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Financing Technology-Based Small Firms in Europe:

A review of the empirical evidence

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Financing Technology-Based Small Firms in Europe: A review of the empirical evidence

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Abstract

This paper reviews the evidence on financing technology-based small firms (TBSFs) in Europe. The main findings in the literature are that 1) European TBSFs finance new investments by relying primarily on internal funds, due to capital market failures induced by asymmetric information; 2) European venture capital has caught up with US venture capital, but this is mainly because of the growth in UK venture investments, and it is unclear whether European venture capital has been able to certify the quality and to enhance the growth of funded companies; 3) the development of trading in high-technology stocks has been limited, if compared with the NASDAQ: the so-called "New Markets" established in the Nineties have collapsed in the wake of the Internet bubble crash; 4) public venture capital and R&D tax incentives have positively affected high-tech firms, but more research is needed on the forms of public support and on their evaluation.

Keywords: Technology-based small firms, capital structure, venture capital, high-tech stock markets, public support.

JEL Codes: G24, G28, G32, M13.

1. Introduction

Where do European technology-based small firms (TBSFs) take the money from? TBSFs are defined as small business 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 they lack 'hard' and collateralisable assets, and their track record is short. Moreover, firm founders with science or technology background suffer from limited financial and marketing expertise. This paper is meant to be a guide through the main facts on TBSFs finance and their economic interpretations, potentially useful for both academic scholars and policy makers. We seek to shed light on cross-country invariancies 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.

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This exercise is motivated by at least two observations. On the one hand, Schumpeter pointed out how 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, Malerba and Orsenigo 2000). By challenging the existing technological paradigms, new firms in high technology sectors promote dynamic efficiency, discipline the behaviour of incumbents, and are ultimately major agents of technical change and job creation (Audretsch 1995, Bartelsman, Haltiwanger and Scarpetta 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 lacking a track record, and involved in R&D activities, 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 most 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 categories – market-based vs. bank-based – or different varieties of capitalism (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 economic agents. It has long been held that the finance-innovation nexus is not independent from 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, as Europeans we find it worth focusing on Europe since it lags behind the US in the

exploitation of new technological knowledge for commercial uses (Dosi, Llerena and Sylos Labini 2006).

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 the US one in terms of investment amounts. Yet, 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 may not be sufficient to provide effective support to TBSFs. *Third*, similarly limited has been the development of trading in high-technology stocks, if compared with the NASDAQ. The EASDAQ and the so-called "New Markets" (NMs) established in France, Germany and Italy in the late Nineties 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 TBSFs finance, with significant cross-country heterogeneity despite the role of the European Union in harmonising the 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 positively yield beneficial long-run effects.

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

2. The capital structure of TBSFs.

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 the TBSFs 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 for 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. As a matter of fact, TBSFs display high default probability, and their value in case of default falls dramatically, because it is mainly made up of growth opportunities and specialized and intangible assets, which cannot be collateralized and can hardly be redeployed. Moreover, transaction costs related to debt and equity financing seem to be higher for TBSFs than for large and mature companies. In this respect, it has been shown that the market power of banks is decreasing in the size of the borrower (Petersen and Rajan 1995). In addition, stock market flotation is rather costly for TBSFs, because underwriting costs are larger for IPOs than for seasoned issues (Calomiris, Himmelberg and Wachtel 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 the 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 anytime 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 in equity markets

[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.

(Myers and Majluf 1984, Greenwald, Stiglitz and Weiss 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 it is the case when lenders impose debt covenants and when new equity results in a wider share ownership (*control aversion* in Cressy 1995, Chittenden et al. 1996, Cressy and Olofsson 1997).

2.2. Tests of the capital structure theories on samples of European TBSFs.

The outlined capital structure theories yield differential 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 the 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 skilful entrepreneurs to eschew from 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, a larger availability of debt capital (Cressy 1996).

Raw estimates of the shares of internal and external funding sources provide a preliminary support the pecking order theory, as they show that European TBSFs primarily rely on internal funds (Giudici and Paleari 2000, Scellato and Ughetto 2007, Colombo and Grilli 2007 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 a larger share of qualified employees report more problems in accessing external finance (Westhead and Storey 1997 and 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

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

[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 a better access to loans. However, profits for firms with a short track record are negligible.

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. Control aversion and discouraged borrowing do not seem to be the main reasons behind the pecking order.

Less used is the testing strategy introduced by Fazzari, Hubbard and Petersen (1988), who claimed that credit-constrained firms exhibit larger investment-cash flow sensitivities. Kaplan and Zingales (1997, 2000) have criticized this approach by 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 signals future growth opportunities (see also Fazzari, Hubbard and Petersen 2000).[5] The few papers on European TBSFs within this approach analyze the effects of venture capital backing, and shall be reviewed in Section 3.2.1. Direct tests of the pecking order, such as the one devised by Shyam-Sunder and Myers (1999), have not been performed on TBSFs.[6]

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 therefore is in line with the US evidence on financial constraints to investments and R&D spending (Hall 1992, 2002, 2005; 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 to take care of sample selection biases, unobserved heterogeneity, endogeneity and the dynamic adjustment of capital structures. Measurement errors on the most important variables - such as the 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, Scaramozzino and Harris (2005, 2008) have used this methodology on samples of South Korean and UK listed companies, but applications to TBSFs are missing.

[5] It is doubtful whether larger investment-cash follow 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 of internal funds (pecking order model of the coefficient is negative), and a regression of the debt-ratio on a debt-ratio target (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).

Regarding the economics of TBSFs, theoretical reasoning suggests that better information flows and investor rights, available in market-based systems such as the US 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 the country-specific institutional traits are not controlled for. Cross-country studies would be needed, but there are at least two kinds of difficulties. Qian and Strahan (2007) find that stronger credit protection is beneficial mainly for firms intensive in tangible assets. This might mean that the capital structure of TBSFs would not be affected by varieties of capitalism. Moreover, 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. Bougheas, Mizen and Yalcin (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 to industrial groups and mutual guarantee societies relax the financial constraints on TBSFs (see Hoshi, Kashyap and Scharfstein 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 neither market-based nor bank-based systems. Venture capital has emerged in the United States 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 Stromberg 2003). The features of venture capital and its expected impact on new firms creation and growth have been described and discussed at length (Tyebjee 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). Hereby 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 funded companies?

3.1 Venture capital in Europe: facts and figures

The birth of the European venture capital industry dates back to the Seventies, but its full emergence occurred only during the second half of the Nineties. The early attempts made in France, Germany and Italy in the Seventies and Eighties 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, Dubocage and Rivaud-Danset 2004, Tykvova 2007). The message in the available data is that Europe as a whole managed to catch up with the US in terms of venture capital investments. While in 1998 the VC funds relative to GDP were equal to 0.074 % for Europe and 0.2% for the US, in 2005 these figures were 0.2% for Europe and 0.23 % for the US (Oehler et al. 2007). Evidence of a catching up is also suggested by Fig. 1, which compares the amounts invested by US venture capital and by the aggregate of France, Germany, Italy and the UK between 2000 and 2007.[7] It would appear that while Europe was still lagging behind in 2000, it was more resilient to the 2001 stock market crash, performing better than the US in many years during the 2000s. A similar pattern is reported by Oehler et al. (2007) using VentureXpert data on disbursed VC funds.

Was the catch up a balanced process across European countries? The available data justify a negative answer. Fig. 2 depicts the evolution of venture capital investments in France, Germany, Italy and the UK between 1996 and 2008. Two facts clearly stand out. First, venture capital in all the European countries considered soared in the late Nineties, peaked in 2000, and dropped rather sharply between 2001 and 2002, in the wake of the Internet bubble crash. Between 1996 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

[7] We focus on VC as an investment in seed, early stage and expansion companies. Our approach is consistent with Beuselink and Manigart (2007).

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). Second, venture capital in continental Europe has stagnated during the 2000s, whereas venture investments in the UK more than trebled between 2003 and 2006. As of 2008, the UK was the main venture market in Europe, representing about 25% of the European Venture Industry (EVCA 2008 Yearbook).

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 might be related to the role of private equity fund raising by pension funds, which have reached their highest value in 2006 with 24 402 million Euros (EVCA Yearbooks). 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 are possible determinants of the Europe-US venture capital gap (Cumming et al. 2003, Das et al. 2004, Bascha et al. 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). Quite interestingly for our goals, it is clear from Fig. 3 that the peaks experienced by the UK venture capital in 2000 and 2006 are associated with an increasing share of early stage investments. Consistently, Lockett et al. (2002) provide evidence that UK venture capitalists slightly improved their attitude towards young and small firms, while in the early Nineties they tended to give priority to large deal sizes and large companies (Murray 1999, Jeng and Wells 2000, Mayer, Schoors and Yafeh 2005). More clues on the plausibility of this hypothesis are given in Section 4, devoted to the performance of European high-tech stock exchanges.

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. This assumption is falsified if venture capitalists are biased towards speculation and against advice activities (Bottazzi and Da Rin 2002). In principle, venture capital can perform a certification function for funded companies and reduce the informational asymmetries that hinder their access to outside capital. Furthermore, 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. Reviewing the evidence on these issues can give hints on the validity of Bottazzi and Da Rin's conjecture.

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 the outside investors. Second, companies that receive venture capital are characterized by corporate governance structures with 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 et al. 2008). Indeed, the post-IPO CEO ownership declines and board seats held by venture capitalists tend to increase (Berry et al. 2006, Boone et al. 2004).[8] These effects may vary across countries, because VC contracts are influenced by the legal environment of the venture capitalists (Kaplan, Martel and Stromberg 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 *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 be, in fact, *more* underpriced. According to the *grandstanding hypothesis* (Gompers 1996) VC firms aim to maximize the probability of future fundraising because VC funds have finite lives. To do so, they need to create a reputation for being able of taking 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. The *conflicts of interest hypothesis* argues that 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, they ask for 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, Filatotchev and Wright (2007) on UK IPOs. Ellul and Pagano (2006) also show that UK venture-backed IPOs are less underpriced. Coakley, Hadass and Wood's (2007) paper on 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 IT and

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

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 by, again, Chahine, Filatotchev and Wright (2007) on Paris Bourse IPOs, suggesting that French VC may grandstand, as shown also for the US by Lee and Wahal (2004).

A broader approach to the impact of VC on asymmetric information, including also unquoted TBSFs, estimates the investment-cash flow sensitivities for venture-backed companies (see Section 2 for the theoretical underpinnings). Only two papers have dealt with this issue, with contrasting results. Surprisingly, Manigart et al. (2003) find that investments of VC-backed firms are more elastic to cash flow in a sample of Belgian firms. Bertoni, Colombo and Croce (2009) control for the heterogeneity of VC firms (independent vs. 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 – i.e. IVC can bridge the funding gap.

3.2.2. The venture capitalist: a *coach* or a *scout*?

Venture capitalists can enhance the post-investment growth and innovation performances of the 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 CVC. Post-IPO growth may not benefit from venture-backing if venture capitalists follow a "quick-and-dirt" 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 functions; the empirical question is whether one or the other prevails. Evidence in favour of the coach hypothesis may be good news from the point of view of an individual firm, but

[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 focused on firm growth.

[11] See also Maula and Murray (2002), Katila et al. (2008) and Narayanan et al. (2009) for a comparison between CVC and IVC.

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 to receive 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 (2009) 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 to receive 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 the post-investment innovativeness, proxied by the number of patents, essentially because venture capital flows to the 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 to receive 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 doubtful whether it has provided effective advice to TBSFs* (***Result 3***). The lack of advice may hide more fundamental problems. One is the possible shortage of the expertise and competences needed for an effective support to venture-backed companies. Casper (2007) reports this as being a major problem for the development of UK biotechnology. Alternatively, grandstanding and

[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 leakages of reserved information to the venture capital firm.

[13] On the contrary, Kortum and Lerner (2000) find that venture-backed companies in the USA produce more patents.

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 methodologies that enable us to distinguish between these two explanations.

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, Da Rin and Hellmann (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 US 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, Martel and Stromberg 2007).

If it is true that institutional differences affect the VC governance (Cumming, Schmidt and Walz 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. Independent venture capitalists are found to be more active than captive ones (Bottazzi, Da Rin and Hellmann 2008). Gompers (2002) showed that firms backed by CVC are more likely to go public. The results in Ginsberg et al. (2005) suggest that under-pricing and informational asymmetries for CVC-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-Nineties, 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. Dedicated trading platforms for the quotation of TBSFs were hoped to 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 AIM in the United Kingdom). The question arises as to what lies behind these partly unsatisfactory outcomes. We shall look into this issue in the upcoming sections, which describe the rise and fall of the European "New Markets" (NMs henceforth) and some indicators of their ability to attract TBSFs and support their performances.

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 Seventies and the early Eighties. 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). Many of the markets did not survive after the 1987 stock market crash, 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), a 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 EU 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 (1997), Bottazzi and Da Rin (2002), Goergen et al. (2004), Posner (2004), Burghof and Hunger (2004) among others. The NMs set milder requirements than on the main markets regarding capitalization, profitability, pre-IPO shareholder equity, IPO value, free float and

[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).

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

track record, but tighter information disclosure rules – appointing sponsors to certify the company's compliance with the financial requirements and offers oversight and advice in the quotation process and in the communications to the 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 millions of local currency) of the AIM, the Neuer Markt, the Nouveau Marché, the Nuovo Mercato, and the NASDAQ for comparison, between 1995 and 2008. As it can be easily grasped, none of the European markets comes even close to match 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 peak of more than 113000 million dollars capitalization 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, aimed to allow a clearer identification of innovative and R&D-intensive companies within the official listing. Since then, the AIM would 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 witness 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 had to confess 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 made 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 by a single official list (Eurolist by Euronext), and

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

[17] See the "TechMARK eligibilityguidance"(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 Market members. In 2005, Deutsche Borse created a further segment, Entry Standard, specifically targeted at 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 Borse).

created Alternext, a new unregulated market closely modelled on AIM.[19] The Italian NM was replaced 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 has been assessed by Bottazzi and Da Rin (2002), Goergen et al. (2004) and Giudici and Roosenboom (2004), who have analysed 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 two 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 Boerse) in the first three 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 behaviours 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. Candidate explanations are mainly two. One holds that liquidity was discouraged by the overly riskiness of the list. 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 relevant weights too. Other markets managed to survive by broadening their scope to include firms from more traditional sectors: for instance, high technology 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 Marchè the share of intangible assets out of total assets was 2.8%, against 20.8% for tangibles.

Perhaps listing companies were 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

[19] By the end of 2006, the number of listed firms on Alternext was 72, and the cumulated amount of capital raised was 527642 million Euros (source: Euronext Paris Statistics). Such a 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).

story may back up this insight. For instance, Greenwald, Stiglitz and Weiss (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 out of the counter, since the 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). IPOs are less frequent than trade sales in the UK too (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 2007 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 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 Societé du Nouveau Marché revealed a negative appraisal of market making from the 28 French NM-quoted firms.[21] These firms complained that ITM 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-technology 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

[20] Some evidence of competition between exchanges has been detected in Pagano, Randl, Roell and Zechner (2001) and Pagano, Roell and Zechner (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 for this market. ANVAR ("Agence Nationale de Valorisation de la Recherche") was the national agency for promoting research, it has been replaced few years ago by OSEO-ANVAR.

economies" such as the UK, as the AIM proved resilient to the 2001 stock market crash. Yet, 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 hand, 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 Europe countries. The crucial question is: What if the AIM had pursued the same strategy as the other NMs? Would it nonetheless survive? 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 is – unluckily - missing.

More generally, assessing the performance of NMs is difficult, because theoretical priors are missing on how NMs choose their strategies, and on how 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? And how low should the listing requirements be? Is (social or TBSFs) 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 a 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 the 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 the European competitiveness with respect to the USA (Megginson 2004). As a matter of fact, Europe is 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 the Small Business Investment Companies (SBICs), the Small Business Investment Research (SBIR) Programme and

several other initiatives at all Federal and State levels (Lerner 1996).[22] The main questions here are: What is the state of public financial support to TBSFs in Europe? Have policies been successful in bridging the funding gaps?

5.1. The theoretical debate.

Before going into the details of the European public support schemes for TBSFs, it is worthwhile reviewing the theoretical debate on the social welfare effects of governmental intervention in this area. 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 perform the desired amount of investments. Further, 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 a 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, the less efficient entrants experience fast growth, thereby corroding the market shares of the 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 et al. 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 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.

[22] As of September 2004, SBA's (Small Business Administration) total financial exposure in the SBIC programs for cohorts 1994 through 2004 was $ 11,25 billion for the participating securities and $ 2,84 billion for debenture (SBA, 2004). 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..

Taking a side in this debate, from the Eighties 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 investments (Armour and Cumming 2006, Da Rin et al. 2006). The European Union has included support to high-tech activities among its industrial policy priorities.[23] Regulatory changes and their impact differ among European countries, because of persisting national specificities. For instance, the UK has traditionally displayed a stronger market orientation, notably through the use of tax incentives. In France 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 investments (Carpentier et al. 2007).[24]

In addition to the adaptation of the market design to the TBSFs specificities, other main public initiatives in Europe aim to directly increase the funds for new ventures. The most significant policy results are attributed to Germany and the UK, yet the scale of public support was far larger in Germany than in the UK (Martin et al. 2003). In Germany, direct public support has been based on the role on two publicly owned banks[25] that provide long term financing to industry, relying on bank guarantees, refinancing laws, mezzanine capital and co-investments (Heger et al. 2005, Martin et al. 2003, Sunley et al. 2005). The UK government initiatives are based on specialized measures to spur innovation through grants.[26] In France, direct funding and co-funding schemes have been implemented by public organizations[27] and through national programmes such as the French Innovation Plan (2004) by the French Ministry of Industry (Dubocage and Rivaud-Danset 2002). In Italy, financial grants to small firms (Law 488/1992) have been targeted to 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, Giannangeli and Grilli 2007).

5.3. Proximity and competencies

[23] In 2001, the European Investment Fund (EIF) has been transformed into the Europe's largest investor (EIF, 2002)

[24] 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.

[25] The *KFW, Kredit Für Wiederaufbau* – organization credit for reconstruction and the *DtA , Deutsche Ausgleichsbank*, (through its subsidiary: the public bank *TBG,* the *Technologie-Beteiligungsgesellschaft*. These two institutions merged in 2003.

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

[27] Among them, one could mention CDC Entreprise (Caisse des Depôts et Consignation) that is the major institutional investor for French technological venture capital and OSEO-ANVAR ("Agence Nationale de Valorisation de la Recherche") that is the national agency for promoting research.

Along with national initiatives, regional programs have been implemented with the aim 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 programs effective, especially for early stage investments (Martin et al. 2004). Also, a regional focus is more suited to address 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, as it has allowed to construct markets where none existed (Bascha and Walz 2001, Lehrer and Asakawa 2004).[28] In addition, some regional policy programs addressed specific sectors, such as the BIOREGIO program that served as a model for further interregional competition designed to promote start-ups (Wilson and Souitaris 2002, Champenois et al. 2004).[29] Yet, the German regional policy instruments are highly demand driven and depend on the dynamism of the länder. In the UK, public venture capital initiatives are represented by the Regional Venture Capital Funds, which since 2001 provide risk capital to SMEs with growth potential (Sunley and Klagge 2005, Mason and Harrison 2003, Heger et al. 2005). The specificity of the RVCFs is that they are regionally administered but they 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 by region. In recent years, also some Italian regions have 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 on stimulating the demand for funds (Da Rin et al. 2006, Mason et al. 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 angels networks.[30] BA can play a vital role in the creation and growth of new ventures, by helping raise financial capital and by offering skills and the 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, BA) and

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

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

[30] In Italy, public support to TBSFs is also provided by the Italian Business Angel Network (IBAN), established in 1999, which includes 8 Business Angel Networks, located all over Italian regions. The capital shares of these BANs are typically held by the Regions, by regional development agencies and by private banks.

other members of the network (accountants, lawyers, banks, consultants) (Mason and Harrison 2002).[31] 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 lower fares than the market price. Yet, the evaluation of the incubators' effects remains a controversial issue.[32]

5.4 Policy evaluation.

Is public financial support of TBSFs effective in Europe? The literature on the evaluation of high-tech support policies in Europe is quite sparse, and Hall's (2002) remark that "further study of governmental seed capital and subsidy programs using quasi-experimental methods is warranted" appears to be still valid. 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. Quite a robust cross-country evidence is that R&D expenditure is quite inelastic in the short-term, but its price-responsiveness increases over the long run (see Griffith, Redding and Van Reenen 2001 on the UK, Bloom, Griffith and Van Reenen 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 Cummings 2003). Nuechterlein (2000) and Gompers and Lerner (2001) show 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 less IPOs. Consistently, early stage and high-tech VC investments are higher in countries where public investments are proportionally larger (Beuselinck et al. 2006).[33] 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, especially in Germany, tend to confirm that the development of a successful VC market is associated with the emergence of spatial clusters of high tech firms (Champenois et al. 2004, Audretsch and Fritsch 2002). According

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

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

[33] The authors have conducted a study on ten European countries (Belgium, Finland, France, Ireland, Italy, Norway, the Netherlands, Spain, Sweden and the UK). They use data on public VC investments coming from the annual statistics of EVCA.

to Casper (2007), who examines the social network of San Diego Biotechnology, regional clusters represent a crucial source of economic development.

Finally, some "public policy success stories" in smaller European countries are worth mentioning. In the Netherlands, special tax treatment has allowed to create one of the largest pension fund industries (Sormani 2001). The Swedish government established investment companies modelled on SBIC since 1980, reduced capital gain taxes on start-ups, and played an active role for the development of the venture capital industry through formal VC companies and State-owned funds (Isaksson 2007).[34]

5.5 Summary and open issues

In sum, reviewing the European financial support to TBSFs shows that *European governments have adapted their fiscal and legal environments to the needs of young 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. A first key issue concerns the heterogeneity of the public programs that generates a "system failure" given the lack of coordination between to numerous actors and organizations (Peneder 2008).[35] 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, appear to be highly desirable. 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, on knowledge infrastructures and on the sequential stages of the VC market (Martin et al. 2003). One remaining question is how public policies can better coordinate their financial and non-financial measures – e.g. those focused 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 US; see Oehler et al. 2007).

6. Conclusion

The foregoing literature survey has offered a bird's eye view on 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 TBSF finance new investments by relying primarily on

[34] Outside the European continent, the most cited examples are Israel (Avnimelech and Teubal 2006), Canada (Ayayi 2004), and more recently India (Dossani and Kenney 2002).
[35] Cf. Peneder (2008), who proposes a set of recommendations with respect to policies to address the equity gap.

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 venture capital investments in Europe and in the US are now comparable, the venture capital industry in Europe has stagnated, and it is not clear whether European venture capitalists have provided effective advice to TBSFs. Specifically, the hypothesis that venture capital certifies the quality of funded companies has not received strong support so far. Moreover, 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 sort out the most promising companies. *Third*, the European attempts to provide easier access of TBSFs to public equity, following the EASDAQ model, have failed: the so-called "New Markets" inaugurated in the Nineties have collapsed after the Internet bubble, lacking liquidity and transparency. *Fourth*, there is encouraging evidence on the certification and signalling functions played by European policy, along with positive long-term effects associated to preferential R&D tax treatment.

It is worth noting that these pieces of evidence are robust across countries with different financial systems. In explaining cross-country differentials in the birth of new TBSFs and in their growth performances, 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 it could be the case for European venture capital. Where non-market forms of interaction prevail, high-tech companies can still develop global comparative advantages 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). If the evolution of financial systems is constrained by path dependencies, as increasingly suggested in the literature (Bianco, Gerali and Massaro 1997, Holzl 2006, Vitols 2005), different countries have little to learn from each others' experiences. The grip of history has also 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 on-going processes of stock market integration in Europe (e.g. Euronext) suggest that the benefits from concentration in the "market of financial markets" are clear to both policy-makers and stock exchanges.

In sum, the European experience with TBSFs 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 Nineties, at both the national and supranational policy-making levels (Schmidt and Tyrell 2004, Posner 2004, Casper 2007). Will the drive towards market-based systems prove helpful for TBSF support? Based on the institutional complementarity concept (Aoki 2001) we conjecture that future attempts at setting up market-based support for high-tech SMEs are doomed to fail, unless they are conceived as part of broader (and perhaps painful) reforms involving also sectors outside of 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 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.

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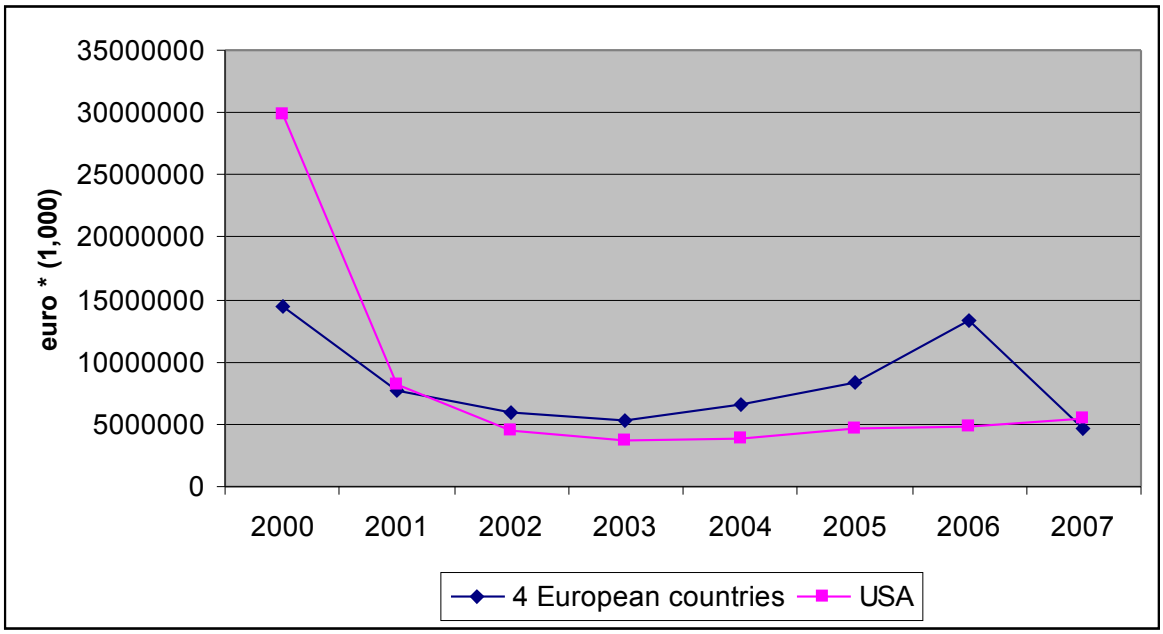
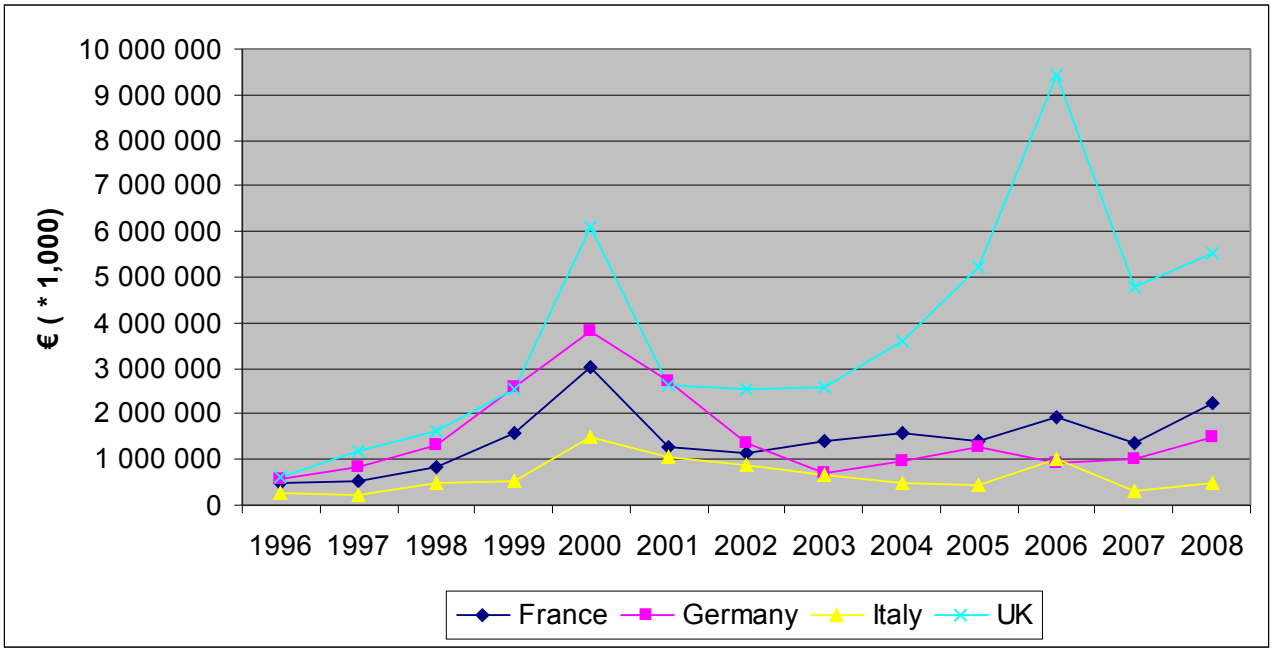
Appendix

Figure 1: Venture capital investments in the USA and in 4 European countries (France Germany, Italy, UK): 2000-2007.



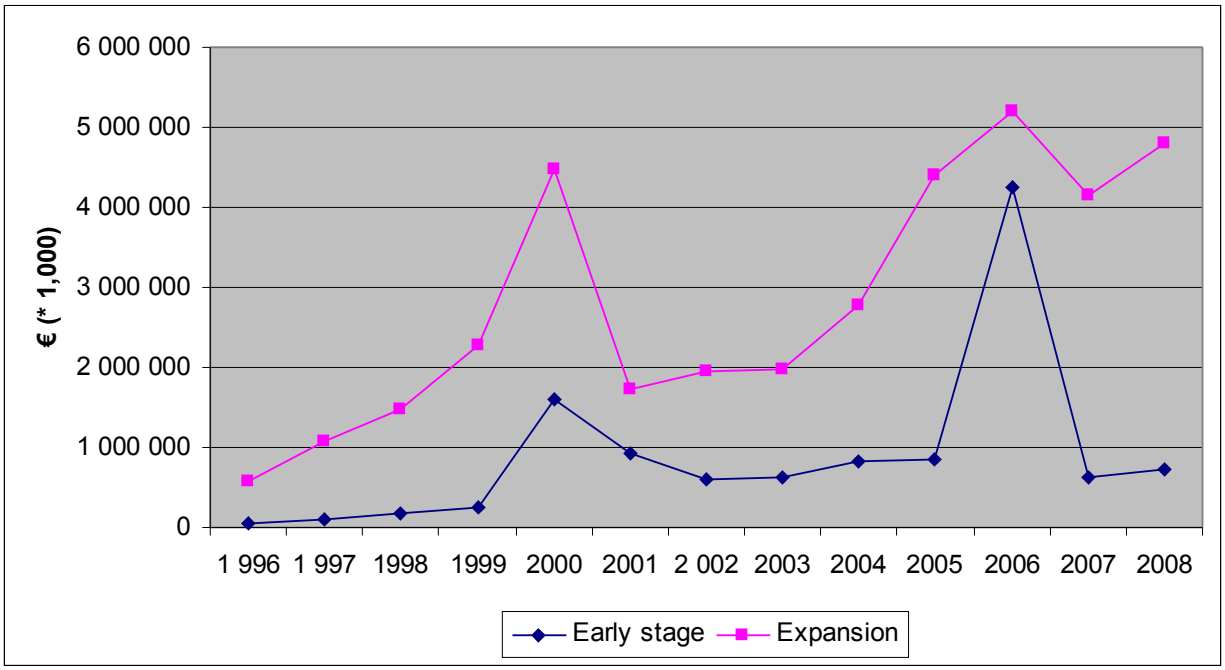
Sources: EVCA, Pricewaterhouse Coopers/NVCA. The amounts of US venture capital investment result from the addition of "seed/start-up", "early stage", "expansion"and "later stage". US data have been converted to Euros using annual average USD-EUR exchange rates.

Figure 2: Venture capital investments amounts in France, Germany, Italy and the UK: 1996-2008.



Source: EVCA. Between 1996 and 2006, we calculate European VC investment by adding "seed", "start-up", and "expansion". After 2006, EVCA categories have changed and to be homogeneous with previous data we calculate VC the following way: "seed" plus "start up" plus "later ventures" plus "growth".

Figure 3: UK venture capital investments by stage: 1996-2008.



Source: EVCA

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

Author(s) (year)	Westhead, Storey (1997)	Guiso (1998)	Giudici, 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 fin. (1/0)
Positive effects	R&D/sales QSEs/employees Patents	--	% sales from innovations % intangible assets
Negative effects	Age	Group	# employees Age
No effect	Past profits (1/0) # 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, 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 application (1/0) Loan received (1/0)	Using personal cap. (1/0) Using debt (1/0)	Loan appl. insuccess (0-100)
Positive effects	*(on loan applications)* Technical education Specific experience	*(on personal capital)* Economic education Technical work exp. Specialized work exp. # owners	Age R&D/sales QSEs/employees Past growth Innovation measures
Negative effects	*(on loan applications)* # founders	--	# employees
No effect	Economic education General experience Incubation Private equity # defaults	General education Commercial work exp. General work exp. Incubation # defaults	--
Method	Bivariate probit	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, not significant. "1/0" indicates a dummy variable.

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

Author(s) (year)	Manigart, De Maes. (2003)	Ellul, 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
Underpricing for VC-backed IPOs	No effect	Lower except in 1998-2000	Lower Larger in the Paris Bourse	Lower in the LSE
Method	OLS	2SLS	OLS	2SLS

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

Author(s) (year)	Colombo, Grilli (2009)	Engel, Keilbach (2007)	Audretsch, Lehmann (04)	Bottazzi, Da Rin (02)
Country	Italy	Germany	Germany	B, D, F, NL, I
Years	1980-2000	1995-1998	1997-2002	1996-2000
Sectors	High-tech manuf. & svc.	Manufacturing, services	Neuer Markt	Euro.NM
Sample size	439	21517	341	219
Source	RITA database	Creditreform	Deutsch Boerse German Patent Office	Euro.NM
		Performance equation		
Dep. variable(s)	Empl.growth	Empl.growth Patents	Empl.growth	Empl.growth Sales growth
Positive effects	VC backing Economic education Technical experience Age # founders	VC backing	VC eq.share (0.2, 0.5 q.)	ROA Leverage Age
Negative effects	--		Size	--
No effect	Technical education Commercial experience Fitted VC backing		VC eq.share (0.80 quant.) Education Patents Age Leverage	VC backing
Method	2SLS	Propensity score match.	Quantile regression	OLS
		Selection equation		
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 # 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, not significant. "1/0" indicates a dummy variable. "quant.": quantile. The selection equation in Audretsch and Lehmann (2004) is not aimed to deal with endogeneity issues.

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

Listed companies	AIM	Nouveau M.	Neuer M.	Nuovo M.	EASDAQ
1995	121	--	--	--	n.a.
1996	252	18	--	--	5556
1997	308	38	17	--	5487
1998	312	81	64	--	5068
1999	347	111	201	6	4829
2000	524	118	339	40	4734
2001	629	164	327	45	4063
2002	704	153	264	45	3649
2003	754	137	--	43	3294
2004	1021	128	--	40	3229
2005	1399	--	--	38	3164
2006	1634	--	--	--	3133
2007	1694	--	--	--	n.a.
2008	1550	--	--	--	n.a.

Capitalization ($ Mln)	AIM	Nouveau M.	Neuer M.	Nuovo M.	EASDAQ
1995	3670.3	--	--	--	1519939.8
1996	8809.8	956.7	--	--	1511824.4
1997	9420.8	1655.9	n.a.	--	1737509.7
1998	7411.7	5069.5	46636.0	--	2243734.0
1999	21740.9	15261.1	74571.8	6996.9	5204620.4
2000	21824.8	22791.3	113596.8	20811.2	3597085.9
2001	16731.8	13604.3	29942.1	11120.0	2739674.7
2002	16262.2	7243.8	10341.7	6706.0	1994494.0
2003	32162.3	10267.4	--	10425.3	2844192.6
2004	61233.3	10753.0	--	9071.8	3532912.0
2005	98816.3	--	--	8615.1	3603984.9
2006	177978.1	--	--	--	3865003.6
2007	196917.1	--	--	--	4013650.3
2008	56113.5	--	--	--	n.a.

Sources: AIM Market Statistics, World Federation of Exchanges. AIM data have been converted in USD using the average December USD-GBP exchange rates (source: New York Federal Reserve website). “n.a.”: not available.