technology have apparently been much less the focus of European venture capital investments. Most

European venture capital has been targeted at general investment goods, consumer goods and service industries. In Germany, for example, more than 25 percent of venture capital investments in 1994 went into mechanical engineering, a traditional strength of the German economy, and a further 15 percent into trade (Pfirrmann et al., 1997, p. 51).

These structural differences did have an influence on performance. According to the European Commission (1998c), the internal rate of return to early stage investments in Europe was 5.7 percent in 1996, less than half the internal rate of return realized in the United States (14.2 percent) and even further below the average internal rate of return to all European venture capital investments (19.4 percent). This strongly suggests that the quality of venture capital organizations specialized on early stage financing was still much higher in the US than in Europe. Substantial progress which continental Europe's major venture capital industries made since the mid-1990s has certainly been a catalyst for the enormous growth and diversity of venture capital in the late 1990s that the French and German micro-data assembled for this study document.

Table 1 provides evidence from in-depth interviews with 6 French and 12 German venture capital organizations about their management practice. These interviews were made primarily to check whether the data sources I used to quantify venture capital activity in France and Germany correctly identify genuine venture capital organizations among the numerous private equity investors participating in the IPOs on Europe's stock exchanges. The procedure to identify venture capital organizations was to include all member organizations of the two national venture capital associations in France and Germany as well as any additional members of the European Venture Capital Association. Other private equity participants in the sample were counted as venture capitalist if they declared themselves as such. A list of all venture capital organizations thus identified is contained in appendix A.

The survey responses in Table 1 suggest that an active involvement in the management of portfolio firms is not uncommon for both French and German venture capitalists. The respondents were fairly small in terms of funds under management and young of age, with an average period of venture capital activity in the respective host country of less than two years. In the interviews, they were asked to relate their prior activity to specific IPOs of their portfolio firms. The total cumulative number of portfolio firms was more than twice as large for the French venture capitalists, and they also had completed more exits than their German counterparts. Board membership prior to the IPO was less than one year on average, and between 50 and 90 percent of board memberships were maintained for more at least one year after the IPO. Business contacts with portfolio firms were frequent, with monthly checks on performance. However, fewer than 8 percent of business contacts of the French venture capitalists related to new financings and more than 60 percent to business strategy, while the contacts of German venture capitalists appear to be more evenly spread, with more than 40 percent related to new financing rounds.

To provide a more comprehensive picture, Tables 2 to 10 present detailed evidence from the survey on a variety of different dimensions. Compared with the German venture capital industry, the French counterpart appears to operate at a greater level of production efficiency, receives government support that is more narrowly targeted at small venture capital organizations, and has a higher concentration of its primary equity market participation in IPOs from high-tech firms. Moreover, venture capital-backed IPOs are greater in terms of equity value compared with non-venture-backed IPOs in France's Nouveau Marché, while the opposite holds in Germany's Neuer Markt.

Operating efficiency. Table 2 documents differences in the size and growth of 184 French and 61 German venture capitalist that backed the 446 IPOs on the Nouveau Marché and Neuer Markt between 1996 and 2000 that are contained in

our dataset. Prima facie, the French venture capital industry appears to operate with more efficiency than its German counterpart. With a smaller team of professionals, the average French venture capital firm manages more than twice the investment volume and more than three times the number of portfolio firms, with partial catching up of the German counterparts observed in 2000. However, German venture capital firms concentrate their investments more heavily in the early stage of their portfolio firms' development, in which the risks and benefits of financial support are greatest.[26]

Most of the differences in the average characteristics of French and German venture capital firms are highly significant if tested either using a conventional t-test for differences in means or the two non-parametric tests reported in Table 2. In most cases, the non-parametric tests may be more reliable since the characteristics of individual venture capital organizations cannot be assumed to be normally distributed in an industry with a high rate of entry and skewness in the distribution of size. Taken together, this evidence tends to confirm that French venture capital indeed fills a broader gap in the financial system, as I suggested above, while German venture capital is more focused on the specific financing problems of fast-growing start-ups.

Government support. As I noted above, government support is an important feature of venture capital's institutional framework. Its impact will depend not only on its absolute size, but also on the way subsidies are targeted at particular

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[26] The early stage is the period during which the initial business plan is worked out, prototypes are built and the market potential is explored. Infusions of venture capital are usually quite limited during the early stage and financing rounds are made contingent on progress towards certain milestones in business development. Much larger capital infusions are required during the expansion stage, in which the production and distribution are set up on a large scale and a big marketing effort is made. The late stage refers to

areas of technology or at stages in the development of the firms that venture capital supports. Table 3 documents differences between venture capital firms operating with and without government support in France. Such support can take a variety of different forms in practice: for example, subsidized loans, tax-financed equity participation schemes or government guarantees to cover part of the financial losses that eligible private equity investors may suffer. Most of these government schemes have conditions attached so that not all venture capitalists will want to apply for these subsidies. Some authors have therefore stressed the behavioral distinction between subsidised and non-subsidised venture capital. For example, Bascha and Walz (2002) note that public-private partnerships, a common organizational form in Germany, often require significantly lower returns on capital than fully independent venture capital firms do, especially when they are young. Most of the latter seem to follow the US model of refinancing their investments through closed-end funds.

The survey did not seek to quantify the support which a particular venture capitalist or his portfolio investments received from the government, but simply asked for yes or no. In France, those receiving government support have significantly smaller teams of professionals and manage smaller investment volumes, although the number of portfolio firms does not appear to differ much between these two groups of venture capitalists. Moreover, those without government support seem to concentrate their portfolio investments more on start-ups in high technology, which includes information technology and

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private equity investments that are related to management buy-outs and buy-ins and other forms of financial engineering for established firms, not for fast-growing start-ups.

biomedical technology.[27] But there do not seem to be any significant differences in the stage distribution of the investments made by these two groups of venture capital organizations in France.

Table 4 documents the German situation where the differences between venture capital organizations operating with government support and those without are generally smaller than in France. It is noteworthy, however, that the number of professional employees and the number of portfolio investments have been growing much more rapidly in venture capital organizations with government support. This differential is shown to be significant by all three tests reported. But no significant difference is recorded for the average annual growth rate of the investment volume and for the stage distribution of the portfolio investments made by German venture capital organizations with and without government support.

Ownership structure. Table 5 documents differences between captive, or dependent, and independent venture capital organizations in France. Not only do independent venture capitalists concentrate more of their investment in high technology, but they also employ larger teams of professionals, manage a greater number of portfolio firms and have much larger overall volumes of investments, on average. Perhaps surprisingly, they concentrate a larger share of their investments in the late stage of their portfolio firms' development. The captives' greater reliance on government subsidies is a further element of distinction from their independent counterpart. In a dynamic perspective, the

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[27] Respondents were asked to state in which of the following 7 areas their portfolio investments were primarily concentrated: *information and communications technology*, *biotechnology and medical care*, *manufacturing and services*, *financial services*, *other sectors*, *regional focus*, and *no particular sectoral or regional focus*. The first two categories count as high technology for the purpose of this study.

growth differentials for the number of professionals and the volume of investments managed by dependent and independent venture capitalists suggests a greater improvement in efficiency of the latter, which may be due to faster learning-by-doing. Although their average annual growth rate for the professional employees was three times higher, dependent venture capital organizations achieved only about half the average annual growth rate of their independent counterparts in the volume of investments under management.[28]

Table 6 documents the differences between dependent and independent venture capital organizations in Germany. Here the strong focus of independent venture capitalists on high technology and the expansion stage of portfolio firms are particularly striking. In terms of their number of professional employees, independent venture capitalists were twice as large as their dependent counterparts in 1997 and 2000. In both types of organizations, the average volume of investments grew much more rapidly than the number of portfolio firms, which is consistent with the idea of a short-run demand curve for venture capital that was inelastic relative to the rapidly expanding supply during those years. Independent venture capitalists experienced an average annual growth rate of 216 percent, almost five time larger than their dependent counterparts. The fact that the average number of portfolio firms stayed constant, in spite of an average annual growth rate of the number of investments above 80 percent, is again attributable to a wave of entries by small venture capital organizations.

Market outcomes. Table 7 compares IPOs on Germany's Neuer Markt with those on France's Nouveau Marché. The main difference seems to be that underpricing was significantly lower in the sample of 130 French IPOs than

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[28] Notice that a high average annual growth rate in the number of professional employees per firm is fully compatible with a declining average number of employees during a period

among the 325 IPOs in the German sample. As a consequence, the average amount of money left on the table was seven times larger on the Neuer Markt. On this count, the French primary equity market looks more mature, while the Germany's Neuer Markt looks more like a learning experiment.

Another significant difference between the two countries was the higher participation intensity of venture capital organizations in the German primary equity market. The shares held by venture capitalists before the IPO averaged 12.6 percent, and still 7.1 percent after the IPO, against 8.2 and 5.7 percent in France. These figures are averages for all IPOs, including those without any participation by a venture capitalist. Insiders, such as owner-managers and founders of start-up firms, and strategic investors both held larger shares of the firms going public on the Nouveau Marché and continued to do so also after their partial unwinding during the IPO. By implication, the percentage free float after the average IPO was significantly higher on the Neuer Markt. In terms of employment growth, the evidence reveals that firms going public on the Nouveau Marché had experienced a significantly higher rate of employment growth in the two years prior to their IPO.

Table 8 compares IPOs from high technology and low technology firms on Germany's Neuer Markt, while Table 9 does the same for the Nouveau Marché. What is most striking in Germany's case is that the venture capital share in these IPOs was actually lower in the high-tech sectors, biomedical and information technology, than in other sectors. This confirms the persistence of the initial conditions in the mid-1990s, when many inexperienced newcomers to Germany's venture capital industry shied away from too risky investments in high-tech start-ups and instead chose to invest in relatively safe small firms with

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with a high rate of market entry by small venture capital organizations.

a more traditional business and industry background. Some private equity investors even seem to have increased their shares in traditional firms at the time of the IPO, instead of unwinding them. The average age of low-tech firms was larger at the time of IPO, yet this did not translate into a lower rate of underpricing, compared to biomedical firms. In the longer term, over six and twelve months, the average rate of return was even higher for IPOs of low-tech firms than for information technology IPOs. Moreover, low-tech firms going public also had faster employment growth in the run-up to the IPO.

Table 9 compares IPOs from high technology and low technology firms on France's Nouveau Marché. In contrast to the German case, the venture capital share is higher in the high-tech sectors than in low-tech companies. And so is the employment growth rate, the underpricing and the rate of return in the first year after the IPO. In many ways, therefore, the empirical picture of the French IPO market is more in line with our theoretical expectations than Germany's Neuer Markt does.

Table 10, using annual data, provides a comparison of venture capital-backed and non-venture capital backed IPOs over time. The table highlights the influence of market conditions on the size of the underpricing, which appears to fluctuate greatly even over the course of only four years. In line with theoretical considerations, German venture capital-backed IPOs came earlier in the life of issuing firms than those without venture capital backing. However, the opposite seems to hold in France. Sales and employment in portfolio firms were not systematically higher than the corresponding averages for issuers without venture capital backing. Moreover, the market-to-book ratio, which is often considered a measure of the relative importance of human or intangible capital in a firm, was systematically higher among IPO firms backed by venture capitalists, except for the case of German IPOs in 1998 and 2000. That this ratio was higher among venture-backed IPO firms is fully in line with theoretical

expectations. In terms of their pre-IPO equity values, venture-backed firms going public on the Nouveau Marché were larger than non-venture-backed firms in all years since 1998. But the opposite holds for firms that went public on Germany's Neuer Markt. In terms of employment, venture-backed firms have tended to grow slower, in both countries, when compared to IPO firms not backed by venture capital.

The key question for policy makers – whether venture capital has improved the efficiency of the venture capital cycle, including the exit route of taking new technology-based firms public – can only be answered on the basis of multivariate regression analyses that take the full set of economic determinants into account. The best available window on venture capital's efficiency is of the performance of individual IPOs in the primary equity market.[29] Stolpe (2003a) provides a comprehensive empirical analysis that can only partially be summarized here. In doing so, two potentially important endogeneity problems in these regressions will have to be emphasized: *first*, there is the endogeneity of underwriter choice when individual venture capitalists have reputational capital that enables them to negotiate favourable underwriting contracts for their portfolio firms. And *second*, the econometric problem of lagged endogenous regressors arises when information revealed through the underpricing of one IPO impacts on the performance of subsequent IPOs, as suggested by the real option hypothesis of this paper.

Venture capital's impact on underwriter choice. When the impact of venture capital on the level of underpricing in an IPO is examined by means of multiple regression analysis to control for other potential determinants of underpricing,

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

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

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[29] See Gompers and Lerner's (1999) book on the US venture capital cycle for a more comprehensive research strategy that includes several complementary approaches to study the empirical efficiency of venture capital.

International evidence provided by Ljungqvist and Wilhelm (2001) shows that US-based investment banks are the most prestigious underwriters in the sense that they possess the highest ability to attract outside investors and to lower the level of underpricing in an IPO, especially outside the US.[30] Stolpe (2003a) therefore assigned a rank indicator value of 1 to all US investment banks and other US underwriters. The value 2 is assigned to large domestic investment banks in France or Germany. In the German case, evidence from Franzke (2001) was used to determine the ten most prestigious domestic underwriters in Germany. In the case of France, the top ten domestic underwriters were picked on the basis of their overall strength in terms of balance sheets and investment banking activity. A value of 3 was assigned to other domestic underwriters in France or Germany. Lastly, a value of 4 was assigned to all foreign underwriters other than those from the US.[31]

Not all firms going public will want to choose the highest quality of underwriter services since these come at a cost. There are two types of costs to consider: First, there are the direct costs of going public, including underwriting fees which European underwriters usually set at three percent and US underwriters at seven percent of gross proceeds.[32] Second, there is the underwriter's market power, his discretion in share allocations and his hidden influence on the issue price. Even if an underwriter of high quality reduces underpricing on average, his market power may allow him to make a suboptimal marketing effort in

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30 For a detailed comparison of the institutions and performance of US and European primary equity markets, see Ritter (2003).

31 A list of all German and French underwriters with rank 2 is provided in appendix A.

32 The literature has shown that this so-called gross spread is roughly constant across the business cycle and across cycles in the demand for underwriting services.

individual IPOs whose volume is small relative to the IPOs where his reputation is at stake.

In contrast to the US evidence (Megginson and Weiss 1991), Stolpe (2003a) estimates an ordered logit model of underwriter choice that suggests venture capital backing actually lowers underwriter quality in Germany, although the dummy coefficient is significant only at the 10 percent level and the size of the venture capital stake in the IPO firm is insignificant. This may be interpreted as suggesting that most German venture capital firms still have a rather low standing vis-à-vis reputable investment banks. In line with expectations, a more prestigious underwriter is chosen by larger issuers, with the log of employment measuring firm size, by issuers seeking to raise a larger volume of capital, included as the log of gross proceeds, and by relatively young IPO candidates, included as the log of 1 plus the firm's age. The older an issuer, the lower the quality of the underwriter. On France's Nouveau Marché, the effect of venture capital backing on the choice of underwriter quality has the expected negative sign, but is not significant at any conventional level. As in Germany, Stolpe (2003a) shows that a more prestigious underwriter is chosen by larger firms, in terms of the number of employees, and by issuers seeking to raise a large volume of capital. In contrast to Germany, the age of the IPO firm does not have a significant impact in France.

To further clarify the pattern of correlation between underwriters' rank and the presence of venture capital backing, Stolpe (2003a) provides evidence on the distribution of venture- and non-venture backed IPOs across the four quality-related classes of underwriters. Moreover, the study provides univariate evidence on the impact of underwriter quality on the level of underpricing and on the amount of money-left-on-the-table relative to the gross proceeds of an IPO. Compared to the prevalence of venture backing among all IPOs, those with foreign underwriters, including both US and European underwriters, are more

likely to be backed by venture capital, both in Germany and France. The evidence from the Nouveau Marché moreover shows that more prestigious domestic underwriters tend to have a larger venture-backed share of IPOs than less prestigious domestic underwriters in France.

In Germany, by contrast, the most prestigious underwriters, whether US-based or domestic, have relatively fewer IPOs with venture capital backing than less prestigious underwriters. This casts doubt on the assumption that venture capitalists always help in selecting more prestigious underwriters, although it does not deny that venture capital backing is related in some way to the quality of underwriters. Stolpe (2003a) thus confirms that underwriter quality should be a control variable in multiple regression analyses of underpricing seeking to assess the effectiveness of venture capital in certifying IPO quality. However, the descriptive evidence does not point to a large endogeneity bias.

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

standard deviation. Additional variables must be included to control for the certification provided by venture capitalists, and the incentives of insiders to exploit privileged information at the expense of outside investors.

Stolpe's (2003a) results for Germany's Neuer Markt are largely in line with theoretical expectations. The IPO candidate's log of leverage and the presence of venture capital backing both have a significant negative impact on the percentage underpricing. Several measures of firm-specific uncertainty, such as the log of market-to-book value, the dummy for biomedical start-ups and the aftermarket standard deviation, are clearly associated with higher levels of underpricing. It is surprising, however, that also firm size, measured by the log of employment, and an indicator of maturity, the log of sales per employee, have significant positive coefficients. In line with the winner's curse, one would expect that uncertainty is lower and relevant information more evenly distributed, the larger and the more mature an IPO candidate; underpricing should then be lower. A further surprise is the insignificant dummy coefficient for the bubble years of 1999 and 2000, which suggests that underpricing was not higher in this period after controlling for other relevant determinants.

With regard to the certification hypothesis, the evidence from 212 IPO observations on the Neuer Markt is mixed. While the underwriter rank is insignificant[33], the presence of venture capital backing has a substantial and significant *negative* impact on the level of underpricing on the Neuer Markt. Moreover, the selling of shares by venture capitalists at the IPO, measured by a dummy variable, also has the expected sign, the effect being positive and significant. This suggests, in line with theoretical predictions, that the credibility

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[33] As reported in the note to Table 13.

and effectiveness of certification is reduced when a venture capitalist sells a large part of her stake at the time of the IPO.

The rather limited sample with only 51 observations from the Nouveau Marché, in which Stolpe (2003a) can use only a subset of the potential explanatories without serious multicollinearity, allows no more than tentative inferences to be made. Unfortunately, no significant coefficient for the influence of venture capital bakcing on the level of underpricing could be obtained.[34] However, once again, the log of market-to-book value, an ex ante indicator of firm-specific uncertainty due to unobservable human capital, and the aftermarket standard deviation, the ex post indicator of firm-specific uncertainty, have significantly positive coefficients. Moreover, market conditions, such as the market price index trend and the calendar day have a similarly large influence as in the Neuer Markt sample. The age of an IPO candidate has no significant impact on underpricing.

These findings are broadly in line with the existing literature on the determinants of underpricing in Germany and France. For example, Ljungqvist (1997) found that the stock market price trend, the macroeconomic climate, inside retention rates and an issue's inverse offer size affect underpricing positively on Germany's primary equity market even before the 1990s' boom. Over longer horizons, however, he showed German IPOs to be poor investments loosing more than 12 per cent over the first three years of trading relative to the market, exclusive of the initial underpricing return. A qualitatively quite similar picture now emerges from the bubble years of the Neuer Markt.

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[34] This confirms Schertler's (2002b) results from a sample of 71 IPOs on the Nouveau Marché.

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

5. Concluding remarks

The Risk Capital Action Plan of the European Commission aimed at five overarching objectives – to overcome market fragmentation, to reduce institutional and regulatory barriers, to increase the number of small high-tech businesses, to improve the human resources available for entrepreneurship and innovation and, finally, to remove cultural barriers against venture capital and entrepreneurship. The short-term measures of the plan included a reform of the European patent system, a detailed examination of the cost to European firms of raising debt and equity finance as well as a review of the implementation and possible amendment of the prospectus directive to facilitate companies raising cross-border capital, for example through an IPO. The medium-term measures of the plan included the adoption of prudential rules to allow institutional investors to invest more in venture capital, the reform of legislation on insolvency and bankruptcy as well as an assessment of reform requirements in the taxation of venture capital funds, capital gains in unlisted firms, stock options and start-up firms in general.

A key question is how the success of these and similar policies can be evaluated if the objective is to enhance the efficiency of the venture capital investment

process. If the impact of social multipliers were ignored, empirical studies might exaggerate the effectiveness of policy interventions and might be misled to conclude that all measures implemented as part of the Risk Capital Action Plan contributed to the growth of venture capital in the late 1990s, whereas only a few may have been really important. Moreover, in the presence of non-market interaction, it would be wrong to equate a large volume of venture capital investments with a high level of efficiency. It is important to emphasise that social multipliers do not require all policies in support of venture capital to be harmonized throughout Europe's common market. Instead, it remains in each country's best interest to remove any remaining country-specific barriers to venture capital and to improve the efficiency of the whole or parts of the venture capital cycle that take place within its own borders.

As a window on the efficiency, this paper has suggested to look at the determinants of underpricing. The findings are broadly in line with previous studies that have provided evidence on the determinants of underpricing. The bulk of the evidence lends support to the winner's curse hypothesis by corroborating the importance of uncertainty and asymmetric information as well as the role of financial intermediaries in certifying the unobservable qualities of issuers and lowering the level of underpricing. However, more research is needed to better understand the welfare implications of hot issue markets that are driven by endogenous forces, such as the revelation of pürivate valuations through the sequential exercise of IPO options.

On the whole, Europe's venture capital industry is still too dependent on subsidies and — without substantial gains in efficiency — it may remain so for quite some time. Public support for venture capital has been substantial in many European countries during the 1990s and continues to be so. This should be a matter of some concern since subsidies can create a variety of incentive problems of their own. For example, subsidies may attract poor managers into

venture capital organizations and reduce their quality of screening and of the corporate governance services they provide portfolio firms. In this case, subsidies may even raise the total user costs of venture capital for those technology-based start-ups that primarily want to benefit from the advertisement and certification effect of having won venture capital backing. For some start-ups, the direct financial resources that a venture capitalist provides may be much less important than the effective support in going public. If public funding were always limited to addressing identifiable market failures, as proclaimed by the European Commission (2000), the inefficiencies from subsidies would be reduced. But to limit subsidies strictly to market failures *requires* that governments accept not only the extremely cyclical nature of the venture capital industry, but also the strongly divergent investment patterns across countries and regions that is implied by the theory of non-market interaction. In the presence of social multipliers, it need not be a market failure when the distribution of venture capital investments across countries and regions is highly unequal.

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Appendix A: Data sources

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

The venture capitalists involved in IPOs on France's Nouveau Marché from 1996 through 2000 are as follows: 21 Société centrale, 3i, ABN-AMRO Capital France, Access2Net, Acland, ACTIDEV, Advent International, AGF Private Equity, AGRO Plus, Air Liquide Ventures, Alliance Entreprendre, Alpha, Asace Création, Alta, Berkeley Associates, Alternative Ventures, Apax Partners & Cie, Apollo Invest, Aquitaine Création Innovation – ACI, Ardèche Participation, Argos Soditic, Astorg, Atlas Venture, Atria Capital Partenaires, Auriga, Avenir Entreprises Gestion, Avenir Tourisme, Axa Investment Managers Private Equity Europe, AZEO, Banexi Ventures, Banque de Vizille, Barclays Private Equity, Baring Private Equity Partners, BBS Finance, BC Partners, BIOAM, BNP Paribas Développement, BNP Private Equity, Brantley Venture Partners II L.P., Bretagne Investissements, Bretagne Participations, Bretagne Jeunes Entreprises, Bridgepoint Capital, Butler Capital Partners, Capital Investissement Franche-Comté, Capital Privé, Carlyle Group, CDC Innovation, CDC-Equity Capital, CDC-Services Industrie Electropar France, Environmental Investment Partners, CDC-Valeurs de Croissance, Centre Capital Développement, Charterhouse,

Chevrillon-Candover, CICLAD, CINIDEV, CINVEN, CITA, Clam Private Equità, COFINEP, Compagnie Financière du midi Toulousain, Compagnie Financiére Edmond de Rothschild, Croissance Nord Pas-de-Calais, CVC, Capital Partners, Dassault Développement, ELECTRA Partners Europe SA, EMERTEC, EPF Partners, EPICEA, ESFIN Gestion, EUREFI, EURO Capital, EuropaWeb, Expanso, FEMU QUÌ, FILTARN, Finadvance, Finama Private Equity, Finances & Stratégies, Financière d'Aquitaine et du Grand Sud-Ouest, Financière de Brienne, Financière Galliéra, Financière Natexis Banques Populaires, Financière Tuileries, Financiére Voltaire, Finexplus, FINORPA,Fonds Partenaires, FRFI-ALSACE, Galileo, GIMV NV, Group LMBO, Herrikoa, IDEB, IDI Euridi, IDI Kairos Ventures, IDPC, Ile-de-France Développement, Industries & Finances, Initiative & Finance, Innovacom, Innoven Partenaires, Institut Lorrain de Participation – ILP, Intuitucapital, Investir en Provence, IPBM, IPO-Institut de Participtions de l'Quest, IRDI Midi-Pyrénées, IRPAC Champagne-Ardennes, Croissance, I-Source, Jafco Investment (UK) Limited, Johnson&Johnson Development Corp., Kairos Partners, LBO France – LTI, Lebon Développement, Legal & General Ventures, Limousin Participations, Lion Expansion, LORIENT Développement, MIDI-Pyrénées Création, Multicroissance, Natexis Industrie, Naxexis Investissement, Nord Création, Nord Innovation, Normandie PME Gestion, Océan Participations, Oppenheim Beteiligungs AG, OUEST Croissance, OUEST Développement, P.A.I. Management, Parconexi, PART'COM IN-COM Médiatel, Partech International, Participex, Pays de la Loire Développement, Pechel Industries, Picardie Avenir, Poitou Charentes Expansion, Poitou Charentes Innovation, Prime Technology Ventures NV, Privast Capital Partner, Quilvest Capital France, R.E.L., Régions Expansion, Rhône Dauphiné Développement, Rhône-Alpes Création, Robertsau Gestion, SADEPAR, Samenar, Schroder Ventures, Sebadour, Seeft Venture, SGAM Private Equity, SIPAREX Ingénierie et Finance, SNVB Participations, SOCADIF, Société Régionale de Participations, SOCRI, SODERO Participations, Sofi Paca, Sofilaro, Sofilaro Participations, SOFIMAC, SOFININDEX, Sofinnova Partners, SOFIREM, SOFRED, Sopromec, Soridec, SPEF, SPTF, SUD CAPITAL Gestion, SUDINNOVA, Synerfi S.A., Synergie, Finance Sobrepar, TCR Europe SA, Tertiaire Développement, Thomson-CSF Ventures, Tofinso, TURENNE Capital Partenaires, T-Venture, UI - Agrinova Dynamust IDIA, Uni Expansion Ouest, Unigrains, Union Européenne de cic Finance, VAUBAN Partenaires, VENTECH, and Viventures.

The venture capitalists involved in IPOs on Germany's Neuer Markt from 1997 through 2000 are as follows: 3i Gesellschaft für Industriebeteiligungen mbH, ABN AMRO Capital

Gesellschaft für Beteiligungsberatung mbH, Accura Technologie Holding AG, Adir Group, AET, Alafi Capital Corp., Alpha Beteiligungsberatung mbH, Alpinvest Int. B.V., Apax, Atlas Venture GmbH, ATRIUM Private Equity GmbH, Baaderbank, BAG Aktiengesellschaft für Industriebeteiligungen, Bayern Kapital Risikokapitalbeteiligungs GmbH, BB-Kapitalbeteiligungsgesellschaft mbH (now Capiton AG), Berlin Capital Fund GmbH, Beteiligungsgesellschaft für die deutsche Wirtschaft mbH, BioMed Venture AG, bmp AG, BWK GmbH - Baden-Württembergische Kapitalbeteiligungsges., BW-Venture Capital GmbH, Capital Management Wolpers, capiton AG, Cavendish, CEA Capital Partners GmbH&Co. Beteiligungs KG, CEA Interactive GmbH, Centro Internationale Handelsbank AG, Commerz Unternehmensbeteiligungs-AG, Croissance Discovery FCPR, DBF III, Deutsche Beteiligungs AG – Unternehmensbeteiligungsgesellschaft, Deutsche Effecten- und Wechsel-Beteiligungsgesellschaft AG, DG PRIVATE EQUITY GmbH (now DZ Equity Partner, after merger with DZ Capital Partner in 2000), DVCG Deutsche Venture Capital Gesellschaft mbH, Econa AG, equinet Venture Partners AG, ETF Group, Evergreen Group, GAN Avenir FCPR, German Equity Partner B.V., German European Venture Capital Partners, Gold-Zack AG, GUB Unternehmensbeteiligungen AG, HANNOVER Finanz GmbH (Commerzunternehmensbeteiligungs GmbH), HASPA Beteiligungsgesellschaft für den Mittelstand, HSBC Private Equity Deutschland GmbH, HVB Beteiligungsgesellschaft mbH, IBB Beteiligungsgesellschaft mbH, IKB Beteiligungsgesellschaft mbH, Innovacom, Invesco Asset Management, IVC Venture Capital AG, Jakob Falkner, Julius Bär Kapitalanlage AG, Kapitalbeteiligungsgesellschaft der Deutschen Versicherungswirtschaft AG (KDV), KB LUX Venture Capital Fund-Biotechnology, Knorr Capital Partner AG, Lavinia, LBB – Beteiligungsgesellschaft, LBBW, Mittelständische Beteiligungsgesellschaft Baden-Württemberg GmbH, MVC Mitteldeutsche Venture Capital AG, NIB Norddeutsche Innovations- und Beteiligungsgesellschaft mbH, NORD Holding Unternehmensbeteiligungsgesellschaft mbH, Pari Capital AG , Pegasus, PINE Finanz Private Investition &Equity GmbH, Plug in Equity, pre-IPO Aktiengesellschaft, PRICAP Venture Partners AG, Prime Asset Management AG, RBS Kapitalbeteiligungsgesellschaft Rheinisch Bergischer Sparkassen mbH, Sachsen LB Corporate Finance Holding GmbH, SBG-Sparkassen-Beteiligungsgesellschaft mbH & Co. KG, Siemens Venture Capital GmbH, Sparkassen-beteiligungsgesellschaft Heilbronn-Franken & Co. KG, Sparta, S-REFIT Regionaler Finanzierungsfonds für Innovationen u. Technologieunternehmen, Stargroup, Strategic European Technologies N.V., SüdKB Süd-Kapitalbeteiligungs-Gesellschaft mbH, S-Unternehmensbeteiligungsgesellschaft der Sparkasse Leipzig mbH, Tamar Technology

Investors L.P., tbg Technologie-Beteiligungsgesellschaft mbH der Deutschen Ausgleichsbank, TCB, Technologieholding Fonds VC, TechnoStart Beratungsgesellschaft für Beteiligungsfonds mbH, TFG Venture Capital AG & Co, KGaA Unternehmensbeteiligungsgesellschaft, T-Venture Telematik Venture Holding GmbH, TVM Techno Venture Management GmbH, U.C.A. Aktiengesellschaft, Vertex, VMR Luxembourg, wellington partners venture capital gmbH, and WestKB - Westdeutsche Kapitalbeteiligungsgesellschaft mbH.

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

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

Appendix B: Tables

Table 1: Pilot survey answers from four French and four German venture capitalists on their support of 18 initial public offerings on the Neuer Markt and Nouveau Marché

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

Source: Author's data set.

Table 2: Differences between 184 French and 61 German venture capitalists

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

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

Source: Author's data set.

Table 3: Differences between Venture Capitalists operating with and without government support in France

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

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

Source: Author's data set.

Table 4: Differences between Venture capitalists operating with and without government support in Germany

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

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

Source: Author's data set.

Table 5: Differences between dependent and independent venture capitalists in France

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

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

Source: Author's data set.

Table 6: Differences between dependent and independent venture capitalists in Germany

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

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

Source: Author's data set.

Table 7: A comparison of initial public offerings on Germany's Neuer Markt and France's Nouveau Marché

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

Notes: A = Averages; O= Observations.
Source: Author's data set.

Table 8: A comparison of high-tech and low-tech initial public offerings on Germany's Neuer Markt

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

Notes: A = Averages; O= Observations.
Source: Author's data set.

Table 9: A comparison of high-tech and low-tech initial public offerings on the French Nouveau Marché

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

Notes: A = Averages; O= Observations.
Source: Author's data set.

Table 10: The distribution of VC-backed and non-VC-backed IPOs in France and Germany, based on annual data.

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

Notes: O = Observations; IaC = information and communications technology; BaM = biomedical technology; IaS = industry and services; FiS = financial services; IR = initial return, percentage underpricing; YR = return on offer price after one year; MBR = market-to-book ratio; MLOT = money left on table, the total value of the shares issued on the first day of trading in the secondary market minus the gross proceeds.

Source: Author's data set.

Table 11: Venture capital and countries' tax and legal indicators in the cross section, 2002.

	Early stage per mil of GDP	Gross capital formation per mil of GDP	Total EVCA score	Pension regulation	Capital gains tax	R&D incentives	Entrepre-neurial environ-ment
Portugal	0.13	3.55	2.32	2	1	2.3	1.8
Spain	0.17	3.89	2.17	2	1	1.8	1.9
Austria	0.20	4.31	2.53	2	3	2.8	2.6
Italy	0.24	5.08	1.96	2	1	2.0	2.3
Ireland	0.33	4.26	1.58	1	3	2.3	1.0
France	0.36	5.01	2.09	3	3	2.0	1.4
Belgium	0.39	4.90	2.14	2	1	2.5	2.8
Netherlands	0.43	4.57	1.79	1	1	2.1	2.5
Germany	0.56	5.10	2.41	2	3	3.0	2.5
United Kingdom	0.58	6.02	1.20	1	1	2.0	1.3
Denmark	0.85	4.67	2.48	1	3	2.8	2.0
Sweden	0.93	5.53	2.09	2	3	2.6	1.8
Finland	1.04	4.95	2.25	2	3	2.8	2.1

Source: EVCA (2003b).

Table 12: Aggregate investment flows, per mil of GDP

	Gross capital formation 2001	Early stage investments 2001	Gross capital formation 2002	Early stage investments 2002	Expansion stage investments 2002	Total venture capital investments 2002
Mean	4.76	0.48	4.60	0.37	0.76	2.48
Median	4.91	0.39	4.65	0.29	0.59	1.40
Maximum	6.02	1.04	5.98	0.99	1.46	6.05
Minimum	3.55	0.13	3.35	0.05	0.37	0.53
Std. Dev.	0.66	0.30	0.68	0.29	0.40	1.91
Sum	61.84	6.20	59.74	4.85	9.88	32.27
Observations	13	13	13	13	13	13

Source: EVCA (2003b).

Table 13: Correlation matrix for selected indicators of countries' tax and legal environments and venture capital investments flows in 2002

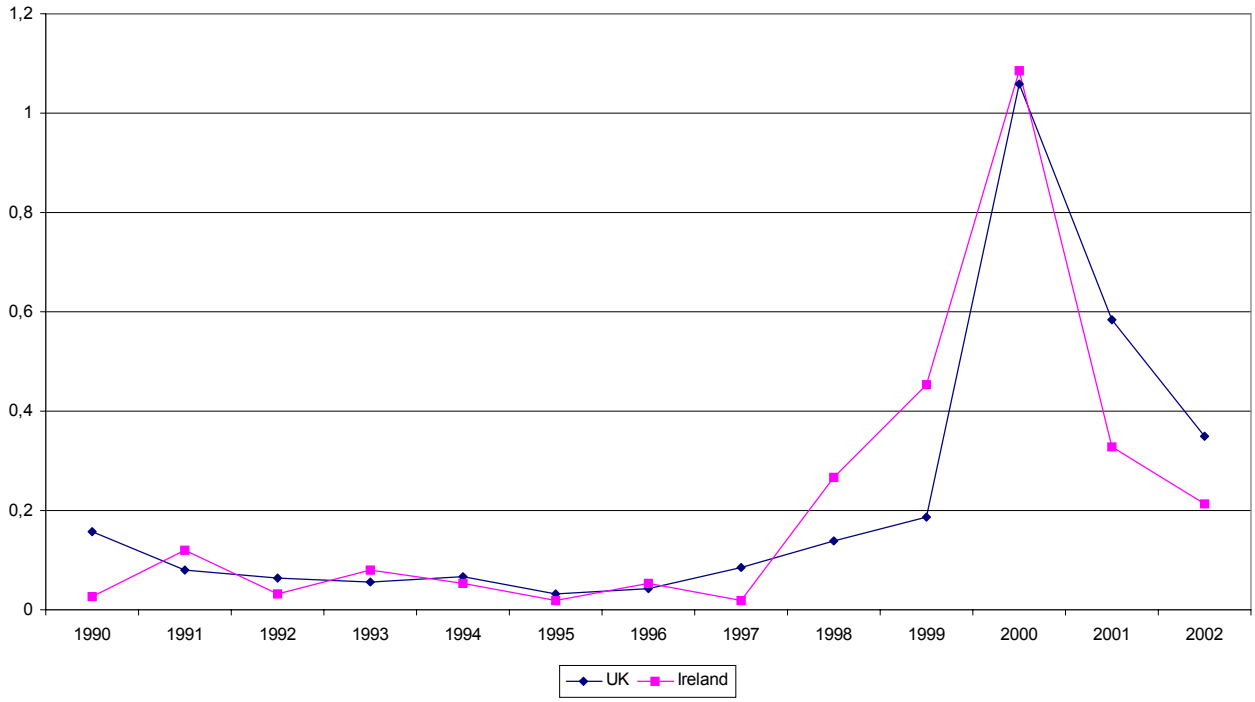
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total EVCA score[a] (1)	1.00	0.47	0.38	0.61	0.56	-0.47	0.07	-0.45	-0.56
Regulation on Pension funds (2)	0.47	1.00	0.17	-0.02	0.15	-0.06	-0.17	-0.33	-0.06
Capital gains tax rate (3)	0.38	0.17	1.00	0.66	-0.18	0.04	0.41	-0.16	-0.04
R&D incentives (4)	0.61	-0.02	0.66	1.00	0.41	-0.03	0.43	-0.22	-0.26
Entrepreneurial environment (5)	0.56	0.15	-0.18	0.41	1.00	-0.10	-0.00	-0.10	-0.30
Gross capital formation per mil of GDP 2002 (6)	-0.47	-0.06	0.04	-0.03	-0.10	1.00	0.40	0.33	0.76
Early stage venture capital investments per mil of GDP 2002 (7)	0.07	-0.17	0.41	0.43	-0.00	0.40	1.00	0.52	0.54
Expansion stage venture capital investments per mil of GDP 2002 (8)	-0.45	-0.33	-0.16	-0.22	-0.10	0.33	0.52	1.00	0.72
Total venture capital investments per mil of GDP 2002 (9)	-0.56	-0.06	-0.04	-0.26	-0.30	0.76	0.54	0.72	1.00

[a]Total score for tax and legal environment, according to the EVCA aggregation scheme

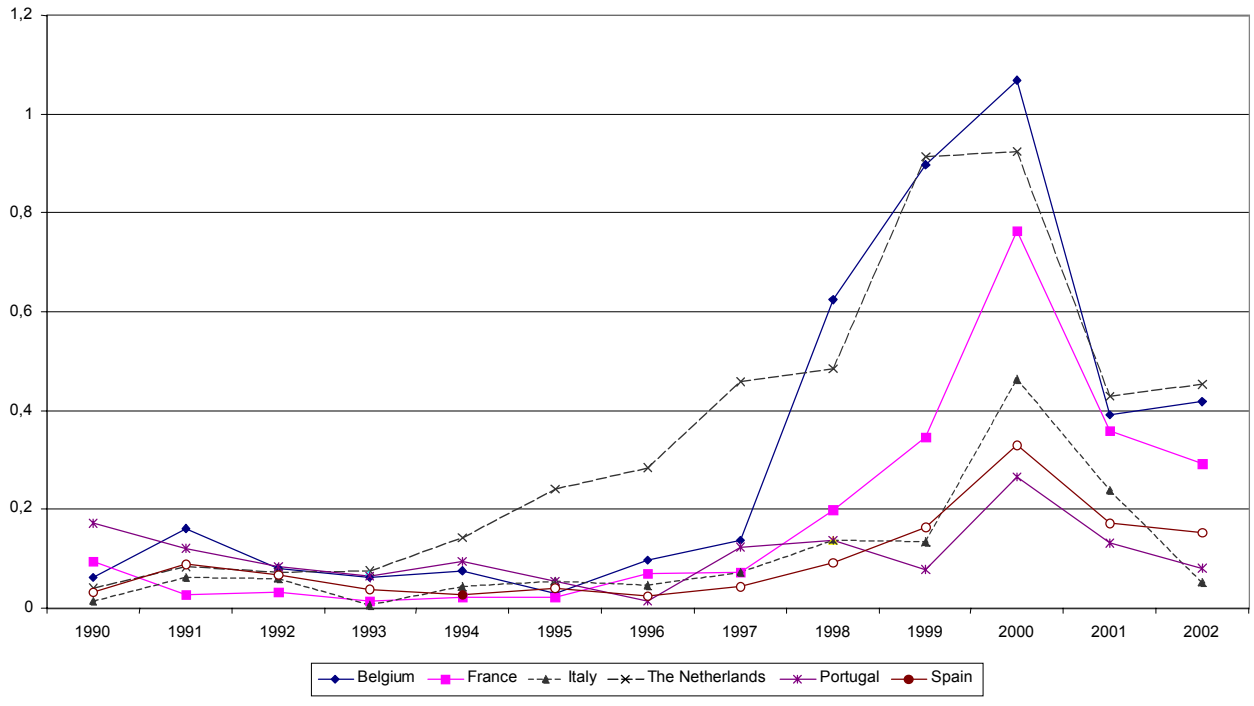
Source: EVCA (2003b).

Figure 1: Early stage venture capital investments in different European legal systems

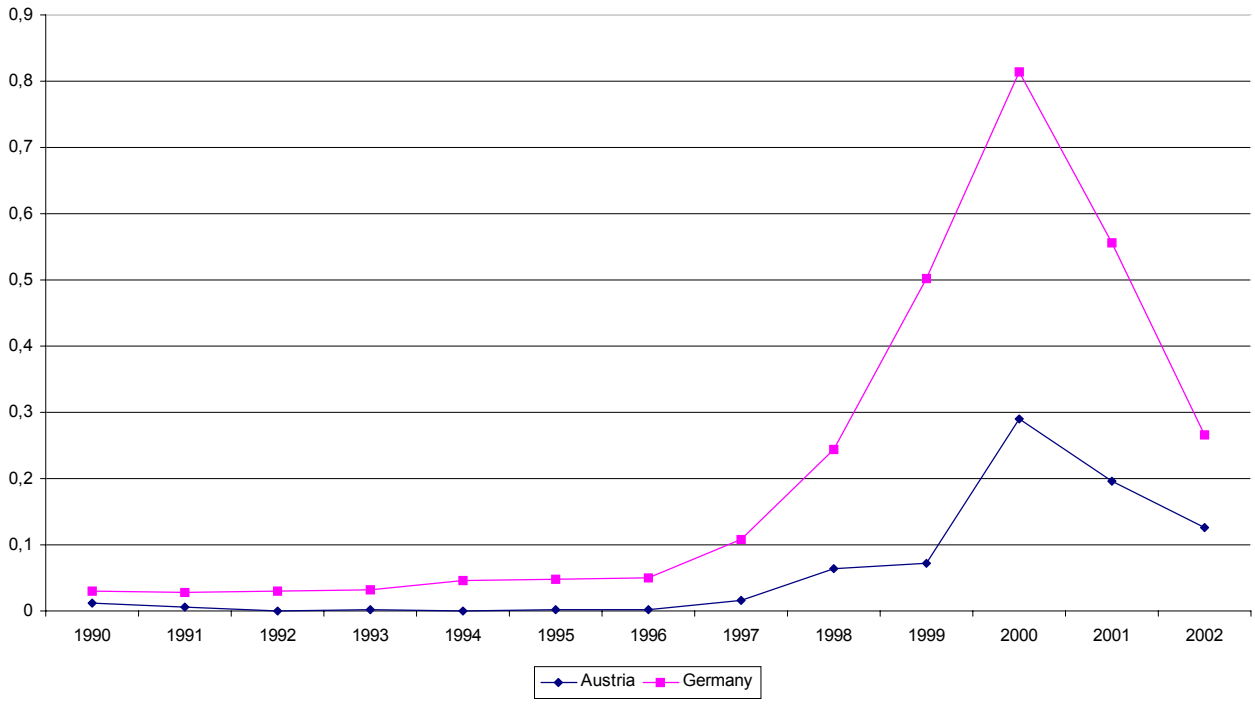
Panel A: Early stage venture capital investments in English legal systems, per mil of GDP



Panel B: Early stage venture capital investments in French legal systems, per mil of GDP



Panel C: Early stage venture capital investments in German legal systems, per mil of GDP



Panel D: Early stage venture capital investments in Scandinavian legal systems, per mil of GDP

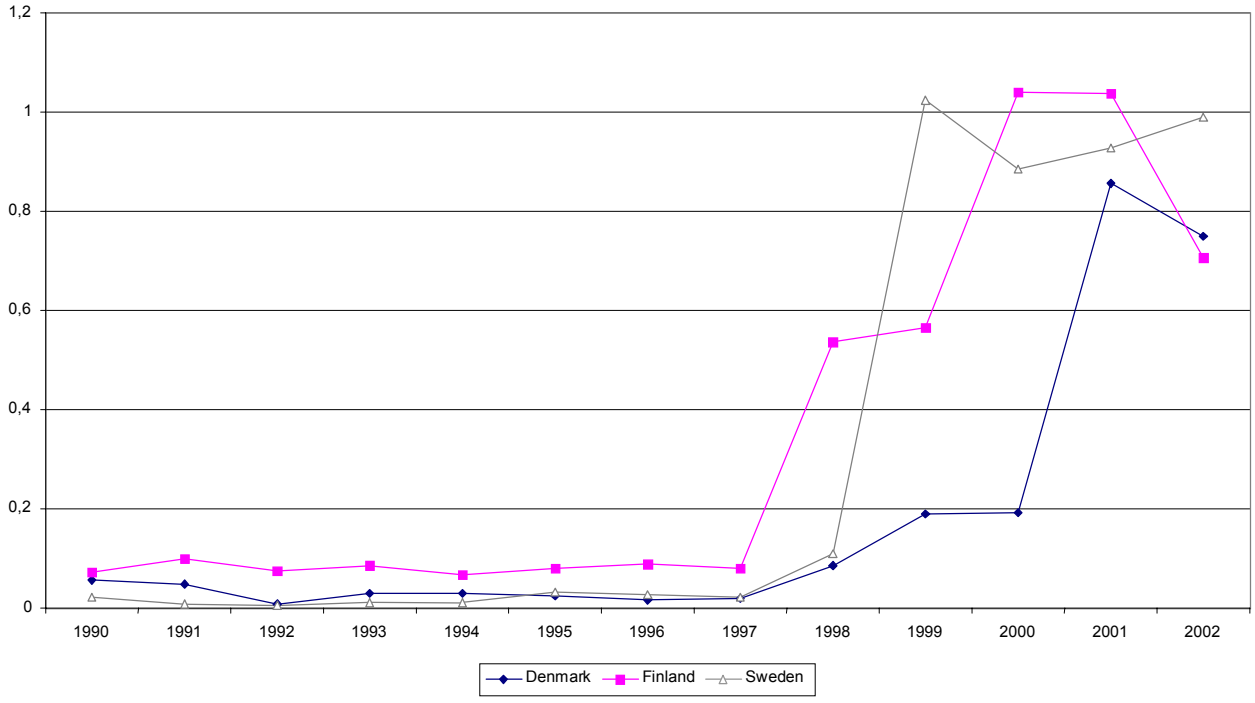
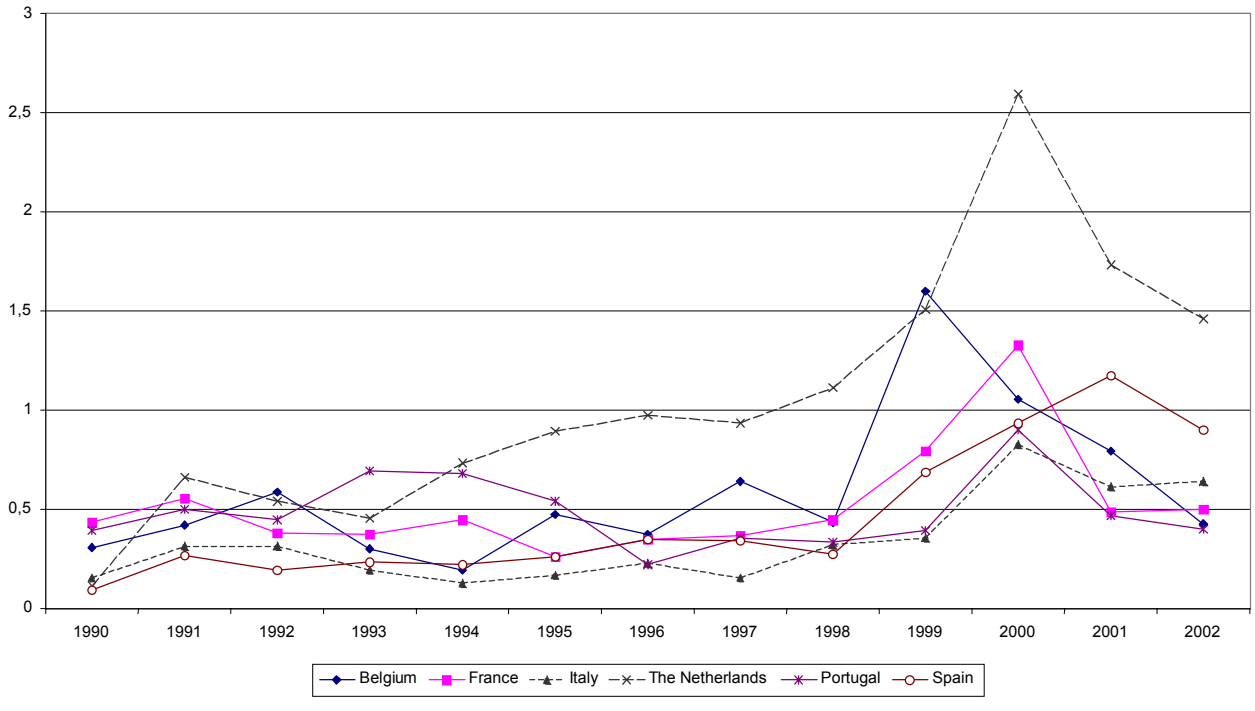


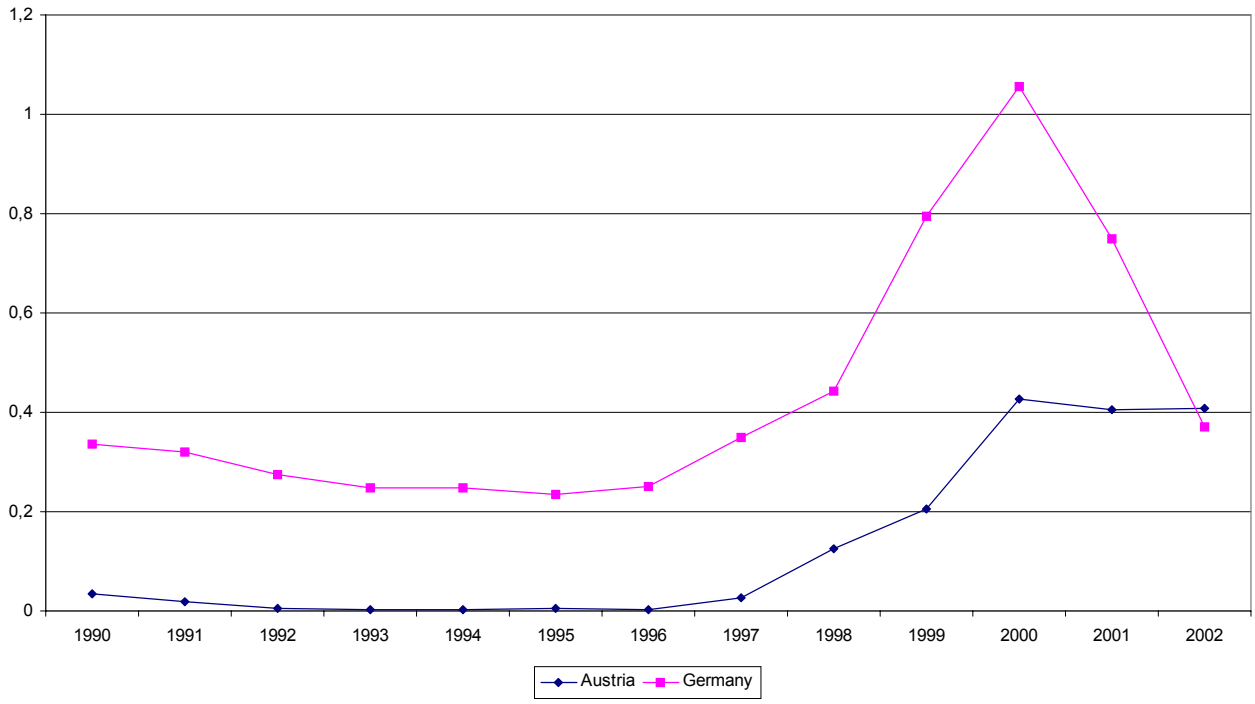
Figure 2: Expansion stage venture capital investments in different European legal systems

Panel A: Expansion stage venture capital investment in English legal system, per mil of GDP

Panel B: Expansion stage venture capital investment in French legal systems, per mil of GDP



Panel C: Expansion stage venture capital investment in German legal systems, per mil of GDP



Panel D: Expansion stage venture capital investment in Scandinavian legal systems, per mil of GDP

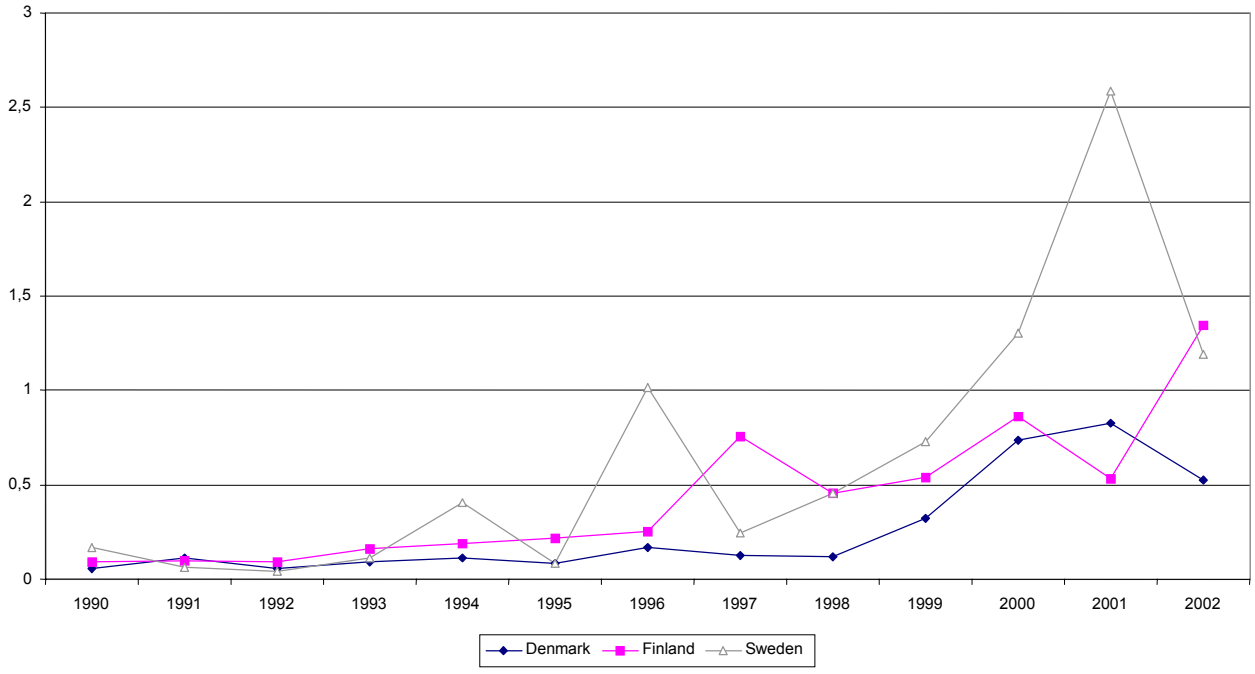


Figure 3: Equilibria in the market for venture capital