

Financing technology-based small firms in Europe: what do we know?

Valérie Revest · Alessandro Sapió

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Abstract This paper reviews the evidence on financing technology-based small firms (TBSFs) in Europe. European TBSFs finance new investments by relying primarily on internal funds, due to capital market failures induced by asymmetric information. European venture capital has caught up with US venture capital, but this is mainly because of the growth in UK venture investments. It is unclear whether European venture capital has been able to certify the quality and enhance the growth of funded companies. Compared with the NASDAQ, there is little development of trading in high-tech stocks in Europe: the so-called New Markets established in the 1990s collapsed in the wake of the Internet bubble crash. Public venture capital and research and development (R&D) tax incentives seem to have positively affected high-tech firms.

Keywords High-tech · Small firms · Capital structure · Venture capital · Stock markets · Public policy

JEL Classifications G24 · G28 · G32 · M13 · L26

1 Introduction

Where do European technology-based small firms (TBSFs) get their money from? TBSFs are defined as small businesses whose products or services largely depend on the application of scientific and technological knowledge (Allen 1992). Typically, these companies enjoy rich endowments of intangible assets but lack “hard” and collateralizable assets, and their track record is short. Moreover, firm founders with science or technology backgrounds suffer from limited financial and marketing expertise. This paper sets out to steer readers through the main facts on TBSF finance and their economic interpretation, potentially useful for both academic scholars and policy-makers. We seek to shed light on cross-country invariances and specificities in the capital structures of TBSFs across Europe, in the organization and dynamics of the European venture capital industries and high-tech stock markets, as well as in policy-making.

This exercise is motivated by at least two observations. On the one hand, Schumpeter pointed out that entrepreneurial firms and new entrants play a fundamental role in innovative activities, as they generate novelties which disrupt the quasi-rents enjoyed by previous innovators. Such a creative destruction process is the core of a Schumpeter mark I technological regime (Nelson and Winter 1982; Kamien and Schwartz 1982; Breschi et al. 2000). By challenging the existing technological

V. Revest · A. Sapió (✉)
Universtà di Napoli Parthenope, Napoli, Italy
e-mail: alessandro.sapio@uniparthenope.it

paradigms, new firms in high-tech sectors promote dynamic efficiency, discipline the behaviour of incumbents and are ultimately major agents of technical change and job creation (Audretsch 1995; Bartelsman et al. 2004).

On the other hand, the rate and direction of technical change are affected by the rate and criteria by which financial intermediaries and markets allocate resources among firms (Dosi 1990; Aoki and Dosi 1992). Schumpeter himself envisioned a “double agency” in capitalist development, with banks and financial markets playing the essential role of “bridges” or “facilitators” of the innovative efforts carried out by entrepreneurs (Schumpeter 1911). The effectiveness of financial intermediaries in performing these functions finds a limit in the informational opacity of new firms involved in R&D, characterized by highly uncertain returns and costly monitoring. As implied by the theories of moral hazard and adverse selection (Akerlof 1970), new high-tech companies are likely to face a significant wedge between the cost of internal and external funds. Financial barriers to entry can be particularly high in sectors with large sunk costs and long lead times between R&D and commercialization (Geroski 1995). Entrepreneurs with promising business projects but short of outside capital may not be able to overcome such barriers. The beneficial effects of new firms on dynamic efficiency and technical change can be severely hampered.

In a comparative perspective, analyzing the main European countries (France, Germany, Italy and the UK) is most useful, as their financial systems are usually classified within different varieties of capitalism: Germany is seen as a prototype of a bank-based system (a category including Japan and the Scandinavian countries), whereas the UK is, along with the USA, a so-called market-based system (Hall and Soskice 2001). European countries still differ in terms of tax and bankruptcy codes, in ownership dispersion, in the market for corporate control and in the role of banks and security markets as providers of incentives to undertake innovation. It has long been held that the finance–innovation nexus is not independent of the features of a financial system (Dosi 1990). Consistently, the law and finance literature shows that the legal and institutional environment affects the nature of financial contracts and consequently the effectiveness of market-based means of

supporting high-tech finance developed in common law countries (Levine 1997; La Porta et al. 1998; Rajan and Zingales 2001). Nevertheless, the European delay in the creation of frontier technological knowledge (Dosi et al. 2006) may at least partly rest on the inability of venture capitalists and stock markets to pick high-quality TBSFs and/or help them improve their performance.

Our review of the literature on high-tech small-business finance sheds light on four main pieces of evidence. First, European TBSFs finance new investments by relying primarily on internal funds. There seems to be a wedge between the cost of internal and outside finance, likely due to capital market failures induced by asymmetric information. A second result is that the European venture capital industry has caught up with that of the USA in terms of investment amounts. However, this was mainly the outcome of fast growth in UK venture investments, and it is unclear whether European venture capital has successfully certified the quality of funded companies and supported their growth, suggesting that greater investments are not enough to support TBSFs effectively. Third, similarly limited has been the development of trading in high-tech stocks, if compared with the NASDAQ. The EASDAQ and the so-called New Markets (NMs) established in France, Germany and Italy in the late 1990s have proven unviable in the wake of the Internet bubble crash. Such failures cannot be easily reconciled with a financial systems view, because the EASDAQ collapsed even though it was embedded in the British financial system and based on the NASDAQ regulations. Fourth and last, European governments are actively involved in supporting TBSF finance, with significant cross-country heterogeneity despite the role of the European Union in harmonizing national financial regulations. There is promising yet incomplete evidence that public venture capital in Europe has performed an important certification role and that R&D tax incentives yield beneficial long-run effects.

The issues summarized above are discussed in the following sections devoted to the financial structure of TBSFs (Sect. 2), venture capital (Sect. 3), stock markets for high-tech companies (Sect. 4) and public support policies (Sect. 5). Each section includes an agenda for future research. Section 6 wraps up and concludes.

2 The capital structure of technology-based small firms

How do technology-based small firms (TBSFs) finance their investments? There are compelling reasons to believe that the assumptions behind the Modigliani–Miller (1958) theorem are violated by TBSFs, based on asymmetric information and transaction costs considerations. If so, the financial policy affects the size of a firm's cash flow, not just its allocation among uses, and in turn the ability of high-tech firms to invest and grow. After briefly reviewing the main theories of capital structure, based on departures from Modigliani and Miller's frictionless world, in this section we examine the evidence on TBSF capital structures and suggest some open economic and econometric issues. The reader is referred to Myers (1984, 2001), Harris and Raviv (1991), Hubbard (1998) and Barclay and Smith (2005) for general surveys on the capital structure puzzle, whereas Berger and Udell (1998) and Denis (2004) deal with the financial structure of TBSFs.

2.1 Theoretical background

Thirty years after the much celebrated *irrelevance theorem*, Merton Miller remarked that, in showing what was not relevant to capital structure, he and Modigliani also showed what indeed *was* relevant (Miller 1988). That remark is all the more important now that start-ups in technologically progressive sectors have risen to prominence in the economics and policy agendas. Substitution between internal and external funds is bound to be extremely costly for small, young and risky companies, in light of their large bankruptcy and transaction costs and their opacity: TBSFs display high default probability, and their value in the event of default falls dramatically, because it is mainly made up of growth opportunities and specialized and intangible assets, which cannot be collateralized and are difficult to redeploy. Moreover, transaction costs related to debt and equity financing seem higher for TBSFs than for large and mature companies. In this respect, it has been shown that the market power of banks decreases with borrower size (Petersen and Rajan 1995). In addition, stock market flotation is rather costly for TBSFs, because underwriting costs are larger for initial public offerings (IPOs) than for seasoned issues (Calomiris et al. 1995).

Finally, information asymmetries between the managers of TBSFs and outside investors can be most severe due to the short track record of companies in the start-up and early growth stages, the inherent uncertainty of the innovation process, the difficulty of monitoring R&D investments and insufficient understanding of technically complex projects by investors and lending institutions. What is more, R&D-intensive firms are reluctant to disclose information on their innovative projects because of rivalry in the R&D race (Kamien and Schwartz 1982; Bhattacharya and Ritter 1985).¹

Bankruptcy costs are the main disadvantage for fund-seeking TBSFs in the *target adjustment theory* (Myers 1984). According to this theory, firms issue/retire debt any time their debt ratio falls below/rises above a target. The target is the debt ratio that equalizes the marginal cost of financial distress and the marginal tax advantage of debt-financing.² Asymmetric information and the entailed credit market failure are the central tenets of the *pecking order theory* (Donaldson 1961; Myers 1984). Firms apply for loans only if they run into deficits of internal funds, but they may end up fully or partly rationed; equity is issued rarely and only as a last resort. Models of adverse selection in credit markets (Jaffee and Russell 1976; Stiglitz and Weiss 1981) and equity markets (Myers and Majluf 1984; Greenwood et al. 1984) have backed up this insight.³ In fact, the very expectation of credit rationing may create “discouraged borrowers” (Jappelli 1990; Kon and Storey 2003). A pecking order may also arise if firm founders are unwilling to lose control, as is the case when lenders impose debt covenants and when new equity results in wider share ownership (*control aversion* in Cressy 1995; Chittenden et al. 1996; Cressy and Olofsson 1997).

¹ Moreover, theoretical work has shown that it may be optimal for banks to reveal information about the projects of their clients in order to reduce negative externalities on other borrowers (Agarwal and Elston 2001).

² An optimal capital structure has been shown to exist in the Modigliani–Miller framework with added frictions (corporate taxes, bankruptcy). See Bradley et al. (1984) and references therein.

³ See also the model in Fazzari et al. (1988). Agency problems are implied by the separation between ownership and control (Jensen and Meckling 1976), but the associated costs may be less relevant to the financing of TBSFs, which are often closely held.

2.2 Testing the capital structure theories on samples of European TBSFs

The outlined capital structure theories yield different predictions on the impact of profitability and, most importantly for TBSFs, entrepreneurial talent.⁴ If the pecking order is due to credit market failures, one should observe a negative correlation between access to credit and measures of entrepreneurial quality (including human capital, experience, R&D intensity and innovativeness), because credit rationing takes its toll mainly on skilled individuals who are not wealthy enough (Evans and Jovanovic 1989). In a control aversion story, we would expect skillful entrepreneurs to eschew loan applications. On the contrary, in the target adjustment theory entrepreneurs with higher sector-specific human capital and experience set a larger start-up size, more so if the firm is engaged in R&D-intensive activities. This implies larger demand for loans and, since the market is assumed efficient, larger availability of debt capital (Cressy 1996).

Raw estimates of the shares of internal and external funding sources provide preliminary support for the pecking order theory, as they show that European TBSFs primarily rely on internal funds (Giudici and Paleari 2000, Colombo and Grilli 2007, Scellato and Ughetto 2009 on Italy; Carpentier et al. 2007 on France). The econometric strategy most often followed in this area is to regress measures of success in loan applications, collected through surveys, on variables which are in principle observable by lending institutes, including various proxies for size, age, asset tangibility, education, R&D and innovativeness. The econometric methodologies (logit, probit and tobit regressions) are suited to the dichotomous or truncated nature of the dependent variables (see Table 1 for a summary). According to some works, firms with higher R&D intensity, more patents, lower share of tangible assets and larger share of qualified employees report more problems in

⁴ If companies follow a pecking order, larger (past and current) profitability reduces the internal deficit and the demand for loans, implying a negative leverage–profitability correlation. Conversely, the target adjustment theory stresses that higher profitability is seen by the market as a signal of future growth opportunities, resulting in better access to loans. However, profits for firms with a short track record can be negligible.

accessing external finance (Westhead and Storey 1997, Freel 2007 on the UK; Giudici and Paleari 2000 on Italy), while Guiso's (1998) analysis of loan applications runs against this evidence. Colombo and Grilli (2007) show that the propensity to use internal capital as opposed to debt is positively correlated with education in economics and with specialized work experience in technical functions. These results are consistent with the pecking order theory. The main finding in Grilli (2005) is that higher entrepreneurial human capital only affects the demand for loans, but not the supply. In other words, technically trained firm founders *do* apply for loans but are rationed. Control aversion and discouraged borrowing do not seem to be the main reasons behind the pecking order.

Less widely used is the testing strategy introduced by Fazzari et al. (1988), who claimed that credit-constrained firms exhibit larger investment–cash flow sensitivities. Kaplan and Zingales (1997, 2000) have criticized this approach, showing that, theoretically, the relationship between investment–cash flow sensitivities and the wedge between the costs of internal and external capital is not monotonic. Moreover, investment spending would react to cash flow even in a frictionless world if higher cash flow signalled future growth opportunities (see also Fazzari et al. 2000).⁵ The few papers on European TBSFs within this approach analyze the effects of venture capital backing and shall be reviewed in Sect. 3.2.1. Direct tests of the pecking order, such as that devised by Shyam-Sunder and Myers (1999), have not been performed on TBSFs.⁶

⁵ It is doubtful whether larger investment–cash flow sensitivities are suited to signal credit rationing, for further reasons. For instance, a large share of retained earnings in the capital structure may not be due to credit constraints: firms may want to keep some “reserve borrowing power” (Gertler 1988), especially if they are not endowed with “hard” collateral, or simply retain cash as precautionary saving (Kaplan and Zingales 1997).

⁶ The test compares the goodness of fit of two alternative econometric models: a regression of the debt ratio on the deficit if internal funds (pecking order model if the coefficient is negative) and a regression of the debt ratio on a target debt ratio (target adjustment model if the coefficient is below 1). In fact, the test lacks statistical power if equity is a large proportion of capital or is in the middle of the financial hierarchy (Chirinko and Singha 2000).

Table 1 Synopsis of econometric studies on the capital structure of European technology-based small firms

Author(s) (year):	Westhead and Storey (1997)	Guiso (1998)	Giudici and Paleari (2000)
Country	UK	Italy	Italy
Years	1992–1993	1993	1997
Sectors	High-tech	Manuf. (>50 employees)	High-tech (SMEs)
Sample size	188	608	46
Source	Interviews	Bank of Italy survey on investments in industry	Survey
Dependent variable	Problems acc. fin. (1/0)	Loan appl. rejected (1/0)	Problems accessing finance (1/0)
Positive effects	R&D/sales QSEs/employees Patents	–	% sales from innovations % intangible assets
Negative effects	Age	Group	No. of employees Age
No effect	Past profits (1/0) No. of employees	Age Sales/workers Collaterals R&D and patents High-tech sector	Past growth
Method	Logit	Probit with IV	Probit
Author(s) (year)	Grilli (2005)	Colombo and Grilli (2007)	Freel (2007)
Country	Italy	Italy	UK
Years	1999–2001	1999	1998–2001
Sectors	Internet services	High-tech start-ups	Manufacturing, services
Sample size	179	386	256
Source	RITA database	RITA database	Survey of entrepreneurship in northern Britain
Dependent variable(s)	Loan applications (1/0) Loans received (1/0)	Personal capital Loans	Loan application failure (0–100)
Positive effects	(<i>On loan applications</i>) Technical education Specific experience	(<i>On personal capital</i>) Economic education Technical work exp. Specialized work exp.	Age R&D/sales QSEs/employees Past growth
Negative effects	(<i>On loan applications</i>) No. of founders	No. of owners	Innovation measures No. of employees
No effect	Economic education General experience Incubation Private equity No. of defaults	General education Commercial work exp. General work exp. Incubation No. of defaults	–
Method	Bivariate probit with partial observability	Bivariate tobit	Tobit

“Positive effects”, “Negative effects” and “No effect” mean that the estimated coefficients on the reported variables are, respectively, positive and significant, negative and significant, and not significant. “1/0” indicates a dummy variable. *IV* instrumental variables, *SMEs* small and medium-sized enterprises, *QSEs* qualified and skilled employees, *RITA* research on entrepreneurship in advanced technologies

2.3 Summary and open issues

The literature on the capital structure of TBSFs suggests that: *the investments of technology-based small firms are financed using primarily internal funds due to credit rationing* (result 1). The European literature is therefore in line with the US evidence on financial constraints to investments and R&D spending (Hall 1992, 2002; Hao and Jaffe 1993; Carpenter and Petersen 2002). The robustness of the results, however, is under question due to a number of methodological limitations. Work in this area is still hampered by econometric and measurement problems; a detailed discussion is provided by Elsas and Florysiak (2008), who recommend caution with sample selection biases, unobserved heterogeneity, endogeneity and the dynamic adjustment of capital structures. Measurement errors on the most important variables—such as loan application success, the R&D and innovation proxies—are also major concerns, which would justify the use of instrumental variables. One way to control for heterogeneity is to estimate quantile regression models. Fattouh et al. (2005, 2008) have used this methodology on samples of South Korean and UK listed companies, but applications to TBSFs are lacking.

Regarding the economics of TBSFs, theoretical reasoning suggests that better information flows and investor rights, available in market-based systems such as the USA and the UK, may offset the information asymmetries at the core of credit rationing (La Porta et al. 1998; Seifert and Gonenc 2008). On the other hand, companies in bank-based countries (e.g. Germany, France) display greater reliance on social networks and long-term relationships with creditors, which may soften their budget constraints. Results based on country-level studies are not easily comparable because country-specific institutional traits are not easy to control for. For instance, loans to SMEs are to a large extent influenced by relationship variables, which are difficult to measure and compare across economies.

Very little attention has been paid to the role of macroeconomic conditions in determining the capital structure choice of TBSFs. It is quite likely that these firms are disproportionately affected during cyclical downturns, as banks regard loans and securities as imperfect substitutes in their own portfolios. Bough-eas et al. (2006) provide evidence that small, young

and risky UK ventures are most affected by the credit channel of monetary policy transmission. The work by Korajczyk and Levy (2003) on the impact of monetary policy on US companies might be replicated on samples of European high-tech start-ups.

Finally, social ties are powerful tools for companies seeking to overcome the informational barriers to finance. Most of the literature on financial networks deals with US firms, but does not focus on high-tech sectors (Uzzi 1999; Mizruchi and Stearns 2001; Godley and Ross 1996). Notable exceptions are the paper by Ostgaard and Birley (1996) on UK new firms and by Shane and Cable (2002), who analyzed seed-stage high-tech companies which exploited MIT patents. More generally, an interesting research question is whether long-term relationships with banks and participation in industrial groups and mutual guarantee societies relax the financial constraints on TBSFs (see Hoshi et al. 1991 on the Japanese *keiretsu*).

3 Venture capital in Europe

The reviewed evidence of credit rationing is seemingly robust across the European varieties of capitalism. Apparently, the trade-off between managerial incentives and informed monitoring by intermediaries in high-tech finance is not solved optimally by either market-based or bank-based systems. Venture capital has emerged in the USA as a possible candidate to improve upon traditional means of financial support when information asymmetries are particularly severe. Indeed, from the theoretical point of view, the venture capital contract can be seen as a debt–equity hybrid, giving greater control to the investor or to the entrepreneur depending on the performance of the funded company (Kaplan and Strömberg 2003). The features of venture capital and its expected impact on new firms' creation and growth have been described and discussed at length (Tyejee and Vickery 1988; Lerner 1995; Gompers and Lerner 1997; Giudici and Roosenboom 2004; Antonelli and Teubal 2008 among the many). An up-to-date reference on the state of European venture capital is the book by Gregoriou et al. (2007). Here we are interested in assessing how the literature responds to questions such as: How large is the gap between European and US venture capital? Are there national specificities among European venture capital

industries? Is European venture capital able to ameliorate the growth and visibility of the funded companies?

3.1 Venture capital in Europe: facts and figures

The birth of the European venture capital (VC) industry dates back to the 1970s, but its full emergence occurred only in the late 1990s. The early attempts made in France, Germany and Italy in the 1970s and 1980s were unsuccessful, as the capital raised was not sufficient to cover the needs of innovating firms and the development of VC industry was prevented by institutional constraints (Becker and Hellmann 2005; Tykvova 2007; Dubocage and Rivaud-Danset 2002). The message in the available data is that Europe as a whole managed to catch up with the USA in terms of venture capital investments. Evidence of catching-up is suggested by Fig. 1, which compares the amounts of venture capital received by USA-based and by European companies between 1998 and 2005 (Oehler et al. 2007, using VentureXpert data).⁷ It would appear that, while Europe was still lagging behind in 2000, it was more resilient to the 2001 stock market crash, performing as well as the USA during the 2000s. While in 1998 the disbursed venture capital funds relative to gross domestic product (GDP) were equal to 0.074% for Europe and 0.2% for the USA, in 2005 these figures were 0.19% for Europe and 0.23% for the USA (Oehler et al. 2007). A similar pattern can be detected using data on investments by countries of location of the venture capital firm in charge of the deal (European Venture Capital Association (EVCA) Yearbook Methodology).

Was the catch-up a balanced process across European countries? The available data suggest it was not. Figure 2 depicts the evolution of venture capital funds disbursed in France, Germany, Italy and the UK between 1998 and 2005. Two facts stand out. First, between 1998 and 2000, the UK managed to attract VC at a faster rate than the other major European countries. This proved essential in bridging the US–Europe venture capital gap. Second, the UK remained the

largest receiver of venture capital even after the sharp drop that occurred between 2000 and 2001 due to the Internet bubble crash. Together with the UK, Germany was the only country able to attract increasing amounts of VC after the bubble. The data on investments by venture capital firms based in European countries (not reported here) suggest that, between 1998 and 2002, the German VC industry came to dominate France and Italy in terms of amounts invested, and its size was comparable to the UK venture capital industry. The creation of the Neuer Markt, the role of commercial banks and the creation of public venture capital funds all contributed to the fast growth of German venture capital (Tykvova 2007; Bascha and Walz 2007). However, venture capital in continental Europe (i.e. France, Germany and Italy) stagnated during the 2000s, whereas investments by UK venture capitalists more than trebled between 2003 and 2006 (source: EVCA 1996–2008). Quite interestingly for our goals, it is clear from Fig. 3 that the peak of investments by UK-based venture capitalists in 2006 was associated with a fast growth of early-stage investments, unlike the 2000 peak. Consistently, Lockett et al. (2002) provide evidence that UK venture capitalists slightly improved their attitude towards young and small firms, while in the early 1990s they tended to give priority to large deal sizes and large companies (Murray 1999; Jeng and Wells 2000; Mayer et al. 2005).

Why is venture capital in continental Europe lagging behind? One possible explanation lies in the weaker development of pension funds in bank-based European financial systems. The UK peak observed in 2006 corresponds to a peak in private equity fund raising by the UK (24,402 million Euros; see EVCA Yearbooks 1996–2008). Another set of candidates includes the lack of attractive exit opportunities, the lack of an active high-tech stock market like the NASDAQ, a low frequency of syndication and a low use of convertible securities; all these were considered as determinants of the Europe–USA venture capital gap (Cumming and MacIntosh 2003; Das et al. 2004; Bascha and Walz 2001). In a sense, one may argue that some European countries failed to exploit the complementarity between venture capital and stock markets, which is grounded on a *thick market externality*, as in Pagano (1993). Further insight on the plausibility of this hypothesis is given in Sect. 4, devoted to the performance of European high-tech stock exchanges.

⁷ Here we define venture capital investments as investments in seed, early-stage and expansion projects, as in Beuselinck and Manigart (2007).

Fig. 1 Venture capital funds disbursed in the USA and in European countries: 1998–2005. Sources: VentureXpert, Oehler et al. (2007)

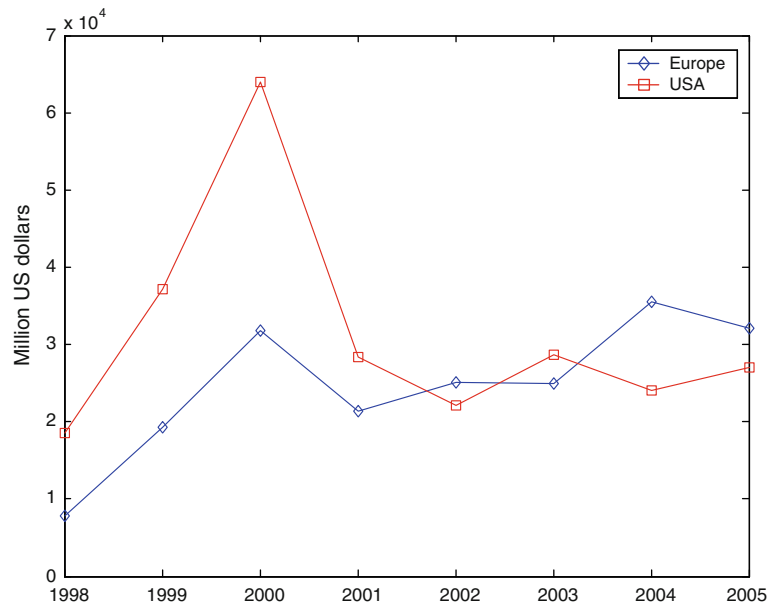
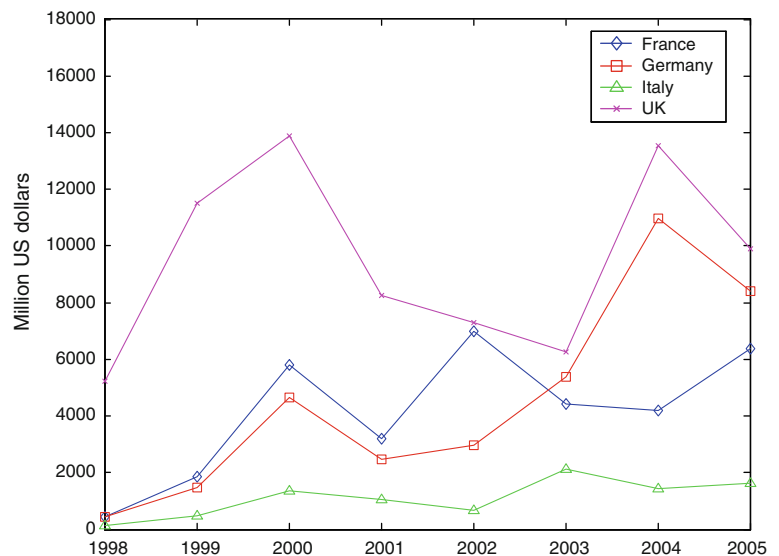


Fig. 2 Venture capital funds disbursed in France, Germany, Italy and the UK: 1998–2005. Sources: VentureXpert, Oehler et al. (2007)

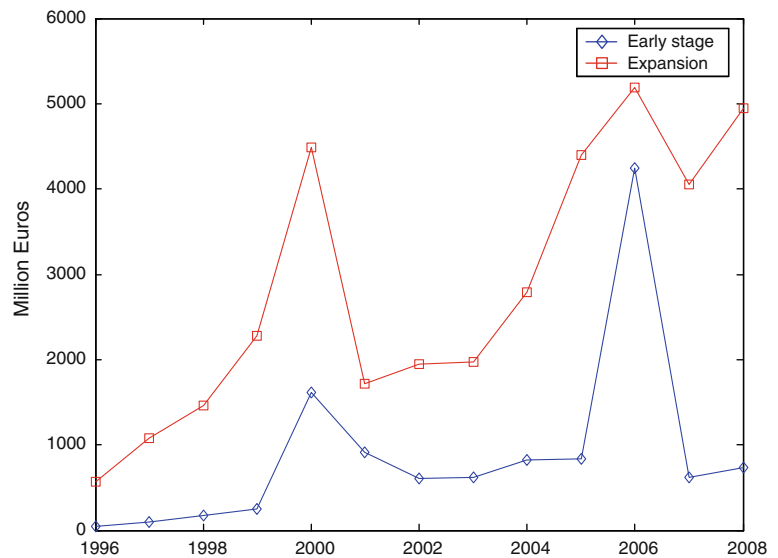


3.2 The impact of venture capital on the performance of funded companies

The foregoing conclusions about European venture capital rest on the implicit assumption that increasing the supply of venture capital will automatically imply better support for high-tech small firms. Such assumption is falsified if venture capitalists provide “more money than advice”, as conjectured by Bottazzi and Da Rin (2005), or—even worse—if they are biased towards speculation. In principle,

venture-backed TBSFs may grow and innovate faster than their non-venture-backed competitors because they avail themselves of the superior advice provided by venture capitalists. Furthermore, venture capital can perform a certification function for funded companies and reduce the informational asymmetries that hinder their access to outside capital. Reviewing the evidence on certification effects and venture-backed firm growth can help assess the validity of Bottazzi and Da Rin’s conjecture.

Fig. 3 Investments by UK venture capitalists in early stage and expansion: 1996–2008. Source: EVCA (1996–2008)



3.2.1 Venture capital and information asymmetries

From an investor's point of view, a venture-backed company may be less informationally opaque for two main reasons. First, venture capitalists are supposed to be highly skilled talent scouts capable of picking firms with promising projects. Venture backing would therefore signal quality to outside investors. Second, companies that receive venture capital have corporate governance structures with a greater level of monitoring both at the time of IPO and after, reducing the scope for moral hazard (Gorman and Sahlman 1989; Sahlman 1990; Gompers and Lerner 1999; Campbell and Frye 2009). Indeed, post-IPO chief executive officer (CEO) ownership declines and board seats held by venture capitalists tend to increase (Berry et al. 2006; Boone et al. 2007).⁸ These effects may vary across countries, because VC contracts are influenced by the legal environment of venture capitalists (Kaplan et al. 2007; Cumming and Johan 2006).⁹

The financial literature relies on first-day IPO under-pricing as an indicator of pre-listing information asymmetries (Ritter and Welch 2002). The

⁸ VCs typically own a substantial fraction of the company, usually in the form of convertible securities (Hellmann 1998, Casamatta 2003, Cornelli and Yosha 2003, Kaplan and Strömberg 2003).

⁹ See Kaplan and Strömberg (2003, 2004) on the importance of financial contracting for mitigating agency conflicts.

certification hypothesis states that, because venture capitalists certify the company's financial soundness, venture-backed IPOs should be characterized by less severe under-pricing (Booth and Smith 1986; Megginson and Weiss 1991). Lower under-pricing may also be observed if venture backing is expected to enhance the liquidity of trading after the IPO (Ellul and Pagano 2006). Alternative theoretical reasoning suggests that VC-backed IPOs could, in fact, be *more* under-priced. According to the *grandstanding hypothesis* (Gompers 1996), VC firms aim to maximize the probability of future fund-raising because VC funds have finite lives. To do so, they need to create a reputation for being able to take portfolio companies public. The VC firms are ready to bear the cost of larger under-pricing because a market exit signals their quality as investors. According to the *conflicts of interest hypothesis*, the affiliation of venture capital funds with major financial institutions can lead to conflicts of interest, as the underwriting banks would be interested in setting a higher offer price. The IPO's investors anticipate this conflict of interest and, in order to compensate, seek more under-pricing (Hamao et al. 2000).

Table 2 summarizes the results of econometric tests of the above hypotheses on samples of European TBSFs. Consistent with the certification hypothesis are the results by Chahine et al. (2007) on UK IPOs. Ellul and Pagano (2006) also show that UK venture-backed IPOs are less under-priced than non venture-backed ones. Coakley et al.'s (2007) paper on

Table 2 Synopsis of the econometric studies on under-pricing for venture-backed companies in Europe

Authors (year):	Manigart and De Maeseneire (2003)	Ellul and Pagano (2006)	Coakley et al. (2007)	Chahine et al. (2007)
Countries	B, D, F, NL, I	UK	UK	UK, France
Years	1996–2000	1998–2000	1985–2003	1996–2002
Exchange	Euro.NM EASDAQ	LSE	LSE	LSE, Paris Bourse
Sample size	300	337	591	444
Under-pricing for VC-backed IPOs	No effect	Lower	Lower except in 1998–2000	Lower (LSE) Higher (Paris Bourse)
Method	OLS	2SLS	OLS	2SLS

OLS ordinary least squares, 2SLS two-stage least squares, B Belgium, D Germany, F France, NL the Netherlands, I Italy

London Stock Exchange (LSE) IPOs supports the certification hypothesis, except in the Internet bubble years (1998–2000) when the size of under-pricing displayed an increasing trend especially in high-tech sectors such as information technology (IT) and telecommunications, consistent with speculative behaviour by venture capitalists. Manigart and De Maeseneire (2003) find no effect of venture backing on under-pricing, while rejection of the certification hypothesis is reported again by Chahine et al. (2007) on Paris Bourse IPOs, suggesting that French VC may grandstand, as also shown for the USA by Lee and Wahal (2004).

A broader approach to the impact of VC on asymmetric information, including unquoted TBSFs, estimates the investment–cash flow sensitivities for venture-backed companies (see Sect. 2 for the theoretical underpinnings). Only two papers have dealt with this issue, with contrasting results. Surprisingly, Manigart et al. (2003) find that investments by VC-backed firms are more elastic to cash flow in a sample of Belgian firms. Bertoni et al. (2008) control for the heterogeneity of VC firms (independent versus corporate VC) and show that investment–cash flow sensitivities are lower for venture-funded firms in general, and are not statistically significant when firms are backed by independent VC, suggesting a positive role for the latter in bridging funding gaps.

3.2.2 The venture capitalist: a coach or a scout?

Venture capitalists can enhance the post-investment growth and innovation performance of venture-backed companies, performing a *coach* function for

the funded companies.¹⁰ Active venture capitalists provide assistance in strategic decision-making and allow access to a wider network of business contacts (Hellmann and Puri 2002). In particular, corporate venture capital offers strategic resources, such as technological synergies and brand image, whereas independent venture capital adds value by helping raise additional finance, recruiting key employees and professionalizing the company (Dushnitsky 2006; Ernst et al. 2005; Maula et al. 2005).¹¹ Dushnitsky and Lenox (2006) show that firms in high-tech sectors take best advantage of the “window on technology” offered by corporate VC. However, post-IPO growth may not benefit from venture-backing if venture capitalists follow a “quick-and-dirty” approach to their investments (Bottazzi and Da Rin 2002).

At the same time, entrepreneurs with higher human capital, whose companies face better growth prospects, are more likely to survive the pre-investment screening process. Hence, venture-backed companies may grow faster simply because venture capitalists are endowed with superior sorting skills. In this case, the venture capitalist can be seen as a *scout*. Venture capitalists are likely to perform both the coach and scout functions; the empirical question is whether one or the other prevails. Evidence in

¹⁰ Other indicators of firm performance—such as the hazard rates and the amount of funds raised—can be affected by venture capital. While we do not deny their importance, only Bottazzi and Da Rin (2002) have dealt with them; a much larger number of works has focussed on firm growth.

¹¹ See also Maula and Murray (2002), Katila et al. (2008) and Narayanan et al. (2009) for a comparison between corporate VC and independent VC.

favour of the coach hypothesis may be good news for the individual firm, but may suggest that sorting is socially inefficient, as private equity may not accrue to the companies capable of making the best use of it.

Empirically, one is ready to accept the scout hypothesis if the growth performance of a firm and its probability of receiving venture capital are correlated with the same set of variables, or relatedly, if the positive impact of venture funding on performance is not robust to controlling for endogeneity and selection biases.¹² Work by Colombo and Grilli (2010) on a sample of Italian TBSFs provides some evidence that venture capitalists perform mainly a coaching function. Firms established by individuals with prior experience in field-specific technical functions grow faster, whereas the probability of receiving venture capital depends on prior managerial experience. Similar evidence was provided by Baum and Silverman (2004) on Canadian firms. According to Engel and Keilbach (2007), German venture-backed firms display faster employment growth than their non-venture-backed peers after controlling for endogeneity, showing that venture capitalists are both coaches and scouts. However, venture capital funding does not affect post-investment innovativeness, proxied by the number of patents, essentially because venture capital flows to companies with higher ex ante patent counts.¹³ This would rather support the scout hypothesis. The quantile regression estimates by Audretsch and Lehmann (2004) on German companies listed on the Neuer Markt reveal that venture capital improves the growth performance for all firms, but not for the fast growers. Human capital of the founders has a significantly positive effect on the probability of receiving venture capital, but not on growth. However, endogeneity is not controlled for. Finally, in a sample of companies listed on the Euro.NM circuit, Bottazzi

and Da Rin (2002) fail to find any significant effect of venture capital funds on employment and sales growth, despite controlling for endogeneity and unobserved heterogeneity. See Table 3 for details of the cited studies.

3.3 Open issues

As suggested by the reviewed evidence: *European venture capital has caught up with US venture capital in terms of investment amounts, driven by the fast growth in UK venture capital, but it is still unclear whether it has provided effective advice and certification to TBSFs* (result 2). The lack of advice may hide more fundamental problems. One is the possible shortage of the expertise and competences needed for effective support to venture-backed companies. Casper (2007) reports this as being a major problem for the development of UK biotechnology. Alternatively, grandstanding and conflicts of interests are consistent with the intuition that the growth of funded companies is not in the European venture capitalists' objective function. One challenge for future research is to devise methods that allow these two explanations to be distinguished.

If the lack of effective advice is a key determinant of the European delay, and if advice activities are intensive in human capital, it makes sense to pay more attention to the role of venture capitalists' education and experience. Sorensen's (2007) estimates of a double-matching model on US data indicate that venture capitalists with longer experience (proxied by the number of previous financing rounds) tend to be better at sorting and coaching fund recipients. Bottazzi et al. (2008) show that European venture capitalists with prior business experience tend to be more active, thereby increasing the likelihood of a successful exit. An interesting empirical question is whether the growing experience of European VC will allow for convergence with the USA in spite of differences in legal environments and financial systems. In this respect, it is worth noting that more experienced VCs tend to use US-style contracts (Kaplan et al. 2007).

If it is true that institutional differences affect VC governance (Cumming et al. 2008), a more thorough assessment of the relative performance of VC industries should also take account of the differential impact of corporate and independent venture capital.

¹² Endogeneity of venture capital investments and selection effects can be very relevant in this context. For instance, firms with poorer performance may be discouraged and self-select out of the venture capital market. Firms with high growth prospects may also be discouraged if they face adverse bargaining conditions. Furthermore, venture funding and innovative performance can appear to be positively correlated, because companies seeking venture capital may prefer to patent intensively prior to receiving VC in order to avoid leakage of reserved information to the venture capital firm.

¹³ On the contrary, Kortum and Lerner (2000) find that US companies produce more patents also after receiving venture capital.

Table 3 Synopsis of the econometric studies on the impact of venture capital on company growth in Europe

Authors (year)	Colombo and Grilli (2010)	Engel and Keilbach (2007)	Audretsch and Lehmann (2004)	Bottazzi and Da Rin (2002)
Country	Italy	Germany	Germany	B, D, F, NL, I
Years	1980–2000	1995–1998	1997–2002	1996–2000
Sector/Exchange	High-tech manuf. & svc.	Manufacturing, services	Neuer Markt	Euro.NM
Sample size	439	21,517	341	219
Source	RITA database	Creditreform	Deutsche Börse German Patent Office	Euro.NM
<i>Performance equation</i>				
Dep. variable(s)	Employee growth Sales growth	Employee growth Patents	Employee growth	Employee growth Sales growth
Positive effects	VC backing Economic education Technical experience No. of founders	VC backing	VC eq. share (0.2, 0.5 quantiles)	ROA Leverage Age
Negative effects	–	Size	–	–
No effect	Technical education Commercial experience Managerial experience	–	VC eq. share (0.80 quant.) Education Patents Age Leverage	VC backing
Method	Restricted control function; IV Endogenous switching regression	Propensity score matching	Quantile regression	OLS
<i>Selection equation</i>				
Dep. variable(s)	VC backing (1/0)	VC backing (1/0)	VC backing (1/0) VC equity share	–
Positive effects	Economic education VC backed in sector VC backed in area	Education Patents Size R&D sector	Education of directors Biotechnology sector	–
Negative effects	–	Age	–	–
No effect	Technical education Technical experience Commercial experience Age Incubation No. of founders	–	Patents Education of executives Size Age	–
Method	Probit	Probit	Probit, tobit	–

“Positive effects”, “Negative effects” and “No effect” mean that the estimated coefficients on the reported variables are, respectively, positive and significant, negative and significant, and not significant. “1/0” indicates a dummy variable. *quant.* quantile, *ROA* return on assets, *eq. Share* equity share. The selection equation in Audretsch and Lehmann (2004) does not aim to deal with endogeneity issues

Independent venture capitalists are found to be more active than captive ones (Bottazzi et al. 2008). Gompers (2002) showed that firms backed by corporate VC are more likely to go public. The results in

Ginsberg et al. (2005) suggest that under-pricing and informational asymmetries for corporate VC-backed IPOs are lower, while the available evidence on European VC is rather contradictory.

4 Stock markets for high-tech companies in Europe

The provision of market-based support for European SMEs became something of a hype in the late 1990s when the EASDAQ, a NASDAQ-like exchange promoted by the European Commission and the EVCA, prompted a wave of NASDAQ “copies” as competitive responses by the national stock exchanges. It was hoped that dedicated trading platforms for quotation of TBSFs would stimulate European venture capital by creating profitable exit opportunities and, in turn, new jobs and faster productivity growth in European countries. The history of NMs in Europe is constellated with notable failures (e.g. the EASDAQ, the Neuer Markt) and one durable experience (the Alternative Investment Market in the UK). The question arises as to what lies behind these partly unsatisfactory outcomes. We shall look into this issue in the coming sections, which describe the rise and fall of the European New Markets (NMs) and some indicators of their ability to attract TBSFs and support their performance.

4.1 Historical evolution

Within the European context, the earliest attempts to set up second-tier markets for growing firms date back to the late 1970s and the early 1980s. The pioneering markets for TBSFs were based on the so-called feeder principle: their goal was to select the most profitable young companies and feed them upward to the main markets. The quotation of TBSFs was favoured by low entry requirements and low information standards. Posner (2004, Table 1) reports an exhaustive list of the stock markets based on the feeder principle.¹⁴ Those early experiences were unsuccessful: most investors perceived that feeder markets housed only poorly performing companies and preferred to wait for the best ones to be promoted to the main market (Posner 2004, 2009). Many of the markets did not survive the 1987 stock market crash,

¹⁴ The pioneer markets were the Compartiment Spécial, opened in France in 1977, followed by the Italian Mercato Ristretto (1978), the Unlisted Securities Market (USM) (1980, UK), the Third Market (1987, UK), and Bors 3 (Germany, 1982). The Netherlands, Norway, Sweden, Belgium and Spain also inaugurated markets based on the feeder principle (Posner 2004).

notably the British Third Market (Mallin and Ow-Yong 1998; Weber and Posner 2000; Ritter 2003).

In 1993, the European Union passed the Investment Services Directive (ISD), legislation aimed at integrating national investment services, including stock exchanges, by extending the principle of mutual recognition to service providers. By virtue of the ISD, an exchange regulated in one European Union country could operate in another via electronic networks and computer terminals. This enabled the creation of a pan-European stock exchange for young high-tech companies, which was promoted by the European Commission together with the EVCA (Weber and Posner 2000; Posner 2004). The new market, the EASDAQ, was inaugurated in 1996. It was based on the NASDAQ principle, which entailed low entry requirements but strong informational standards.

The creation of the EASDAQ was felt by national exchanges as a threat: the risk that financial activity might migrate to the new pan-European stock market led most national exchanges to set up their own versions of stock markets for TBSFs at the domestic level. The London Stock Exchange anticipated by creating the Alternative Investment Market (AIM) in June 1995. The Paris Bourse responded in 1996 by inaugurating the Nouveau Marché, and in 1997 the Deutsche Börse established the Neuer Markt. Finally, trading on the Italian Nuovo Mercato began in June 1999.¹⁵ All of the New Markets were designed according to the NASDAQ principle, except the AIM, a feeder. Admission and listing requirements on NMs have been summarized and analyzed by Clatworthy and Peel (1998), Bottazzi and Da Rin (2002), Goergen et al. (2004), Posner (2009) and Burghof and Hunger (2004) among others. The NMs set milder requirements than the main markets regarding capitalization, profitability, pre-IPO shareholder equity, IPO value, free float and track record, but tighter information disclosure rules—appointing sponsors to certify the company’s compliance with the financial requirements and offer supervision and advice in the quotation process and in communications to the

¹⁵ Other stock markets based on the NASDAQ principle have been created in Europe since then: Euro.NM Belgium (1997), Euro.NM Amsterdam (1997), SWX New Market (Switzerland, 1999), Austrian Growth Market (1999), Nuevo Mercado (Spain, 2000), OMX First North (Nordic and Baltic Countries, 2003).

Table 4 Historical evolution of high-tech stock markets in Europe, 1995–2008, compared with the NASDAQ: end-of-year listed companies and capitalization (in million USD)

Years	AIM	Nouveau M.	Neuer M.	Nuovo M.	NASDAQ
Number of listed companies					
1995	121	–	–	–	n.a.
1996	252	18	–	–	5,556
1997	308	38	17	–	5,487
1998	312	81	64	–	5,068
1999	347	111	201	6	4,829
2000	524	118	339	40	4,734
2001	629	164	327	45	4,063
2002	704	153	264	45	3,649
2003	754	137	–	43	3,294
2004	1,021	128	–	40	3,229
2005	1,399	–	–	38	3,164
2006	1,634	–	–	–	3,133
2007	1,694	–	–	–	n.a.
2008	1,550	–	–	–	n.a.
Capitalization (USD million)					
1995	3,670.3	–	–	–	1,519,939.8
1996	8,809.8	956.7	–	–	1,511,824.4
1997	9,420.8	1,655.9	n.a.	–	1,737,509.7
1998	7,411.7	5,069.5	46,636.0	–	2,243,734.0
1999	21,740.9	15,261.1	74,571.8	6,996.9	5,204,620.4
2000	21,824.8	22,791.3	113,596.8	20,811.2	3,597,085.9
2001	16,731.8	13,604.3	29,942.1	11,120.0	2,739,674.7
2002	16,262.2	7,243.8	10,341.7	6,706.0	1,994,494.0
2003	32,162.3	10,267.4	–	10,425.3	2,844,192.6
2004	61,233.3	10,753.0	–	9,071.8	3,532,912.0
2005	98,816.3	–	–	8,615.1	3,603,984.9
2006	177,978.1	–	–	–	3,865,003.6
2007	196,917.1	–	–	–	4,013,650.3
2008	56,113.5	–	–	–	n.a.

Sources: AIM Market Statistics, World Federation of Exchanges. AIM data were converted into USD using average December USD–GBP exchange rates (source: New York Federal Reserve website)

n.a. not available

regulatory authorities; appointing market makers who match buyers and sellers; providing accounting information in line with international standards; and complying with lock-up rules constraining the disposal of shares by insiders.

The historical evolution of the main European NMs is represented in Table 4, reporting the number of member companies and the capitalization (in million USD) of the AIM, the Neuer Markt, the Nouveau Marché, the Nuovo Mercato and the NASDAQ for

comparison, between 1995 and 2008. As can be easily grasped, none of the European markets comes even close to matching the size of the NASDAQ. The New Markets created by national exchanges in continental Europe experienced very fast growth only in the early years.¹⁶ The Neuer Markt soon came to be the leading high-tech exchange in Europe, reaching a

¹⁶ The EASDAQ, whose data are not reported here, fared poorly even in those early years.

capitalization peak of more than USD 113 billion in 2000; in the same year, the Nouveau Marché overtook the AIM in capitalization terms, with the younger Nuovo Mercato almost catching up with them. All of this urged the London Stock Exchange to make the AIM rules more rigorous, and to set up the TechMARK segment in 1999, aiming to allow clearer identification of innovative and R&D-intensive companies within the official listing. Since then, the AIM has sought to broaden its focus to SMEs in general, also outside high-tech sectors; moreover, prior admission to the LSE was an eligibility requirement in the TechMARK.¹⁷ In a way, these facts testify that the enthusiasm of the British for high-tech stock exchanges dried up quite early.

As of 2001, the burst of the so-called Internet bubble hit all the markets quite hard. Several companies were forced to admit that they could not meet the earning forecasts declared in the introduction prospectuses, and the ensuing bankruptcies contributed to a general downward trend in stock prices and capitalization, resulting in numerous de-listings and making new IPOs rare. Between 2000 and 2002, the drop in capitalization was dramatic: -91% in the Neuer Markt and -68% in the French and Italian NMs, less so in the NASDAQ (-44%) and in the AIM (-25%). The Neuer Markt and EASDAQ ceased operations in 2003.¹⁸ In January 2005, the Paris Bourse replaced the first market, the second market and the French NM with a single official list (Eurolist by Euronext), and created Alternext, a new unregulated market closely modelled on the AIM.¹⁹ The Italian NM was replaced

¹⁷ See the “TechMARK eligibility guidance” (<http://www.londonstockexchange.com/techmark>).

¹⁸ The German stock exchange was re-structured in two segments: Prime Standard and General Standard. Although the former inherited the Neuer Markt information disclosure rules, it includes companies from the main market along with previous Neuer Markt members. In 2005, Deutsche Börse created a further segment, Entry Standard, specifically targeting SMEs. While successful—market capitalization was about 9.5 billion Euros as of October 2007, with 109 listed companies—this segment has mainly attracted companies in the financial and real-estate sectors (source: Deutsche Börse).

¹⁹ By the end of 2006, the number of listed firms on Alternext was 72, and the cumulated amount of capital raised was 527.642 million Euros (source: Euronext Paris Statistics). Such successful performance might, however, be the outcome of fiscal subsidies and financial guarantees awarded by the French Ministry of Finance to TBSFs listed on the Alternext market (Faulconbridge et al. 2007).

in September 2005 by MTAX; the relevant legislation shows that admission requirements are now very similar to those in the main market.

The impact of the bubble is assessed by Bottazzi and Da Rin (2002), Goergen et al. (2004) and Giudici and Roosenboom (2004), who analyzed the long-term performance of IPOs on the NMs, measured by the sum of the abnormal returns over a long time horizon. Companies that went public on NMs exhibited significant underperformance, up to 60% in the first 2 years post IPO for the German and Italian NMs. For comparison, the underperformance on the main markets is in the order of 10% (Chahine 2004 on Paris Bourse) and 12% (Ljungqvist 1997 on Deutsche Börse) in the first 3 years. However, the sign of the abnormal returns switches to positive once the impact of the burst of the Internet bubble is removed. The role of speculative behaviour in driving abnormal returns has been underlined by Derrien (2005) in a study on the Paris Bourse during the Internet bubble.

4.2 What lies behind the failures?

The debate on why stock markets for TBSFs collapsed is still open. There are chiefly two candidate explanations. One holds that liquidity was discouraged by an excessive degree of risk. The other calls into question the adequacy of the market architecture.

Within the former strand, a first conjecture is that NMs were poorly diversified, housing mainly companies from a narrow set of R&D-intensive sectors. By the end of 1999, more than 80% of the EASDAQ companies belonged to technology-based sectors, such as software, electronics, IT, biotech and medical equipment, telecommunications, and specialized equipment. On the Nuovo Mercato, telecommunications accounted for the largest emission share (over 40%); biotech and IT had considerable weights too. Other markets managed to survive by broadening their scope to include firms from more traditional sectors: for instance, high-tech firms on the AIM have never accounted for more than 25% of market turnover (AIM Statistics; see also Mallin and Ow-Yong 1998). Still, R&D and tangibility indicators suggest that the involvement of listed companies in innovative activities was generally modest. The median R&D intensity in a Euro.NM sample was a bare 1% according to Bottazzi and Da Rin (2002); in

the Nouveau Marché the share of intangible assets out of total assets was 2.8%, against 20.8% for tangibles.

Listing companies may have been highly risky for other reasons. One such reason is that credit rationing can prevent some of the most promising ventures from going public. A pecking-order story may back up this insight. For instance, Greenwald et al. (1984) showed that new equity issuing by credit-rationed firms is a bad signal to investors, increasing the cost of stock flotation. Also, some of the best VC-backed companies may have been acquired by larger corporations over the counter, since trade sale is the prevailing exit strategy for venture capital investments in Europe. For instance, between 1997 and 2002, only 75 out of 873 divestments in Italy occurred through IPOs (i.e. 8.6%), against 466 trade sales (53.3%) (source: AIFI—Italian Private Equity and Venture Capital Association). IPOs were less frequent than trade sales in the UK as well (Baygan 2003).

In addition, one may argue that the poor performance of the NMs was the outcome of a “second-level” competitive process, namely competition between exchanges. The European markets for high-tech firms opened roughly at the same time, in response to the threat posed by the EASDAQ. The ensuing competition between NMs could have diluted the amount of liquidity available to each of them. Moreover, downside competition among exchanges might have led the market authorities to allow for quotation of firms that were perhaps too young to go public, and managed by unskilled or even fraudulent CEOs (see Revest 2008 for France).²⁰ Relatedly, conflicts of interest between IPO underwriters and their affiliated analysts seem to have biased the IPO earning forecasts and stock recommendations, leading to large long-run underperformance (see Bessler and Stanzel 2009 on the Neuer Markt).

Finally, the adequacy of the market architecture has been questioned. Revest (2001) has explored the case of the Nouveau Marché, showing that many French advisers and market makers (Introduceurs teneurs de marché, ITMs) expressed a negative opinion about the double quotation system on the

Nouveau Marché comprising both an order-driven market and market making. An investigation by Ernst & Young in collaboration with the Agence Nationale de Valorisation de la Recherche and the Société du Nouveau Marché revealed a negative appraisal of market making from the 28 French NM-quoted firms.²¹ These firms complained that ITMs acted too prudently and they regretted the lack of real market making. The limits of the French market making system have been emphasized during periods of high volatility, when ITMs did not post prices and consequently trades were not possible.

4.3 Open issues

We can conclude this section by stating that: *the European stock exchanges dedicated to high-tech companies have failed to deliver support to technology-based small firms* (result 3). It is tempting to add, as a corollary, that stock market support was more effective in “liberal market economies” such as the UK, as the AIM proved resilient to the 2001 stock market crash. However, such a “varieties of capitalism” view is misleading. On the one hand, history provides a counterexample, such as the EASDAQ, which collapsed despite its NASDAQ-like architecture. On the other, the AIM’s strategy to diversify its listing and downplay its high-tech character makes it hard to compare it with NMs in bank-based Continental European countries. The crucial question is: What if the AIM had pursued the same strategy as the other NMs? Would it have nonetheless survived? A positive answer would suggest that high-tech stock markets are more likely to succeed if embedded in a market-based financial system. In order to come up with an answer we need a counterfactual, which—regrettably—is missing.

More generally, assessing the performance of NMs is difficult, because there are no theoretical priors on how high-tech stock exchanges choose their strategies, and on what a well-performing NM would look like—both from the viewpoint of TBSFs welfare and in a social welfare perspective. For instance, how do high-tech stock exchanges set their listing requirements?

²⁰ Some evidence of competition between exchanges has been detected in Pagano et al. (2001, 2002), who explore the differential success of European and US main stock exchanges using data on cross-listings.

²¹ The Société du Nouveau Marché was the market authority. The Agence Nationale de Valorisation de la Recherche (ANVAR) was the national agency for promoting research; then replaced by Oséo-ANVAR.

And how low should the listing requirements be? Is (social or TBSF) welfare dynamically maximized in a high-tech stock market where 100% of its members are small, young, R&D-intensive companies? The answer is likely negative, because the amount of risk in an NM including only TBSFs might be so high as to discourage investors and lead to market collapse. The quotation of a fair share of “traditional” companies could therefore bring liquidity to the exchange and dilute an otherwise overly high amount of risk. The optimal share of mid-caps and large caps may vary across countries characterized by different financial systems and economic fundamentals. Furthermore, it is expected to decline over the life of an exchange if the market enjoys reputation gains and if stock exchanges, as organizations, learn from past errors and adjust their architectures.

5 Public financial support to TBSFs

In recent decades, the European national governments and the European Union have intensified their support to the emergence and development of active high-tech sectors. Start-up finance has been among the primary targets to improve European competitiveness with respect to the USA (Megginson 2004). In fact, Europeans are following the example of US policy-makers, who largely supported young innovative firms through favourable regulation, e.g. an attractive tax code on stock options (Gompers and Lerner 2001) and flexible bankruptcy laws (White 1996). It is also worth noting that the involvement of US public agencies in the venture capital business has been strong and helpful for the subsequent development of the industry—through Small Business Investment Companies (SBICs), the Small Business Investment Research (SBIR) Programme and several other initiatives at both state and federal levels (Lerner 1999).²² An interesting question is whether the European policy initiatives have been successful in bridging the funding gaps of TBSFs.

²² Besides the heavy involvement of the Small Business Administration in the SBIC program, one can also mention the role played by the Angel Capital Electronic network (renamed Active Capital), and the support of the National Institutes of Health to US biotechnology.

5.1 The theoretical debate

Before going into the details of the European public support schemes for TBSFs, it is worth reviewing the theoretical debate on the social welfare effects of governmental intervention in this area. It is widely accepted that, in economies characterized by pervasive market failures, public policies are socially desirable. Informational asymmetries between private investors and fund-seeking new firms imply that TBSFs face credit rationing and may not be able to undertake the desired amount of investments. Furthermore, the gap between the social and private returns to R&D, due to incomplete appropriability, can lead to underinvestment (Nelson 1959; Arrow 1962). The state should therefore intervene in order to promote more efficient allocation of resources. Financial assistance can be provided directly, e.g. by awarding R&D grants, or indirectly in the form of preferential tax treatment, credit ceilings, as well as by offering quality certification, for instance through loan guarantee schemes and public venture capital funds (Mason and Harrison 2003; Lerner 2002).

Several objections have been raised against public financial support to new firms. It has been stressed that subsidizing entry might distort the learning processes that drive the dynamics of start-ups, and result in a waste of public money (Santarelli and Vivarelli 2002). Thanks to subsidies, less efficient entrants experience fast growth, thereby corroding the market shares of more efficient firms; but their growth vanishes once the subsidy expires and they are forced to exit (*substitution effect*). In addition, the more efficient entrants would have survived even without the subsidy (*deadweight effect*). Taxes on capital gains can be a major impediment to the growth of a high-quality VC industry (Keuschnigg and Nielsen 2003, 2004), and more generally they can impair entrepreneurship (Poterba 1989; Rosen 2005). If the state becomes a direct player in the venture capital industry, the increased supply of funds can depress the returns to private VC; therefore public VC can crowd out private VC investments (Armour and Cumming 2006; Cumming and MacIntosh 2006). Similarly, R&D grants may partly displace private R&D. In general, the ability of public officials to allocate funds more efficiently than the market and to properly define the policy targets has been questioned (Avnimelech and Teubal 2006; Gilson 2003; Holtz-Eakin 2000).

5.2 National support programmes

Taking a side in this debate, from the 1980s onwards the European governments have gradually changed the fiscal and legal environment of TBSFs in order to stimulate both entrepreneurship and the involvement of investors in high-tech projects (Armour and Cumming 2006; Da Rin et al. 2006). The European Union has included support to high-tech activities among its industrial policy priorities. Regulatory changes and their impact differ among European countries, because of persisting national specificities. The most significant policy results are attributed to Germany and the UK, though the scale of public support was far larger in Germany (Martin et al. 2003). In Germany, direct public support has been based on two publicly owned banks²³ that provide long-term financing to industry, relying on bank guarantees, refinancing, mezzanine capital and co-investments (Heger et al. 2005; Martin et al. 2003; Sunley et al. 2005). The UK government initiatives have traditionally displayed a stronger market orientation and are mainly based on specialized measures to spur innovation through grants.²⁴ In France, direct funding and co-funding schemes have been implemented by public organizations²⁵ and through national programmes such as the French Innovation Plan (2004) by the French Ministry of Industry (Dubocage and Rivaud-Danset 2002). The introduction of a particular legal status for TBSFs and differential tax treatment had a positive effect on entrepreneurship, but very limited in terms of

²³ The Kredit Für Wiederaufbau (KfW, “credit for reconstruction”) and Deutsche Ausgleichsbank (DtA) through its subsidiary, the public bank Technologie-Beteiligungsgesellschaft (TBG). These two institutions merged in 2003.

²⁴ For instance, the Science Enterprise Challenge programme, active since 1999, involves a network of universities and promotes the creation of tight links between the business and research communities. Other measures, such as the Small Firms Loan Guarantee Scheme (SFLG), are more directly targeted at overcoming market failures which cause high-tech small firms to be credit-rationed.

²⁵ Among them, one could mention Caisse des Dépôts et Consignation (CDC) Entreprise, which is the major institutional investor for French technological venture capital, and the Agence Nationale de Valorisation de la Recherche (Oséo-ANVAR), the national agency for promoting research.

investments (Carpentier et al. 2007).²⁶ In Italy, financial grants to small firms (Law 488/1992) have targeted firms in less developed regions, regardless of their sectors, and have been awarded according to automatic criteria, without screening on the quality of the projects (Potestio 2004; Altobelli et al. 2006; Colombo and Grilli 2006; Colombo et al. 2007).

5.3 Proximity and competencies

Along with national initiatives, regional programmes have been implemented to exploit the benefits of proximity. Building closer relations between investors, investees and intermediary firms seems to be a key step in making public VC programmes effective, especially for early-stage investments (Martin et al. 2005). Also, a regional focus is more suited to addressing market failures and financial gaps in particular geographical areas (Murray 1998). Finally, regional programmes may be better coordinated with other local innovation policies, actors and incubators (Sunley et al. 2005).

In Germany, the two main quasi-public institutions have encouraged Länder governments to develop their own venture capital initiatives. This “regional” use of national funding has succeeded, creating markets where none existed before (Bascha and Walz 2001; Lehrer and Asakawa 2004).²⁷ In addition, some regional policy programmes address specific sectors, such as the BioRegio programme that served as a model for further interregional competition designed to promote start-ups (Wilson and Souitaris 2002; Champenois et al. 2006).²⁸ However, the German regional policy instruments are highly demand driven and depend on the dynamism of the Länder economies. In the UK, public venture capital initiatives are represented by the Regional Venture Capital Funds (RVCFs), which since 2001 have provided risk capital to SMEs with growth potential (Sunley et al. 2005;

²⁶ For instance the Law on Research and Innovation of July 12, 1999 promotes the transfer of knowledge towards companies and the creation of new innovating companies.

²⁷ The main state initiatives were the following: to establish equity stock companies, to set new regional VC firms (with private investors) and to provide capital to new funds (Sunley et al. 2005).

²⁸ This programme awarded monetary prizes to the regions offering the best regional commercialization networks of biotechnology (Casper 2000, Dohse 2000, Lehrer and Asakawa 2004).

Mason and Harrison 2003; Heger et al. 2005). The peculiarity of the RVCFs is that they are regionally administered but follow a standard national model and appear to be less affected by the economic wealth of the regions (Heger et al. 2005). While the RVCFs give more autonomy to actors, one drawback is that they rely on the competencies of only one manager per region. In recent years, some Italian regions have also designed their own policy schemes to support the VC industry (Bertoni et al. 2007).

While the role of regions is recognized by the public authorities, there is still a lack of interest in stimulating the demand for funds (Da Rin et al. 2006; Mason and Harrison 2002, 2003). With a view to overcoming the informational and competency gaps suffered by TBSFs, some countries (the UK and to a lesser extent Italy) have encouraged the development of national and regional business angel networks.²⁹ Business angels can play a vital role in the creation and growth of new ventures by helping raise financial capital and offering skills and access to personal networks (Mason 2006; Kelly 2007). The effectiveness of this policy instrument is positively correlated to the development of knowledge and competencies of all the actors involved (entrepreneurs, business angels) and other members of the network, such as accountants, lawyers, bankers and consultants (Mason and Harrison 2002).³⁰ The crucial issues of competencies and proximity appear also through the role of science parks and incubators, which in many countries have become popular policy instruments to foster entrepreneurship (Siegel et al. 2003; Phan et al. 2005; Zhang 2005). Incubators can relax the financial constraints of start-ups by providing the use of material and immaterial assets at less than the market price. However, the effectiveness of incubators remains a controversial issue.³¹

²⁹ In Italy, public support to TBSFs is also provided by the Italian Business Angel Network (IBAN), established in 1999, which includes eight Business Angel Networks (BANs) distributed across Italian regions. The capital shares of these BANs are typically held by the regional authorities, regional development agencies and private banks.

³⁰ Riding (2008) found that it could be counterproductive for public policy to encourage non-competent informal investors.

³¹ For instance, according to Tamasy (2007), public incubators only produce weak effects on the decision of individuals to start a business.

5.4 Policy evaluation

Is public financial support to TBSFs effective in Europe? The literature on the evaluation of high-tech support policies in Europe is quite sparse, and no doubt “further study of governmental seed capital and subsidy programmes using quasi-experimental methods is warranted” (Hall 2002). Nevertheless, there are some encouraging signals about the effects of fiscal incentives to R&D and public venture capital.

The extent to which fiscal incentives have the power to influence innovative activities depends on the price-elasticity of R&D. There is fairly robust cross-country evidence that R&D expenditure is rather inelastic in the short term, but its price-responsiveness increases over the long run (see Griffith et al. 2001 on the UK; Bloom et al. 2002 on OECD countries; Hall and Van Reenen 2000 for a review). Other studies on several European countries show that favourable corporate capital gains taxation generates positive effects on the level of high-tech and early-stage venture investments (Da Rin et al. 2006; Armour and Cumming 2006). Gompers and Lerner (2001) find that tax reductions allow VC financing to increase. In a cross-country study on 21 European countries, Jeng and Wells (2000) show that public investment is useful to support investments in sectors with fewer IPOs. Consistently, early-stage and high-tech VC investments are higher in countries where public investments are proportionally larger (Beuselinck and Manigart 2007).³² This positive impact of public funding is confirmed by Leleux and Surlemont (2003), who reject the public VC crowding-out hypothesis. Concerning the role of regional policies, some empirical results concerning Germany tend to confirm that the development of a successful VC market is associated with the emergence of spatial clusters of high-tech firms (Champeinois et al. 2006; Audretsch and Fritsch 2002), with potentially beneficial effects on economic growth.

Finally, some public policy success stories in smaller European countries are worth mentioning. In The Netherlands, special tax treatment has allowed one of the largest pension fund industries to be created (Sormani 2001). The Swedish government has

³² The authors conducted a study on ten European countries (Belgium, Finland, France, Ireland, Italy, Norway, The Netherlands, Spain, Sweden and the UK), using data on public VC investments from the annual statistics of EVCA.

established investment companies modelled on SBIC since 1980, reduced capital gain taxes on start-ups and played an active role in the development of the venture capital industry through formal VC companies and state-owned funds (Isaaksson 2007).³³

5.5 Summary and open issues

In sum, reviewing the European public support to TBSFs finance shows that: *European governments have adapted their fiscal and legal environments to the needs of small high-tech firms, combining national and regional measures. R&D tax incentives and public venture capital seem to have produced beneficial effects* (result 4).

Future research on public support to TBSFs may develop along the following lines. The first key issue concerns the heterogeneity of public programmes, which can generate a “system failure” given the lack of coordination between the many actors and organizations (Peneder 2008). What appears highly desirable is harmonization of the regulation and taxation of private equity funds, and the development of tools for coordination, facilitating communication between the players and the development of projects. Relatedly, in the European context the interaction between national and regional programmes is also a critical issue. It is likely that the success of these policies at both aggregation levels relies on the adequate involvement of both formal and informal actors, as well as on the quality of the available knowledge infrastructures (Martin et al. 2003). One remaining question is how public policies can better coordinate their financial and non-financial measures, e.g. those focussed on training and network formation (Jääskeläinen et al. 2007), as well as those linked with job creation in the labour market (e.g. the Overseas Private Investment Corporation in the USA; see Oehler et al. 2007).

6 Conclusion

The foregoing literature survey has offered a bird’s eye view of the status of both private and public sources of financial support to technology-based

small firms in European countries. Four main results are highlighted. First, European TBSFs finance new investments by relying primarily on internal funds. There seems to be a wedge between the cost of internal and outside finance, including debt and external equity. Such a wedge is likely due to capital market failures induced by asymmetric information. Second, although the size of investments by European and US venture capitalists is now comparable, in the last decade the venture capital industry in Europe has stagnated, and it is not clear whether European venture capitalists have provided effective advice and certification for TBSFs. Specifically, while venture-backed firms tend to grow faster, it is unclear if this is due to the influence of venture capitalists as opposed to their ability to select the most promising companies. Moreover, so far the hypothesis that venture capital certifies the quality of funded companies has not received any strong support. Third, European attempts to provide easier access by TBSFs to public equity, following the EASDAQ model, have failed: the so-called New Markets inaugurated in the 1990s collapsed after the Internet bubble, lacking liquidity and transparency. Fourth, there is encouraging evidence on the certification and signalling functions played by European and national policies, along with positive long-term effects associated to preferential R&D tax treatments.

It is worth noting that this body of evidence is robust across countries with different financial systems. In explaining cross-country differentials in the birth of new TBSFs and in their growth performance, whether a country’s financial system is close to the bank-based or to the market-based prototypes does not seem to be essential. Where markets are highly developed, lack of expertise and conflicts of interest can hinder the effectiveness of financial support, as could be the case for European venture capital. Where non-market forms of interaction prevail, high-tech companies can still develop global comparative advantage in subsectors whose technological regimes are consistent with the features of “coordinated market economies”—e.g. winner-takes-all sectors with cumulative learning—or benefit from support by large companies setting up networks of SMEs (see the case studies on Germany and Sweden discussed in Casper 2007). It is increasingly suggested that the evolution of financial systems is constrained by path dependencies, involving inertia in household saving patterns, investment

³³ Outside Europe, the most cited examples are Israel (Avnimelech and Teubal 2006), Canada (Ayayi 2004) and more recently India (Dossani and Kenney 2002).

behaviours and corporate ownership structures (Bianco et al. 1997; Bebchuk and Roe 1999; Holzl 2006; Vitols 2005).³⁴ If so, different countries have little to learn from each other's experiences. The grip of history also has other consequences, related to the political fragmentation of Europe. For instance, the national stock exchanges have spawned a large number of competing stock markets for high-tech companies, none of which could credibly compete with the NASDAQ. The European Commission's attempt to set up a pan-European high-tech market and the ongoing processes of stock market integration in Europe (e.g. Euronext) suggest that the benefits from concentration in the "market of financial markets" are understood by both policy-makers and stock exchanges.

In sum, the European experience with TBSF finance makes it clear that institutional forms adopted by one country need not prove successful across borders. Despite this, the non-bank financial intermediaries and institutional investors have become more influential in Europe since the 1990s, at both the national and supranational policy-making levels (Schmidt and Tyrell 2004; Posner 2004; Casper 2007). Based on the institutional complementarity concept (Aoki 2001) we conjecture that future attempts to set up market-based support for high-tech SMEs are doomed to fail unless they are conceived as part of broader (and perhaps painful) reforms also involving sectors outside the financial system. Instrumental to enhancing the liquidity of high-tech stock markets are policies that redistribute wealth to households with high propensities to hold equity. This, however, will require a radical change in the education and welfare systems (Vitols 2005), in the organization of research activities (Antonelli 2008), in fiscal policies and in labour market regulations towards greater flexibility of the workforce (Da Rin et al. 2006). All these reforms entail large social costs, let alone the sheer losses from exposing citizens to the extreme risks of international finance. Future research on innovation finance may pay more attention to these issues.

³⁴ Bebchuk and Roe (1999) discuss the role of efficiency, rent-seeking and interest group politics in giving rise to path dependencies in corporate ownership and governance structures. More general reflections on path dependencies in the economy may be found in David (1994) concerning the role of history in shaping expectations and the interrelatedness among the elements of complex organizations.

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