Valuing and financing technology-based firms: a European perspective

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I. Introduction

Universities and university researchers have three main mechanisms for transferring knowledge: conferences and scientific publications, training of skilled labour force, and commercialization of knowledge. Of these, the commercialization of university activities has become a key component in government agendas (Wright et al., 2006). There are fundamentally two main reasons why policymakers emphasize the concept of the entrepreneurial university. Firstly, the creation of more direct links between science and utilization may foster the process of technology transfer and contribute to global economic development. The dissemination of knowledge generated in universities beyond the confines of the academic community itself is indeed considered to be a driver of national and regional economic growth (Mustar et al., 2006). Secondly, in a context of restricted institutional funds, business activities may represent an important alternative source of financing for universities. Based on these assumptions, national governments have adopted a series of measures to encourage the development of university-based firms. Universities are therefore able to leverage the technology-transfer process directly while a variety of benefits are simultaneously provided to these firms, that are therefore expected to exploit these benefits in terms of superior performance.

The growing importance of an entrepreneurial culture has therefore led some universities to adopt an economic development mandate in addition to their traditional missions of education and research. These changes have increasingly attracted the attention of researchers in the United States and Europe (Rothaermel et al., 2007). The relevant literature has already divided into several distinct topics (O' Shea et al., 2008), including the role of national legislation in stimulating academic enterprise (Shane, 2004), which factors in the university environment facilitate the creation of business activities (O'Shea et al., 2005), the institutional conditions under which spin-offs are incubated (Lockett et al., 2005), the characteristics of individual academics who become entrepreneurs (Landry et al., 2006), the benefits firms derive from affiliation with an academic institution (Mian, 1996), and the profitability of university commercial initiatives (Lambert, 2003).

The academic and policy discussion has evidenced that the founding and growth of new technology companies is based on the availability of two critical resources: intellectual

capital, for the creation and management of innovations, and financial capital, for investments and growth. In regards to intellectual capital, the value-adding benefits of university affiliation are well documented in the literature. Chief among them are access to sources of knowledge and innovation, not to mention physical resources such as laboratories and libraries (Quintas et al., 1992). Universities also provide a window onto emerging technologies, knowledge which can improve the flexibility of a firm's R&D activities (MacLachlan, 1995) and reduce the costs of developing technological capabilities (George et al., 2002). The affiliation can foster collaboration with public research institutes (Oliver and Liebeskind, 1998) and promote information sharing, especially of tacit knowledge (Cohen and Levinthal, 1990). Finally, links with universities can enhance the confidence of other stakeholders (Mian, 1997) such as venture capitalists (VCs) and business angels. This can facilitate fund raising for innovative activities, thereby making the use of this capital more effective. Access to financing is indeed a key determinant of growth and value generation in any new technology-based firm (Wright et al., 2006).

Thanks to these benefits, policymakers expect a high level of innovation and performance. However, previous studies suggest that university-based firms may face difficulties translating these benefits into substantial gains, and little is known about the wealth created by these firms. University affiliation may therefore have unrecognised downsides. For example, Ensley and Hmieleski (2005) find that university-based start-ups perform significantly worse in terms of cash flow and revenue growth than independent firms. They suggest that the top management teams (TMTs) of university-based firms may not be representative of those in the "outside word". Group cohesion and a shared strategic vision may also be lacking. Another potential obstacle is that the academic founders of the firms may not have enough business and commercial experience to properly exploit the potential of their innovations. Zahra et al. (2007) suggest that a lack of experience and connections may reduce the capacity of university-based firms to commercialise new technology. Specifically, they find that university spin-offs are characterised by lower "knowledge conversion capability", productivity, and returns on assets. Colombo and Piva (2008) propose that a lack of commercial knowledge is the most important weakness of these firms, while stronger investment in technical activities is their greatest strength. Clearly, being more innovative is not enough to achieve superior performance. Wright et al. (2006) find that venture

capitalists perceive university-based firms as more risky than independent firms, because academics may not have the credibility to attract customers and managers with commercial expertise. Indeed, in the context of labour specialisation, prestigious research achievements do not necessarily go along with an inclination to do business. Finally, the academics involved in creating new ventures may not be motivated solely or primarily by an entrepreneurial vision. For example, they may be attracted by the prospect of enhancing one's academic position (Meyer, 2003). Perhaps the most significant problem, therefore, is that the TMT members of university-based companies may not be sufficiently committed to or capable of maximising profit.

A second critical factor in the development of innovative firms is the availability of financial capital. The research and policy debate is centred on understanding, evaluating and improving the external funding environment confronting innovative start-ups. Much of these discussions have revolved around the unsuitability of debt for early-stage financing and the merits of equity as sources of external finance for innovation, with equity invariably portrayed as patient and committed capital (Freel, 2007). Nonetheless, the existence of asymmetric information in capital markets means financial institutions may not adequately assess the investment projects they are asked to finance. This effect becomes marked in the case of small and innovative businesses, owing to the greater difficulties they encounter in transmitting reliable information about their real status and performance (Canovas and Solano, 2007). Financial constraints to firm growth are, in particular, a potential weakness in Europe, where the public equity markets are less developed than in the US. Thus, an explicit goal of current public policy is to promote the development risk capital markets in order to sustain innovative entrepreneurship and to facilitate the expansion of existing small firms. Indeed, in the absence of sufficient internally generated cash flows to fund investments, public capital markets offer an opportunity for companies to obtain 'low cost' direct financing, without the costly interposition of a financial intermediary such as a bank or a venture capitalist (Holmström and Tirole, 1997). In this context, a primary role is assigned to the process of going public, traditionally considered as a natural step in the corporate life cycle. The IPO would therefore serve as a springboard for implementing strategies of internal and external growth.

In this framework, this PhD thesis investigates the role of university and stock markets in the process of creating and financing European science-based entrepreneurial firms. First, we contribute to the literature providing the first dynamic study on the effect of university affiliation on the performance and valuation of firms. We investigate if being a university-based company is perceived as a distinctive quality by investors, influencing the valuation of the firm and the level of uncertainty associated with the valuation process. Second, we adopt a dynamic approach to analyse the operating and market performance of university-based companies in the long run and their attitude to growth and divest through M&As. Finally, we contribute to the literature analysing the role of the IPO in the lifecycle of new technology based firms. We focus in particular on the interaction between variables of innovative input (R&D expenses) and output (patents) and the evolution of sample companies in terms of capital raising, investment activities and market dynamicity.

The remainder of this chapter briefly summarizes each of the articles in this PhD thesis, in terms of motivations and main findings.

1. Overview of studies

1.1 Study 1: Valuing University-based firms

Recent studies have found that university-based firms do not perform as well as independent firms (Ensley and Hmieleski, 2005). This finding has sparked interest in understanding just what drawbacks hinder the translation of benefits into performance gains. One suggestion is that academics involved in creating new ventures may be driven not only by an entrepreneurial attitude, but the prospect of enhancing their academic position (Meyer, 2003). In short, concerns remain that the goal of achieving substantial returns from the commercialization of university research has not yet been achieved (Lockett and Wright, 2005). It would therefore be useful to understand how the benefits enjoyed by university firms are valued by potential investors. Does the market actually perceive the purported value of university affiliation, and if so do specific benefits translate into higher valuations and improved performance?

This paper addresses this issue by comparing a sample of European university-based firms to a control sample of independent firms. University-based firms are defined as

companies developed by faculty members and based on their own research, or as companies created to capitalise on research carried out in universities. We identify 131 university-based companies among the 1,389 non-financial SMEs that went public on the stock markets of the four largest European economies (Germany, the UK, France, and Italy) during the period 1995-2003. This proportion in itself is a significant result. Generating ten percent of newly public SMEs, the entrepreneurial university model promises to become a critical driver of European economies in the knowledge-based era.

The empirical investigation focuses on the valuation of these university-based firms, and also analyses the level of uncertainty associated with this process. Adopting a market-based perspective, we analyse the characteristics of university-based companies going public in recent years on the main European markets. We focus on how these firms differ from independent companies at the IPO in terms of innovation activities, TMT human capital, operating performance, ownership and corporate governance. This analysis helps us to understand how institutional affiliation exerts his influence in the long run and the peculiarities of university-based firms that may influence investors' valuation and firm performance. Valuation of university-based companies is indeed the main objective of this paper, and to the best of our knowledge, this is the first study that addresses this issue. In particular, we investigate if being a university-based company is perceived as a distinctive quality by investors, influencing the valuation of the firm and the level of uncertainty associated with the valuation process. Moreover, we adopt a dynamic approach to investigate the valuation and the operating and market performance of university-based companies in the long run.

Overall, results show that university affiliation exerts a long-lasting effect on the firm, enhancing its initial valuation and reducing the risk to investors. In the five years after the listing, university-based firms do not outperform their independent counterparts in terms of market performance, but they are associated with a lowering effect on the level of uncertainty, measured by market volatility. These findings are robust even after controlling for the level of innovation and characteristics of the human capital. In other words, the affiliation with a university does affect the valuation and risk level of firms, independently by its effect on other factors and characteristics of the firm.

Investors seem to value a firm's level of R&D investment and the business skills of its directors highly. These factors may be seen as necessary to sustain long-term

performance. A prevalence of business degrees and experience among the upper management signals a strong commitment to profitability, making it more likely that innovations can be translated into performance gains. Business acumen may be scarcer in university-based firms, however, as academics are likely to have other objectives besides profit: implementing personal ideas, enhancing academic prestige, and buying new research infrastructure for example. An excessive focus on technological aspects of the company may reduce commitment to business growth and performance. These hypotheses may explain why university-based firms tend to have a lower level of operating performance than independent firms both before and after the IPO. If universities want to maximise the profit of their commercial initiatives, it is recommended that they devote attention to the development of business-oriented top management teams. Even if innovation is essential to the creation of wealth and sustained competitive advantage, it is not sufficient to ensure the success of a firm.

On the whole, the results presented in this paper show that the "entrepreneurial university" model has great promise. Along with considerations of technology transfer, university-based firms represent a significant contribution to European economies and their financial markets. Moreover, these companies are distinguished by a greater propensity to innovation in terms of both inputs (R&D expenses) and outputs (patents). Their attitude towards public equity markets is also encouraging. Compared to independent firms, their IPOs are characterised by a higher level of fresh capital raised and a lower level of divestment. Investors typically view these behaviours as signs of firm commitment on the part of TMT members and existing shareholders. Thus, public equity markets are an appropriate source of financing for university-based companies; investors seem to appreciate the excellent growth potential associated with superior innovation capabilities.

1.2 Study 2: The M&A Dynamics of European Science-Based Entrepreneurial Firms

From a resource-based perspective of the firm, the resource configuration of a company is related to its evolution and performance (Barney et al., 2001). University affiliation may therefore have a significant impact on the strategies that firms pursue, given that companies obtain benefits and resource endowments from their affiliations with universities. However, despite the benefits yielded, little is known about the evolution

of university-based firms (also called, science-based entrepreneurial firms) and their capacity to create wealth. In this paper, we investigate the potential effects of university affiliation on the subsequent evolution of the firm, focusing, in particular, on the process of industrial restructuring through M&As. The study of M&A deals may provide substantial information about the strategic dynamics of these companies and their ability to interact with other key actors in the global market.

There are several theories on the determinants of M&A deals that may help to explain the peculiarities of the M&A activities of science-based entrepreneurial firms (SBEFs). For instance, the matching theory of ownership change (Lichtenberg and Siegel, 1987 and 1989) suggests that M&As are important mechanisms in the market for corporate control as business transfers represent essential resource flows that facilitate the division of labour. The threat of takeover motivates managers to work to maximize profits, because ownership change provides a way of getting rid of ineffective managers, representing therefore a mechanism for correcting efficiency lapses. The role of human capital in M&A deals is also of great interest. Business transfers involve important human resource flows that facilitate division of labour, with individuals changing jobs to pursue other development opportunities (Holms and Schmitz, 1990). The M&A market therefore promotes the upgrading of a firm's human capital. However, upgrades may be not limited to human resources. They may also involve physical and technological capital, so that companies may specialize in either internal development of R&D or acquisitions (Blonigen and Taylor, 2000). Companies with internally available resources are expected to show less interest in seeking external technology acquisitions through M&As and, at the same time, they may be more frequent targets in the M&A market. To this extent, the Q-theory of Mergers (Jovanovic and Rouseeau, 2002) predicts that a firm's investment rate should rise with its Q ratio (the ratio of market value and the replacement cost of capital). Thus, mergers may represent a channel through which capital flows to better projects and better management, with high-Q firms acquiring low-Q firms.

The implications of this theoretical framework for this study are the hypotheses that SBEFs have a lower propensity to acquire and a higher probability of being acquired. SBEFs may be less keen in pursuing acquisitions for several reasons. For instance, they may be less committed to engaging in growing strategies due to the academic background of their ownership or management. Presumably, academics may be more

focussed on core technical aspects and less interested in horizontal integration. The IPO is already a signal of the success of a business initiative that may be "enough" for academics, reducing their commitment to the achievement of further business growth. Also, in terms of division and specialization of labour, it is unlikely that academic personnel represent a solution for correcting inefficiencies of other firms in the market. In entrepreneurial ventures, researchers tend to be "innovation oriented, often lacking of goal orientation" (Wright et al., 2007, p. 143). Moreover, in a trade-off framework between internal resources and external technology acquisitions, the superior innovative capabilities of SBEFs may reduce their interest in pursuing acquisitions.

On the other hand, SBEFs are expected to more often be the target of M&A deals. Previous studies have suggested that the status of being a university-based firm is often associated with lower operational efficiency (Bonardo et al., 2008) and less profit-orientation (Meyer, 2003). Thus, the M&A market may establish new ownership and management structures in SBEFs that improve their productivity and maximize the financial return of the human and technological capital embodied by them (matching theory of ownership change). Second, academics that establish and manage SBEFs may be less interested in maintaining a position in a mature firm. Hence, the M&A market can provide them with an exit opportunity that allows return to their original academic activities (division of labour hypothesis). Some academic entrepreneurs may also seek to go and start another new business, a supposition that is coherent with the notion of habitual academic entrepreneurs (Mosey and Wright, 2007).

From the external perspective of an acquirer, SBEFs may be preferred targets owing to their superior internally available technological capabilities (Colombo and Piva, 2007). University affiliation may also act as a signal of quality with a positive image impact that improves the attractiveness of the firm for investors. Indeed, institutional affiliation may give legitimacy to firms, especially for innovative SMEs, attracting the attention of other prestigious affiliations, thus mitigating legitimacy concerns of other key actors. A similar role may be played by TMT relational and educational capital, which may improve firms' networking capacity (Hsu, 2007). Prestigious directors are considered better able to form relationships with other individuals and to participate in important associations with bankers, investors, suppliers, and customers (Stuart et al., 1999). Moreover, from a network theory perspective, relational capital, in the form of social relations with public institutions or financial entities, is not just a form of resources, but

can also be used as a conduit for information and resources. The latter should have its highest impact when it bridges a SBEF's intellectual capital and another company's complementary assets. The signalling effect of university affiliation and the higher level of intellectual capital may also improve the international exposure of science-based firms, therefore improving their involvement in cross-border M&As.

The academic background of SBEF founders is therefore expected to be an important factor that influences the post-IPO strategic decisions of the firms. This holds true especially for academics who are still in the TMT at the IPO. Their continuing presence may indeed improve a firm's propensity to divest and reduce its interest in acquiring. In this paper, we therefore distinguish between SBEFs where the TMTs have academic members at the IPO and other SBEFs with no formal TMT involvement of academics. In the former case, we expect a strengthened corroboration of the hypotheses regarding the lower propensity of university-based firms to acquire and their higher probability of being acquired.

We test theoretical hypotheses using a sample of 499 innovative SMEs that went public in Europe in the period 1995-2003. These are all the innovative SMEs that went public on the four largest European economies since 1995 to 2003. We identify as university-based firms companies developed by faculty members based on their research, or companies created to capitalise on research carried out in universities (131 companies). Our results show that university affiliation does influence the evolution of firms. Compared to their independent counterparts, SBEFs have a higher probability of being acquired and a lower propensity to make acquisitions. Given the scarce operational efficiency and profit-orientation of these university-based firms, the M&A market may be useful in establishing new ownership and management structures, in SBEFs, that ameliorate their productivity and maximize the financial return of the embodied human and technological capital. From an external perspective, SBEFs may be attractive targets in acquisition due to their superior innovative capacity; or their university affiliation may carry out a certification role, enhancing their attractiveness in the eyes of other firms. Coherently, even controlling for intellectual capital, profitability and other potential determinants, SBEFs show a higher probability to be acquired. This also suggests that the M&A market provides academic founders, less interested in maintaining a position in a mature firm (Mosey and Wright, 2007), with an exit opportunity that allows return to their original academic activities.

The market for taking control of SBEFs is therefore quite active, with most of the sample SBEFs acquired soon after the IPO. The high attractiveness of SBEFs is indicative of a positive role played by these companies in the process of technology transfer. The creation of a university-based firm is indeed a first step in the process of commercial exploitation of university-research. The subsequent step of going public is a signal of the success of this entrepreneurial venture. The take-over of the SBEF may be a final outcome of the process of knowledge diffusion. Moreover, the higher proportion of intra-industry M&As for university-based companies may also be viewed as a sign of interest for acquiring the intellectual capital embodied in science-based firms. Acquirers operating within the same industry are indeed assumed to be more attracted by such intellectual capital and also to be better able to value it.

On the other hand, SBEFs are less inclined to acquire other companies. This evidence is partially explained by the superior internal technological resources available to SBEFs, reducing their interest to seek external technology acquisitions. But this is not the whole picture. Indeed, the evidence on the higher probability of university-based firms to be acquired is robust to control variables measuring intellectual capital. Instead, interesting results on the inverse relationship between the level of internal technological resources and external sourcing through acquisitions comes from a "SBEF-intensive" industry, namely biotechnologies, where as much as 60% of innovative SMEs going public are SBEFs. In this industry, the role of technology-driven acquisitions is indeed found to be particularly relevant. In particular, considering only biotech companies, we are able to capture the peculiar role played by patents in determining M&A activities in this sector, whereas they are not relevant for the rest of the sample.

SBEFs may be less keen in pursuing acquisitions for other several reasons. They may be less committed to engaging in external growing strategies due to the academic background and to focus on core technical aspects. In entrepreneurial teams, indeed, researchers tend to be innovation oriented, often lacking of goal orientation. In general, indeed, findings have a stronger statistical significance when focussing only on SBEFs where the TMTs still have academic members at the IPO, compared to other SBEFs with no formal TMT involvement of academics. The continuing presence of academics in the TMT of the firms after the IPO improves their propensity to divest, whereas it reduces their attitude to acquire. However, their relational and educational capital may improve the networking capacity of the firm. To this extent, they may improve also the

international exposure of science-based firms, therefore improving their involvement in cross-border M&As. SBEFs indeed take part in cross-border M&As more frequently than do independent firms. University affiliation may therefore act as a signal of organizational legitimacy, giving international visibility to the firm.

1.3 Study 3: Financial dynamicity of high-tech SMEs

Technology-based SMEs experience different financial problems during the business lifecycle, due to the need of R&D and marketing expenses and peculiar typologies of investments (Hall, 2002). Innovation projects are riskier than physical investment projects and therefore outside investors are reluctant to finance innovation activities or require a risk premium for the financing. According to the agency costs theory, financing problems arise primarily as a consequence of information asymmetries between external investors and entrepreneurs. The level of information asymmetry between the firm and external investors is high, given the valuation difficulties of intangible assets and the reluctance of innovators to share with outside investors information about their technologies because of problems of appropriability. Providing convincing signals about the quality of the innovation project is costly (Bhattacharya and Ritter, 1985) and sometimes leads to market failure. Moreover, the difficulty of using intangible assets as collaterals also leads to increased costs of external capital in the form of a risk premium. Financial constrains may be particularly severe in the case of young and small and medium sized firms (Canovas and Solano, 2007). Therefore, some innovation projects may not be started, delayed or abandoned because of the risk of bankruptcy and the low value of intangibles in case of liquidation (Gomes et al., 2006).

Financial constraints to firm growth are in particular a potential weakness of the EU, where the public equity markets are less developed than in the US. Thus, an explicit goal of current public policy in Europe is to promote the development of efficient and liquid risk capital markets in order to sustain innovative entrepreneurship and to facilitate the expansion of existing small firms. In this context, a primary role is assigned to the process of going public, traditionally portrayed as a natural step in the corporate life cycle. In theory, an IPO creates liquidity for the firm's shares, provides an infusion of capital to fund growth, allows insiders to cash out, provides cheaper and

ongoing access to capital, facilitates the sale of the company, gives founders the ability to diversify their risk, allows venture capitalists and early stage investors to exit their investment, and increases the transparency of the firm by subjecting it to potential capital market discipline in the future (Celikyurt et al., 2008). Moreover, recent studies suggest that business growth through acquisitions is a fundamental motivations for an IPO (Brau and Fawcett, 2006; Celikyurt et al. 2008).

In the last decade, the launch of second-tier markets in every European country has, at least in part, fulfilled the aim of providing small and medium enterprises with the means to finance growth. Indeed, stock exchanges have successfully encouraged small firms to gain access to public listing by setting up dedicated markets with less stringent requirements. The decision to take the firm public presents many opportunities for the continued growth of the firm. Even when additional commercial credit is available to the entrepreneur, the covenants attached to the loan may indeed be too restrictive for him or her to pursue opportunities with high-growth prospects, but also with high risk. As a consequence, for many entrepreneurial ventures, an IPO enables the management of a firm to pursue growth opportunities that would otherwise be impossible to fund. However, although the literature suggests that the access to external equity and the reduction of information asymmetries given by the status of public company may be particularly beneficial for innovative companies, we still know little about the interaction between innovation and the evolution of high-tech SMEs after the IPO. Does their innovative level influence their attitude to raise capitals, to invest and their market dynamics?

In this paper we address this research issue, describing the post-IPO activities of the population of 382 high-tech SMEs going public in Europe in the period 1998-2003. Focusing on three main aspects, capital raising, investments and market dynamicity, we analyse companies' characteristics at the IPO that may be indicative of the post floatation evolution of sample firms. In particular, we are interested in the interaction between variables of innovative input (R&D expenses) and output (patents) and the evolution of sample companies. The empirical results may be indicative for high-tech SMEs that want to become public, to understand how the stock markets can help them in their growing and divestment strategies. On the other hand, this analysis can also be used by investors that want to invest in high-tech SMEs to understand those characteristics which help to predict their post-IPO evolution.

The paper contributes to the literature showing the existence of a relationship between the innovative level and the post-IPO evolution of sample companies. In particular, companies more committed in R&D efforts seem to be particularly interested in the IPO as a mechanism to raise external equity and to acquire participation in other companies. Arguably, equity is needed to finance innovation while acquisitions are driven by technological needs, with sample companies trying to find new resources and alliances to improve their ability to innovate. Therefore, this investigation suggests that going public may be an effective strategy for a firm that wants to raise capitals or acquire technologies and form alliances to improve its R&D efforts. On the other hand, high-tech SMEs with a consolidated portfolio of patents at the IPO seem to be less interested in raising equity and acquiring other companies. Moreover, they have a higher attitude to raise debt capital. We interpret this result suggesting that having patents is an index of maturity in innovative industries that helps investors to individuate firms with a lower level of risk (patents are negatively correlated with the failure probability).

Also, the offering structure reveals information on the underlying motives for going public. In particular, firms with a higher level of divestment at the IPO are typically less interested in business growth and more prone to transfer the control in the post-IPO period. Moreover, both university affiliation and VC financing have a positive effect on the post-IPO divestment activity of high-tech SMEs. Even controlling for intellectual capital, these companies are still positively associated with the probability of being acquired. The presence of VC in a company and the university affiliation may indeed be perceived as quality (certification) signals by a potential acquirer, improving the probability of the company being a target for other firms. On the other hand, the original founders of university-based firms (academics) and VCs may be more willing to sell their participations in firms after the IPO, so that the IPO can be viewed as part of a more general process of sequential divesture through M&As (Reuer and Shen, 2003). Finally, venture backed companies show a lower probability to fail, confirming the validity of the certification role of VC financing. Also, TMT experiences and the presence of independent directors in the board seem to be valuable instruments to reduce the risk of firm failure.

As a whole, empirical findings show that going public is really a unique opportunity for high-tech SMEs to have access to external equity and implement both internal and external growing strategies. Equity raised at the IPO and in the post-floatation years

sustains a substantial investment activity more than reducing firm leverage that remains quite stable in the years considered, coherently with the investment financing motivation for equity offers (Kim and Weisbach, 2008). Moreover, once public high-tech SMEs seem to be “really public”. In other words, they enjoy a good level of investor recognition and visibility, so that the market for corporate control of these firms is active with almost one third of the sample being acquired in the five years after the IPO. Therefore, going public also represents an exit strategy for founders who want to cash out. Divesting after a company has been made public may indeed constitute a better strategy than selling a still private firm directly at a value that is lower due to illiquidity discount. Such advantages of the strategy of sequential divesture though IPO would be especially high in knowledge-intensive industries.

In conclusion, this study shows that European stock markets, as in the aims of policymakers, play an important role in the process of financing and growth of high-tech companies. The market vitality of our sample firms suggests that the status of public company succeeds in reducing information asymmetries between the firm and investors. This is fundamental to find proper source of financing and proper investors for the different stages of the lifecycle of innovation. From this perspective, giving an exit strategy to early stage investors, stock markets also contribute to the development of the VC and private equity industries, essential for the creation of high-tech firms.

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PAPER 1:

VALUING UNIVERSITY-BASED FIRMS

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Entrepreneurship Theory and Practice

II. Valuing university-based firms[◊]

Abstract

This paper discusses the entrepreneurial university model, investigating for the first time the valuation of university-based companies and their ability to translate the potential benefits of affiliation into performance gains. Among the 1,389 non-financial SMEs that went public in Europe over the last decade, 131 were university-based firms. The entrepreneurial university model therefore shows great promise as a vehicle driving European economies in the knowledge-based era. Our results show that the resources gained by affiliating with a university have an important effect on firms, enhancing their initial valuation and reducing risk for years to come. Even after controlling for variables related to the level of innovation and human capital, university affiliation is perceived by investors as a sign of quality. However, university-based companies also exhibit a deteriorating operating performance. This may explain why in the long run their valuations do not outperform those of independent firms, despite higher innovative potential and initial valuations.

Keywords: University entrepreneurship, Technology transfer, Valuation, Performance, Uncertainty.

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1. Introduction

Universities and university researchers have three main mechanisms for transferring knowledge: conferences and scientific publications, training of skilled labour force, and commercialization of knowledge. Of these, the commercialization of university activities has become a key component in government agendas (Wright et al., 2006). There are fundamentally two main reasons why policymakers emphasize the concept of the entrepreneurial university. Firstly, the creation of more direct links between science and utilization may foster the process of technology transfer and contribute to global economic development. The dissemination of knowledge generated in universities beyond the confines of the academic community itself is indeed considered to be a driver of national and regional economic growth (Mustar et al., 2006). Secondly, in a context of restricted institutional funds, business activities may represent an important alternative source of financing for universities. Based on these assumptions, national governments have adopted a series of measures to encourage the development of university-based firms. Universities are therefore able to leverage the technology-transfer process directly while a variety of benefits are simultaneously provided to these firms, that are therefore expected to exploit these benefits in terms of superior performance. However, little is known about the ability of these firms to translate the potential benefits of academic affiliation into performance gains.

Recent studies have found that university-based firms do not perform as well as independent firms (Ensley and Hmieleski, 2005). This finding has sparked interest in understanding just what drawbacks hinder the translation of benefits into performance gains. One suggestion is that academics involved in creating new ventures may be driven not only by an entrepreneurial attitude, but the prospect of enhancing their academic position (Meyer, 2003). In short, concerns remain that the goal of achieving substantial returns from the commercialization of university research has not yet been achieved (Lockett and Wright, 2005). It would therefore be useful to understand how the benefits enjoyed by university firms are valued by potential investors. Does the market actually perceive the purported value of university affiliation, and if so do specific benefits translate into higher valuations and improved performance?

This paper addresses this issue by comparing a sample of European university-based firms to a control sample of independent firms. University-based firms are defined as

companies developed by faculty members and based on their own research, or as companies created to capitalise on research carried out in universities. We identify 131 university-based companies among the 1,389 non-financial SMEs that went public on the stock markets of the four largest European economies (Germany, the UK, France, and Italy) during the period 1995-2003. This proportion in itself is a significant result. Generating ten percent of newly public SMEs, the entrepreneurial university model promises to become a critical driver of European economies in the knowledge-based era.

Our empirical analysis focuses on the valuation of these university-based firms, and also analyses the level of uncertainty associated with this process. Using a market-based perspective, we first investigate the influence of institutional affiliation on firms at the moment of going public. We then adopt a dynamic approach to examine how the valuation and performance of firms evolves after going public. Overall, our results show that university affiliation exerts a long-lasting effect on the firm, enhancing its initial valuation and reducing the risk to investors.

The remainder of the paper is structured as follows. Section 2 reviews the literature on university-based firms. In Section 3, we compare the sample of university-based firm to a control sample of independent firms, and draw some preliminary results. Section 4 describes the variables and the dynamic methodologies used to investigate valuation and performance over time. The econometric results are presented in Section 5. Section 6 concludes.

2. University-based firms

In the last decade, budget constraints have encouraged an increasing number of university officials to view technology transfer as an alternative source of revenue. This inducement has led universities to initiate joint ventures with private companies and develop research programs with commercial prospects (Geuna and Nesta, 2006). While collaborative relationships between universities and firms have existed for nearly a century in the United States, it is only in recent decades that universities in the rest of the world have begun to take a hand in commercialising new technologies (Siegel et al.,

2003)[1]. Several national governments, including European ones, have enacted policies aimed at fostering technology transfer and creating a supportive environment for new technology-based firms.

The growing importance of an entrepreneurial culture has led some universities to adopt an economic development mandate in addition to their traditional missions of education and research. These changes have increasingly attracted the attention of researchers in the United States and Europe (Rothaermel et al., 2007). The relevant literature has already divided into several distinct topics, including the role of national legislation in stimulating academic enterprise (Shane, 2004), which factors in the university environment facilitate the creation of business activities (O'Shea et al., 2005), the institutional conditions under which spin-offs are incubated (Lockett et al., 2005), the characteristics of individual academics who become entrepreneurs (Landry et al., 2006), the benefits firms derive from affiliation with an academic institution (Mian, 1996), and the profitability of university commercial initiatives (Lambert, 2003). The present study is related to the last two streams.

The value-adding benefits of university affiliation are well documented in the literature. Chief among them are access to sources of knowledge and innovation, not to mention physical resources such as laboratories and libraries (Quintas et al., 1992). Universities also provide a window onto emerging technologies, knowledge which can improve the flexibility of a firm's R&D activities (MacLachlan, 1995) and reduce the costs of developing technological capabilities (George et al., 2002). The affiliation can foster collaboration with public research institutes (Oliver and Liebeskind, 1998) and promote information sharing, especially of tacit knowledge (Cohen and Levinthal, 1990). Finally, links with universities can enhance the confidence of other stakeholders (Mian, 1997) such as venture capitalists (VCs) and business angels. This can facilitate fund raising for innovative activities, thereby making the use of this capital more effective. Access to financing is indeed a key determinant of growth and value generation in any new technology-based firm (Wright et al., 2006).

Thanks to these benefits, policymakers expect a high level of innovation and performance. However, previous studies suggest that university-based firms may face difficulties translating these benefits into substantial gains, and little is known about the

[1] The main incentive for universities seems to be legislation (e.g. the Bayh-Dole Act of 1980 in the US) that decreases the uncertainty associated with commercialising government-funded research (Shane, 2004). This practice facilitates technological diffusion from universities to firms.

wealth created by these firms. University affiliation may therefore have unrecognised downsides. For example, Ensley and Hmieleski (2005) find that university-based start-ups perform significantly worse in terms of cash flow and revenue growth than independent firms. They suggest that the top management teams (TMTs) of university-based firms may not be representative of those in the "outside word". Group cohesion and a shared strategic vision may also be lacking. Another potential obstacle is that the academic founders of the firms may not have enough business and commercial experience to properly exploit the potential of their innovations. Zahra et al. (2007) suggest that a lack of experience and connections may reduce the capacity of university-based firms to commercialise new technology. Specifically, they find that university spin-offs are characterised by lower "knowledge conversion capability", productivity, and returns on assets. Colombo and Piva (2008) propose that a lack of commercial knowledge is the most important weakness of these firms, while stronger investment in technical activities is their greatest strength. Clearly, being more innovative is not enough to achieve superior performance. Wright et al. (2006) find that venture capitalists perceive university-based firms as more risky than independent firms, because academics may not have the credibility to attract customers and managers with commercial expertise. Indeed, in the context of labour specialisation, prestigious research achievements do not necessarily go along with an inclination to do business. Finally, the academics involved in creating new ventures may not be motivated solely or primarily by an entrepreneurial vision. For example, they may be attracted by the prospect of enhancing one's academic position (Meyer, 2003). Perhaps the most significant problem, therefore, is that the TMT members of university-based companies may not be sufficiently committed to or capable of maximising profit.

The purpose of this paper is to provide the first dynamic study on the effect of university affiliation on the performance and valuation of firms. Adopting a market-based perspective, we analyse the characteristics of university-based companies going public in recent years on the main European markets. We focus on how these firms differ from independent companies at the IPO in terms of innovation activities, TMT human capital, operating performance, ownership and corporate governance. This analysis helps us to understand how institutional affiliation exerts his influence in the long run and the peculiarities of university-based firms that may influence investors' valuation and firm performance. Valuation of university-based companies is indeed the

main objective of this paper, and to the best of our knowledge, this is the first study that addresses this issue. In particular, we investigate if being a university-based company is perceived as a distinctive quality by investors, influencing the valuation of the firm and the level of uncertainty associated with the valuation process. Moreover, we adopt a dynamic approach to investigate the valuation and the operating and market performance of university-based companies in the long run[2].

3. Data and sample

A critical factor in the development of innovative firms is the availability of financial capital. Thus, much of the research and policy debate is centered on understanding, evaluating and improving the external funding environment confronting start-ups. The discussion revolves around the unsuitability of early-stage loans and the merits of equity as a source of external financing, where equity is invariably portrayed as patient and committed capital (Freel, 2007). Nonetheless, the existence of asymmetric information in capital markets means that financial institutions may not adequately assess the projects they are asked to finance. This is especially true in the case of small and innovative businesses, which have great difficulty transmitting reliable information about their status and performance (Canovas and Solano, 2007). Financial constraints on firm growth are a potential weakness in Europe in particular, where the public equity markets are less developed than in the US. Thus, an explicit goal of current public policy in the EU is to promote the development of risk capital markets capable of sustaining entrepreneurship and facilitating the expansion of existing small firms. In the absence of sufficient internally generated cash flows for investment, public capital markets can offer 'low-cost' direct financing without the need for costly financial intermediaries such as banks or venture capitalists (Holmström and Tirole, 1997). In this context, the process of going public (traditionally considered a natural step of the corporate life cycle) plays a key role.

[2] The use of market measures is of even greater interest in the light of the fact that accounting ratios provide less information than they used to due to the growing importance of intangible assets and to the related increase in discretion entering financial statements. Indeed, recent studies in the financial accounting literature agree on the greater informative value of market-based measures, able to capture a mix of information, including both financial statement and non financial statement information (Beaver et al., 2005).

Stock exchanges have encouraged small firms to go public by setting up dedicated markets with less stringent requirements. In the last decade every European country has launched these second-tier markets, at least partially fulfilling the aim of providing small and medium-sized enterprises with the means to finance growth. This development provides a favourable setting to analyse the initial public offerings (IPO)[3] of successful university-based firms, a unique form of entrepreneurial activity.

The IPO is a critical juncture in the development of any firm, granting many opportunities for continued growth. Even if additional commercial credit is available to the entrepreneur, the conditions attached may be too restrictive to pursue high-risk opportunities with the prospect of strong growth. Thus, an IPO may enable management to invest in opportunities that would be impossible to fund otherwise. The challenge of an IPO is convincing a wide variety of potential stakeholders that the firm has long-term potential. The listing requirements vetted by national exchange commissions stipulate that any firm undertaking an IPO must publish an official prospectus. In particular, this document is required to describe the full history of the firm and provide the curricula vitae of the founder(s) and TMT members. Potential investors carefully scrutinise these documents in an effort to assess the prospects of an equity position in the IPO. The prospectus is the primary means for communicating information about the company at this stage. This paper relies on prospectuses to determine the university affiliations of firms that recently went public in Europe[4].

3.1 Treatment sample

The EURIPO[5] database provides prospectuses and other detailed information on all companies that have recently gone public in Europe. We consider the sample of all

[3] Thanks to the new and second-tier markets, the nature of the companies going public has rapidly changed in the last decade, with more small and medium companies going public. For instance, the average size is diminished, with an average sales of only 27 €m in the year prior to the IPO on second markets in 2006 (Paleari et al., 2007).

[4] The purpose of the prospectus is to sell shares. It is therefore assumed that all relevant information will be included. Since owners and managers can be held legally accountable for errors in the document, it contains the most accurate information available to the firm. As a result, prospectus data are considered reliable and enjoy a longstanding role in strategy research. More recently, these data have also been used in entrepreneurship research (Shrader and Siegel, 2007). Previous research has relied on signalling theory to guide interpretation of the prospectus and capture information that might impact future performance and potential investors' valuations (Ritter and Welch, 2002). The prospectus also supports a resource-based view of the firm (Wernerfelt, 1984), indicating any unique resources that could sustain competitive advantage and encourage investors.

[5] The EURIPO database is managed by Universoft, a spin-off of the University of Bergamo (www.euripo.eu). It contains data on more than 5 000 companies that went public in Europe since 1985.

small and medium-sized enterprises (SMEs) operating in innovative industries: electronics and engineering (Electronics & Eng), information technology (IT), pharmaceutical and biotech (Pharma & Bio) and communications (Communications)[6]. Based on information reported in the prospectus, university-based firms are defined as companies that were developed by faculty members based on their own research, or created to capitalise on academic research. This definition is consistent with similar terms in the literature[7], and used throughout the paper. Three examples of text identifying university affiliation follow[8].

(1) "1983: incorporation of Init AG as a spin-off from the research project 'Demand-operated bus transport' of the University of Karlsruhe by Dr. [name omitted]".

(2) "The Company was formed in 1992 to capitalise on over 30 years of pioneering and innovative research by a scientific team at the Rheumatology and Allergy Research Unit ("RARU") at Birmingham University […]".

(3) "The Company was formed in 1996 at Brunel University Science Park, Uxbridge, to research and develop a number of technologies […] and to make use of Dr. [name omitted]'s experience".

[6] Following the European Commission, SMEs are defined as firms with annual sales inferior to 50 million € at the time of their IPO. The four sectors of innovative industry are in line with other studies (e.g. Cloodt et al., 2006). The industry classification the official one adopted by the European stock exchanges, namely the ICB (Industry Classification Benchmark).

[7] For instance, Ensley and Hmieleski (2005, p. 1097) define university-based firms as those that "were developed by students or faculty based on their research, or utilized research from a university's technology transfer area." Druilhe and Garnsey (2004, p. 274) consider those companies "drawing on university-based technological and scientific knowledge, and involving academics or students who were still members or who had just quit the university." Smith and Ho (2006, p. 1560) refer to a "technology-based company founded by a member/former member of a university or one of the seven laboratories, using IP developed in the institution by the founding individual(s)." Colombo et al. (2006, p. 3) define academic start-ups as "new ventures with an entrepreneurial team at least partially composed of academics and/or researchers from public research organizations." O' Shea et al. (2008) refer to spin-offs as companies that involve "1) the transfer of a core technology from an academic institution into a new company; and 2) the founding member(s) may include the inventor academic(s) who may or may not be currently affiliated with the academic institution."

[8] In France, typical sections of the IPO prospectuses used to identify university affiliation are "Historique du Groupe", "Recherche et développement" and "Ressources humaines". In Germany, they are "Gründung", "Organe der Gesellschaft", and "Forschung und Entwicklung". In Italy, we examine "Storia ed evoluzione dell'attività", "Politica di ricerca e sviluppo", "Attività svolte dai componenti del Consiglio di Amministrazione" and "Struttura organizzativa". In the UK, we have "History and background", "Management", "Directors" and "Research and Development Programmes". Since owners and managers can be held legally accountable with regard to the accuracy of the information disclosed in this document, it represents the best source of information on the quality for the firm.

3.2 Control sample

The final sample of university-based firms is composed by 131 companies (treatment sample) that we match with an equivalently group of independent ones (control sample). We use the nearest-neighbour propensity score method. Propensity scores are used to select "control" units (from the database EURIPO) that are similar to "treatment" units when several independent characteristics are considered important to the analysis (Dehejia and Wahba, 2002). We first estimate a logistic regression to predict whether a company is university-based or independent. The predictive variables are firm size (the natural logarithm of market capitalization at the IPO), age (natural logarithm of the company's age in years at the IPO), industry and country dummies, and a dummy for the IPO year. To match "treatment" units with "control" units, we first estimate the propensity scores, or fitted values, using the logistic regression model. Second, we separate the treatment and control groups and sort the observations within each group from lowest to highest scores. In the third step, we discard any independent companies with a propensity score outside the range exhibited by university-based firms (common support option). Fourth, we group the remaining firms into "blocks" with similar propensity scores and perform balancing tests for each predictive variable as well as the propensity scores themselves. These balancing tests are based on differences in means t-tests between university-based and independent firms within each block. Finally, we rank all firms in each block (in both samples) based on their propensity scores and assign to each treatment firm its closest match from the control sample[9].

[9] The ultimate purpose of this process is to balance the characteristics of the two groups as much as possible. To verify the success of the matching, it is informative to inspect summary statistics for the treatment and reduced control groups. As shown in Table 1, the two samples are well balanced with respect to all characteristics, with one exception. The Pharma & Bio category represents a significantly larger share of university-based companies. This industry suffers from a lack of "common support", meaning there are not enough independent companies in the database (with similar matching characteristics) to construct a comparable sample. To obviate this problem, we always control for the industry variable.

Table 1: Treatment and Control Samples

	University-based (%)	Independent (%)	Z-test
Country			
UK	47.32	41.22	-0.81
Germany	35.87	37.41	0.26
France	14.51	18.32	0.83
Italy	2.29	3.05	0.38
Industry			
Pharma & Bio	38.93	27.48	-2.29**
IT	34.35	40.45	1.02
Electronics & Eng.	18.32	19.86	0.24
Communications	8.39	12.21	0.31
Age at IPO (years)			
Age < 5	33.57	32.82	-0.25
5< Age <10	24.42	27.48	0.54
10< Age <15	22.92	20.61	-0.32
Age> 15	19.08	19.08	0.00
IPO year			
1995-1997	23.66	28.24	0.99
1998-2000	64.12	60.31	-0.64
2001-2003	12.21	11.45	-0.19

Significance level at 1% (***), 5% (**) and 10% (*).

The sample of university-based and independent companies is described in Table 1, by country, industry, IPO date, and age at first listing. Predictably, the United Kingdom dominates the treatment sample with 62 University-based firms (47.3%). The UK has indeed the most highly developed stock exchange in Europe[10], and its university system is probably the most entrepreneurial. The greatest concentrations of university-based companies are found in the biotechnology and IT industries (38.9% and 34.3% of the treatment sample respectively). Prior studies have also found these sectors to be strongly associated with university spin-off activity (Smith and Ho, 2006). Most of the firms went public within 10 years of their foundation. Almost two-thirds of the treatment sample went public between 1998 and 2000, a commonly identified 'hot issue' period in IPO markets for high-tech companies[11].

[10] At the end of 2006, the ratio between stock market capitalization and GDP was 1.5 in the UK. In contrast, most other countries in Continental Europe were between 0.5 and 1.0 (Paleari et al., 2007).

[11] Firms may time their IPO to take advantage of 'windows of opportunity', i.e., periods of market buoyancy during which over-valuation of other companies in the industry provides an incentive to issue new shares (Loughran and Ritter, 1995).

3.3 University-based firms at the IPO

We use several measures to compare university-based and independent firms, referring to three main fields: (1) characteristics of the offer and firm, (2) innovation and human capital, and (3) ownership and corporate governance. A detailed definition of the variables is provided in Table 2, and Table 3 shows their descriptive statistics. This first step of our empirical analysis is to determine whether university-based companies show some peculiarities at the time of their IPO which may influence investors' perception and valuation. It is also interesting to find out if specific features detected by other studies in early stages of the university-based firm life cycle still exist at the time of the IPO.

University-based firms have a median age of 7 years when going public in Europe, and their average market value is 85 million € (Panel A, Table 3). Their low leverage values suggest that loans are considered unsuitable for early-stage financing of innovative businesses. The majority of firms in both samples are backed by venture capital, with a slightly higher presence in university-based companies (60% vs. 55%). University-based companies also exhibit less profitability on average than independent firms at their IPO. This evidence corroborates and extends in time the results of previous studies on university-based firms (Ensley and Hmieleski, 2005; Zahra et al., 2007). The IPO is typically used by university-based firms to finance business growth rather than as a divestment/diversification opportunity for the original shareholders. This can be deduced from their lower participation ratios (percentage of shares sold by existing shareholders) and higher dilution ratios (percentage of shares newly issued for the IPO to raise money). Preliminary evidence for a different valuation of firms is provided by the fact that independent companies are characterised by lower market-to-book ratios (3.3 vs. 3.9) and a higher level of underpricing (29.7% vs. 18.9%). These last two differences are actually the focus of our econometric analysis.

Table 2: Variable definitions

Variable [a]	Definition
FIRMS AND OFFER CHARACTERISTICS	
Market Value (€m)	Market capitalization
Age (years)	Age (years since incorporation)
Leverage (%)	Ratio between debt and total assets
Profitability (%)	Return on assets
Dilution ratio (%)	New shares issued at listing over market capitalization after the IPO
Participation ratio (%)	Percentage of the IPO offering composed of existing shares
Market to Book	Ratio of market capitalization plus debt to the book value of total assets at IPO
Underpricing (%)	Stock return on the first day of trading.
INNOVATION AND HUMAN CAPITAL	
Patents (No.)	Number of patents registered at the European Patent Office
R&D investments	Ratio between R&D investments and sales.
Ph.D. in the TMT (%)	Proportion of TMT members that are university professors or hold a PhD degree
MBA in the TMT (%)	Proportion of TMT members with a MBA degree
TMT Experience (% of directors)	Proportion of TMT members with TMT membership experience in other firms
TMT Relational Capital (% of directors)	Proportion of TMT members with experience in public institutions or the TMTs of financial entities
OWNERSHIP AND CORPORATE GOVERNANCE	
VC-backed (% of firms)	Dummy variable equal to 1 if at least one venture capitalist is present in the ownership structure
Concentration (%)	Equity stake held by substantial shareholders. Substantial shareholders are defined by the cut-off ownership levels for mandatory disclosure (between 2% and 5%, depending on the nation).
Concentration Change (%)	Divestment by substantial shareholders
TMT Ownership (%)	Ownership stake held by TMT members
TMT ownership Change (%)	Divestment by TMT members
TMT size (No. directors)	Number of TMT members
Independent Directors (%)	Proportion of independent TMT members

[a] Variables measured at the time of the IPO. Accounting data are hand-collected from IPO prospectuses, while the number of registered patents was obtained from the European Patent Office.

The figures on innovative activity and human capital in university-based firms are encouraging (Panel B). On average, university-based firms own more patents (6 compared to 2) and invest more heavily in R&D (15% of sales vs. 11%). Referring to human capital, the backgrounds of TMT members are considerably different in the two

samples. The leaders of university-based companies are characterised by somewhat higher educational achievement (about 5% more possess Ph.D.s and MBAs) and significantly higher relational capital (subdivided into TMT experience and TMT relational capital)[12]. This evidence suggests that university affiliation improves the scientific knowledge embodied in the firm.

Table 3: Descriptive statistics

Variables [a]	University-based [b]	Independent
PANEL A: FIRMS AND OFFER CHARACTERISTICS		
Market Value (millions of €)	85.41	82.51
Age (years, median)	7.00	7.50
Leverage (%)	26.26	23.74
Profitability (%, median)	-1.81***	7.29
Dilution ratio (%)	32.69	31.19
Participation ratio (%)	7.82***	12.48
Market-to-book	3.98***	3.26
Underpricing (%)	18.86**	29.69
PANEL B: INNOVATION AND HUMAN CAPITAL		
Patents (No., median)	6***	2
R&D investments (%, median)	15.12***	10.56
Ph.D. in the TMT (%)	25.42***	5.28
MBA in the TMT (%)	16.98**	11.29
TMT Experience (% of directors)	75.43**	70.88
TMT Relational Capital (% of directors)	14.41***	7.51
PANEL C: OWNERSHIP AND CORPORATE GOVERNANCE		
VC-backed (% of firms)	60.15	55.25
Concentration (%)	66.91***	77.03
Concentration Change (%)	16.25**	20.58
TMT ownership (%)	35.09**	42.77
TMT ownership Change (%)	25.77	26.65
Number of directors (No.)	5.88**	5.05
Independent directors (%)	36.98	35.58

[a] Averages when not specified.
[b] Tests are between University-based and independent firms. The significance levels are based on *t*-statistics (mean), the Mann-Whitney U-test (median), and *Z*-tests of equal proportions as required. Significance level at 1% (***), 5% (**) and 10% (*).

[12] Capello and Faggian (2005) define relational capital as any relationship – market relationships, power relationships and cooperation – established between firms, institutions and people. In our study, market relationships are measured by the TMT Experience variable, calculated as the percentage of the firm's TMT members with TMT membership in at least another firm. The level of firms' relationship with institutions is measured as the percentage of directors with experiences in public institutions or in the TMT of financial entities (TMT Relational Capital).

Lastly, we find that both categories of shareholders (substantial shareholders and TMT members)[13] hold a larger stake in these companies. Given that independent companies seem to be largely financed by a small number of shareholders, arguably 'family and friends', this trend may support the idea that these firms have greater difficulty acquiring external financial resources. University-based firms may be helped in this regard by the legitimacy provided by affiliation.

4. Methodology

In this section, we describe the empirical models used to investigate the influence of university affiliation on valuation and performance.

There are several important differences between university-based and independent firms that might be relevant. However, a university affiliation may exert its greatest influence on the market simply by legitimising the firm. Indeed, the literature on corporate governance suggests that firms can reduce uncertainty in the eyes of investors by complying with institutional elements[14]. Accordingly, university affiliation may exert a positive influence on market valuation and reduce the perceived uncertainty of future performance. Beyond this direct influence, university-based firms may also possess more innovative capital. In high-tech industries the creation of value is guaranteed only through innovation, which relies heavily on the acquisition of new competences (George and Zahra, 2002). Previous studies (Guo et al., 2006; Chin et al., 2006) have found that innovative activity is an important driver of market valuation. We therefore propose that the superior innovative capital and reputation of university-based firms enhance perceived value. On the other hand, their lower operating profitability may have a negative effect on investors' valuation. We test the effect of operating

[13] The information on ownership interests contained in the IPO prospectuses, as well as in annual reports, is determined by the national securities commissions for each country. In all the jurisdictions evaluated, there is a formal obligation which requires major shareholders to disclose their holdings in a company. The percentage level at which such an obligation was triggered varied from country to country. France (Code de Commerce, article L. 233-7) and Germany (Securities Acquisition and Take-over Act, sections 21 and 22) adopted 5% as a base level, like in the US, while Italy (Law No. 58 of 1998) and the UK (Companies Act 1985 sections 198-212) were at 2% and 3%, respectively.

[14] Previous works on this topic (DiMaggio and Powell 1983; Scott 1995), particularly those written by institutional theorists, suggest four main forms of legitimacy: (1) conformance, or "following the rules"; (2) selection, or operating in an environment conducive to one's goals; (3) manipulation, or opportunistic intervention in a cultural environment to develop of new bases of support; and (4) the creation of new operating practices, models, and ideas where other sources of legitimacy do not yet exist.

performance on market initial valuation and we also investigate how it evolves in the aftermarket.

Another important difference between university-based and independent firms is related to human capital. The literature conventionally attributes two main functions to TMTs: the Advisory and Agency. In its advisory role, the TMT influences strategic decisions through expertise and wisdom. There is a strong relationship between team experience and strategy, which in turn is a key determinant of long-term performance (Shrader and Siegel, 2007). From this viewpoint, the TMT helps the firm identify and acquire tangible and intangible resources. In the latter category, prestigious TMT members may form and facilitate relationships with other stakeholders such as banks, investors, suppliers, and customers. TMT members with prior business experience already have broad social networks, and are more effective in developing new ties. Unlike academic experience, business experience appears essential to building relationships with experienced managers and potential equity investors (Mosey and Wright, 2007). Finally, prestigious executives can influence investor perceptions through their symbolic role alone. This process, primarily rooted in social characteristics theory (Berger et al., 1992), stems from the idea that individuals will ascribe certain values, skills, and abilities to status characteristics such as education level, affiliations, and experience.

In its agency role, the TMT monitors the behaviour of management on behalf of shareholders. Scholars and regulators agree that in order to accomplish this function, TMTs should include a majority of independent members (Lasfer, 2006). It is expected that independent directors will live up to their reputation as active monitors, rather than colluding with managers to expropriate wealth from minority shareholders. The presence of independent supervisory directors may be perceived as enhancing the TMT's agency role, increasing the price that investors are willing to pay for shares[15].

Finally, the literature suggests that TMT ownership is another internal governance mechanism designed to mitigate agency problems and thereby maximise value creation. The basic idea is straightforward: TMT members with ownership have a strong

[15] Many surveys have documented that independent TMT members are able to reduce financial fraud and improve the quality of accounting information (Beasley, 1996). They are also found to play an important role in CEO dismissal (Weisbach, 1988). A survey of institutional investor opinions by Coombes and Watson (2000) shows that governance is a significant factor in the investment decision. In a separate survey, Useem et al. (1993) find that pension funds and investment managers appear to prefer TMTs with independent members and diversified skills and experience.

incentive to behave in the interest of shareholders (including themselves) and thus increase the value of the firm (Jensen and Meckling, 1976). They are less likely to deviate from value-maximising behaviour by consuming perquisites, shirking, or undertaking sub-optimal investment projects that increase their own benefits. Moreover, the willingness of TMT members to invest in their own projects may serve as a signal of quality (Leland and Pyle, 1977). Thus, a lower level of divestment by TMT members at the IPO may reduce agency problems and alleviate external investors' concerns about the real value of the firm.

4.1 Models

We first investigate the determinants of the market initial valuation of university-based companies, relying upon perceived value by investors (measured by the market-to-book ratio) and valuation uncertainty (measured by underpricing). The market-to-book ratio is a robust indicator of the perceived future value of the firm. Indeed, economic theory assumes that the difference between market value and book value is the present value of a company's future abnormal earnings, the latter resulting from either monopoly power or innovation. The market-to-book ratio is therefore a widely used measure that reflects the future growth opportunities of the firm as assessed by the market (Fama and French, 1998).

University affiliation may also exert a significant effect on valuation uncertainty. Our measure of valuation uncertainty at the IPO is underpricing. This exists when a firm's stock is initially offered at a lower listing price compared to its closing price on the first day of trading. The IPO underpricing anomaly is a worldwide phenomenon[16]. Various theories have been developed to explain the first-day IPO underpricing, with most postulating the existence of information asymmetry between certain parties to the IPO process. A common claim of these models is that first-day underpricing is actually a proxy for the extent of information asymmetry, and compensates investors for the greater risk.

[16] Underpricing is a common occurrence for firms undertaking an IPO. A review of the international literature on IPO underpricing is provided by Ritter and Welch (2002).

We use OLS regression with White robust standard errors to model the effects of university affiliation on initial market valuation and valuation uncertainty. The model is specified as follows:

$$y_i = \alpha + \overline{\beta_0}(\text{Baseline variables}) + \overline{\beta_1}(\text{Institutional affiliation dummies}) + \overline{\beta_2}(\text{Innovation variables}) + \overline{\beta_3}(\text{TMT advisory variables}) + \overline{\beta_4}(\text{TMT agency variables}) + \varepsilon_i$$

The dependent variables are (1) market-to-book (the natural logarithm of the ratio between market capitalization plus debt and the book value of total assets at IPO) and (2) underpricing (the natural logarithm of the return on the first day of trading).

We use the same set of explanatory variables for all models, grouped into five categories: baseline regression variables, institutional affiliation, innovation, TMT advisory role, and TMT agency role. The first set includes control variables that could influence our dependent variables: firm characteristics at the IPO (size, age, leverage and profitability)[17]; dummy variables for the industry, country and year; in some cases market-to-book and underpricing[18]; and characteristics of the initial offer (dilution ratio and participation ratio)[19]. Our most important theoretical variables refer to institutional affiliation, the second category. Here we use dummy variables for the existence of university affiliations and VC financing. The effects of innovation, the third category, are quantified using R&D investment as a measure of input and the number of patents held as a measure of output[20]. Finally, we investigate the TMT's advisory role (proxied by the proportion of directors with MBA or Ph.D. degrees, the proportion of TMT members with membership in other TMTs, and TMT relational capital) and agency role (the fraction of TMT members that are also substantial shareholders, and the proportion of independent directors in the TMT).

[17] All variables are evaluated at the IPO. Firm size is the natural logarithm of total assets, age is the natural logarithm of the number of years since incorporation, profitability is the return on assets, and leverage is the natural logarithm of the ratio between debt and total assets.

[18] These are taken as independent variables when we investigate long-term performance and price volatility. Obviously, they are not used when we estimate models of market-to-book or underpricing.

[19] The dilution ratio is defined as the ratio between the number of newly issued shares and the total number of shares outstanding after the IPO. The participation ratio is the percentage of existing shares placed in the IPO.

[20] R&D Investment is the natural logarithm of the ratio between R&D expenses and sales at the IPO. The Patents variable is the natural logarithm of the number of patents held at the IPO, scaled by the natural logarithm of market capitalization.

This is also the first study to investigate university-based firms in the long run. As such, a second set of models focuses on observable trends in the market performance and volatility of these firms over time. Market performance is expressed by five-year Buy-and-Hold Abnormal Returns (BHARs) (Loughran and Ritter, 1995), which are calculated for stock *i* in time period *T* as follows:

$$BHR_{i,T} = \left[\prod_{t=1}^{T}(1+R_{i,t})\right]-1$$

$$BHAR_T = \frac{1}{N}\sum_{i=1}^{N}\left[\left(\prod_{t=1}^{T}(1+R_{i,t})\right)-\left(\prod_{t=1}^{T}(1+R_{M,t})\right)\right]$$

$R_{i,t}$ is the return on stock *i* at time *t*, *T* is the time period for which BHR is to be determined, *N* is the number of stocks in a portfolio, and $R_{m,t}$ is the raw return of the FTSE Euromid index, used as a benchmark[21].

To test the effect of university affiliation on valuation uncertainty in the long run, we refer to the standard deviation of monthly market returns five years after the IPO (see also Leuz, 2003; Cuijpers and Buijink, 2005).

We use the same previous model used to investigate the valuation at the IPO to study, this time, the aftermarket valuation and uncertainty (volatility) of the sample firms. The new dependent variables are (1) the natural logarithm of five-year BHARs and (2) the price volatility in the five years after the IPO (the standard deviation of monthly market returns).

Prior research indicates that market prices reflect a rich and comprehensive mix of information, which includes financial statement data as a subset. Thus, we investigate the evolution of post-IPO operating performance of sample firms. This investigation helps us to understand the aftermarket evolution of stock value and extend our dynamic

[21] Post-IPO returns are measured over a period of 60 "months", defined as intervals of 21 trading day. The first 21 trading days after the IPO are excluded, as underwriter banks are still stabilising prices during this period. BHAR is used instead of BHR to measure performance because the former neutralizes market momentum. To test the robustness of our results we used Dj Euro Stoxx Technology as an alternative benchmark, and also considered a 36-month horizon. The results did not change qualitatively.

approach to the analysis of value creation capacity of university-based firms. The structure of our accounting data confers two dimensions on this third set of models: a cross-sectional unit (the firm) and a temporal reference. The relationship between performance and a firm's characteristics at the IPO is investigated through the following dynamic panel data model:

$$y_{i,t} = \alpha + \beta_0 y_{t-1} + \beta_1 y_{t-2} + \sum_{j=2}^{5} \beta_j IPO_{t-j} +$$
$$\overline{\beta_2}(\text{Baseline variables}) + \overline{\beta_3}(\text{Institutional affiliation dummies}) + \overline{\beta_4}(\text{Innovation variables})$$
$$+ \overline{\beta_5}(\text{TMT advisory variables}) + \overline{\beta_6}(\text{TMT agency variables}) + \varepsilon_{i,t}$$

Here the subscript *t* refers to a calendar year between 1992 and 2007 inclusive. The variable y_{it} is a proxy for the performance of firm *i* in year *t*.

We consider three measures of operating performance: asset turnover (sales over total assets), return on assets (EBITDA over total assets), and return on equity (net profit over the book value of equity). The set of exogenous regressors is the same as that used in previous OLS models. However, we include IPO_{t-j} dummies equal to one if the calendar year *t-j* happens to be the IPO year. As the dependent variable is likely to be autocorrelated, we also include the lagged dependent variables y_{t-1} and y_{t-2}.

This model requires dynamic estimation techniques. Following the literature on dynamic panel data with large *N* and small *T* (Arellano and Bond 1991; Bond 2002), the model is estimated using the generalised method of moments (GMM). In particular, we choose the efficient GMM-System (GMM-SYS) estimator developed by Blundell and Bond (1998)[22].

[22] This estimator proved to be a dramatic improvement over the usual first-difference GMM estimator developed by Arellano and Bond (1991). Furthermore, in GMM-SYS it is possible to include time-invariant regressors which would disappear in first-difference GMM. Asymptotically, this practice does not affect the coefficients estimated for other regressors (Roodman, 2006). This characteristic is particularly useful for our study, since the vast majority of our independent variables refer to IPO characteristics and are thus time-invariant.

5. Econometric results

5.1 Valuation at the IPO

University-based firms are expected to be associated with a higher initial market valuation (i.e., market-to-book ratio) than independent firms. All the empirical models reported in Table 4 support this hypothesis: university affiliation is positively associated with initial market valuation[23]. Thus, it seems that university affiliation is perceived as an asset by investors. As discussed earlier, strong affiliations with universities and other respected institutions may lend legitimacy to innovative SMEs, attracting the attention of investors and mitigating the concerns of key actors. The relational capital and educational attainment of TMT members, both of which strengthen the firm's relationships to other institutions, might be expected to have a similar effect (Hsu, 2007). We do find a significant positive correlation between the proportion of Ph.D. degrees among TMT members and the firm's initial market-to-book ratio, but the presence of directors with MBA degrees does not seem to influence investors. TMT relational capital is also positively associated with value. It is noteworthy that even after controlling for educational capital, TMT experience and TMT relational capital, the coefficient of the university affiliation dummy is still significantly positive. Finally, the presence of independent directors in the TMT does indeed reduce investor concerns and agency costs, as testified by the positive coefficient on this variable. Linkages with banks and their involvement in the IPO pricing can indeed certify the quality of firms because the repeated nature of their business encourages them to preserve their reputational capital and to desist from opportunism (Paleari and Vismara, 2007).

As for control variables, we find that larger and older firms are valued at a lower level than smaller firms are. Being a young company means indeed to be in an early stage of the life cycle, with better possibilities to express abnormal growth rates. Profitability is positively related to IPO firm value. This indicates that investors value fast growing and highly profitable firms at a higher level. Finally, during the bubble period firms receive higher valuation.

[23] An alternative measure of valuation would be the ratio of first-day market capitalization to the post-issue book value of equity (Market Value to Equity Value). The post-issue book value of equity includes the total proceeds of the primary offering (i.e., the number of newly issued shares times the offer price) and the book value of equity from the most recent pre-IPO financial statement. We also consider market-to-sales, defined as the ratio between the first-day market capitalization and total sales over the year preceding the IPO. As reported in Table A.2, our results did not significantly change using either alternative definition.

Table 4: Valuation at the IPO: OLS on the market-to-book ratio (measure of value)

Market-to -book [a]	Model 1	Model 2	Model 3	Model 4
Baseline regression				
Size	-0.21**	-0.21**	-0.22**	-0.25**
Age	-0.11**	-0.12**	-0.12**	-0.13**
Leverage	-0.13	-0.10	-0.10	-0.10
Profitability	0.23**	0.26**	0.26**	0.25**
Dilution ratio	-0.56*	-0.48*	-0.52*	-0.39*
Participation ratio	-0.56	-0.59	-0.39	-0.28
Underpricing	-0.25*	-0.23*	-0.25*	-0.24*
Electronics	0.05	0.08	0.13	0.14
Pharma & Bio	0.13	0.12	0.12	0.12
IT	-0.02	-0.06	-0.06	-0.05
Bubble period	0.22**	0.22**	0.21*	0.21*
UK	0.24**	0.21*	0.17	0.19
Germany	0.21	0.22	0.22	0.21
Institutional Affiliation				
University-based	0.18**	0.16*	0.22**	0.22**
VC-backed	0.05	0.02	0.03	0.02
Innovation				
Patents		0.61	0.85	0.82
R&D investments		0.56**	0.65**	0.65**
TMT advisory role				
Ph.D. in the TMT			0.22*	0.29*
MBA in the TMT			-0.17	-0.18
TMT Experience			0.02	0.03
Relational Capital			0.84***	0.85***
TMT agency role				
Concentration Change				0.04
TMT ownership Change				0.46
Independent directors				0.15*
Constant	2.56***	2.71***	2.78***	2.83***
R^2 % [b]	19.43***	22.32***	26.44***	27.34***
White Test Ho: homoskedasticity (p value)	0.09*	0.20	0.44	0.46
Variance Inflation Factors	1.89	1.92	2.06	2.17

[a] *t*-Test for significance of the independent variables.
[b] F-Test for significance of the regression.
*** 1% significance level; ** 5% significance level; * 10% significance level.

By mitigating concerns over legitimacy, university affiliation is also expected to reduce valuation uncertainty and thus underpricing. In agreement with this hypothesis, we find a negative correlation between underpricing and university affiliation, although this relation shows a low level of statistical significance (Table 5).

Table 5: Valuation at the IPO: OLS on underpricing (measure of uncertainty)

Underpricing [a]	Model 1	Model 2	Model 3	Model 4
Baseline regression				
Size	-0.01	-0.01	-0.01	-0.01
Age	0.02	0.02	0.02	0.01
Leverage	0.01	0.01	0.01	0.02
Profitability	-0.02	-0.03	-0.02	-0.02
Dilution ratio	0.05	0.05	0.07	0.05
Participation ratio	-0.04	-0.05	-0.05	-0.07
Market-to-Book	-0.06	-0.05	-0.06	-0.07
Electronics	0.06	0.05	0.05	0.06
Pharma & Bio	0.04	0.01	0.00	0.01
IT	0.13**	0.11*	0.11*	0.10*
Bubble period	0.17***	0.09***	0.09**	0.09**
UK	0.10	0.09	0.10	0.12
Germany	0.24***	0.22***	0.24***	0.24***
Institutional Affiliation				
University-based	-0.09*	-0.08*	-0.01	-0.02
VC-backed	0.05	0.05	0.06	0.07
Innovation				
Patents		0.05	0.14	0.13
R&D investments		-0.05	-0.03	-0.02
TMT advisory role				
Ph.D. in the TMT			0.09	0.04
MBA in the TMT			-0.51***	-0.48***
TMT Experience			-0.22*	-0.24*
Relational Capital			0.12	0.12
TMT agency role				
Concentration Change				0.10
TMT ownership Change				0.17
Independent directors				-0.02
Constant	-0.03	-0.04	-0.19	-0.17
R^2 % [b]	22.09***	22.12***	26.31***	26.82***
White Test Ho: homoskedasticity (p value)	0.95	0.80	0.47	0.46
Variance Inflation Factors	1.92	1.94	2.09	2.19

[a] *t*-Test for significance of the independent variables.
[b] F-Test for significance of the regression.
*** 1% significance level; ** 5% significance level; * 10% significance level.

In particular, it seems that underpricing is reduced more by TMT educational capital and experiences than by the status of being a university-based company. Experiences in other TMTs and business skills (MBA degree) seem to be particularly factual in reducing underpricing. To some extent, TMT members' actions and characteristics are signals to observers attempting to discern their intentions and predispositions. In this

sense, managerial skills and business network may signal a superior attitude and ability to pursue profit maximization strategies, reducing uncertainty associated with the valuation process at the IPO.

We also find evidence of a higher level of underpricing during the new economy bubble period. This result is connected with the evidence of higher underpricing for information technology companies and German ones, thanks to the success of the Neuer Market during the bubble years.

5.2 Aftermarket valuation

Various empirical studies have shown that the long-run share prices of newly public companies tend to underperform with respect to private firms as well as the overall market. Indeed, beginning with Ritter (1991) and Loughran and Ritter (1995), on the long run share price performance and with Jain and Kini (1994) and Mikkelson et al. (1997) on the operating performance, empirical studies show the tendency of newly public companies to underperform in the long run. Consistent with those works, we find that our IPO companies underperform in comparison with a benchmark market index[24]. In particular, although the previous models show that the market values university-based firms more highly, the same companies do not out-perform their independent counterparts in the long run (Table 6). We also find evidence that R&D investment has a slight positive effect on the five-year BHAR. Investors thus seem to recognise that intellectual capital constitutes a source of value to the firm, creating wealth to investors. Interestingly, the significance of the negative correlation between long-term value and university affiliation fades away when we control for TMT characteristics. Educational capital (the proportion of Ph.D. degrees) in particular appears to absorb the negative effect of being a university-based company.

[24] Several theoretical explanations for this anomaly have been proposed. One possibility is that firms usually time their IPOs in order to take advantage of "windows of opportunity" (Loughran and Ritter, 1995), biasing their long-run performance downward. Another factor is that IPO investors rely heavily on the limited information contained in the prospectus. This unusual power over information, together with the firm's desire to go public at the highest possible price, encourages the firm to follow aggressive reporting policies (or at least to be less concerned about hiding value from tax authorities) (Pagano et al., 1998). In short, managers have an extraordinary incentive to make their firms shine as brightly as possible before going public. Finally, the IPO may increase agency problems by dispersing ownership and worsening the conflict between managers and shareholders, as predicted by Jensen and Meckling (1976).

Table 6: Aftermarket valuation: OLS on 5-year BHARs (measure of value)

BHAR [a]	Model 1	Model 2	Model 3	Model 4
Baseline regression				
Size	0.05**	0.04**	0.05**	0.05**
Age	-0.02	-0.02	-0.01	-0.01
Leverage	0.05	0.06	0.05	0.04
Profitability	0.19***	0.19***	0.18***	0.16***
Dilution ratio	0.07	0.07	0.09	0.10
Participation ratio	0.11	0.09	0.11	0.09
Market-to-Book	-0.11***	-0.09***	-0.11***	-0.09**
Underpricing	-0.07	-0.06	-0.06	-0.05
Electronics	0.09	0.09	0.10	0.09
Pharma & Bio	0.01	0.01	0.01	0.03
IT	-0.09*	-0.09*	-0.07	-0.08
Bubble period	0.07*	0.07*	0.05	0.05
UK	0.01	0.01	0.02	0.03
Germany	-0.16***	-0.16***	-0.11**	-0.13**
Institutional Affiliation				
University-based	-0.07**	-0.08**	-0.05	-0.03
VC-backed	-0.03	-0.03	-0.02	-0.01
Innovation				
Patents		0.23	0.14	0.23
R&D investments		0.19*	0.26*	0.33*
TMT advisory role				
Ph.D. in the TMT			-0.17**	-0.20**
MBA in the TMT			0.11	0.09
TMT Experience			0.27**	0.36**
Relational Capital			0.05	0.09
TMT agency role				
Concentration Change				-0.38**
TMT ownership Change				-0.02
Independent directors				0.07*
Constant	0.15	0.21	-0.08	-0.15
R^2 % [b]	28.12***	29.16***	33.83***	35.12***
White Test Ho: homoskedasticity (p value)	0.25	0.47	0.47	0.46
Variance Inflation Factors	1.93	1.95	2.13	2.27

[a] *t*-Test for significance of the independent variables.
[b] F-Test for significance of the regression.
*** 1% significance level; ** 5% significance level; * 10% significance level.

This result is quite unexpected, and seems to imply that TMT members with prestigious educational profiles (Ph.D. degrees) have a detrimental effect on the market performance of their companies. We can hypothesise that TMT members with strong technological skills are more interested in technological innovation than profitability

(Meyer, 2003). At the same time, directors with previous business experience (i.e., membership in other TMTs) seem to positively influence long-run stock prices. Business acumen and skills are essential in translating innovation into lasting performance gains. The presence of independent directors increases the likelihood of superior market performance, albeit weakly, as the agency perspective promises. Finally, the level of divestment by substantial shareholders at the IPO is negatively correlated with long-run performance. Thus correlation suggests that incumbent investors are better informed on the real wealth-creation capacity of the firm.

When we focus on the effect of university affiliation on valuation uncertainty in the long run (Table 7), we find a positive effect of institutional affiliation on the reduction of information asymmetries. The dummy variable that identifies university-based firms is indeed negatively correlated to the standard deviation of stock prices, suggesting a lower level of investors' uncertainty about the value of these companies. Also the presence of TMT members with strong business experiences reduces volatility, while a high level of divestment by substantial shareholders at the IPO seems to increase the level of uncertainty associated with the IPO process. Incumbent shareholders are indeed assumed to be more informed about the real value of the company. Therefore, a high level of divestment at the IPO by these shareholders may be perceived as a negative signal, increasing valuation concerns of external investors.

More profitable and larger firms show a lower level of price volatility, probably because they provide stakeholders with more disclosures (Ashbaugh, 2001) and have higher levels of analyst following and public exposure (Cuijpers and Buijink, 2005). Last, the bubble period is found to be associated with higher levels of price volatility. This evidence, associate with a higher level of uncertainty for IT companies, suggests that during that period valuations have been biased by a high level of information asymmetries.

Table 7: Aftermarket valuation: OLS on 5-year volatility (measure of uncertainty)

Volatility [a]	Model 1	Model 2	Model 3	Model 4
Baseline regression				
Size	-0.42**	-0.41**	-0.38**	-0.37**
Age	-0.12	-0.13	-0.12	-0.12
Leverage	0.21	0.31	0.27	0.28
Profitability	-0.15**	-0.15**	-0.14**	-0.15*
Dilution ratio	0.13	0.14	0.20	0.18
Participation ratio	-0.32**	-0.33**	-0.32**	-0.32**
Market-to-Book	0.17**	0.16*	0.16	0.16
Underpricing	0.01	0.01	-0.02	-0.01
Electronics	0.83	0.79	0.91	0.52
Pharma & Bio	-0.32	-0.32	-0.15	-0.18
IT	0.18*	0.18**	0.19*	0.18*
Bubble period	0.27**	0.26**	0.27**	0.25**
UK	-0.01	-0.01	-0.01	-0.01
Germany	0.25	0.25	0.24	0.25
Institutional Affiliation				
University-based	-0.10*	-0.07	-0.10*	-0.10*
VC-backed	0.01	0.01	0.02	0.02
Innovation				
Patents		-0.12	-0.12	-0.11
R&D investments		0.30	0.15	0.14
TMT advisory role				
Ph.D. in the TMT			-0.01	-0.01
MBA in the TMT			-0.01	-0.01
TMT Experience			-0.22*	-0.30*
Relational Capital			0.20	0.18
TMT agency role				
Concentration Change				0.36***
TMT ownership Change				0.01
Independent directors				0.15
Constant	0.08**	0.09**	0.09**	0.10**
R^2 % [b]	25.11***	25.19***	27.54***	31.47***
White Test Ho: homoskedasticity (p value)	0.31	0.47	0.46	0.46
Variance Inflation Factors	1.93	1.95	2.13	2.27

[a] *t*-Test for significance of the independent variables.
[b] F-Test for significance of the regression.
*** 1% significance level; ** 5% significance level; * 10% significance level.

5.3 Operating performance

We find that university-based firms do not outperform their independent counterparts in terms of long-run market performance, but they are associated with lower effect uncertainty (measured by market volatility). This makes of the university-based firms an interesting asset class in which to invest, as their reduced level of risk is not associated to limited price returns. In a portfolio theory approach, therefore, these firms would dominate their independent counterparts as their lower risk is not counterbalanced by lower returns. However, university-based firms do worse than independent firms in terms of operating performance. Whether due to the windows of opportunity hypothesis, earnings management, or agency problems (see footnote 24), university-affiliated firms exhibit deteriorating operating performance after the IPO. This effect is evident in the negative correlations with IPO dummies listed in Table 8. In turn, this result may explain why these companies, although a higher initial valuation, are not able to outperform their independent counterparts in terms of long run market value. Indeed, market-based measures capture a mix of information, including both financial statement and non financial statement information (Beaver et al., 2005). Therefore, the slightly negative market performance of university-based firms may be also conditioned by their poor post-issue operating profitability, that reduces the positive effect of institutional affiliation on market valuation.

Table 8: Operating performance: GMM-System model

Y =	Asset Turnover	Return on Assets	Return on Equity
$Y_{(t-1)}$	0.37***	0.28**	0.18***
$Y_{(t-2)}$	0.05	0.11	0.08
IPO_0	-0.61***	-0.09	-0.17
IPO_1	-0.13	-0.26**	-0.28**
IPO_2	-0.11	-0.26**	-0.38***
IPO_3	-0.07	-0.29***	-0.36***
Baseline regression			
Size	-0.09	0.05	0.08
Age	0.11***	0.05**	0.08**
Leverage	-0.29	-0.61*	-0.83*
Dilution ratio	-0.32	0.09	-0.12
Participation ratio	0.85*	0.56**	0.41*
Market-to-Book	-0.08	0.01	0.02
Underpricing	0.03	-0.01	-0.03
Electronics	-0.16	-0.08	-0.23**
Pharma & Bio	-0.35***	-0.21***	-0.24***
IT	-0.22**	-0.17***	-0.21***
UK	0.01	0.02	0.06
Germany	-0.07	-0.02	-0.07
Institutional Affiliation			
University-based	-0.18**	-0.06**	-0.09*
VC-backed	0.02	0.01	0.01
Innovation			
Patents	0.01	-0.07	-0.12
R&D investments	0.11	-0.01	0.01
TMT advisory role			
Ph.D. in the TMT	-0.32*	-0.12	-0.12
MBA in the TMT	0.05	0.05	-0.09
TMT Experience	0.05	0.01	0.06
Relational Capital	-0.29	-0.06	-0.08
TMT agency role			
Concentration Change	-0.19	0.02	-0.03
TMT ownership Change	-0.01	0.05	-0.08
Independent directors	0.01	0.01	0.05
Constant	2.46**	-1.51	-1.17
Instruments	76	76	76
χ^2	407.16***	278.63***	232.14***
AR(1) Test (z) (p value)	0.00***	0.00***	0.00***
AR(2) Test (z) (p value)	0.36	0.38	0.32
Hansen Overid. restrictions (p value)	0.39	0.27	0.56
GMM Instruments Tests			
Hansen Test excluding groups (p value)	0.48	0.69	0.54
Difference (null H = exogenus) (p value)	0.28	0.23	0.51
Exogenus Instruments tests			
Hansen Test excluding groups (p value)	0.24	0.32	0.18
Difference (null H = exogenus) (p value)	0.62	0.30	0.66

*** 1% significance level; ** 5% significance level; * 10% significance level.

6. Conclusions

This study has investigated the previously unaddressed issue of the valuation of university-based firms. To this extent, we adopt a market-based perspective by selecting a sample of European university-based firms that recently went public. Matching the sample with independent firms, we find that on average university-based firms are less profitable but more innovative at the IPO. The affiliation with a university is perceived by the market of investors as a signal of firm quality as the listing of university-based firms is associated with higher valuations and lower uncertainty levels.

In the five years after the listing, university-based firms do not outperform their independent counterparts in terms of market performance, but they are associated with a lowering effect on the level of uncertainty, measured by market volatility. This makes of the university-based firms an interesting asset class in which to invest, as their reduced level of risk is not associated to limited price returns.

These findings are robust even after controlling for the level of innovation and characteristics of the human capital. In other words, the affiliation with a university does affect the valuation and risk level of firms, independently by its effect on other factors and characteristics of the firm.

However, investors seem to value a firm's level of R&D investment and the business skills of its directors highly. These factors may be seen as necessary to sustain long-term performance. A prevalence of business degrees and experience among the upper management signals a strong commitment to profitability, making it more likely that innovations can be translated into performance gains. Business acumen may be scarcer in university-based firms, however, as academics are likely to have other objectives besides profit: implementing personal ideas, enhancing academic prestige, and buying new research infrastructure for example. An excessive focus on technological aspects of the company may reduce commitment to business growth and performance. These hypotheses may explain why university-based firms tend to have a lower level of operating performance than independent firms both before and after the IPO. If universities want to maximise the profit of their commercial initiatives, it is recommended that they devote attention to the development of business-oriented top management teams. Even if innovation is essential to the creation of wealth and sustained competitive advantage, it is not sufficient to ensure the success of a firm.

On the whole, the results presented in this paper show that the "entrepreneurial university" model has great promise. Along with considerations of technology transfer, university-based firms represent a significant contribution to European economies and their financial markets. We find indeed that 131 out of 1,389 non-financial SMEs that went public in Europe during the period 1995-2003 were university-based firms. Moreover, these companies are distinguished by a greater propensity to innovation in terms of both inputs (R&D expenses) and outputs (patents). Their attitude towards public equity markets is also encouraging. Compared to independent firms, their IPOs are characterised by a higher level of fresh capital raised and a lower level of divestment. Investors typically view these behaviours as signs of firm commitment on the part of TMT members and existing shareholders. Thus, public equity markets are an appropriate source of financing for university-based companies; investors seem to appreciate the excellent growth potential associated with superior innovation capabilities.

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Appendix

Table A.1: Logistic regression on the final sample of firms selected to verify the success of the matching strategy

Logit on University-Based firms	
Market Value	0.06
Age	-0.11
UK	0.58
Germany	0.22
Pharma & Bio	0.90*
IT	0.29
Electronics	0.38
1995-1997 dummy	-0.33
Bubble	0.10
Log Likelihood	-176.07
χ^2	11.07

*** 1% significance level; ** 5% significance level; * 10% significance level.

Table A.2: Robustness tests on different definitions of initial market valuation and 3-year BHARs

Models [a]	Market Value to Equity Value	Market to Sales [c]	3-year BHARs
Baseline regression			
Size	-0.16**	-0.14**	0.02
Age	-0.11***	-0.19**	-0.03
Leverage	0.18	0.13	0.06
Profitability	0.09*	_	0.15**
Dilution ratio	-0.45*	-0.86*	0.06
Participation ratio	0.15	0.46	-0.12
Market-to-Book	_	_	-0.08**
Underpricing	-0.11	-0.07	-0.07*
Electronics	-0.01	0.02	0.03
Pharma & Bio	0.07	0.24*	0.06
IT	0.09	0.13	-0.04
Bubble period	0.11*	0.09	-0.04
UK	0.02	0.02	0.06
Germany	0.16**	0.24*	-0.12***
Institutional Affiliation			
University-based	0.12*	0.48**	-0.01
VC-backed	0.04	0.32*	0.09**
Innovation			
Patents	0.02	0.09	0.15
R&D investments	0.11	0.54*	0.11
TMT advisory role			
Ph.D. in the TMT	0.42**	1.11**	-0.62**
MBA in the TMT	-0.01	-0.18	0.11
TMT Experience	0.07	0.08	0.32**
Relational Capital	0.67**	1.09**	0.15
TMT agency role			
Concentration Change	0.06	-0.14	-0.16*
TMT ownership Change	0.23	-0.21	-0.02
Independent directors	0.11*	0.40**	0.12*
Constant	2.27***	1.51	0.91
R^2 % [b]	25.57***	22.78***	23.27***

[a] *t*-Test for significance of the independent variables.
[b] F-Test for significance of the regression.
[c] In this regression we exclude the independent variable profitability given its high correlation with the dependent one.
*** 1% significance level; ** 5% significance level; * 10% significance level.

PAPER 2:

THE M&A DYNAMICS OF EUROPEAN SCIENCE-BASED ENTREPRENEURIAL FIRMS

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Journal of Technology Transfer, *Forthcoming*

III. The M&A Dynamics of European Science-Based Entrepreneurial Firms[◊]

Abstract

This paper investigates the dynamics of a sample of 131 science-based entrepreneurial firms (SBEFs), selected out of 500 innovative small and medium enterprises (SMEs) that went public in Europe in the period 1995-2003. We found that the market for control of these firms was active, with most of our sample firms being acquired after their Initial Public Offering (IPO), usually by companies operating within the same industry. Floated SBEFs showed a higher propensity to be acquired than independent firms; this distinction persisted after controlling for intellectual capital and other possible determinants. While university affiliation enhanced attractiveness in the eyes of other companies, it negatively affected the propensity for acquisition. The higher availability of internal technological resources was an important determinant of the decreased propensity of SBEFs to pursue acquisitions. We argue that university-based firms do contribute to the technology transfer process, as evidenced by the widespread interest of the business world in investing in these firms. The creation of a SBEF is a first step in the process of commercial exploitation of university-research, while the subsequent step of going public is a sign of the success of this entrepreneurial venture. The take-over of SBEFs may be a final outcome of the process of knowledge diffusion.

Keywords: SBEFs, university spin-offs, science-based entrepreneurship, Europe, IPOs, M&As.

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1. Introduction

Considerable academic and policy discussion has been focused on creating a supportive environment for the development of innovative firms. The founding and growth of these companies is based on the availability of two critical resources: human capital, for creation and management of innovations, and financial capital, for investment and growth.

Regarding human capital, a flourishing literature has investigated the contribution of universities to the creation of science-based entrepreneurial firms (SBEFs), which are considered to be a key driver of the rejuvenation of European innovative industries (Djokovic and Souitaris, 2008). Current literature suggests that, similar to the aim of policymakers, the creation of more direct links between universities and the business world represents an effective solution for fostering the creation of innovative firms. Indeed, thanks to the creation of business incubators and formal programs for technology transfer, universities have been able to leverage the technology transfer process directly, while a variety of benefits are simultaneously offered to SBEFs (Ensley and Hmieleski, 2005). For instance, university affiliations provide firms with privileged access to cutting-edge scientific knowledge. Links with universities also have beneficial effects on reputation that, in turn, facilitate collaboration with other organizations and enhance the credibility of the firm in the eyes of other stakeholders (Mian, 1997).

A second critical factor in the development of innovative firms is the availability of financial capital. The research and policy debate is centred on understanding, evaluating and improving the external funding environment confronting innovative start-up companies. Much of these discussions have revolved around the unsuitability of debt for early-stage financing and the merits of equity as sources of external finance for innovation, with equity invariably portrayed as patient and committed capital (Freel, 2007). Nonetheless, the existence of asymmetric information in capital markets means financial institutions may not adequately assess the investment projects they are asked to finance. This effect becomes marked in the case of small and innovative businesses, owing to the greater difficulties they encounter in transmitting reliable information about their real status and performance (Canovas and Solano, 2007). Financial constraints on firm growth are, in particular, a potential weakness in Europe, where the

public equity markets are less developed than in the US. Thus, an explicit goal of current public policy is to promote the development risk capital markets in order to sustain innovative entrepreneurship and to facilitate the expansion of existing small firms. Indeed, in the absence of sufficient internally generated cash flows to fund investments, public capital markets offer an opportunity for companies to obtain 'low cost' direct financing, without the costly interposition of a financial intermediary such as a bank or a venture capitalist (Holmström and Tirole, 1997). In this context, a primary role is assigned to the process of going public, traditionally considered as a natural step in the corporate life cycle. Accordingly, the IPO can serve as a springboard for implementing strategies of internal and external growth. Moreover, the creation of public shares subsequent to the listing decision allows stocks to be used as currency to participate in mergers and acquisitions (M&As). Divesting after a company has been made public may indeed constitute a better strategy than selling a still private firm directly at a value that is lower due to illiquidity. Such advantages of the strategy of sequential divesture though IPO would be especially high in knowledge-intensive industries.

In this context, it is of interest to analyse how the decision to go public affects firm evolution, particularly with respect to the relationship with M&As. While this is of special interest in the study of the dynamics of SBEFs, it is rarely addressed in the literature. The current paper examines M&A deals of innovative firms that went public in Europe during the 1995-2003 period. The final sample includes 500 companies that have been involved in a total of 3,000 M&As. Among these companies, 131 are SBEFs.

We found that university affiliation does influence firm evolution. SBEFs have a higher probability of being acquired and a lower propensity to make acquisitions than their independent counterparts. Given the relatively low operational efficiency and profit-orientation of university-based firms (Bonardo et al., 2008), the M&A market might be useful in establishing new ownership and management structures in SBEFs that can improve their productivity and maximize the financial return of the embodied human and technological capital. From an external perspective, SBEFs may be attractive acquisition targets owing to their superior innovative capacity. Furthermore, their university affiliation might involve a certification role, enhancing their attractiveness in the eyes of other firms. Coherently, even controlling for intellectual capital, profitability and other potential determinants, SBEFs have shown a higher probability to be

acquired. This distinction further suggests that the M&A market provides academic founders that are less interested in maintaining a position in a mature firm (Mosey and Wright, 2007) with an exit opportunity that allows them to return to their original academic activities.

The market for taking control of SBEFs is therefore quite active, with most of our sample SBEFs being acquired soon after the IPO. The high attractiveness of SBEFs is indicative of a positive role played by these companies in the process of technology transfer. The creation of a university-based firm is indeed a first step in the process of commercial exploitation of university-research. The subsequent step of going public is a signal of the success of this entrepreneurial venture. The take-over of the SBEF might be considered a final outcome of the process of knowledge diffusion. Moreover, the higher proportion of intra-industry M&As for university-based companies might also be viewed as a sign of interest in acquiring the intellectual capital embodied in science-based firms. Acquirers operating within the same industry are indeed assumed to be more attracted by such intellectual capital and also to be better able to value it.

On the other hand, SBEFs are less inclined to acquire other companies. This tendency can be explained, at least in part, by the superior internal technological resources available to SBEFs which may reduce their interest in seeking external technology acquisitions. But this is not the whole picture. Indeed, the higher probability of university-based firms to be acquired persists even when intellectual capital variables are controlled. Instead, interesting results on the inverse relationship between the level of internal technological resources and external sourcing through acquisitions comes from a “SBEF-intensive” industry, namely biotechnology, where as much as 60% of innovative small and medium enterprises (SMEs) that go public are SBEFs. In this industry, the role of technology-driven acquisitions is highly relevant. Considering biotech companies only, we are able to capture the peculiar role played by patents in determining M&A activities in this sector.

SBEFs might be less keen to pursue acquisitions for several other reasons. They might be less committed to engaging in external growing strategies due to the academic background, preferring to focus on core technical issues. In entrepreneurial ventures, researchers tend to be innovation oriented, often lacking in goal orientation (Wright et al., 2007). Our findings generally have a stronger statistical significance when the focus is only on SBEFs, where the TMTs still have academic members at the IPO, compared

to other SBEFs with no formal academic TMT involvement. The continuing presence of academics in the TMT of firms after the IPO improves their propensity to divest, but reduces their tendency to acquire. Importantly however, their relational and educational capital may improve the networking capacity of the firm. They may improve the international exposure of science-based firms, therefore improving their involvement in cross-border M&As. SBEFs indeed take part in cross-border M&As more frequently than do independent firms. University affiliation may therefore act as a signal of organizational legitimacy, giving international visibility to the firm.

The remainder of this paper is structured as follows. Section 2 summarizes the theoretical background and conceptual framework of this work. The research design, methodology and sample are described in Section 3. Section 4 presents the results of the empirical analysis on the propensity to acquire or be acquired. In Section 5, we provide complementary results on cross-border deals, including deals between SBEFs with and without academics in the TMT at the IPO, and focusing specifically on "SBEF-intensive" industries. Section 6 presents the conclusions.

2. Theoretical framework

2.1 Science-Based Entrepreneurial Firms

Firms competing in innovative industries base their competitive advantage on their capacity to raise and entrepreneurially exploit intellectual and financial capital. In this context, universities may represent an important source of knowledge upon which technological innovations can be based. Accordingly, a series of policies have been adopted by national governments with the aims of fostering the technology transfer process and of creating a supportive environment in which to create new science-based firms. As a result, the rate of formation of this type of firm has increased significantly in recent years (Wright et al., 2006).

University affiliation may have a significant impact on the strategies that firms pursue. From a resource-based perspective of the firm, the resource configuration of a company is related to its evolution and performance (Barney et al., 2001). It is well documented in the literature that companies obtain benefits and resource endowments from their affiliations with universities. Access to sources of knowledge and innovation, as well as access to physical resources, such as university laboratories and libraries, are key value

adding factors (Quintas et al., 1992). Furthermore, the window on emerging technologies provided by university affiliation can improve a firm's flexibility in conducting R&D activities (MacLachlan, 1995) and, at the same time, reduce the costs of technological development (George et al., 2002). Links with universities can also foster collaboration with public research institutions (Oliver and Liebeskind, 1998) and consequently, information sharing, especially where knowledge is more likely to be tacit (Cohen and Levinthal, 1990). They can also enhance the confidence of other stakeholders, such as venture capitalists, and act as a signal, mitigating the legitimacy concerns of other key actors (Mian, 1997).

Despite the benefits yielded, little is known about the evolution of university-based firms and their capacity to create wealth. In particular, the available evidence indicates that these firms are often not gazelles, and further that university affiliation may also have downsides. On a personal level, prestigious research achievements do not necessarily fit with an inclination to do business. The academic founders of SBEFs might not have enough business skills or commercial capabilities to exploit the innovative potential of their companies (Colombo and Piva, 2007). Developing a technology into a marketable product or service requires capabilities derived from prior industry and entrepreneurial experience, which the academic scientist may lack (Wright et al. 2004). This may have a negative influence on the profitability of science-based firms and their capacity to interact with other firms and to attract customers as well as managers with commercial expertise. Difficulties in identifying key decision makers can also discourage potential investors (Wright et al., 2006). Furthermore, involvement of academics in creating new ventures may not be driven, solely or primarily, by an entrepreneurial vision. Such ventures may be motivated, at least in part, by the prospect of enhancing one's academic position (Meyer, 2003). As a consequence, university-based firms may not be as profit-oriented as independent firms.

2.2 The dynamics of Science-Based Entrepreneurial Firms

University affiliation may influence the ability of a company to attract external investors and to develop partnerships with other firms. In this paper, we investigate the potential effects of university affiliation on the subsequent evolution of the firm, focusing, in particular, on the process of industrial restructuring through M&As. The study of M&A deals may provide substantial information about the strategic dynamics of these

companies and their ability to interact with other key actors in the global market. For instance, the matching theory of ownership change (Lichtenberg and Siegel, 1987 and 1989) helps to explain the peculiarities of the M&A activities of SBEFs. The rationale behind this theory suggests that M&As are important mechanisms in the market for corporate control as business transfers represent essential resource flows that facilitate the division of labour. The threat of takeover motivates managers to work to maximize profits, because ownership change provides a way of getting rid of ineffective managers, representing therefore a mechanism for correcting efficiency lapses[25].

The role of human capital in M&A deals is also of great interest. Business transfers involve important human resource flows that facilitate division of labour, with individuals changing jobs to pursue other development opportunities (Holms and Schmitz, 1990). The M&A market therefore promotes the upgrading of a firm's human capital. However, upgrades may be not limited to human resources. They may also involve physical and technological capital, so that companies may specialize in either internal development of R&D or acquisitions (Blonigen and Taylor, 2000). Companies with internally available resources are expected to show less interest in seeking external technology acquisitions through M&As and, at the same time, they may be more frequent targets in the M&A market. To this extent, the Q-theory of Mergers (Jovanovic and Rouseeau, 2002) predicts that a firm's investment rate should rise with its Q ratio (the ratio of market value and the replacement cost of capital). Thus, mergers may represent a channel through which capital flows to better projects and better management, with high-Q firms acquiring low-Q firms.

The implications of this theoretical framework for our study are the hypotheses that SBEFs have a lower propensity to acquire and a higher probability of being acquired. SBEFs may be less keen in pursuing acquisitions for several reasons. For instance, they may be less committed to engaging in growing strategies due to the academic background of their ownership or management. Presumably, academics may be more focussed on core technical aspects and less interested in horizontal integration. The IPO is already a signal of the success of a business initiative that might be "enough" for

[25] This theory does not assume that there are good or bad owners, but rather good and bad matches between companies and managers. The quality of the match is indexed by the plant's efficiency, so that a low level of productivity indicates a poor match and will induce a change in ownership. Thus, deteriorating productivity provides a signal to a plant's owner that he is operating in a less efficient manner than an alternative parent could due to an inherent incompatibility (a comparative disadvantage) or due to an overall lack of managerial competence (an absolute disadvantage).

academics, reducing their commitment to the achievement of further business growth. Also, in terms of division and specialization of labour, it is unlikely that academic personnel represent a solution for correcting inefficiencies of other firms in the market. In entrepreneurial ventures, researchers tend to be "innovation oriented, often lacking of goal orientation" (Wright et al., 2007, p. 143). Moreover, in a trade-off framework between internal resources and external technology acquisitions, the superior innovative capabilities of SBEFs might reduce their interest in pursuing acquisitions.

On the other hand, SBEFs are expected to more often be the target of M&A deals. Previous studies have suggested that the status of being a university-based firm is often associated with lower operational efficiency (Bonardo et al., 2008) and less profit-orientation (Meyer, 2003). Thus, the M&A market might establish new ownership and management structures in SBEFs that improve their productivity and maximize the financial return of the human and technological capital embodied by them (matching theory of ownership change). Second, academics that establish and manage SBEFs might be less interested in maintaining a position in a mature firm. Hence, the M&A market can provide them with an exit opportunity that allows return to their original academic activities (division of labour hypothesis). Some academic entrepreneurs may also seek to go and start another new business, a supposition that is coherent with the notion of habitual academic entrepreneurs (Mosey and Wright, 2007).

From the external perspective of an acquirer, SBEFs may be preferred targets owing to their superior internally available technological capabilities (Colombo and Piva, 2007). University affiliation might also act as a signal of quality with a positive image impact that improves the attractiveness of the firm for investors. Indeed, institutional affiliation may give legitimacy to firms, especially for innovative SMEs, attracting the attention of other prestigious affiliations, thus mitigating legitimacy concerns of other key actors. A similar role may be played by TMT relational and educational capital, which may improve firms' networking capacity (Hsu, 2007). Prestigious directors are considered better able to form relationships with other individuals and to participate in important associations with bankers, investors, suppliers, and customers (Stuart et al., 1999). Moreover, from a network theory perspective, relational capital, in the form of social relations with public institutions or financial entities, is not just a form of resources, but can also be used as a conduit for information and resources. The latter should have its highest impact when it bridges a SBEF's intellectual capital and another company's

complementary assets. The signalling effect of university affiliation and the higher level of intellectual capital may also improve the international exposure of science-based firms, therefore improving their involvement in cross-border M&As.

The academic background of SBEF founders is therefore expected to be an important factor that influences the post-IPO strategic decisions of the firms. This holds true especially for academics who are still in the TMT at the IPO. Their continuing presence may indeed improve a firm's propensity to divest and reduce its interest in acquiring. We therefore distinguish between SBEFs where the TMTs have academic members at the IPO and other SBEFs with no formal TMT involvement of academics. In the former case, we expect a strengthened corroboration of our hypotheses regarding the lower propensity of university-based firms to acquire and their higher probability of being acquired.

2.3 The relationship between IPOs and the market for corporate control

The IPO market and the M&A market are not as independent as often assumed. The fresh capital raised through IPO could make available the funds needed to fuel the firm's external growth. Besides cash acquisitions, the IPO may also facilitate stock deals, as the establishment of a market price and the creation of public shares allows stocks to be used as currency to participate in M&As. Indeed, the prospects of future deals grow as valuation challenges for would-be-investors are alleviated with the IPO placing a price on the firm. Forming a currency of stock for future M&A deals is actually one of the most important motivations for going public (Paleari et al., 2008)[26].

The IPO may also mitigate inefficiencies in the M&A market in another way. IPOs can be part of a larger process of transferring control rights, where owner-managers of private firms use the IPO as part of a divestiture strategy. In order to identify potential acquirers and to increase a firm's visibility, shareholders of private firms could decide to use sequential divestitures through IPOs rather than outright sales. The process of going public would therefore be responsive to adverse selection problems by increasing

[26] On reading the IPO prospectuses, one would find that the most cited reason for going public is the desire to raise equity capital to finance firm's growth and new valuable projects (Ellingsen and Rydqvist, 1997). Paleari et al. (2008) find that pursuing growth strategies through capital expenditures and acquisition has been the leading motivation for European companies to go public in the last decade. In a survey of 336 chief financial officers of companies going public in the US, Brau and Fawcett (2006) find that the primary motivation for going public is to facilitate acquisitions.

the amount of information available on the firm (Reuer and Shen, 2003). The IPO and the contextual move from the private to the public domain increases the level of a firm's disclosure and of investors' monitoring. The consequent decrease in information asymmetries may, in turn, increase the opportunities of equity deals. To the extent that the process of going public credibly reveals information on a firm's value, the IPO market can enhance the efficiency of the M&A market. Such a certification role in the process of going public is typically played by investment bankers involved in the IPO pricing. They are expected to credibly certify the quality of firms because of the repeat nature of their business, which encourages them to preserve their reputational capital and to desist from opportunism (Paleari and Vismara, 2007). As a consequence, existing shareholders of private firms can maximize their firm's value by adopting the strategy of divesting after taking the company public, rather than directly selling a still-private firm at value limited by illiquidity (lack-of-marketability) discount (Silber, 1991).

IPOs may therefore favour both acquisitions and divestment strategies, improving the efficiency of the M&A market. Such advantages are particularly pronounced in knowledge-intensive industries, where M&A negotiations tend to be lengthier and buyers respond by offering lower bids (Coff, 1999). Valuation is especially challenging for innovative companies which embody tacit knowledge and technologies that are difficult understand and value. The problem of a firm's transparency to the market is therefore particularly acute for a university-based firm where there are fewer contacts with industry, so that bidders may be less aware of it (Clarysse et al., 2007). Moreover, the IPO may be a way of establishing a market value that satisfies university shareholders rather than direct sale to a corporation.

3. Research Design

3.1 Sample selection

In this paper, we analyse the M&A activity of innovative firms that went public in Europe in the period from 1995 to 2003. The list of IPO firms is from the EURIPO database that includes all of the IPOs that took place in Europe over the last decade[27]. We focus on the four largest economies in Europe, namely Germany (Deutsche Börse),

[27] EURIPO (www.euripo.eu) is a database on European IPOs built and managed by Universoft, a spin-off company of the University of Bergamo.

the United Kingdom (London Stock Exchange), France (Euronext), and Italy (Borsa Italiana). From this sample, we considered all SMEs that operate in innovative industries: electronics (Electronics), information technology (IT), pharmaceutical and biotech (Pharma & Bio), industrial machinery (Machinery) and communications (Communications)[28]. The final sample is made up of 499 firms (Table 9).

We identified as SBEFs[29] those companies that had been developed by faculty members, based on their research, or companies created to capitalise on research carried out in universities. Our definition of SBEFs was in keeping with the literature[30]. However, in Section 5, we disaggregate the sample of SBEF firms with and without formal involvement of academics in the TMT (the former are labelled University Spin-Offs, USOs).

Firms were categorized based on information disclosed in their official IPO prospectuses, which are mandatory for companies issuing public stocks. The prospectuses contain a wealth of information regarding the firm's history and management. In particular, companies going public are required to describe their history and to report the curriculum vitae of their founder(s) and TMT members[31]. Examples

[28] SMEs are defined according to the definition of the European Commission as firms with sales inferior to 50 €m at the IPO. Innovative industries are identified in line with other studies (e.g., Cloodt et al., 2006).

[29] The entrepreneurial orientation concept as applied to a firm has its origins in the strategy literature (Becherer and Maurer, 1997). For instance, Miller (1983) defined an entrepreneurial firm as one that "engages in product marketing innovation, undertakes somewhat risky ventures, and is first to come up with proactive innovations, beating competitors to the punch". This is certainly the case of new ventures created drawing on university-based technological and scientific knowledge.

[30] For instance, Ensley and Hmieleski (2005, p. 1097) define university-based firms as those that were "developed by students or faculty based on their research, or utilized research from a university's technology transfer area"; Druilhe and Garnsey (2004, p. 274) identify companies "drawing on university-based technological and scientific knowledge and involving academics or students who were still members or who had just quit the university"; Smith and Ho (2006, p. 1560) refer to "technology-based company founded by a member/former member of a university or one of the seven laboratories using IP developed in the institution by the founding individual(s)"; Colombo et al. (2006, p. 3) define academic start-ups as "new ventures with an entrepreneurial team at least partially composed of academics and/or researchers from public research organizations"; O' Shea et al. (2008) refer to spin-offs as companies that involve "1) the transfer of a core technology from an academic institution into a new company; 2) the founding member(s) may include the inventor academic(s) who may or may not be currently affiliated with the academic institution".

[31] Typical sections of the IPO prospectuses that report the information needed to identify SBEFs are in France, the sections "Historique du Groupe", "Recherche et développement" and "Ressources humaines"; in Germany, "Gründung", "Organe der Gesellschaft" and "Forschung und Entwicklung"; in Italy "Storia ed evoluzione dell'attività", "Politica di ricerca e sviluppo", "Attività svolte dai componenti del Consiglio di Amministrazione" and "Struttura organizzativa"; in the UK, "History and background", "Management", "Directors" and "Research and Development Programmes". The purpose of the prospectus is to sell stock. Therefore, it is assumed that all relevant information will be included. Since owners and managers can be held legally accountable for the accuracy of the information disclosed in this document, it represents the best source of information on the quality for the firm. As a result, prospectus

taken from IPO prospectuses are as follows.

(4) "The Company was formed in 1992 to capitalise on over 30 years of pioneering and innovative research by a scientific team at the Rheumatology and Allergy Research Unit ("RARU") at Birmingham University […]."

(5) "1983: incorporation of Init AG as a spin-off from the research project 'Demand operated bus transport' of the University of Karlsruhe by Dr. […]."

(6) "The Company was formed in 1996 at Brunel University Science Park, Uxbridge, to research and develop a number of technologies […] and to make use of Dr […] experience."

(7) "The company was founded as a GmbH on October 19, 1989 as "Novasoft Consulting gesellschaft mit beschrankter Haftung" by Dr. XX and Dr. XY […] Dr. XX is a research assistant in the area of planning and logistics at the research institute in Aachen […], Dr. XY worked as research assistant in the area of theoretical physics at the University of Technology, Aachen."

In agreement with previous studies (e.g. Smith and Ho, 2006), we found that biotech and IT industries were strongly associated with university spin-off activity[32]. In particular, we found that most biotech companies going public were SBEFs (52 out of 88 IPOs in this sector), consistent with the particular research-based nature of this industry. While the relevance of university-based firms was also significant for the IT and the electronic sectors, it was lower in Communications and Machinery[33]. As for country specificities, predictably, the UK and Germany were the most highly represented countries in the sample of innovative SMEs (39% and 38%, respectively), while Italy only contributed to 5.2% of the sample. This composition was due to the differing sizes of the countries' economies and to their differing levels of stock market development. The proportion of firms based in the UK was even higher when SBEFs were taken into account (62 UK SBEFs out of 131). This evidence suggested that the

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data are considered reliable and there is a long tradition of using such information in strategy research and, more recently, in entrepreneurship research (Shrader and Siegel, 2007).

[32] We relied on a sample of IPO firms, which, as such, can be viewed as a positive selection of successful SBEFs. However, we believe that it can be considered representative of the phenomenon of university-based firm creation. We find indeed a distribution of SBEFs among industries similar to previous studies (for instance, the Smith and Ho [2006] sample that focuses on spin-offs from the public sector research base in Oxfordshire [UK]). Moreover, the evidence that university affiliation still affects the behaviour of firms after the IPO may be viewed as a signal of a long-term effect of such affiliation on the resource endowment of firms.

[33] Section 5 is devoted to complementary and robustness issues and contains an ad-hoc analysis of "SBEF-intensive" industries.

university system in Britain has probably been more entrepreneurial over the last decade than their European counterparts (Slaughter and Leslie, 1999)[34]. German IPOs were particularly frequent in the IT industry (51% of the total number of IT IPOs), thanks to the success of the Neuer Market during the examined time period. On the other hand, France and Italy were influential in the composition of the Machinery industry. In particular, 49% of Machinery firms were French, and 18% were Italian. Finally, most firms (62%) went public between 1998-2000, coinciding with the favourable momentum of the stock markets that ended during the first months of 2000, with the burst of the new economy bubble.

[34] We found 47 SBEFs in Germany (35.9% of the sample of SBEFs), 19 in France (14.5%) and 3 in Italy (2.3%). Also, if we consider the number of SBEFs over the total number of companies selected in each country, UK had the highest proportion (31.6%). The percentage of SBEFs was 25% in Germany, 22% in France, and 11.5% in Italy.

Table 9: Sample

	Sample	Electronics	IT	Pharma & Bio	Machinery	Communications
No. firms	499	77	206	88	45	83
(%)		*(15.43)*	*(41.28)*	*(17.64)*	*(9.02)*	*(16.63)*
No SBEFs	131	21	44	52	3	11
(%)		*(16.03)*	*(33.59)*	*(39.69)*	*(2.29)*	*(8.40)*
% SBEFs	26.25	27.27	21.36	59.09	6.67	13.25
France	87	24	13	18	22	10
(%)	*(17.43)*	*(27.59)*	*(14.94)*	*(20.69)*	*(25.29)*	*(11.49)*
Germany	190	28	106	21	2	33
(%)	*(38.08)*	*(14.74)*	*(55.79)*	*(11.05)*	*(1.05)*	*(17.37)*
Italy	26	7	6	4	8	1
(%)	*(5.21)*	*(26.92)*	*(23.08)*	*(15.38)*	*(30.77)*	*(3.85)*
UK	196	18	81	45	13	39
(%)	*(39.28)*	*(9.18)*	*(41.33)*	*(22.96)*	*(6.63)*	*(19.90)*
1995-1997	117	23	34	19	15	26
(%)	*(23.45)*	*(19.66)*	*(29.06)*	*(16.24)*	*(12.82)*	*(22.22)*
1998-2000 *(Bubble*)	309	37	157	48	19	48
(%)	*(61.92)*	*(11.97)*	*(50.81)*	*(15.53)*	*(6.15)*	*(15.53)*
2001-2003	73	17	15	21	11	9
(%)	*(14.63)*	*(23.29)*	*(20.55)*	*(28.77)*	*(15.07)*	*(12.33)*

[a] Percentages in the first column are relative to the entire sample.

3.2 Variables and measures

We utilized several variables of four typologies: (1) general characteristics of the firms, (2) intellectual capital, (3) ownership and corporate governance, (4) M&A characteristics.

Table 10: Variable definition

Variable [a]	Definition
GENERAL CHARACTERISTICS OF FIRMS	
Market Value (€m)	Market capitalization
Age (years)	Age (years since incorporation)
Leverage (%)	Ratio between debt and total assets
Profitability (%)	Return on assets
Market to Book	Ratio between market and book value of equity
INTELLECTUAL CAPITAL	
Patents (No.)	Number of patents registered at the European Patent Office
Ph.D. in the TMT (%)	Proportion of TMT members that are university professors or hold a PhD degree
MBA in the TMT (%)	Proportion of TMT members with a MBA degree
TMT Experience (% of directors)	Proportion of directors with TMT membership experiences in other firms
TMT Relational Capital (% of directors)	Proportion of TMT members with experiences in public institutions or in the TMT of financial entities
TMT Age (years)	Age of TMT members (average)
CEO Experience (No. of TMT membership)	Proportion of directors with CEO experiences in other firms
CEO Relational Capital (No.)	Number of CEO experiences in public institution or in the TMT of financial entities
CEO Age (years)	Age of the CEO.
OWNERSHIP AND CORPORATE GOVERNANCE	
Ownership Concentration (%)	Equity stake held by substantial shareholders. Details of directors' interests and external interests which amounted to at least 2 or 3% of issued share capital are required to be disclosed at the IPO. Substantial shareholders are identified by these cut-off ownership levels for mandatory disclosures required by national laws.
TMT Ownership (%)	Ownership stake held by TMT members
CEO Ownership (%)	Ownership stake held by CEO
TMT size (No. directors)	Number of TMT members
Independent Directors (%)	Proportion of independent TMT members
VC-backed (% of firms)	Dummy variable equal to 1 if at least one

	venture capitalist is present in the ownership structure
Capital Inflow at the IPO (%)	New shares issued at listing over market capitalization after the IPO
CEO = Founder (% of firms)	Percentage of firms where the CEO is also the founder.
CEO = Main Shareholder (% of firms)	Percentage of firms where the CEO is also the main shareholder
Split CEO Chairman (% of firms)	Percentage of firms with a split roles of CEO and chairman
Non-Executive Chairman (% of firms)	Proportion of firms where the chairman holds a non-executive position
M&A CHARACTERISTICS	
Firms involved in M&A deals (% of the sample)	Percentage of firms involved as acquirer or a target in at least one M&A deal
Deals (No.)	Number of deals as acquirer or target
Deals as Acquirer (%)	Number of deals as acquirer over the total number of M&As
Deals after IPO (%)	Number of deals pursued after the IPO as acquirer or target
Time to first deal after IPO (months)	Time elapsing between the IPO and the first M&A deal
Stock as payment method (%)	Proportion of deals (as acquirer or target) where the payment method adopted is stock
Intra-industry (%)	Proportion of deals (as acquirer or target) where firms involved belong to the same industry
Cross-border (%)	Proportion of deals (as acquirer or target) between firms belonging to different countries
Private Targets/Acquirers (%)	Proportion of deals as acquirer/target where the target/ acquirer is a private company
Equity stake acquired in targets (%)	Average equity stake acquired by sample firms in target firms
Equity stake sold to acquirer (%)	Average equity stake sold by sample firms in deals
Financial acquirers (%)	Proportion of deals as target where the acquiring company belongs to the financial industry
CHARACTERSISTICS OF CONTROL ACQUISITIONS	
Control transfers (% of the sample)	Percentage of sample firms whose control has been transferred through post-IPO M&A deals
One-shot acquisition (%)	Percentage of firms (among control transfers) acquired in one deal
Only one acquirer (%)	Percentage of firms (among control transfers) that are acquired by only one acquirer
Time to First Control Acquisition (months)	Time elapsing between the IPO and the first acquisition that leads to control transfer
Time to Transfer Control (months)	Time elapsing between the IPO and the last acquisition that leads to control transfer

[a] Firm-specific variables (General characteristics, Intellectual capital, Ownership and Corporate Governance) are measured at the IPO.

Firm-specific variables were measured at the IPO and were considered as possible determinants of M&A activity. M&A-specific variables encompassed several aspects in order to identify the aim and the relevance of M&A activity in the evolution of our sample firms. When sample firms were targets of M&A deals, we distinguished between the acquisition of minority interests (just being a target) and the acquisition of a firm's control (identified as control transfer M&As). Precise definitions of the variables are provided in Table 10

3.3 Sample description

At the time of their IPOs, SMEs going public in Europe were in median 8 years old and had an average market value of 79 €m (Table 11). Size varied among industries, from an average of 44.5 €m of market capitalization of Machinery firms, to 99 €m for IT firms[35]. Leverage, measured as the debt to total asset ratio, spanned from an average of 21% (biotech companies) to 67% (machinery firms). Machinery was also the sector with the highest median profitability (measured as return on assets), and the lowest market-to-book ratio. On the other hand, biotech companies were the least profitable (most had no earnings prior to the IPO) and had the highest market-to-book ratio. There were, therefore, two extremes in the industry composition of the sample. Machinery companies were the smallest, oldest, most indebted and more profitable companies, while Pharma & Bio companies were the youngest, (second) biggest, less indebted and less profitable firms.

[35] The sample is made up of SMEs operating in innovative industries that went public in Europe in the period 1995-2003. According to the EU definition of SME, only companies with (pre-IPO) sales lower to 50 €m are selected. As a consequence, the average market size in our sample is higher for industries with high relevance of intangible assets, such as IT and biotech, and lower for machinery and electronics. This is due to the different levels of the price-to-sales ratio, that is higher in more intangible industries. Similar considerations can be drawn for the market-to-book ratio.

Table 11: Descriptive statistics

Variables [a]	Sample	Electronics	IT	Pharma & Bio	Machinery	Communications	SBEFs [b]
PANEL A: GENERAL CHARACTERISTICS OF FIRMS							
Market Value (€m)	78.57	55.25	99.05	79.56	44.52	59.62	85.41
Age (years, median)	8	9	9	6	10	6	7
Leverage (%, median)	28.66	54.98	23.12	21.08	67.03	50.48	34.86
Profitability (%, median)	7.31	8.51	4.84	- 3.58	14.05	9.73	- 1.82***
Market to Book	3.61	3.52	3.72	3.61	3.35	3.66	3.77**
PANEL B: INTELLECTUAL CAPITAL							
Patents (No.)	17.07	34.41	6.32	37.76	14.86	6.76	35.55**
Patents (No., median)	2	6	2	9	5	1	6***
Ph.D. in the TMT (%)	10.28	6.95	9.52	23.64	3.01	2.82	25.41***
MBA in the TMT (%)	10.79	16.14	6.38	19.54	9.51	8.24	16.98***
TMT Experience (% of directors)	72.61	61.92	74.58	80.24	62.15	71.78	84.15***
TMT Relational Capital (% of directors)	8.33	8.94	4.59	17.04	8.51	7.58	14.41***
TMT Age (years)	47.23	47.56	46.25	48.41	50.14	46.42	46.85
CEO Experience (No. of TMT memberships)	2.22	1.98	2.21	2.14	3.33	1.95	2.58**
CEO Relational Capital (No.)	0.69	0.46	0.78	0.79	0.29	0.65	0.87***
CEO Age (years)	46.79	48.68	46.63	47.58	49.61	45.34	45.44*
PANEL C: OWNERSHIP AND CORPORATE GOVERNANCE							
Ownership Concentration (%)	54.51	59.63	53.04	48.45	59.97	57.58	50.02***
TMT Ownership (%)	36.35	31.96	33.34	28.45	44.87	50.44	31.85*
CEO Ownership (%)	26.68	19.94	32.92	18.24	22.65	25.36	16.94**
TMT size (No. directors)	5.11	5.21	4.52	5.92	5.94	5.15	5.88***
Independent Directors (%)	34.71	40.89	30.19	41.32	33.13	34.15	36.98*
VC-backed (% of firms)	55.22	59.15	58.84	58.62	32.43	47.94	60.15
Capital Inflow at the IPO (%)	32.23	29.21	30.65	47.38	16.66	31.53	45.87**
CEO = Founder (% of firms)	58.69	56.33	60.64	54.02	45.94	68.05	60.76
CEO = Main Shareholder (% of firms)	48.34	43.05	49.19	40.22	56.75	57.35	42.01**
Split CEO Chairman (% of firms)	36.54	35.29	29.73	48.27	37.50	40.54	53.54***
Non Executive Chairman (% of firms)	27.27	27.53	20.04	35.63	38.71	31.08	34.62**

[a] Averages.

[b] Tests are between SBEFS and independent firms. The significance levels are based on t-statistics (mean), Mann-Whitney U-test (median), *Z*-tests of equal proportions, as required. Significance level at 1% (***), 5% (**) and 10% (*).

Compared to independent firms, we found that SBEFs were less profitable (negative median return-on-assets), but more innovative (higher number of patents). University-based firms also had higher educational (PhDs and MBAs in the TMT) and relational capital (TMT and CEO experience and relational capital[36]) than independent firms had. These findings, although partially due to industry biases, confirm the conclusions of prior studies (e.g. Ensley and Hmieleski, 2005; Bonardo et al., 2008; Colombo and Piva, 2007). Moreover, we found that the market of investors assigned higher value to university-based firms (the median market-to-book ratio was higher for SBEFs than for independent firms). Different explanations can be proposed. In a signalling framework, investors may view university affiliation as a credible sign of the firm's quality, as linkage with a university can mitigate the concerns over legitimacy associated with the IPO process. Furthermore, since university-based firms are associated with higher innovative activity, the market may recognize greater growth opportunities in these firms.

Our examination of ownership structure revealed that the median equity stake held by substantial shareholders (Ownership Concentration) was 54.5%, while the mean value of TMT and CEO ownership were 36.4% and 26.7%, respectively. These results suggest that innovative SMEs initially relied on capital from a limited number of backers, often coinciding with the TMT. This was particularly true for independent firms that showed higher values of ownership for all categories considered by shareholders, reflecting less effort expended in acquiring external financial resources. On the contrary, TMT ownership may have also been lower in SBEFs because academics who become entrepreneurs have limited personal funds to invest in their companies. This interpretation is supported by the lower proportion of university-based firms in which the CEO was also the main shareholder. On the other hand, the proportion of firms in which the CEO was also the founder was similar between science-based and independent firms.

[36] Capello and Faggian (2005) define relational capital as any relationship – market relationships, power relationships and cooperation – established between firms, institutions and people. In our study, market relationships are measured by the TMT Experiences variable, calculated as the percentage of the firm's TMT members with TMT membership in at least another firm. The level of firms' relationship with institutions is measured as the percentage of directors with experiences in public institutions or in the TMT of financial entities (TMT Relational Capital). For the CEO, we consider the number of CEO memberships in other firms (CEO Experiences) and the number of CEO experiences in public institutions or in the TMT of financial entities (CEO Relational Capital).

University-based firms showed a higher propensity to view the IPO as a means of raising new funds, with a high level of fresh capital inflow at the IPO (45.9% vs. 32.2% for independent firms). Although SBEFs seemed to count more on limited personal funds than independent companies, access to venture capital had not yet become more important. Public grants were probably still perceived by universities as the primary way to raise funds for the creation and development of business activities (Wright et al., 2006). Finally, university-based firms seem to be more compliant with the prescriptions on corporate governance practice, with SBEF TMTs having, on average, a larger number of components and a higher percentage of independent directors.

3.4 Methodology

The study of the SBEF dynamics was centred on their M&A activity. The data source on M&A deals was the Thomson One Banker Deals database, which in turn relies on other sources, such as stock exchange commissions, trade publications, law firms and investment bank surveys. This database provides information on worldwide markets from publicly (private and public) announced M&As[37]. We identified 2,997 M&A transactions involving our sample firms. Among these, 951 were deals in which the sample firms were targets and 2,046 were deals in which they were acquirers.

We used two regression models to investigate the effects of university affiliation on the M&A dynamics of firms. The regressions also tested the influence of other factors, such as VC-backing, intellectual capital, and ownership structure or corporate governance[38].

[37] In line with other authors (e.g. Bertrand and Zuniga, 2006), we kept all deals of industrial restructuring. Thus, our sample firms could be targeted in several M&A transactions, since with M&As we do not refer exclusively to the combination of two companies to form a new company. The raw data were checked to eliminate double counting of transactions. Deals were identified by the cut-off ownership levels for mandatory disclosures required by national laws. In all the jurisdictions evaluated, there was a formal obligation which required major shareholders to disclose their holdings in a company. The percentage level at which such an obligation was triggered varied from country to country. France (Code de Commerce, article L. 233-7) and Germany (Securities Acquisition and Take-over Act, sections 21 and 22) adopted 5% as a base level, like in the US, while Italy (Law No. 58 of 1998) and the UK (Companies Act 1985 sections 198-212) were at 2% and 3%, respectively.

[38] In all the models, we considered the post-IPO period because the large majority of deals were effectuated after the floatation The post IPO period of analysis considered for each firm was different, depending on the date of the IPO. However, we tested that the distribution among IPO years (1995-2003) of SBEFs and independent firms was not statistically different. The proportion of SBEFs over the total sample reached its lowest value in 1996 (20.71%) and its highest value in 2000 (29.08%) with a mean value of 26.25%. Thus, we do not believe that considering different time spans can introduce a bias in the comparison between SBEFs and independent innovative SMEs. On the other hand, cutting the years considered after the IPO, to have similar time spans for all our sample firms, can appreciably reduce the informativeness of the available data.

The first model consisted of a Poisson regression used to investigate the propensity of sample firms to grow through M&As. The dependent variable in this model was the number of acquisitions pursued by sample firms after floatation. We also analysed the relevance of M&As in the process of divestment of original shareholders after the IPO. First, we used Cox proportional hazard regressions to investigate which characteristics of the firm at the IPO improved the probability of it becoming a target (at least one time) after floatation. We then focused on companies that had transferred their control after the IPO. We studied the temporary distribution of the probability to be acquired after the IPO (targeted in a deal, or a sequence of deals, where the control stake of the company was transferred), and we used a Cox proportional hazard regression (where the output variable was equal to 1 if the control equity stake of the firm was acquired) to investigate the determinants of this probability.

In all our regression models, we used a common set of explaining variables grouped in four categories: baseline regression variables, institutional affiliation, intellectual capital, and ownership and corporate governance[39]. We included in the baseline regression a set of control variables that could have influenced post IPO M&A activity: (1) firm size, measured by the natural logarithm of market capitalization at the IPO; (2) firm leverage, measured by the debt to total assets ratio at the IPO; (3) firm profitability, measured by return on assets at the IPO; (4) market to book, measured by the ratio between market and book value of equity at the IPO; and (5) a series of dummy variables for industry, countries and year specificities. Our most important theoretical variables referred to institutional affiliation. We used dummy variables to test the effect of university affiliation and pre-IPO VC financing. Moreover, we took into consideration the effect of intellectual capital by testing several variables, such as patents (the logarithm of the number of patents held by each firm at the IPO, scaled by the logarithm of market capitalization), the proportion of directors with MBA and PhD degrees, and the proportion of TMT members with experience in other TMTs, and TMT relational capital. Finally, we tested for the effects of ownership concentration, TMT ownership, and TMT structure (number of directors and proportion of independent members).

[39] Our results were not significantly influenced by endogeneity problems, as our independent variables were measured at the IPO, while the dependent variables had post-IPO M&As characteristics. M&As could have, in general, influenced firm profitability (one of our independent variables), resulting in an endogenous relation. However, our models measured profitability prior to the IPO (ex ante), while we considered M&As that were pursued in the post-IPO period (ex post).

4. Results

M&As are fundamental to the evolution of innovative SMEs, both in terms of opportunities to acquire and to be acquired. Indeed, we find that three quarters of the sample firms (78.6%) were involved as an acquirer in at least one M&A transaction during the 1984-2006 period; meanwhile, 64% were targets of M&As (Table 12). The propensity to take part in M&A deals, either as a target or an acquirer, was higher in the communication industry (84% of the firms in this sector performed acquisitions, 73% were targeted), while the propensity to acquire was particularly high in the IT sector (90%). Almost all deals (93%) occurred after the IPO, with one year passing on average from the IPO to the first acquisition deal. In contrast, M&As involving IPO firms as targets tended to occur later, being initiated, on average, three years after the IPO.

These findings confirm that the IPO and M&A markets are linked. The IPO is indeed a means to pursue external growth strategies. In particular, the IPO facilitates stock acquisitions, as the creation of public shares allows stocks to be used as currency to participate in M&As. Accordingly, we found that most transactions used stock as the payment method (51.5% when IPO-firms were acquired, 74.7% when targeted). This confirms the relevance of forming a currency of stock for takeovers as a reason for conducting an IPO (Paleari et al., 2008). Owner-managers of private firms also use the IPO as part of a divestiture strategy. The prevalence of post-IPO deals over pre-IPO deals is indeed consistent for transactions in which firms were targets. The recourse to stocks as currency (payment method) was also more extensive in deals targeting IPO-firms than in deals where the latter was the acquirer (74% vs. 51%).

Table 12: M&A deals (target and acquirers)

Variables	Sample [b]	Electronics	IT	Pharma & Bio	Machinery	Communications
PANEL A: SAMPLE FIRMS AS ACQUIRERS						
Firms involved in M&A deals (% of the sample)	78.56***	63.64	89.81	64.77	68.89	84.34
Deals (average no. per firm)	5.22***	4.87	5.60	3.73	5.13	5.71
Deals after IPO (%) [a]	93.23	90.83	94.64	89.79	92.25	94.41
Time to first deal after IPO (months)	11.65***	7.87	11.95	15.89	21.02	15.61
Stock as Payment method (%) [a]	51.52***	55.97	51.67	51.56	44.72	51.01
Intra-industry (%) [a]	39.31***	28.41	40.85	45.43	35.29	39.62
Cross-border (%) [a]	36.63	38.41	37.46	46.38	15.58	30.57
Private Targets (%) [a]	69.25***	64.38	74.43	62.22	58.82	69.42
Equity Stake Acquired in Targets (%) [a]	83.41***	81.70	83.20	86.57	83.07	82.77
PANEL B: SAMPLE FIRMS AS TARGETS						
Firms involved in M&A deals (% of the sample)	64.32	58.44	64.08	68.18	51.11	73.49
Deals (average no. per firm)	2.96	3.01	2.76	2.97	3.22	3.26
Deals After IPO (%) [a]	90.35	87.14	91.22	91.43	85.51	91.55
Time to first deal after IPO (months)	26.94	19.22	28.23	25.41	24.72	31.05
Stock as Payment method (%) [a]	74.72	78.92	76.54	74.24	61.92	72.11
Intra-industry (%) [a]	20.94	20.59	21.85	21.84	23.87	17.68
Cross-border (%) [a]	36.86	51.55	28.96	48.86	17.11	37.18
Private Acquirers (%) [a]	44.92	23.94	49.93	42.43	56.59	47.63
Financial Acquirers (%) [a]	43.22	31.42	45.77	41.54	48.62	46.01
Equity stake sold to acquirer (%) [a]	62.07	60.38	60.85	56.51	69.76	68.02
Firms transferring control (% of the sample)	37.47	38.96	31.07	46.59	31.11	45.78

[a] Percentage of deals per firm, average.

[b] Statistical tests (first column) are on the difference between firms as acquirers and firms as targets. The significance levels are based on t-statistics (mean), *Z*-tests of equal proportions, as required. Significance level at 1% (***), 5% (**) and 10% (*).

As shown in Table 13, we found that SBEFs were more often targets of M&A deals than independent firms (69% vs. 63%), while independent firms were more active acquirers (80% of the independent firms performed M&As as the acquirer, vs. 73% of SBEFs). Also, the time lag from IPO to the first acquisition deal was shorter for independent SMEs than for SBEFs (8 vs. 18 months, on average), suggesting that the independent SMEs were more prepared to use the IPO as a growth opportunity. This evidence confirmed our predictions for the effect of university affiliation on M&A activity of science-based firms. According to matching theory, the lower profitability of SBEFs may improve their probability of being a target for takeover. Second, the division of labour hypothesis suggests that the M&A market can provide academics with an exit from their company and a return to academic activities. Also, SBEFs may be a preferred acquisition target because of their internally available technological capabilities (Jones et al., 2001; Blonigen and Taylor, 2000). This last hypothesis is corroborated by the lower incidence of financial acquirers for SBEFs[40] and a higher proportion of intra-industry deals where these firms are targets. Acquirers operating in the same industry are indeed assumed to be more attracted by the intellectual capital embodied in science-based firms, and also to be better able to value it. Similarly, the capital upgrading argument may also explain the lower propensity of SBEFs to pursue acquisitions. The superior innovative capabilities of university-based companies may indeed reduce the interest of these firms in pursuing acquisitions. Finally, academics may be more focussed in core technical aspects and less interested in growth or horizontal integration, hence limiting their interest in pursuing acquisitions.

Specificities exist even with regard to the nature of counterparts in deals. Two thirds of the acquisitions made by sample IPO firms were by private firms, while M&As targeting IPO-firms were often performed (55%) by public firms, especially for SBEFs (61.5% of the M&As targeting SBEFs were pursued by public companies). Interestingly, the proportion of private deals in which IPO-firms were considered as targets vs. as acquirers varied among industries. For instance, Machinery firms had the lowest proportion of private firms acquired by IPO-firms (58.8% of M&As by private firms), and the highest proportion of private firms targeting IPO firms (56.6%).

[40] Acquirer firms are identified as Financial Acquirer when their first digit of the SIC code is 6. On average, 46.5% of the M&A deals targeting independent firms were made by financial companies, as reported in Table 13. This percentage lowered to 34.7% for SBEFs. The difference between the two sub-samples was statistically significant.

Table 13: M&A deals of SBEFs and independent firms

	SBEFs				Independent [b]			
	SBEF sub-sample	Electronics	IT	Pharma & Bio	Independent sub-sample	Electronics	IT	Pharma & Bio
PANEL A: SAMPLE FIRMS AS ACQUIRERS								
Firms involved in M&A deals (% of the sample)	73.28	57.14	90.56	63.46	79.62*	64.68	88.89	66.68*
Deals as Acquirer (%) [a]	58.33	54.84	70.14	45.84	72.98***	64.84*	79.26**	63.59***
Deals (average no. per firm)	3.89	4.51	3.46	3.33	5.65**	5.01*	6.21***	4.29**
Deals after IPO (%) [a]	92.91	84.97	96.81	88.39	93.33	92.73	94.03	90.33
Time to first deal after IPO (months)	18.04	19.22	15.01	22.61	8.47***	5.96*	9.33**	6.28***
Stock as Payment method (%) [a]	48.34	36.33	47.66	55.01	52.54	62.33***	52.81	46.84
Intra-industry (%) [a]	42.29	31.13	49.39	42.22	38.34	27.21	38.43*	49.84
Cross-border (%) [a]	45.56	49.09	45.47	52.52	34.07***	28.95**	35.75**	37.92**
Private Targets (%) [a]	65.59	62.22	73.65	56.27	70.44	65.09	76.65	70.41**
Equity stake acquired in targets (%) [a]	88.67	89.39	87.68	90.58	81.69***	79.36**	81.85**	81.28**
PANEL B: SAMPLE FIRMS AS TARGETS								
Firms involved in M&A deals (% of the sample)	68.71	66.66	61.36	75.01	62.77*	55.35	64.81	58.33*
Deals (average no. per firm)	2.67	1.85	2.74	2.66	3.08**	3.52**	2.77	3.54**
Deals after IPO (%) [a]	91.52	87.52	92.74	90.18	89.88	86.98	90.83	93.73
Time to first deal after IPO (months)	27.54	24.11	28.78	25.72	26.58	16.38	28.58	24.98
Stock as Payment method (%) [a]	80.52	88.09	75.98	76.89	72.45***	74.78**	76.67	69.31**
Intra-industry (%) [a]	25.39	21.72	31.63	23.62	19.53**	19.64	19.34**	18.45*
Cross-border (%) [a]	46.13	55.35	31.97	52.42	33.13***	49.83*	27.85*	42.25**
Private Acquirers (%) [a]	38.53	29.76	47.65	36.31	47.42**	21.31	50.52*	53.82**
Financial Acquirers (%) [a]	34.75	27.38	36.21	36.89	46.51***	33.24*	48.23*	50.16**
Equity stake sold to acquirer (%) [a]	58.22	61.81	63.91	53.67	63.57	59.83	59.95	61.54
Firms transferring control (% of the sample)	51.14	47.62	43.18	55.77	32.61***	35.71**	27.77**	33.33***

[a] Percentage of deals per firm, average.

[b] Tests are on the difference between SBEFs and independent firms. The significance levels are based on t-statistics (mean), *Z*-tests of equal proportions, as required. Significance level at 1% (***), 5% (**) and 10% (*).

Most of the deals (63%) were made between firms based in the same country; this tendency was particularly pronounced for machinery firms (84%). Meanwhile cross-border M&As were relatively common for electronics and pharmaceutical firms. SBEFs had a greater propensity to take part in cross-border M&As, both as acquirers (46% of the deals as compared to 34% for independent firms) and as targets (46% vs. 33%). This preliminary evidence on the international exposure of our sample companies confirms that university-affiliation might act as signal of quality with a positive image impact that improves the credibility of the firm on an international level (Mian, 1997). At the same time, the more favourable attitude toward cross-border M&As involving SBEFs may be related to their higher TMT relational capital and educational prestige (Hsu, 2007). We disentangle these effects with ad-hoc regressions; the results are reported in Section 5.

Finally, the equity stake acquired by sample firms in deals was on average 83% of the total share capital of target companies. This means that the acquisitions performed by sample firms typically led to the control of the target firm. This was particularly applicable when the acquirer was a university-based firm. On the other hand, 64% of the sample of IPO firms were involved as targets in M&As and the percentage of the share capital sold by these firms was on average 62%. To identify those companies whose control was transferred in M&As, this percentage of the share capital transacted was compared to stable shareholding. In other words, the control transferred was assumed to take place when the equity stake sold to acquirers represented the majority of the free-float adjusted market capitalization (MSCI, 2000)[41]. We found that 37% of the sample firms transferred control because they were being targeted in deals. M&As represent therefore an important piece of the jigsaw puzzle of the market for corporate control. In particular, the implications in the market for corporate control are stronger for SBEFs. Although there was no statistical difference in the percentage of equity stake sold between university-based and independent firms, the owners of the former used M&As more often to transfer control. Most of the SBEFs (51.4%, see Table 13) transferred control through M&As, as compared to only one third (32.6%) of the independent firms. This dissociation can be attributed firstly to a larger proportion of SBEFs being

[41] In line with common practice (e.g. MSCI, 2000), the market capitalization of a company's equity securities is adjusted to reflect their level of free float. The free float is identified as the proportion of share capital that is deemed to be available for purchase in the public equity markets. For example, a company whose stable share capital is, say, 80% (i.e. free float 20%) is considered to be acquired (control transferred) when it is a target of M&A deals for more than 40% of its share capital.

targeted in M&As (68.7% vs. 62.8% of independent firm), and secondly to SBEFs having lower levels of ownership concentration and a large capital inflow at the IPO[42]. Overall, these preliminary results confirm our predictions of a more active M&A market targeting SBEFs and of a less active M&A market with SBEFs as acquirers. The following sections untangle the various factors that may have influenced these results. We focus, in particular, on the role played by institutional affiliation (university affiliation vis-à-vis VC backing), intellectual capital, TMT characteristics, and ownership structure.

4.1 External growth strategy

We used a Poisson model to analyse the influence of a series of variables on the number of M&A deals firms pursue as acquirer (Table 14)[43]. The baseline regression included control variables. Among these, firm size was positively related to the number of deals undertaken as an acquirer. Large firms may be better able to realize efficiencies from the internalisation of talents or technologies from a target firm because they can apply these assets on a sufficiently large scale (Maksimovic and Philips, 2001). Other significant control variables were sector dummies, market-to-book ratio (negative coefficient), and the bubble period dummy (positive coefficient). The positive impact of the bubble dummy may, therefore, have been not only due to the incentive of managers of overvalued firms to engage in acquisitions. If this was the case, the market-to-book ratio would have been positive as well[44]. On the contrary, our evidence pointed to

[42] As reported in Table 11, the ownership concentration was on average 50% for SBEFs and 54.5% for the whole sample. The capital inflow at the IPO (the ratio between the number of newly issued shares and pre-IPO shares) was, on average, 46% for SBEF and 32% for the whole sample.

[43] We also ran an ordered logistic regression as an alternative model to test the robustness of our results. Moreover, we tested if our results changed focussing only on majority acquisitions, defined as acquisition of an equity stake superior to 50% (this was the case of 80% of the deals in our sample). Results are presented in appendix (Tables A.4 and A.5). However, neither the different model specification, nor the focus on majority acquisitions, lead to significantly different results.

[44] However, M&As may be driven mainly by acquiring managers' endeavour to take advantage of stock market overvaluation only when an acquirer uses stock payment to undertake M&As. We ruled out this possibility of stock-market-driven-acquisition by running the same Poisson regression with the number of stock-paid M&As as dependent variable (Table A.3 in Appendix). Nevertheless, we found that a higher market-to-book still decreases the propensity to pursue acquisitions. Furthermore, we investigated the influence of the market-to-book ratio on the propensity to use stock as payment method. To distinguish between payment methods, we considered only those firms that pursued at least one M&A deal. The sample was therefore reduced to 392 firms. We ran the Poisson regression on the total number of M&As, including as independent variable the proportion of stock-paid acquisitions. This proportion was also used as dependent variable in a linear regression, where we found that higher market valuations increase the propensity of firms to use stock as payment in acquiring deals.

market optimism as a factor affecting the propensity to acquire, regardless of over-valuation motivation.

Our investigation of the effects of institutional affiliation on acquisition behaviour produced robust results indicating that university affiliation was negatively related to a firm's propensity to acquire. The same tendency applied to VC affiliation. Instead, variables of intellectual capital did not have any significant impact. The negative effect of university affiliation did not seem to be due to technological needs. However, the interaction between the dummy SBEF and the other covariates is specifically addressed in section 4.3. The lower propensity to acquire VC-backed companies may have been due to the financial aims of venture capitalists, which typically consider the IPO as an exit strategy (Black and Gilson, 1998) rather than a means to financial growth.

As for ownership, we found a negative relationship between ownership concentration and acquisitions and a positive correlation between TMT ownership and the dependent variable. The negative coefficient of ownership concentration could indicate that shareholders of closely held firms care more about preserving control and are more reluctant to dilute their ownership (Luypaert and Huyghebaert, 2007). On the other hand, the positive coefficient of TMT ownership may signal the willingness of TMT members to use their control rights to foster acquisitions and to increase firm size[45]. Such management-based explanations of acquisition deals may be less important for SBEFs, whose management may be less concerned with firm growth (see moderating effects in Table 18).

[45] From a different perspective, the relation between TMT ownership and the propensity to pursue acquisitions might be interpreted in an Agency framework. Accordingly, an increase in managerial ownership may reduce the agency problems between TMT members (Agent) and shareholders (Principal), since their objectives tend to converge. Thus, TMT ownership could be negatively related to the propensity to acquire. However, this motivation may emerge only for low values of managerial ownership, where there is an actual separation between ownership and control. For high levels of TMT ownership, however, it is predictable that the agency framework does not hold, and TMT members (whose incentives are largely aligned with those of the ownership) may simply use their control rights to foster acquisitions. Our (unreported) results confirmed this prediction. We used moderating effects, introducing an independent variable defined as the product between TMT ownership and a dummy equal to one when TMT ownership is lower than a threshold. The positive relation between the variable measuring the TMT ownership and acquisitions was always confirmed. Instead, the interaction became significantly negative for levels of TMT ownership lower than 10%.

Table 14: Poisson regression on the number of deals as acquirer

Model [a]	(1)	(2)	(3)
Baseline regression			
Market Value	0.22***	0.18**	0.19**
Leverage	- 0.01	- 0.06	- 0.05
Profitability	- 0.08	- 0.16	- 0.18
Market to Book	- 0.93***	- 0.92***	- 0.87***
Electronics	- 0.41**	- 0.31*	- 0.28*
Pharma & Bio	- 0.47**	- 0.47*	- 0.29
IT	0.08	0.08	0.07
Bubble period	0.25*	0.21*	0.23*
UK	- 0.06	- 0.09	- 0.11
Germany	0.51**	0.42**	0.19*
Institutional affiliation			
SBEF	- 0.47***	- 0.78***	- 0.85***
VC-backed	- 0.31***	- 0.38***	- 0.44***
Intellectual Capital			
Patents		- 0.07	- 0.19
Ph.D. in the TMT (%)		- 0.71*	- 0.61
MBA in the TMT (%)		- 0.16	- 0.11
TMT Experience (% of directors)		0.38*	0.25
TMT Relational Capital (% of directors)		0.83*	0.42
Ownership and Corporate Governance			
Ownership Concentration			- 0.76**
TMT Ownership			0.14***
Independent Directors			0.18
TMT size			0.03
Constant	2.69**	3.63***	3.72***
Pseudo R^2 % [b]	11.88***	13.12***	15.12***
N = 499			

The dependent variable is the number of deals as acquirer.

[a] *z*-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

Indeed, involvement of academics in creating new ventures can be considered to be driven not only by an entrepreneurial outlook, but also (or rather) by the prospect of enhancing one's academic position. In other words, given the innovation and research orientation of entrepreneurial academics (Wright et al., 2007), they may not necessarily be interested in setting-up a fast-growing company, but rather may be looking for other avenues in which they can pursue their research interests in order to advance of their academic objectives and prestige (Meyer, 2003).

4.2 Sequential divesture

The typical SBEF reveals significant technological competencies and is thus attractive for potential acquirers: they may be acquired either to commercially exploit such competencies, by combining them with the complementary assets possessed by acquiring firms, or to develop synergies in innovation activities, by combining different knowledge sources so as to obtain super-additive effects between merging firms. We found that SBEFs were targets in 69% of their M&A deals, while independent firm's were targets at a slightly lower rate, in 63% of their M&A deals[46]. Meanwhile, only 73% of the university-based firms were acquirers, compared to 80% of the independent firms.

In this section, we focus on two aspects of the M&A activities of our sample firms. First, we investigated innovative SME characteristics that increased their probability of becoming targets. To this end, we implemented a Cox proportional hazard model, where the dependent (failure) variable was equal to one if a company was a target in at least one deal after the IPO and the time variable was equal to the time that had elapsed from the IPO to the first target deal. Second, we focused on companies that had transferred control after the IPO. We studied the time distribution of control transfers using a Cox proportional hazard model (the time variable was the time that had elapsed from the IPO to the control transfer). Results are shown in Table 15.

We found that firm size was positively related to the probability of being a target. In comparison, the negative coefficient of profitability may be interpreted as evidence in

[46] Since the proportion of university-based companies was not homogeneous among the industries considered, results obtained comparing the two sub-samples may have been biased by industry specificities. For this reason, we compared the two sub-samples as a whole, and separately. In Table 13, we report the statistics only for the three industries with higher relevance of SBEFs, namely Pharma and Bio, IT and Electronics.

support of the matching theory of ownership change, with less efficient firms being more often the target of other companies. Also, the negative coefficients of the market-to-book and bubble dummies may point to a lower appeal of firms with higher (over) valuations.

With respect to affiliation, we found that both university and VC backing have a positive correlation with the probability of being acquired (although the statistical significance was lower for the latter). These results are consistent with our theoretical framework. The ownership change (matching) and the capital upgrading and labour division theories indeed predicted that SBEFs should show a greater propensity to be targeted by other firms for acquisition. Similarly, the presence of VC may improve the attractiveness of a firm (Ragozzino and Reuer, 2007). There was, in addition, a positive relationship between intellectual capital and M&A deals, with the number of patents held by a firm increasing the probability of its being targeted. This last result supports the theoretical hypothesis that M&As can be used as a means for acquiring technological capabilities (Blonigen and Taylor, 2000)[47]. Moreover, TMT member associations with public institutions and financial entities improve the attractiveness of firms. Lastly, the negative correlation between ownership concentration and the probability of being a target may be a signal of the low interest of external investors in acquiring stock position in closely held companies, or of a higher capacity of owners of these companies to protect their dominant positions. On the other hand, the absence of statistical significance for the TMT Ownership variable suggests that managers foster acquisitions to gain prestige and power, but are less active in hindering the acquisition of their own company.

[47] Bloningen and Taylor (2000) documented a significantly negative relation between R&D investments and the probability of engaging in M&A in high-technology industries, concluding that firms in these industries specialize in either internal development of R&D or acquisitions.

Table 15: Cox proportional hazard regression on the probability to be target after the IPO

Model [a]	(1)	(2)	(3)
Baseline regression			
Market Value	0.31***	0.28***	0.29***
Leverage	0.22	0.23	0.25*
Profitability	- 0.31*	- 0.29*	- 0.41*
Market to Book	- 0.66**	- 0.71**	- 0.71**
Electronics	- 0.56**	- 0.69**	- 0.46*
Pharma & Bio	- 0.11	- 0.22	- 0.16
IT	- 0.33	- 0.31	- 0.37
Bubble period	- 0.36**	- 0.36**	- 0.33**
UK	0.49**	0.49**	0.39*
Germany	1.01***	1.05***	0.89***
Institutional affiliation			
SBEF	0.31*	0.31*	0.28*
VC-backed	0.22*	0.16	0.12
Intellectual Capital			
Patents		1.93**	1.78**
Ph.D. in the TMT (%)		0.25	0.22
MBA in the TMT (%)		0.76	0.79
TMT Experience (% of directors)		0.45	0.21
TMT Relational Capital (% of directors)		1.01*	0.98*
Ownership and Corporate Governance			
Ownership Concentration			- 0.85**
TMT Ownership			0.15
Independent Directors			0.17
TMT size			0.03
Log Pseudo Likelihood [b]	- 1468.14***	- 1464.60***	- 1461.32***
N = 499			

[a] *z*-Test for significance of the independent variables.
[b] Wald χ^2-Test for significance of the regression.
*** 1% significance level; ** 5% significance level; * 10% significance level.

To further test our theoretical predictions on the effects of university affiliation, we identified those firms that transferred their control after the IPO. Focussing on control acquisitions (acquisition where the control of the firm was transferred), we found that SBEFs had a higher probability of being acquired than independent firms (Table 16)[48]. A graph of the Kaplan Meier failure function distinguishing SBEFs is shown in Figure 1; the smoothed hazard estimate is presented in Figure 2. A similar distribution was identified between the failure and the hazard rate. In particular, the probability of transferring control increased in the first month after the IPO, and then rapidly decreased thereafter[49].

[48] As shown in Table 16, most control acquisitions were pursued in "one-shot" deals, while the others were pursued in more than one step. It is also possible that a single sample firm was acquired sequentially by more than one acquirer. In particular, the proportion of SBEFs sold to one acquirer only was 60% for SBEFs and 56% for independent SMEs, but this difference was not statistically significant.

[49] Although the shape of the smoothed hazard function is influenced by the level of smoothing, this figure reflects the initial increase of the probability to transfer control after the IPO and its subsequent decrease.

Table 16: Control acquisitions of sample firms.

	SBEFs				Independent [b]			
	SBEF sub-sample	Electronics	IT	Pharma & Bio	Independent sub-sample	Electronics	IT	Pharma & Bio
Firms Transferring Control (%)	51.14	47.62	43.18	55.77	32.61***	35.71**	27.77**	33.33***
One-Shot Acquisition (%)	56.53	55.56	49.99	66.66	53.66	54.99	52.69	54.55
Only One Acquirer (%)	60.87	55.55	61.91	70.01	56.63	55.01	54.01	54.54*
Time to First Control Acquisition (months, mean)	29.43	29.2	27.87	24.22	27.41	28.9	26.93	24.42
Time to Transfer Control (months, mean)	50.07	55.18	43.96	48.33	53.82	47.49	43.29	65.54*

[b] Tests are between SBEFs and independent firms. The significance levels are based on t-statistics (mean) and *Z*-tests of equal proportions, as required. Significance level at 1% (***), 5% (**) and 10% (*).

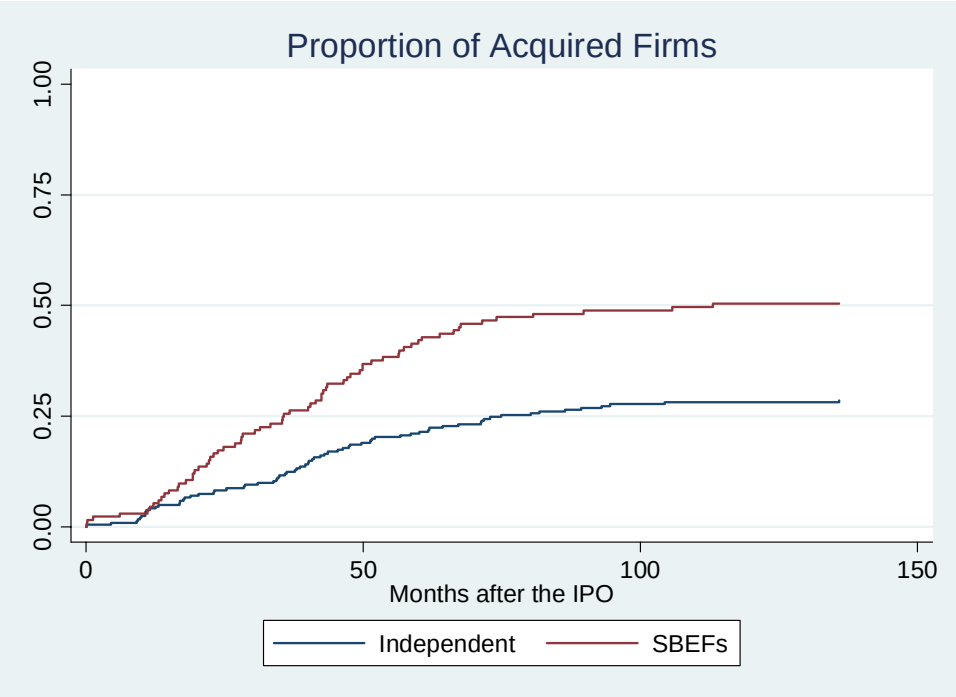

Figure 1: Kaplan Meier failure function (failure = control transfer)

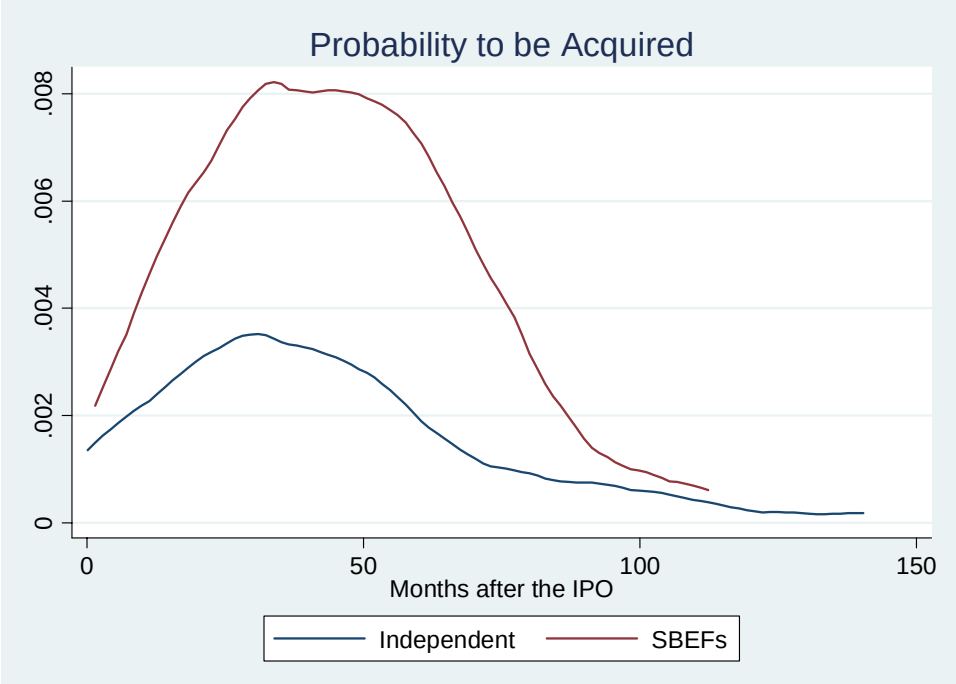

Figure 2: Smoothed Hazard Estimate (failure = control transfer)

The results of the Cox regression on the probability to transfer control showed that university affiliation and VC financing had a positive effect on the post-IPO divestment activity of innovative SMEs (Table 17). Even controlling for intellectual capital, both SBEF and VC dummies were still positively associated with the probability of being acquired. The presence of VC in a company and the university affiliation may indeed be perceived as quality (certification) signals by a potential acquirer, improving the probability of the company being a target for other firms[50]. Moreover, SBEFs seem to be, on average, more innovative than independent firms and so potentially more attractive for their competitors. On the other hand, the original founders of SBEFs (academics) and VCs may be more willing to sell their participations in firms after the IPO, so that IPO can be viewed as part of a more general process of sequential divesture through M&As (Reuer and Shen, 2003). Finally, matching theory suggests that SBEFs may be more subject to acquisitions because they are less efficient in the use of their assets. The Cox analysis showed a negative correlation between profitability (return on assets) and probability to be acquired, suggesting that less efficient companies are more subject to being the target of control acquisitions.

[50] Previous studies in the field of entrepreneurial IPOs have indeed found that VCs are perceived by investors as credible certifying and monitoring agents (Chahine et al., 2007). The involvement of a venture capitalist at the time of an IPO can indeed signal the quality of an entrepreneurial firm in a number of ways. The highly-selective screening process performed by venture capitalists can be a useful tool for acquirers to weed out the "lemons" in M&A markets. Moreover, VCs not only provide capital for the entrepreneurial firms they choose to fund, they often add directly to the quality of a firm by serving on its TMT, assisting in the formulation and implementation of strategy, contributing their network of relations, and hiring key personnel (Hellman and Puri, 2000).

Table 17: Cox proportional hazard regression on the probability to transfer control.

Model [a]	(1)	(2)	(3)
Baseline regression			
Market Value	0.26***	0.23***	0.21**
Leverage	0.52*	0.52*	0.47*
Profitability	- 0.55*	- 0.54*	- 0.49*
Market to Book	- 0.64*	- 0.52	- 0.74*
Electronics	- 0.31	- 0.33	- 0.12
Pharma & Bio	- 0.15	- 0.21	- 0.22
IT	- 0.42	- 0.35	- 0.63
Bubble period	- 0.45*	- 0.56*	- 0.33
UK	0.29	0.31	0.18
Germany	0.19	0.27	0.47
Institutional affiliation			
SBEF	0.87***	0.89***	0.92***
VC-backed	0.43*	0.41*	0.41*
Intellectual Capital			
Patents		0.64	0.38
PhD in the TMT (%)		0.38	0.15
MBA in the TMT (%)		0.27	0.18
TMT Experience (% of directors)		- 1.09	- 1.11
TMT Relational Capital (% of directors)		1.18*	1.31*
Ownership and Corporate Governance			
Ownership Concentration			- 0.52**
TMT Ownership			- 0.19
Independent Directors			0.04
TMT size			0.08
Log Pseudo Likelihood [b]	- 728.99***	- 727.95***	- 725.53***
N = 499			

[a] *z*-Test for significance of the independent variables.
[b] Wald χ^2-Test for significance of the regression.
*** 1% significance level; ** 5% significance level; * 10% significance level.

4.3 Determinants of SBEF specificities

Analysis of the growth and divestment activities of SBEFs through M&As showed a lower propensity for these companies to acquire, and a higher probability for them to be targeted by other firms. In this section, we test whether these specificities of SBEFs were driven by their characteristics in terms of intellectual capital, ownership and corporate governance. To this end, we re-ran our models adding interactive terms to the set of explanatory variables. The results are presented in Table 18. The first column reports the results of the Poisson regression on the number of deals undertaken as an acquirer (previous model in Table 14), the second column reports the results of the Cox regression on the probability of being target (previous model in Table 15), the third column reports the results of the Cox regression on the probability to transfer control (previous model in Table 17).

We found that an important variable influencing the attitude of university-based companies to make acquisitions was the availability of internal technological resources. Thus, the capital upgrading hypothesis is particularly relevant in explaining the acquisition activity of university-based firms. However, the dummy SBEF remained negatively correlated to the number of acquisitions (although its significance lowered), suggesting that there are other factors that differentiate SBEFs from independent companies. Among these, profitability seemed to act in the opposite direction (the interactive term between profitability and SBEF was significantly positive). Profitability increased university-based companies' tendency to acquire, while it seemed not to be a significant determinant for independent firms.

The tendency for less profitable firms to be acquired and to transfer control was confirmed by regressions with interactive terms. The dummy SBEF remained significant, meaning that their attractiveness for potential acquirers was not solely due to their superior intellectual or relational capital. There were only two (slightly) significant interactive terms: Patents x SBEF for the probability of being a target, and Independent Directors x SBEF for the probability to transfer control. Therefore, the appeal of the technological capital embodied in patents, already significant for the whole sample, was particularly desirable in science-based firms. The role of independent directors, never significant in previous results, actually enhanced the probability of control transfer for SBEFs.

Table 18: Determinants of SBEFs specificities.

Model [a]	Poisson on propensity to acquire	Cox on probability to become a target	Cox on probability to transfer control
Baseline regression			
Market Value	0.20**	0.28***	0.24**
Leverage	- 0.05	0.32*	0.48*
Profitability	- 0.26	- 0.78***	- 1.08**
Market to Book	- 0.97***	- 0.89**	- 0.72*
Electronics	- 0.29*	- 0.45*	- 0.24
Pharma & Bio	- 0.36*	- 0.21	- 0.18
IT	0.09	- 0.37	- 0.84
Bubble period	0.28*	- 0.29*	- 0.32
UK	- 0.14	0.02	0.17
Germany	0.26*	0.62**	0.64
Institutional affiliation			
SBEF	- 0.63*	0.77*	0.74**
VC-backed	- 0.38***	0.18	0.35*
Intellectual Capital			
Patents	0.05	1.81*	0.43
PhD in the TMT (%)	- 0.18	0.01	0.47
MBA in the TMT (%)	- 0.19	1.26	0.21
TMT Experience (% of directors)	0.20	0.66	- 0.18
TMT Relational Capital (% of directors)	0.80	1.81**	1.45*
Ownership and Corporate Governance			
Ownership Concentration	- 0.75**	- 0.94**	- 0.85**
TMT Ownership	0.86***	0.85	- 0.14
Independent Directors	0.07	- 1.12	0.02
TMT size	0.02	0.01	0.10
Interaction effects			
Profitability × SBEF	0.53*	0.65	0.84
Patents × SBEF	- 2.73 **	1.42*	0.30
PhD in the TMT (%) × SBEF	- 0.81	0.26	0.05
MBA in the TMT (%) × SBEF	- 1.09	0.42	0.04
TMT Experience (% of directors) × SBEF	0.47	- 0.54	- 0.97
TMT Relational Capital (% of directors) × SBEF	- 0.94	- 0.25	0.23
Ownership Concentration × SBEF	0.28	- 0.21	- 0.12
TMT Ownership × SBEF	- 0.88	- 0.73	- 0.43
Independent Directors × SBEF	0.23	1.59	0.78*
TMT size × SBEF	0.05	0.12	0.02
Constant	3.57***		
Pseudo R^2 % [b]	16.88***		
Log Pseudo Likelihood [b]		- 1458.06***	- 722.03***
N = 499			

[a] *z*-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

5. Complementary issues: internationalization, USOs and industry specificities.

In this section, we address three complementary issues on the M&A dynamics of SBEFs. First, we examine the internationalization of firms through M&A transactions. Second, we disaggregate SBEFs between companies where the TMT was, at least partially, composed of academics (we name these firms University Spin-Offs, USOs) and firms that were created to capitalise on research carried out in universities, but that have no formal involvement by academics in the TMT. Third, we focus on the industries with the highest relevance for SBEFs, namely IT and biotech, to investigate the peculiarities of these "SBEF-intensive" sectors and to test whether previous results were driven by industry biases.

5.1 Cross-border M&As

SBEFs took part in cross-border M&As more frequently than did independent firms. Nearly half (46%) of M&A deals targeting SBEFs were cross-border, compared to only 33% of M&A deals targeting independent firms (Table 13). Similar proportions applied to M&As with a sample of IPO-firms as acquirers (46% vs. 34%). University affiliation seemed therefore to enhance the propensity to take part in cross-border M&A. We performed a linear regression to test the validity of these findings. The dependent variable was, for each firm, the number of cross-border M&As over the total number of M&As (Table 19)[51].

We found that both being a SBEF and the presence of VC[52] improves firms' propensity to take part in cross-border M&As. We interpreted these findings as evidence that university affiliation and VC have a signalling role that improves the international exposure and credibility of a company.

[51] In this regression, we did not distinguish between deals as acquirers and deals as targets, because we tested the cross-border propensity of deals involving SBEFs, notwithstanding the target or acquirer role. However, separate tests of the effect of university affiliation for targets and acquirers led to similar results.

[52] The variable VC is significant only in Model 1.

Table 19: Linear regression on the proportion of cross-border M&As.

Model [a]	(1)	(2)	(3)
Baseline regression			
Market Value	0.08***	0.08***	0.07***
Leverage	- 0.05	- 0.11	- 0.09
Profitability	0.02	0.08	0.06
Market to Book	- 0.01	0.01	0.00
Electronics	0.16**	0.25***	0.27***
Pharma & Bio	0.18**	0.22***	0.22***
IT	0.01	0.04	0.04
Bubble period	- 0.02	- 0.01	- 0.00
UK	0.10*	0.09*	0.12*
Germany	0.03	- 0.03	- 0.00
Institutional affiliation			
SBEF	0.11**	0.14**	0.14**
VC-backed	0.08*	0.04	0.03
Intellectual Capital			
Patents		0.07	0.21
PhD in the TMT (%)		- 0.12	- 0.14
MBA in the TMT (%)		0.09	0.08
TMT Experience (% of directors)		0.11	0.02
TMT Relational Capital (% of directors)		0.14	0.17
Ownership and Corporate Governance			
Ownership Concentration			- 0.04
TMT Ownership			- 0.01
Independent Directors			0.07
TMT size			0.01
Constant	- 0.95**	- 0.91**	- 1.01**
R^2 % [b]	15.91***	17.77***	18.81***
N = 397			

The dependent variable is, for each firm, the number of cross-border M&As over the total number of M&As.

[a] t-Test for significance of the independent variables.

[b] F-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

We tested whether this higher likelihood for SBEFs to take part in cross-border M&As might be affected by the higher level of education of their TMT members which, in turn, improves their ability to interact with other key actors in the global market. Educational capital may also contribute to the development of social capital. This assertion is in agreement with Hsu et. al. (2007) who asserted "what you know influences who you know". Nevertheless, no variable of intellectual capital affects significantly the international exposure of our sample firms. Therefore, even after controlling for other possible factors, the enhancing effect of the university affiliation in the internationalization of the M&A scope is confirmed[53].

5.2 Disaggregating SBEFs: University Spin-Offs

We disaggregated the definition of SBEFs, distinguishing between companies in which the TMT was (at least partially) composed of academics (USOs) and firms that were created to capitalise on research carried out in universities, but that have no formal involvement of academics in the TMT. In other words, we applied a stricter definition to identify USOs in order to determine whether the presence of academics in the TMT had a different effect on M&A dynamics, as compared to other university-based firms. As reported in Table 20, we found that two thirds of the sample SBEFs (67.94%) were USOs. The first column reports the results of the Poisson regression on the number of deals as acquirer (external growth strategy), the second column reports the results of the Cox regression on the probability of becoming a target after the IPO, the third column reports the results of the Cox regression on the probability of transferring control after the IPO, and the last column reports the results of the linear robust regression on the proportion of cross-border M&As.

[53] We also found evidence of higher propensity to cross-border M&A by firms listed in the UK. This may be due to the tradition of London being a major international financial marketplace (financial motivation) or to a higher level of internationalization of the British economy (economic motivation).

Table 20: USOs vs. SBEFs.

Model [a]	Poisson on propensity to acquire	Cox on probability to become a target	Cox on probability to transfer control	Linear regression on Cross-Border M&As
Baseline regression				
Market Value	0.15**	0.29***	0.21**	0.08***
Leverage	- 0.05	0.25*	0.45*	- 0.06
Profitability	- 0.25*	- 0.42*	- 0.51*	0.05
Market to Book	- 0.87***	- 0.71**	- 0.71*	0.00
Electronics	- 0.18	- 0.45*	- 0.21	0.25***
Pharma & Bio	- 0.36*	- 0.16	- 0.26	0.18***
IT	0.07	- 0.37	- 0.61	0.02
Bubble period	0.23*	- 0.33**	- 0.33	- 0.02
UK	- 0.09	0.39*	0.22	0.12*
Germany	0.33*	0.89***	0.68*	0.01
Institutional affiliation				
USOs	- 0.54***	0.28*	0.91***	0.13**
SBEFs no USOs	- 0.28	0.25	0.69**	0.05
VC-backed	- 0.45***	0.15	0.42*	0.03
Intellectual Capital				
Patents	- 0.35	1.98**	0.16	0.19
PhD in the TMT (%)	- 0.49	0.19	0.19	- 0.16
MBA in the TMT (%)	- 0.11	0.65	0.10	0.08
TMT Experience (% of directors)	0.22	0.26	- 0.95	0.07
TMT Relational Capital (% of directors)	0.44	0.88*	1.44*	0.15
Ownership and Corporate Governance				
Ownership Concentration	- 0.59**	- 0.85**	- 0.55**	- 0.10
TMT Ownership	0.14***	0.18	- 0.14	- 0.02
Independent Directors	- 0.04	0.10	0.11	0.07
TMT size	0.03	0.04	0.07	0.02
Constant	3.71***			- 0.98**
(Pseudo) R^2 % [b]	15.58***			18.78***
Log Pseudo Likelihood [b]		- 1460.94***	- 726.52***	
N	499	499	499	397

[a] z-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

The results of this analysis clearly show that the particularities of SBEFs individuated in the empirical analysis were influenced by the presence of academics in the TMTs. In particular, the formal involvement of academics in TMTs, with direct influence on strategic decisions, lead to a lower propensity of SBEFs to make acquisitions, to a higher probability of being acquired, and to greater likelihood that the founders will relinquish control after the IPO. This evidence may be connected to the higher propensity of academics to divest once the company becomes public. Indeed, faculty who found USOs may have little interest in maintaining a position in a mature firm. Also, university spin-offs were more frequently involved in cross-border M&As than were other SBEFs. These results are coherent with our predictions and strengthen their validity.

5.3 "SBEF-intensive" sectors: Biotech and IT

The majority of SBEFs considered in this study belonged to Pharma and Bio and IT industries. We labelled these sectors as "SBEF-intensive" and re-ran the regression carried throughout the study, considering only these two sectors (results in Table 21). In particular, given the high importance of patents in the biotech sector (in median, 9 patents per biotech firm, compared to only 2 for the entire sample, Table 11), we included a variable equal to the product between Patents and the dummy Pharma and Bio (Patents × Pharma&Bio) to capture the peculiar role played by patents in determining M&A activities in this sector. In the biotechnology industry, the role of technology acquisitions may be particularly relevant, because the speed of change of this sector is so rapid that companies can survive only if they acquire capabilities they lack (Aslani and Negassi, 2006). Moreover, the pharmaceutical and biotech industry is of particular interest because of the great difficulties entrepreneurs face in starting businesses without relationships with universities or research institutions. This is, in fact, the most intensively science-based industry (Phlippen and van der Knaap, 2007), with as many as 60% of innovative SMEs going public being SBEFs (Table 9).

Table 21: Regression models on the sample restricted to Pharma & Bio and IT industries.

Model [a]	Poisson on propensity to acquire	Cox on probability to become a target	Cox on probability to transfer control	Linear regression on Cross-Border M&As
Baseline regression				
Market Value	0.32***	0.30***	0.22**	0.06**
Leverage	- 0.54*	0.25*	0.64**	- 0.04
Profitability	0.52**	- 0.24	- 1.14**	0.02
Market to Book	- 0.97***	- 0.55*	- 0.57*	- 0.12
Bubble period	0.26*	- 0.13	- 0.21	- 0.02
UK	0.09	0.13	0.11	0.10*
Germany	0.42*	0.34	0.17	0.01
Institutional affiliation				
USOs	- 0.78***	0.39*	0.87***	0.13**
SBEFs no USOs	- 0.48*	0.25	0.70**	0.04
VC-backed	- 0.57***	0.23	0.56*	0.02
Intellectual Capital				
Patents	- 0.18	1.28*	1.13	0.17
Patents × Pharma&Bio	- 3.03***	1.55**	1.69**	0.14
PhD in the TMT (%)	- 0.01	0.26	0.54	- 0.26
MBA in the TMT (%)	- 0.71	0.71	0.47	- 0.04
TMT Experience (% of directors)	0.54**	0.01	- 0.12	0.07
TMT Relational Capital (% of directors)	0.75	0.95*	1.52*	0.24
Ownership and Corporate Governance				
Ownership Concentration	- 0.75***	- 0.76*	- 0.48*	- 0.10
TMT Ownership	0.38*	0.37	0.21	- 0.03
Independent Directors	0.14	0.25	0.11	0.07
TMT size	0.05	0.08	0.06	0.02
Constant	- 0.74			- 0.45
(Pseudo) R^2 % [b]	23.27***			12.57**
Log Pseudo Likelihood [b]		- 775.71***	- 400.28***	
N	294	294	294	241

[a] z-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

In general, the restricted sample did not lead to substantially different results (Table 21). However, the role of patents was of particular interest for acquisitions in the biotech industry. While a stand-alone patent was not statistically significant, the Patents × Pharma and Bio was associated with a lower probability of acquiring and a higher probability of being acquired (both target and transfer control). These results confirmed the crucial role played by intellectual capital in the biotech and pharmaceutical industry. The M&A market is one possibility for acquiring much needed technological competencies and, in this way, the acquisition of SBEFs contributes to the process of technology transfer.

6. Conclusions

This paper analyses the M&A activities of innovative firms that went public on major European stock markets during the 1995-2003 period. The IPO and the contextual shift from the private to the public domain decreases information asymmetries, thereby increasing opportunities for equity deals. Moreover, IPOs are linked to M&As as they create public shares that may be used as currency in either acquiring other companies or in being acquired in a stock deal. Accordingly, we find that most of the transactions of our sample firms involved stock financing. In general, IPOs can also be part of a larger process of transferring control rights where owner-managers of private firms use the IPO as part of a divestiture strategy. In order to identify potential acquirers and to increase the firm's visibility, shareholders of private firms may indeed decide to use sequential divestitures through IPOs rather than outright sales.

Examining the characteristics of the framework that links M&A and IPO markets, this paper addresses the role of institutional affiliation on the M&A dynamics of IPO firms and finds that university affiliation does influence firm evolution. First, we found that SBEFs have a higher probability of being acquired, relative to their independent counterparts. In particular, the market for the control of these firms is quite active, as most of our sample SBEFs were acquired soon after their IPOs, most often by firms operating within the same industry. Hence the attractiveness of university-based firms is strong, while their relatively low profitability may reflect a deficient matching between technological expertise and managerial competencies. To this extent, an active M&A

market may be an effective instrument leading to a better fit between technological and financial capital.

On the other hand, university-based firms showed a lower propensity to acquire. Given the higher level of innovation of these firms, their lower propensity may be due to their lower need for external technological resources. However, even controlling for proxies of intellectual, educational and relational capital, the affiliation to a university still negatively affects the propensity to acquire. Only in the most science-based industry – biotechnologies – does the level of internal R&D resources play a role in shaping the post-IPO M&A dynamics of the firms. In this industry, firms owning more patents are found to be more reluctant to acquire other firms and, contrarily, to be more frequently targeted. In general, university-based cases may be ones with very strong growth prospects and with platform technologies where new products can be appended, thus reducing the need for acquisitions. In addition, this low acquisition rate may be due, at least in part, to the limited management-based incentives to pursue acquisitions for academic managers-owners. Their academic background may indeed limit their appetite for growth, as they may be more focussed on core technological aspects, or may have been partially driven in their entrepreneurial venture by return expectations on their academic position. These arguments based on the personal motivations of academic entrepreneurship could also be related to the higher probability of university-based firms to be acquired, with academics being more prone to divest once their company has become public.

In conclusion, we argue that although the capacity of wealth creation in SBEFs remains under debate, and probably more can be done to enhance their performance, they do constitute an important element in the process of commercialization and transfer of university research. Indeed, the high attractiveness of SBEFs as targets in M&A deals, especially intra-industry, is a clear sign of the widespread interest of the business world in investing in these firms, and confirms the validity of academic entrepreneurial initiatives as an instrument for technology transfer.

As for most papers, some limitations of our analysis need to be noted. First, we relied on a sample of IPO firms, which, as such, can be viewed as a positive selection of successful SBEFs. However, we have found a distribution of university-based IPOs among industries similar to previous studies that considered SBEFs in an earlier stage of their life cycle (see for example, Smith and Ho, 2006). Moreover, several differences

between university-based companies and independent ones that we found at the IPO have also been evidenced in previous comparative studies (see for example, Colombo and Piva [2007] for TMT educational capital). Nevertheless, the extent to which university-based companies at the IPO differ from academic start-ups remains unresolved, and this may be a further issue to investigate. This analysis may also reveal the resource endowments and the characteristics that improve the success probability of an academic business initiative. Second, we have considered TMT membership of academics at the floatation, ignoring their post-IPO evolution. Future research may investigate this issue, analysing the behaviour of researchers and academics with regards to their TMT positions after the listing, and when the company is taken over.

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Appendix

Table A.3: Regressions on the payment method in acquiring deals

Model [a]	Poisson on the number of stock-paid acquisitions	Poisson on the total number of acquisitions	OLS on the proportion of stock-paid acquisitions
Baseline regression			
Market Value	0.17***	0.12**	-0.01
Leverage	0.06	-0.09	0.02
Profitability	-0.13	-0.11	-0.06
Market to Book	-0.52**	-0.78***	0.27***
Proportion of stock-paid acquisitions	-	0.03	-
Electronics	-0.15	-0.18	0.08
Pharma & Bio	-0.31*	-0.03	0.12*
IT	-0.25*	0.08	0.13*
Bubble period	0.22*	0.26**	0.09
UK	-0.15	-0.05	-0.16**
Germany	0.54**	0.31**	0.10
Institutional affiliation			
SBEF	-0.43***	-0.51***	-0.11
VC-backed	-0.36***	-0.35***	-0.07
Intellectual Capital			
Patents	-0.15	-0.22	0.07
Ph.D. in the TMT (%)	-0.10	-0.51**	0.26*
MBA in the TMT (%)	-0.23	-0.06	-0.05
TMT Experience (% of directors)	0.26	0.18*	0.03
TMT Relational Capital (% of directors)	0.56	0.48*	0.26*
Ownership and Corporate Governance			
Ownership Concentration	-0.52*	-0.35*	0.09
TMT Ownership	0.21*	0.09**	-0.10
Independent Directors	0.21	0.12	-0.04
TMT size	0.02	0.04	-0.01
Constant	1.32	2.87***	0.21
(Pseudo) R^2 % [b]	13.96***	13.32***	13.53***
N	499	392	392

[a] *z*-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

Table A.4: Ordered logistic regression on the number of deals as acquirer

Model [a]	(2)	(3)	(4)
Baseline regression			
Market Value	0.30***	0.29***	0.30*
Leverage	- 0.18	- 0.12	- 0.14
Profitability	- 0.05	- 0.11	- 0.17
Market to Book	- 0.72***	- 0.64***	- 0.62***
Electronics	- 0.83**	- 0.81*	- 0.76*
Pharma & Bio	- 0.61*	- 0.68*	- 0.53*
IT	0.02	0.01	0.08
Bubble period	0.66**	0.63**	0.68**
UK	- 0.05	- 0.02	- 0.07
Germany	0.53*	0.45*	0.23
Institutional affiliation			
SBEF	- 0.65***	- 0.97***	- 0.89***
VC-backed	- 0.51**	- 0.76***	- 0.75**
Intellectual Capital			
Patents		- 0.19	- 0.35
PhD in the TMT (%)		- 0.16	- 0.16
MBA in the TMT (%)		0.13	0.13
TMT Experience (% of directors)		0.27	0.49
TMT Relational Capital (% of directors)		0.98	0.88
Ownership and Corporate Governance			
Ownership Concentration			- 1.11***
TMT Ownership			0.31***
Independent Directors			0.27
TMT size			0.03
Pseudo R^2 % [b]	5.18***	5.85***	6.75***
N = 499			

The dependent variable is the number of deals as acquirer.

[a] z-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

Table A.5: Poisson regression on the number of majority deals as acquirer

Model [a]	(1)	(2)	(3)
Baseline regression			
Market Value	0.22***	0.16**	0.16**
Leverage	0.05	0.07	0.06
Profitability	- 0.08	- 0.19	- 0.19
Market to Book	- 1.01***	- 1.05***	- 1.02***
Electronics	- 0.53***	- 0.49**	- 0.29*
Pharma & Bio	- 0.59***	- 0.58***	- 0.47**
IT	0.04	0.09	0.07
Bubble period	0.07	0.11	0.13
UK	0.15	- 0.05	- 0.02
Germany	0.52**	0.39*	0.18
Institutional affiliation			
SBEF	- 0.43***	- 0.25**	- 0.38**
VC-backed	- 0.35***	- 0.38**	- 0.44***
Intellectual Capital			
Patents		- 0.65	- 0.70
PhD in the TMT (%)		- 1.01**	- 0.87*
MBA in the TMT (%)		- 0.11	- 0.15
TMT Experience (% of directors)		0.41*	0.19
TMT Relational Capital (% of directors)		0.64	0.31
Ownership and Corporate Governance			
Ownership Concentration			- 0.81**
TMT Ownership			0.22**
Independent Directors			0.07
TMT size			0.14
Constant	2.44**	3.15***	3.25***
Pseudo R^2 % [b]	11.54***	12.76***	13.42***
N = 499			

The dependent variable is the number of majority deals as acquirer.

[a] *z*-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

PAPER 3:

FINANCIAL DYNAMICITY OF HIGH-TECH SMEs

Damiano Bonardo, Stefano Paleari, Silvio Vismara

IV. Financial dynamicity of high-tech SMEs

Abstract

This paper links intellectual to financial capital of a sample of 382 high-tech SMEs recently gone public in Europe. Several aspects of human capital, as well as innovation input (R&D expenses) and output (patents) are related to the dynamics of firms' financing and investing decisions. Our empirical results show that firms more committed in R&D efforts (R&D intensive firms) are particularly interested in the IPO as a mechanism to raise external equity and to pursue strategies of external growth through acquisitions. On the other hand, SMEs with a consolidated portfolio of patents seem to be less interested in raising equity and acquiring other companies. Moreover, they have a higher attitude to raise debt capital. As a whole, our results show that the IPO represents a fundamental step in the lifecycle of a firm both for the opportunity to growth and to divest. Moreover, the status of public company associated with a good level of liquidity gives visibility to the company, fostering cross-border and intra-industry deals and business transfers.

Keywords: Intellectual capital, patents, R&D expenditures; IPOs; SEOs; Capital expenditures; M&As; liquidity;

1. Introduction

Financial constraints to the development of innovation are often considered one of the main impediments to high-technology firms seeking to expand and grow. In particular this is the case of small and medium size high-tech firms (Giudici and Paleari, 2000). Financing problems arise primarily as a consequence of information asymmetries between external investors and entrepreneurs, given the valuation difficulties of intangible assets and the reluctance of innovators to share with outside investors information about their technologies. The heavier costs of bankruptcy connected with the limited size of the firm and the difficulty of using intangible assets as collaterals, also lead to difficulties in finding external sources of financing.

The research and policy debate on the availability of financial capital for the development of innovative small and medium enterprises (SMEs) have revolved around the unsuitability of debt for the early-stage financing and the merits of equity as sources of external finance for innovation (Freel., 2007). In this context, the role of VC and stock markets is fundamental. VCs are well-informed financial intermediaries able to evaluate the intangible assets and the future opportunities of value creation embodied in high-tech companies in their start-up phase. Then, the access to the stock market represents a direct source of equity collection for high-tech SMEs, reducing information asymmetries and providing early investors with an exit opportunity.

Therefore, financial constraints to high-tech firm growth may be particularly severe in the EU, where the public equity markets and VC industry are less developed than in the US. Thus, an explicit goal of current public policy in Europe is to promote the development of markets for risk capital in order to sustain innovative entrepreneurship and to assist the expansion of existing small firms. In the last decade, the launch of second-tier markets in every European country has, at least in part, fulfilled the aim of providing small and medium enterprises with the means to finance growth. Indeed, stock exchanges have successfully encouraged small firms to gain access to public listing by setting up dedicated markets with less stringent requirements.

However, although the literature suggests that the access to external equity and the reduction of information asymmetries given by the status of public company may be particularly beneficial for innovative companies, we still know little about the interaction between innovation and the evolution of innovative SMEs after the IPO.

Does the innovative level of companies influence their attitude to raise capitals, to invest and their market dynamics?

In this paper, we respond to this research question, analyzing the post-IPO activities of a sample of 382 SMEs in high-tech industries that went public on the stock markets of the four largest European economies in the period 1998-2003. Focusing on three main aspects, capital raising, investments and market dynamicity, we analyse companies' characteristics at the IPO that may be indicative of the post floatation evolution of sample firms. In particular, we are interested in the interaction between variables of innovative input (R&D expenses) and output (patents) and the evolution of sample companies. Our empirical results may be indicative for innovative SMEs that want to become public, to understand how the stock markets can help them in their growing and divestment strategies. On the other hand, our analysis can also be used by investors that want to invest in innovative SMEs to understand those characteristics which help to predict their post-IPO evolution.

Our paper contributes to the literature showing the existence of a relationship between the innovative level and the post-IPO evolution of sample companies. In particular, companies more committed in R&D efforts seem to be particularly interested in the IPO as a mechanism to raise external equity and to acquire participation in other companies. Arguably, equity is needed to finance innovation while acquisitions are driven by technological needs, with our sample companies trying to find new resources and alliances to improve their ability to innovate. Therefore, our investigation suggests that going public may be a factual strategy for a firm that wants to raise capitals or acquire technologies and form alliances to improve its R&D efforts. On the other hand, innovative SMEs with a consolidated portfolio of patents at the IPO seem to be less interested in raising equity and acquiring other companies. Moreover, they have a higher attitude to raise debt capital. We interpret this result suggesting that having patents is an index of maturity in innovative industries that helps investors to individuate firms with a lower level of risk (patents are negatively correlated with the failure probability).

Also, the offering structure reveals information on the underlying motives for going public. In particular, firms with a higher level of divestment at the IPO are typically less interested in business growth and more prone to transfer control in the post-IPO period. Moreover, both university affiliation and VC financing have a positive effect on the

post-IPO divestment activity of innovative SMEs. Even controlling for intellectual capital, these companies are still positively associated with the probability of being acquired. The presence of VC in a company and the university affiliation may indeed be perceived as quality (certification) signals by a potential acquirer, improving the probability of the company being a target for other firms. On the other hand, the original founders of university-based firms (academics) and VCs may be more willing to sell their participations in firms after the IPO, so that the IPO can be viewed as part of a more general process of sequential divesture through M&As (Reuer and Shen, 2003). Finally, venture backed companies show a lower probability to fail, confirming the validity of the certification role of VC financing. Also, TMT experiences and the presence of independent directors in the board seem to be valuable instruments to reduce the risk of firm failure.

As a whole, our empirical findings show that going public is really a unique opportunity for innovative SMEs to have access to external equity and implement both internal and external growing strategies. Equity raised at the IPO and in the post-floatation years sustains a substantial investment activity more than reducing firm leverage that remains quite stable in the years considered. Moreover, once public our innovative SMEs seem to be "really public". In other words, they enjoy a good level of investor recognition and visibility, so that the market for corporate control of these firms is active with almost one third of the sample being acquired in the five years after the IPO. Therefore, going public also represents an exit strategy for founders who want to cash out. Divesting after a company has been made public may indeed constitute a better strategy than selling a still private firm directly at a value that is lower due to illiquidity discount. Such advantages of the strategy of sequential divesture though IPO would be especially high in knowledge-intensive industries.

The remainder of the paper is structured as follows. Section 2 reviews the literature in the area of initial public offering motivation. In Section 3, we describe the sample of IPOs selected, the variables and the methodologies used to investigate the post-IPO evolution of sample companies. The econometric results are presented in Section 4. Section 5 concludes.

2. Background

The innovation level of a high-tech SME may exert an influence on the strategic decision of the firm after the IPO. The academic literature has shown that the decision to go public is driven by different motivations (Brau and Fawcett, 2006; Kim and Weisbach, 2008). Among these motives, the possibilities to raise financial resources and to pursue strategies of internal and external growth are fundamental. Also, the superior level of investors' recognition connected with the status of public company improves the possibility to cash out for original shareholders. Therefore, in our analysis we focus, in particular, on how the financing and the investment decision are related to innovation. Moreover, we also consider the relationship between innovation and market dynamicity in terms of stock liquidity, propensity to transfer control and failure probability.

2.1 The financing decision: raising capital

High-tech SMEs are often financially constrained. Cash flows generated by the companies may be not sufficient to sustain the investments necessary to maintain a competitive advantage in innovative industries (Freel, 2007). Entrepreneurs may have limited personal wealth or dislike investing more of their own resources in the firm. Debt lenders may also be reluctant to fund SMEs with new and innovative products because of the difficulty associated with evaluating the risk of such products, or because of the sizeable time lag between investments and cash generation. Also, high-tech firms with a high proportion of intangible assets, such as knowledge and reputation, and with more specialized equipment may experience higher bankruptcy costs. To this extent, the decision to take the firm public may overcome such borrowing constraints. Even when additional commercial credit is available to the entrepreneur, indeed, the covenants attached to the loan may be too restrictive for him or her to pursue opportunities with high-growth prospects, but also with high risk. As a consequence, for many entrepreneurial ventures, an IPO enables the management of a firm to pursue growth opportunities that would otherwise be impossible to fund. A company that goes public has two main mechanisms to raise fresh capitals in the form of external equity: the offering of primary shares (dilution ratio) at the IPO and seasoned equity offers in the post-IPO period. The access to the equity market and the raising of fresh equity may

also facilitate borrowing in the credit market. Newly public SMEs may succeed in obtaining further external funds as their public visibility increases and information-related problems decrease in the years subsequent the IPO (Anderson, 1994; Roell, 1996).

2.2 The investment decision: internal and external growth strategies

The decision to go public, linked to the need the finance investments, can represent a springboard for the purse of internal and external growth strategies, thanks to the fresh capital raised at the IPO. However, the empirical evidences on the role played by IPOs and SEOs as an instrument to finance business growth are controversial (Kim and Weisbach, 2008). In particular, some authors suggest that fresh capitals raised at the IPO are used to reduce leverage rather than to finance growth (Pagano et al., 1998; Goergen, 1998). Overall, these findings offer a rather pessimistic view on the role played by European stock exchanges; they suggest that the stock market is not used as a mechanism to finance growth, but rather as a way for owners to reduce their firm's risk and to cut back on their involvement in the company. Nonetheless, more recent contributions suggest that the growth motive for going public has become important. For example, Huyghebaert and Hulle (2006), using a sample of Belgian IPOs in the period 1984-2000, find that the need for additional financing is the main force in determining the size of the primary portion, with younger and smaller firms with a higher market-to-book ratio and limited internal cash generation issuing a larger fraction of primary shares. Also, Kim and Weisbach (2008) find that SEOs' proceeds are mainly used in R&D, capital expenditures and acquisitions, while are not used for long-term debt reduction. Indeed, the acquisition motive is another important and only recently addressed motivation of going public (Brau and Fawcett, 2006; Celikyurt et al., 2008). From this perspective, stock markets represent relevant mechanism in facilitating and improving the efficiency of a growth strategy through M&As. The rationale behind this hypothesis goes as follows. In terms of cash, simply, the fresh capital raised through IPO could make available the funds needed to fuel firm's external growth. In addition to cash acquisitions, the IPO may also facilitate stock deals, as the creation of public shares allows stocks to be used as currency to participate in M&As (Brau and Fawcett, 2006; Bonardo et al., 2008). Also, the IPO and the contextual moving from the private

to the public domain increase the level of firm's disclosure and of invertors' monitoring. The consequent decrease in information asymmetries at IPO may increase the opportunities of equity deals (Reuer and Shen, 2003). Moreover, the prospects of future deals grow as valuation challenges for would-be-investors are alleviated with the IPO placing a price on the firm. It might be, therefore, that to the extent that the process of going public credibly reveals information on the value of the firm, the IPO market can enhance the efficiency of the M&A market.

2.3 Market dynamicity

Beyond the capital raising and investment motivations, stock markets can represent an important opportunity to improve the visibility of the firm in the eyes of investors and other business actors. A superior level of investors' recognition may enhance stock liquidity with beneficial consequences both for existing shareholders and the firm. Market liquidity is indeed a factor often considered to be one of the most important objectives of any IPO (Pham et al., 2003). In particular, a higher level of liquidity reduces transaction costs in future equity raisings (Ibbotson and Ritter, 1995), increases firm value (Amihud and Mendelson, 1986), provides a better environment for managerial incentive schemes and improves market monitoring by encouraging information dissemination by speculators (Holmström and Tirole, 1993). Moreover, investors' recognition may improve the ability for insiders to cash out. From this perspective, the IPO may facilitate the sale of the company giving founders, venture capitalists and early stage investors the ability to diversify their risk or to exit their investment. Indeed, the mispricing explanation suggests that pre-IPO shareholders can opportunistically sell shares of overvalued companies at the IPO for personal gain, or use the floatation as a first step toward having a company taken over at an attractive price (Brau et al., 2003). Although adding a secondary portion to the offer can also have positive effects, such as increasing market liquidity, selling insider shares is generally viewed as negative signal (Brau and Fawcett, 2006; Leland and Pyle, 1977). Moreover, given the existence of information asymmetries between insider shareholders and external investors, large owners may try to maximize their overall proceeds from divesting by limiting the secondary portion and selling gradually afterwards (Gomes, 2000). IPOs can indeed be part of a larger process of transferring control rights where

owner-managers of private firms use the IPO as part of a divestiture strategy. In order to identify potential acquirers and to increase firm's visibility, shareholder of private firms could decide to use sequential divestitures through IPOs rather than outright sales. The process of going public would be therefore responsive to adverse selection problems by increasing the quantity of information available on the firm (Reuer and Shen, 2003). Moreover, investment bankers involved in the IPO pricing can certify the quality of firms because the repeated nature of their business encourages them to preserve their reputational capital and to desist from opportunism (Paleari and Vismara, 2007). As a consequence, existing shareholders of private firms can find value-maximising the strategy of divesting after taking the company public rather than directly selling the still-private firm at a lower value due to illiquidity discount, or lack-of-marketability discount (Silber, 1991). Such advantages of the strategy of sequential divesture though IPO are higher in knowledge-intensive industries, like those selected in this study, where M&A negotiations tend to be more lengthy and buyers respond by offering lower bids (Coff, 1999).

2.4 The provision of finance to innovation

Technology-based SMEs experience different financial problems during the business lifecycle, due to the need of R&D and marketing expenses and peculiar typologies of investments (Hall, 2002; Giudici and Paleari, 2000). Innovation projects are riskier than physical investment projects and therefore outside investors are reluctant to finance innovation activities or require a risk premium for the financing. According to the agency costs theory, financing problems arise primarily as a consequence of information asymmetries between external investors and entrepreneurs. The level of information asymmetry between the firm and external investors is high, given the valuation difficulties of intangible assets and the reluctance of innovators to share with outside investors information about their technologies because of problems of appropriability. Providing convincing signals about the quality of the innovation project is costly (Bhattacharya and Ritter, 1985) and sometimes leads to market failure. Moreover, the difficulty of using intangible assets as collaterals also leads to increased costs of external capital in the form of a risk premium. Financial constrains may be particularly severe in the case of young and small and medium sized firms (Canovas and Solano,

2007). Therefore, some innovation projects may not be started, delayed or abandoned because of the risk of bankruptcy and the low value of intangibles in case of liquidation (Gomes et al., 2006).

The observations made in this section suggest that a high-tech SME should resort to external financing by seeking investors able to evaluate its intangible assets and the future opportunities of value creation embodied in the company. In this context, during the first stage of high-tech firms development, the role of venture capitalists and private equity funds are extremely relevant. VCs are well-informed financial intermediaries, able to face problems related to risky investments in high-technology projects, to engage in active monitoring and therefore to add value to the entrepreneurial team. Then, after the start-up phase, also financial markets may represent a direct source of equity collection for high-tech SMEs. VCs and stock markets are therefore two important mechanisms for the provision of finance to innovation and do not seem to be independent. In other words, the existence of an efficient stock market seems to be essential also for the availability of VC financing in the seed stage of high-tech businesses. Indeed, academic literature shows that venture capital works best when there is an active equity market which allows investors to exit by selling their shares (Rajan and Zingales, 2001). Also, VC investments seem to be closely tied to valuations in public stock markets, increasing when signals of public stock markets become favorable (Gompers et al., 2007).

3. Research design

3.1 Sample selection

This paper investigates the financing and investing decision of the population of 382 high-tech SMEs gone public in the period 1998-2003 on the stock markets of the four largest European economies (namely, Germany, United Kingdom, France, and Italy). The list of IPO firms is from the EURIPO database that provides the IPO prospectus as well as very detailed information on the companies and their management[54]. In line with

[54] SMEs are defined according to the definition of the European Commission as firms with sales inferior to 50 €m at the IPO. The industry classification is the official one adopted by the European stock exchanges, namely the ICB - Industry Classification Benchmark. The EURIPO database is developed by Universoft, a spin-off of the University of Bergamo (www.euripo.eu). It contains data on more than 5 000 companies that went public in Europe since 1985. We focus on the four largest economies in Europe,

other studies (e.g., Cloodt et al., 2006), we consider as high-tech sectors electronics (Electronics), information technology (IT), pharmaceutical and biotech (Pharma & Bio), industrial machinery (Machinery) and communications (Communications). The most numerous industries in the sample are Information Technology and Pharmaceutical and Biotechnological, thanks to the contribute of new stock markets. Companies operating in these intangible sectors are typically the most "research based" ones, and their attitude to go public may signal their need to raise funds to be invested in research and development activities. Germany and UK are the most highly represented countries in the sample (45% and 33%, respectively), due to the larger size of the economy (Germany) and to the superior level of stock market development (UK).

Table 22: Sample

	Sample	Electronics	IT	Pharma & Bio	Machinery	Communications
No. firms	382	54	172	69	30	57
(%)		*(14.14)*	*(45.03)*	*(18.06)*	*(7.85)*	*(14.92)*
France	65	20	8	14	13	10
(%)	*(17.02)*	*(30.77)*	*(12.31)*	*(21.54)*	*(20.00)*	*(15.38)*
Germany	171	25	92	21	0	33
(%)	*(44.76)*	*(14.62)*	*(53.80)*	*(12.28)*	*(0.00)*	*(19.30)*
Italy	19	4	6	3	5	1
(%)	*(4.97)*	*(21.05)*	*(31.58)*	*(15.79)*	*(26.32)*	*(5.26)*
UK	127	5	66	31	12	13
(%)	*(33.25)*	*(3.94)*	*(51.97)*	*(24.41)*	*(9.45)*	*(10.24)*

[a] Percentages in the first column are relative to the whole sample.

3.2 Variables and data sources

In the study, we adopt a market perspective to analyse the relationship between innovation and financial strategies adopted by the companies. We select a set of dependent variables representative of: (1) the decisions and the capability to raise capitals (financing decision), (2) the propensity to invest in internal and external assets (investment decision), (3) the visibility and the attractiveness for potential investors and acquirers in parallel to insiders divesture or diversification strategy (market dynamicity). The capacity to collect external funds is investigated valuing the fresh capital raised at the IPO (percentage of primary shares offered - Dilution ratio), and

namely Germany (Deutsche Börse), the United Kingdom (London Stock Exchange), France (Euronext) and Italy (Borsa Italiana.

subsequent equity follow-ons (seasoned equity offers - SEOs) and debt inflows (leverage and debt growth). Dealing with the investing decision, we distinguish between internal (capital expenditures and fixed assets) and external investments (acquisitions). Last, we analyse the divestment activities of insiders existing shareholders (percentage of secondary shares placed at the IPO - Participation ratio, divestment by substantial shareholders and TMT members) and the external interests in the firms by investors (liquidity and volume traded) and acquiring firms (take-overs). The survival profile of the companies is analysed with reference to the probability of both being targeted in M&A deals, and of going bankruptcy.

We relate these financial strategy decisions to firms' innovation and human capital, as well as the potential influence of institutional affiliation. A detailed definition of these variables is provided in Table 23. Data are collected from different sources. Primary sources of information are the IPO prospectuses collected from EURIPO. In agreement with listing requirements, vetted by the national exchange commissions, any firm undertaking an IPO must publish an official prospectus that contains a wealth of information regarding the firm's history and management. In particular, companies going public are required to describe their history and to report the curriculum vitae of their founder(s) and members of the TMT. Potential investors carefully scrutinize these documents in an effort to assess the prospects of an equity position in the IPO-firm. Given the uncertainty and information asymmetries surrounding IPO-firms and the consequent complicatedness to discern firm quality, the prospectus is the primary means for communicating information about the company[55]. We take advantage of such opportunity to access to firm-specific information on firms and IPOs' characteristics, intellectual capital[56], ownership structure and institutional affiliation. The second sources of information are commercial databases. Accounting data, stock price and

[55] The purpose of the prospectus is to sell stock. Therefore, it is assumed that all relevant information will be included. Since owners and managers can be held legally accountable for the accuracy of the information disclosed in this document, it represents the best source of information on the quality for the firm. As a result, prospectus data are considered reliable and there is a long tradition of using such information in strategy research and, more recently, in entrepreneurship research (Shrader and Siegel, 2007). Previous research has relied on signalling theory to guide the exploration of those signals contained in the prospectus that might impact the potential investors' assessments of firm value and post-issue performance (Ritter and Welch, 2002). The resource-based view of the firm (Wernerfelt, 1984) also applies to our prospectus-based approach. Consistent with this view, information contained in the prospectus might indicate firm-specific resources that could encourage investors to more highly value the IPO-firm, based on its potential for achieving sustained competitive advantage.

[56] The number of registered patents are obtained from the European Patent Office.

volumes are from DataStream. Information on M&A deals, SEOs and other capital raisings is from Thomson One Banker Deals[57].

Table 23: Variable definition

Variable [a]	Definition
FIRMS CHARACTERISTICS	
Market Value (€m)	Market capitalization at offer prices
Age (years)	Age of the firm
Leverage (%)	Ratio between debt and total assets
Profitability (%)	Return on assets
Market to Book	Ratio between market capitalization plus debt over book value of total assets
INTELLECTUAL CAPITAL	
Patents (No.)	Number of patents registered at the European Patent Office
R&D Investments (%)	Ratio between R&D investments and sales
PhD in the TMT (%)	Proportion of TMT members that are university professors or hold a PhD
MBA in the TMT (%)	Proportion of TMT members with a MBA degree
TMT Experience (% of directors)	Proportion of directors with TMT membership experiences in other firms
TMT Relational Capital (% of directors)	Proportion of TMT members with experiences in public institutions or in the TMT of financial entities
CEO Experience (No. of TMT memberships)	Proportion of directors with CEO experiences in other firms
CEO Relational Capital (No.)	Number of CEO experiences in public institutions or in the TMT of financial entities
Number of directors (No.)	Number of TMT members
Independent directors (%)	Proportion of independent TMT members

[57] In line with other authors (e.g. Bertrand and Zuniga, 2006), we considered as M&A deals all those deals of industrial restructuring. Thus, our sample firms could be targeted in several M&A transactions, since with M&As we do not refer exclusively to the combination of two companies to form a new company. The raw data were checked to eliminate double counting of transactions. Deals were identified by the cut-off ownership levels for mandatory disclosures required by national laws. In all the jurisdictions evaluated, there was a formal obligation which required major shareholders to disclose their holdings in a company. The percentage level at which such an obligation was triggered varied from country to country. France (Code de Commerce, article L. 233-7) and Germany (Securities Acquisition and Take-over Act, sections 21 and 22) adopted 5% as a base level, like in the US, while Italy (Law No. 58 of 1998) and the UK (Companies Act 1985 sections 198-212) were at 2% and 3%, respectively.

Table 23 (continued)

OWNERSHIP STRUCTURE	
Ownership Concentration (%)	Equity stake held by substantial shareholders. Details of directors' interests and external interests which amounted to at least 2 or 3% of issued share capital are required to be disclosed at the IPO. Substantial shareholders are identified by these cut-off ownership levels for mandatory disclosures required by national laws.
TMT Ownership (%)	Pre-IPO ownership stake held by TMT members
CEO Ownership (%)	Pre-IPO ownership stake held by CEO
CEO = Founder (% of firms)	Firms where the CEO is also the founder
CEO = Main Shareholder (% of firms)	Firms where the CEO is also the main shareholder
INSTITUTIONAL AFFILIATION	
VC-backed (% of firms)	Dummy variable equal to 1 if venture-backed
University affiliation (% of firms)	Dummy variable equal to 1 for companies developed by faculty members based on their research, or companies created to capitalise on research carried out in universities
CAPITAL RAISING	
Dilution Ratio (%)	Number of newly issued shares over number of shares outstanding after the IPO
Firms pursuing SEOs (% of the sample)	Firms that raised capital through SEO
SEOs (average for firms pursuing SEOs, No.)	Number of SEOs pursued by each firm
SEO Volume / Market Value (%)	Ratio between the cumulative volume of capital raised through SEOs and market capitalization
Debt / Total Assets (median, %)	Ratio between book value of debt over total assets
INTERNAL AND EXTERNAL INVESTMENTS	
Investments over Fixed assets (%)	Ratio between capital expenses and fixed assets
Firms acquirers in M&A deals (% of the sample)	Firms involved as acquirer in at least one M&A deal
Acquisitions (average for firms pursuing acquisitions, No.)	Number of deals as acquirer
Acquisitions Volume / Market value (%)	Ratio between the cumulative volume of money used in acquiring deals and market capitalization
Intra-Industry deals (%)	Proportion of deals as acquirer where firms involved belong to the same industry
Cross-Border deals (%)	Proportion of deals as acquirer between firms belonging to different countries

Table 23 (continued)

MARKET DYNAMICITY	
Participation Ratio (%)	Ratio of existing shares divested at IPO-time relative to the number of pre-IPO shares (secondary shares %)
Substantial shareholders divestment (%)	Divestment at the IPO by substantial shareholders: shares sold, over pre-IPO stakes.
TMT divestment (%)	Divestment at the IPO by TMT members: shares sold over pre-IPO stakes.
Firms targeted in M&A deals (% of the sample)	Firms involved as target in at least one M&A deal
Targets (average for firms target in M&A deals, No.)	Number of deals as target
Targets Volume / Market value (%)	Ratio between the cumulative volume of money used in targeting deals and market capitalization
Financial Acquirer (%)	Proportion of deals as target where the acquiring company belongs to the financial industry
Intra-Industry deals (%)	Proportion of deals as target where the acquiring company belongs to the same industry of the target
Cross-Border deals (%)	Proportion of deals as target where the acquiring company is from the same country of the target
Firms transferring control (% of the sample)	Percentage of sample firms whose control has been transferred through post-IPO M&A deals
Delisted (%)	Percentage of delisted firms
Bankruptcy (%)	Percentage of firms delisted upon request of the company.
Liquidity (%)	Ratio between the turnover volume and the total number of securities listed.

[a] Firm-specific variables (General characteristics, Intellectual capital, Ownership and Corporate Governance) are measured at the IPO.

3.3 Sample description

High-tech SMEs going public in Europe are in median 7.5 years old and have an average market value at IPO of 81 €m (Table 24). Size varies among industries, from an average of 44 €m of market capitalization of machinery firms to 99 €m for IT firms[58]. The leverage, measured as ratio between debt and total assets, spans from an average of 22% for biotech companies to 66% for machinery firms. Machinery is also the sector

[58] The sample is made up of SMEs operating in innovative industries that went public in Europe in the period 1995-2003. According to the EU definition of SME, only companies with (pre-IPO) sales lower to 50 €m are selected. As a consequence, the average market size in our sample is higher for industries with high relevance of intangible assets, such as IT and biotech, and lower for machinery and electronics. This is due to the higher price-to-sales ratio in more intangible industries. Similar considerations can be drawn for the market-to-book ratio.

with the highest median profitability (return on assets) and the lowest market-to-book ratio. On the contrary, biotech companies are the least profitable (most had no earnings prior to the IPO) and have highest market-to-book ratio. There are, therefore, two extremes in the industry composition of the sample. Machinery companies are the smallest, oldest, and most indebted and more profitable companies, while biotech and pharmaceutical companies are the youngest, (second) biggest, less indebted and less profitable firms.

Referring to intellectual capital, biotech companies are the most innovative both in terms of research input (R&D investments) and research output (patents). Indeed, in the biotechnology industry, continuous innovation is a strategic priority in a firm's efforts to acquire and protect a competitive advantage. To succeed in science-based industries, a firm must innovate and protect its innovations from imitation by rivals (Grant, 1998). Thus, in this sector, where successful product commercialization has been rare, companies have sought to protect their innovations through patents (George et al., 2002). Moreover, the speed of change of this sector is so rapid that companies can survive only if they acquire the capabilities that they do not have through alliances and technology acquisitions (Aslani and Negassi, 2006). Biotechnological companies also have TMTs with prestigious educational profiles and large business and institutional networks. Indeed, educational capital might contribute to the development of social capital, an idea that is coherent with the assertion that what you know influences who you know (Hsu et al., 2007). Coherently, TMTs of biotech companies are characterised by higher educational (Ph.D.s and MBAs in the TMT) and relational capital (TMT experience and TMT relational capital)[59]. Other industries with a high level of intellectual capital are Electronics and IT, according to the technology based nature of these sectors, while for Machinery and Communications we find an inferior intensity of intellectual capital.

All the categories of shareholders (substantial, TMT members, and the Chief Executive Officer) hold a large ownership stake. In particular, the ownership fraction of substantial shareholders (Ownership concentration) is 74%, while the equity stakes for TMT

[59] Capello and Faggian (2005) define relational capital as any relationship – market relationships, power relationships and cooperation – established between firms, institutions and people. In our study, market relationships are measured by the TMT Experience variable, calculated as the percentage of the firm's TMT members with TMT membership in at least another firm. The level of firms' relationship with institutions is measured as the percentage of directors with experiences in public institutions or in the TMT of financial entities (TMT Relational Capital).

members and Chief Executive Officer (CEO) are 45% and 28%, respectively. Given that these companies seem to be largely financed by a small number of shareholders, arguably the so-called 'family and friends', this evidence may reflect the great difficulty technology-based companies have in acquiring external financial resources. Finally, when we look to institutional affiliation we note that the proportion of companies with VC or university affiliation[60] is particularly high in Pharma & Bio industry. Indeed, the pharmaceutical and biotech companies face great difficulties to start businesses without relationships with universities or research institutions. This is, in fact, the most science-based industry (Phlippen and van der Knaap, 2007), where as much as 60% of innovative SMEs going public are university affiliated.

[60] Basing on information reported in the prospectus, we identify as university-based firms those companies that were developed by faculty members based on their research, or companies created to capitalise on research carried out in universities. Our definition of university-based companies is coherent with the literature. For instance, Ensley and Hmieleski (2005, p. 1097) define university-based firms those that were "developed by students or faculty based on their research, or utilized research from a university's technology transfer area"; Smith and Ho (2006, p. 1560) refer to "technology-based company founded by a member/former member of a university or one of the seven laboratories using IP developed in the institution by the founding individual(s)"; Colombo et al. (2006, p. 3) define academic start-ups as "new ventures with an entrepreneurial team at least partially composed of academics and/or researchers from public research organizations". Typical sections of the IPO prospectuses that report the information needed to identify university-based firms are in France, the paragraphs "Historique du Groupe", "Recherche et développement" and "Ressources humaines"; in Germany, "Gründung", "Organe der Gesellschaft" and "Forschung und Entwicklung"; in Italy "Storia ed evoluzione dell'attività", "Politica di ricerca e sviluppo", "Attività svolte dai componenti del Consiglio di Amministrazione" and "Struttura organizzativa"; in the UK, "History and background", "Management", "Directors" and "Research and Development Programmes". Since owners and managers can be held legally accountable with regard to the accuracy of the information disclosed in this document, it represents the best source of information on the quality for the firm.

Table 24: Descriptive statistics

Variables	Sample	Electronics	IT	Pharma & Bio	Machinery	Communications
PANEL A: FIRM AND OFFER CHARACTERISTICS						
Market Value (€m)	80.72	58.34	99.55	83.24	44.01	61.43
Age (years, median)	7.5	9	8	6	9	6
Leverage (%, median)	28.45	34.52	23.35	21.88	65.94	25.76
Profitability (%, median)	5.46	7.99	3.22	-1.31	15.31	7.49
Market to Book	3.65	3.56	3.72	3.65	3.19	3.58
Dilution ratio (%)	29.86	27.43	30.74	31.67	28.07	28.07
Participation ratio (%)	8.98	13.24	8.33	5.84	9.97	8.67
Substantial shareholders divestment (%)	16.10	19.39	17.05	11.64	16.85	15.01
TMT divestment (%)	11.65	10.41	12.20	9.82	17.45	10.07
PANEL B: INNOVATION						
Patents (No.)	14.71	32.37	5.25	35.33	12.00	2.95
R&D Investments (%)	11.89	15.51	10.56	17.16	10.15	7.01
PANEL C: INSTITUTIONAL AFFILIATION						
VC-backed (% of firms)	54.65	57.14	53.45	63.23	36.01	55.32
University affiliation (% of firms)	29.58	29.63	25.01	62.32	3.34	17.54
PANEL D: HUMAN CAPITAL AND CORPORATE GOVERNANCE						
Ownership Concentration (%)	73.55	80.96	74.27	66.07	77.19	71.62
TMT Ownership (%)	45.76	43.34	48.01	38.22	61.78	42.72
Number of directors (No.)	4.87	4.97	4.44	5.63	5.36	4.91
Independent directors (%)	35.05	40.54	33.16	37.71	33.83	32.99
CEO Ownership (%)	28.21	28.61	29.07	23.28	28.34	31.66
CEO = Founder (% of firms)	61.48	57.14	64.15	57.35	40.01	73.91
CEO = Main Shareholder (% of firms)	50.87	44.01	53.46	42.65	52.01	61.91
PhD in the TMT (%)	9.87	7.44	9.42	20.88	3.22	0.51
MBA in the TMT (%)	8.66	12.81	5.01	17.87	8.34	4.02
TMT Experience (% of directors)	70.87	58.78	72.62	78.74	64.73	67.44
TMT Relational Capital (% of directors)	6.78	8.83	3.76	13.09	8.44	5.55
CEO Experience (No. of TMT memberships)	2.19	1.70	2.17	2.59	3.41	1.61
CEO Relational Capital (No.)	0.74	0.48	0.93	0.73	0.35	0.62

3.4 Methodology

The analysis focuses on three main aspects: financing decision, investments decision and market dynamicity. For all these aspects, our empirical analysis is divided into two steps. Firstly, we use descriptive statistics to give a framework of the IPO and post-IPO dynamics of our sample firms in terms of the relevant aspects investigated. Secondly, we analyse the characteristics at the IPO that may signal the future evolution of going public innovative SMEs. This analysis may be informative on the ability of the market to foster the development of high-tech companies and give indications on the characteristics of IPOs firms that influence long run strategies. In particular, we are interested to show if there is a relationship between innovation and post-IPO evolution of our sample firms.

The first relevant aspect analysed in this study is the ability of sample firms to collect fresh capitals (equity and debt) at the IPO and in the five years after the floatation. To this aim we use two typologies of empirical models. We use an OLS model with White robust standard errors with the volume of SEOs in the five years after the floatation[61] as dependent variable. Then we use a dynamic panel model to investigate the evolution of leverage in the post-IPO period[62]. Following the literature on dynamic estimators with large N and small T panel data sets (Arellano and Bond 1991; Bond 2002), the model is estimated using the generalize method of moments (GMM) methodology. In particular, we chose the GMM-System (GMM-SYS) estimator developed by Blundell and Bond (1998) in order to increase efficiency[63]. The second relevant aspect of our analysis is the investigation of how capitals raised at the IPO and in the post-IPO period are invested. To this aim we focus on internal investments and acquisitions. For internal investments we use a GMM-System model where the dependent variable is the ratio between capital expenditures and fixed assets in the five years after the floatation[64]. While for

[61] In this model as dependent variable we use the natural logarithm of the total volume of equity issued by each firm in the post-IPO period considered (five years).

[62] We also investigate the growth of the absolute value of debt in the post-IPO period, using a GMM-System model. Results are presented in appendix in Table A.6.

[63] The authors demonstrated dramatic improvement in performance of the system estimator compared to the usual first-difference GMM estimator developed by Arellano and Bond (1991). Furthermore, in system GMM it is possible to include time-invariant regressors, which would disappear in difference GMM. Asymptotically, this does not affect the coefficients estimates for other regressors (Roodman, 2006). This characteristic is of particular interest for our study since the large majority our independent variables refer to characteristics at the IPO, and thus they are time invariant.

[64] We also investigate the growth of the absolute value of fixed assets in the post-IPO period, using a GMM-System model. Results are presented in appendix in Table A.7.

acquisitions we consider the volume of acquisitions pursued by sample firms (OLS model with White robust standard errors)[65].

Besides capital raising and investments, we are also interested to market dynamicity of our innovative SMEs that we analyse through propensity to transfer control, stock liquidity and failure probability. For propensity to transfer control we use a Cox model where the output variable is equal to 1 if the control equity stake of the firm is acquired in an M&A deal and the time variable measures the time elapsing between the IPO and the control transfer[66]. To identify those companies whose control is transferred in M&As, the percentage of the share capital transacted in a M&A deal is compared to the stable shareholding. In other words, the control transferred is assumed to take place when the equity stake sold to acquirers represented the majority of the free-float adjusted market capitalization (MSCI, 2000)[67]. Referring to liquidity, we use an OLS model with White robust standard errors where the dependent variable is equal the turnover in the five years after the IPO. Finally, we also analyse the ability of our innovative IPOs to survive in the years after the floatation. For this analysis, we use a Cox model where the dependent variable is equal to 1 for failed companies and the time variable measures the time elapsing between the IPO and the failure[68].

In all our models we use a common set of potential determinants, selected basing on the literature on IPOs and innovation and grouped in five categories: baseline regression variables, behaviour at the IPO, institutional affiliation, innovation and human capital &

[65] Total volume of acquisitions for each firm is calculated as the natural logarithm of the total monetary value of acquisitions. Since we have not all the data on the monetary volume of deals, in the regression model we use as dependent variable the ratio between the total volume of acquisitions and the availability of deals values (expressed in percentage of the total number of deals for each firm). The correlation between the total number of deals and the available total value of deals is 65.71%, so we believe that our estimation of the real total value can be good. Moreover, as robustness test we also use Poisson model where the dependent variable is the number of acquisitions. Results are presented in appendix in Table A.8.

[66] As robustness test we also consider an OLS model with White robust standard errors where the dependent variable is the volume of M&As as target. Since we have not all the data on the monetary volume of deals, in the regression model we use as dependent variable the ratio between the natural logarithm of total volume of deals as target and the availability of deals values (expressed in percentage of the total number of deals for each firm). The correlation between the total number of deals and the available total value of deals is 67.45%, so we believe that our estimation of the real total value can be good. Results are presented in appendix in Table A.9.

[67] In line with common practice (e.g. MSCI, 2000), the market capitalization of a company's equity securities is adjusted to reflect their level of free float. The free float is identified as the proportion of share capital that is deemed to be available for purchase in the public equity markets. For example, a company whose stable share capital is, say, 80% (i.e. free float 20%) is considered to be acquired (control transferred) when it is a target of M&A deals for more than 40% of its share capital.

[68] We also consider as dependent variable firms that are delisted after a takeover. Results are presented in appendix in Table A.10.

TMT structure. In the baseline regression we include a set of control variables that could influence our dependent variables: firm characteristics at the IPO (size, age, leverage and profitability)[69] and a series of dummy variables for industry, countries and year specificities. Referring to the behaviour at the IPO, we include a set of variables representative of the capital raising and divestment at the IPO (market-to-book, dilution ratio, substantial shareholders divestment, TMT divestment and participation ratio). Important theoretical variables refer to institutional affiliation. We use dummy variables to test the effect of university affiliation and pre-IPO VC financing. Moreover, we take into consideration the effect of innovation on market valuation. We use the R&D investment as a measure of research input and the number of patents held by the firm as a measure of research output[70]. We also include a variable equal to the product between Patents and the dummies Pharma and Bio and Electro (Patents × Pharma & Electro) to capture the peculiar role played by patents in determining M&A activities in these sectors, the ones with the highest attitude to patenting.

Finally, we investigate the role played by TMT human capital and structure on market valuation and performance. For the human capital we consider the variable Education constructed using the factor analysis considering the proportion of directors with MBA and Ph.D. degrees. Also the variable Experience is constructed with factor analysis and includes the variables TMT Experience, TMT Relational Capital, CEO Experience and CEO Relational Capital. For TMT structure we consider the number of directors and the proportion of independent directors.

Our OLS models[71] include all these independent variables. Therefore, OLS models are defined as follow:

$$y_i = \alpha + \overline{\beta_0}(Baseline) + \overline{\beta_1}(IPO\ Behaviour) + \overline{\beta_2}(Institutional\ Affiliation) + \overline{\beta_3}(Innovation) + \overline{\beta_4}(Human\ Capital\ and\ TMT\ Structure) + \varepsilon_i$$

[69] Firm size is measured by the natural logarithm of market capitalization at the IPO; firm age is measured by the natural logarithm of company's years since incorporation at the IPO; firm profitability is measured by return on assets at the IPO; firm leverage is measured by the natural logarithm of the ratio between debt and total assets at the IPO.

[70] The variable R&D investments is measured by the natural logarithm of the ratio between R&D investments and sales at the IPO. The variable Patents is measured by the natural logarithm of the number of patents held by each firm at the IPO, scaled by the natural logarithm of market capitalization.

[71] Also Poisson and Cox models include the same set of independent variables.

In GMM-system models we use the same set of exogenous regressors used in OLS, Cox and Poisson models. However, in these models we also include IPO_{t-j} dummies equal to one if the calendar year *t-j* happens to be the IPO year and, given the autocorrelation of the dependent variable, we include the lagged dependent variable y_{t-1} .

$$y_{i,t} = \alpha + \beta_0 y_{t-1} + \sum_{j=1}^{5} \beta_j IPO_{t-j} + \overline{\beta_2}(Baseline) + \overline{\beta_3}(IPO\ Behaviour) + \overline{\beta_4}(Institutional\ Affiliation) + \overline{\beta_5}(Innovation) + \overline{\beta_6}(Human\ Capital\ and\ TMT\ Structure) + \varepsilon_{i,t}$$

4. Results

4.1 The financing decision: raising capital

The financing patterns for SMEs are peculiar and hint at the presence of greater financing constraints than those borne by large companies. The level of information asymmetries between the firm and external investors is usually higher for small and medium-sized enterprises than for large ones. Information on small enterprises, especially when they are not publicly traded, is often limited and less timely. Moreover, by being usually younger, small businesses have less reputation capital. Finally, the lack of adequate collateral, the reduced bargaining power with financiers and the presence of fixed costs in financing activity further contribute to making external finance more expensive. This would suggest the presence of a strong pecking order of financing sources for SMEs and, as a consequence, a greater reliance on internal generated funds. However, in the case of limited personal funds, SMEs may suffer from lack of alternatives and availability of financing sourcing which hamper their development. SMEs, and in particular innovative ones, have more of their assets in intangibles and undertake risky projects, making debt financing unsuitable. Debt holders bear the downside risk, but do not share the upside benefit of successful innovation. For these companies equity seems to be more appropriate than debt as a source of finance, but the costs of acceding to equity markets may be too high. Thus, an explicit goal of current public policy in Europe is to promote the development of efficient and liquid risk capital markets in order to sustain innovative entrepreneurship and to facilitate the

expansion of existing small firms. In particular, in the last decade in every European country second-tier markets have been launched with the aim to provide SMEs with the means to get 'low cost' direct financing without the costly interposition of a financial intermediary (Holmström and Tirole, 1997). At the IPO stage, firms are able to finance growth by raising a large amount of fresh capital.

As evidenced in Table 24 (Panel A) at the IPO our sample firms show an average dilution ratio of about 30%. This means that almost one third of the market capitalization after the IPO is composed by fresh capital, suggesting that the IPO can be considered as a means of raising new funds to finance growth projects. Moreover, as shown in Table 25 (Panel A) the 65% of our sample firms pursue at least one SEO in the year of the floatation, raising new capital for an average percentage of 32% in comparison to the market capitalization. Therefore, with 72% of sample firms pursuing at least a SEO in the five years after the floatation, the IPO seems to be an important mechanism that can facilitate the raising of external equity. However, in the post floatation period, the use of SEOs to raise equity capital rapidly declines so that five years after the IPO only the 3% of our sample firms are involved in SEOs activities. Also, the value of SEOs in comparison to market capitalization (at the moment of the SEO) declines from 32% to 15%.

Referring to the determinants of SEO activity, Table 26 shows some interesting results. Predictably, larger firms are characterised by larger offerings, while, more interestingly, more profitable firms are characterised by lower volumes of SEOs, probably because they have more internal funds available. Also, we find a negative correlation between participation ratio and SEOs suggesting that a higher divestment at the IPO is connected with a lower attitude to raise capitals in the post-IPO years. The most interesting result is the positive correlation between R&D and SEOs' volumes. This empirical evidence suggests that external equity is used by our sample firms to finance innovation efforts, confirming the validity of external equity to finance innovative companies.

Table 25: Financing, investing and market dynamicity

Year relative to the IPO	0	+1	+2	+3	+4	+5
			PANEL A: CAPITAL RAISING			
Firms pursuing SEOs(% of the sample)	65.44	14.39	9.42	3.66	3.66	3.41
SEOs (No.)	1.05	1.24	1.42	1.36	1.29	1
SEO Volume / Market Value (%)	31.61	28.23	32.41	24.21	26.99	14.96
Debt / Total Assets (median, %)	28.45	26.81	27.87	27.34	28.31	28.99
			PANEL B: INTERNAL AND EXTERNAL INVESTMENTS			
Investments over Fixed assets (%)	58.75	67.21	53.06	38.62	25.86	28.06
Firms acquirers in M&A deals (% of the sample)	32.98	50.52	30.11	21.99	17.28	15.97
Acquisitions (No.)	2.17	2.44	2.21	1.29	1.42	1.46
Acquisitions Volume / Market value (%)	9.79	19.11	17.31	19.41	18.12	14.58
Intra-Industry deals (%)	36.86	32.13	39.48	35.99	36.27	31.44
Cross-Border deals (%)	39.28	40.75	31.27	44.61	46.97	34.02
			PANEL C: MARKET VITALITY			
Firms targeted in M&A deals (% of the sample)	7.59	14.14	23.04	20.16	14.13	14.92
Targets (No.)	1.14	1.21	1.49	1.41	1.41	1.44
Targets Volume / Market value (%)	28.19	25.45	24.38	31.04	40.43	46.21
Financial Acquirer (%)	45.45	24.61	45.03	40.74	56.41	45.33
Intra-Industry deals (%)	12.12	30.76	25.19	22.22	11.53	37.33
Cross-Border deals (%)	18.18	26.15	26.72	34.26	38.46	50.66
Firms transferring control (% of the sample)	2.81	4.19	7.59	6.29	3.93	4.45
Delisted (% of the sample)	0.52	1.58	1.83	6.02	2.87	6.54
Bankruptcy (% of the sample)	0.00	1.05	1.05	2.88	1.31	3.93
Liquidity (%, yearly median)	51.25	30.96	29.16	29.41	33.36	33.01

Table 26: The financing decision: capital raising

SEOs volume [a]	Model 1	Model 2	Model 3	Model 4
Baseline				
Size	0.76***	0.81***	0.78***	0.72***
Age	0.14	0.18	0.18	0.17
Leverage	0.21	0.29	0.19	0.23
Profitability	-0.34*	-0.33*	-0.31*	-0.32*
Electro	-0.24	-0.53	-0.71	-0,70
Pharma	-0.05	-0.17	-0.31	-0.37
IT	-0.03	-0.18	-0.19	-0.17
UK	-0.03	-0.06	-0.15	-0.18
Germany	-0.19	-0.25	-0.23	-0.08
IPO behaviour				
Market To Book	-0.19*	-0.21*	-0.23*	-0.22*
Dilution Ratio	0.41	0.29	0.39	0.45
Participation Ratio	-1.77*	-2.27*	-2.29*	-2.41*
Substantial shareholders divestment	-0.25	-0.77	-0.68	-0.58
TMT divestment	-0.74	-0.86	-0.79	-0.86
Institutional affiliation				
VC backed		0.41*	0.31	0.25
University Affiliation		0.35*	0.15	0.11
Innovation				
R&D			1.53**	1.23**
Patents			0.09	0.08
Patents × Pharma & Electro			0.29*	0.25*
Human capital and TMT structure				
Education				0.28*
Experience				0.05
Independent				0.12
Directors				0.11*
Constant	-12.12***	-11.99***	-11.21***	-10.83***
R^2 % [b]	25.62***	28.17***	31.75***	32.52***

OLS regression with White robust standard errors where the dependent variable is the total volume of external equity raised through SEOs by each company after the IPO.
[a] t-Test for significance of the independent variables.
[b] F-Test for significance of the regression.
*** 1% significance level; ** 5% significance level; * 10% significance level.

Referring to debt sourcing, Table 25 (Panel A) shows that leverage is nearly stable in the post IPO period, suggesting that our sample companies do not go public to rebalance their capital structure. Moreover, the low level of leverage (28%) suggests the unsuitability of debt for the financing of innovative businesses. In this context, when we look to the determinants of leverage evolution in the post-IPO period (Table 27) is interesting to note the positive correlation between patents and leverage growth.

Table 27: The financing decision: the evolution of firm's leverage

Leverage	Model 1	Model 2	Model 3	Model 4
Baseline				
Y_(t-1)	0.46***	0.46***	0.46***	0.46***
IPO_1	-0.13*	-0.13*	-0.13*	-0.13*
IPO_2	-0.03	-0.02	-0.02	-0.02
IPO_3	0.02	0.02	0.02	0.02
IPO_4	0.05	0.05	0.05	0.05
Size	-0.01	-0.01	-0.01	-0.01
Age	0.02	0.02	0.02	0.02
Leverage	_	_	_	_
Profitability	0.02	0.01	0.01	0.01
Electro	-0.03	-0.02	-0.03	-0.04
Pharma	0.01	0.02	0.01	-0.06
IT	-0.06*	-0.04	-0.05	-0.04
UK	-0.09*	-0.09*	-0.09*	-0.11*
Germany	-0.01	-0.01	-0.01	-0.01
IPO behaviour				
Market To Book	-0.01	-0.01	-0.01	-0.01
Dilution Ratio	0.12*	0.13*	0.13*	0.12*
Participation Ratio	0.18**	0.19**	0.15*	0.16*
Substantial shareholders divestment	0.24*	0.25*	0.27*	0.26*
TMT divestment	0.09	0.09	0.08	0.08
Institutional affiliation				
VC backed		-0.04*	-0.04*	-0.04*
University Affiliation		-0.06*	-0.06*	-0.06*
Innovation				
R&D			-0.11	-0.10
Patents			0.04***	0.04***
Patents × Pharma & Electro			0.13***	0.13***
Human capital and TMT structure				
Education				0.02
Experience				-0.03
Independent				0.02
Directors				-0.01
Constant	0.24***	0.27***	0.28***	0.28***
Instruments	32	34	36	40
χ^2	172.97***	177.54***	204.91***	213.01***
AR(1) Test (z) (p value)	0.00***	0.00***	0.00***	0.00***
AR(2) Test (z) (p value)	0.33	0.33	0.33	0.33
Hansen Overid. restrictions (p value)	0.47	0.48	0.47	0.47
GMM Instruments Tests				
Hansen Test excluding groups (p value)	0.24	0.35	0.35	0.35
Difference (null H = exogenous) (p value)	0.41	0.25	0.30	0.28
Exogenous Instruments tests				
Hansen Test excluding groups (p value)	0.47	0.41	0.42	0.41
Difference (null H = exogenous) (p value)	0.28	0.23	0.26	0.25

GMM-System model where the dependent variable is the leverage of firms in the five years after the IPO.
*** 1% significance level; ** 5% significance level; * 10% significance level.

This positive correlation may point out that debt financing is particularly unsuitable in early stages of the lifecycle of innovative companies, while when a company finalize its research in some assets, as patents, access to debt financing can be easier. Also, we find that venture backed companies and firms with university affiliation show a lower attitude to increase their leverage in the years after the IPO.

4.2 The investment decision: internal and external growth strategies

Our empirical results clearly show that for our sample of innovative SMEs the IPO represents a springboard for implementing strategies of internal and external growth. Table 25 (Panel B) shows a high level of internal investments (Capex) in all the years considered after the IPO, with a maximum level of 67% in the year after the floatation and a minimum of 26% in the fourth year after the IPO. Also, acquisitions are fundamental in the evolution of innovative SMEs, with three out of four of the sample firms (74.4%) involved in at least a deal as acquirer in the years after the floatation considered, with a total deal value between 10% and 20% of the market capitalization of the firm itself[72]. As a whole, these results are consistent with the investment financing motivation for equity offers (Kim and Weisbach, 2008). Moreover, these findings indicate that the IPO and M&A markets are probably not as independent as often assumed. The IPO could, indeed, be viewed as a means to pursue external growth strategies. The IPO could make available the ready funds needed to fuel firm's external growth and facilitate stock deals, as the creation of public shares allows stocks to be used as currency to participate in M&As. Also, the IPO may increase the level of firm's disclosure and of investors' monitoring, enhancing the efficiency of the M&A market. Furthermore, our descriptive results suggest that the IPO and the subsequent acquisition activity may be beneficial for business conglomeration, with one third of deals (35%) between companies belonging to the same industry. Finally, our innovative SMEs seem to have a significant tendency to internationalization, given the significant proportion of cross-border deals (39%).

When we look to the determinants of internal (Table 28) and external (Table 29) growth we find interesting results.

[72] Considering an average availability of deal value of 50%.

Table 28: The investment decision: the evolution of firm's internal investments

Investments Over Fixed Assets	Model 1	Model 2	Model 3	Model 4
Baseline				
Y_(t-1)	0.35***	0.35***	0.35***	0.35***
IPO_1	0.15***	0.15***	0.15***	0.15***
IPO_2	0.12***	0.11***	0.11***	0.11***
IPO_3	0.03	0.02	0.02	0.02
IPO_4	-0.03*	-0.03*	-0.03*	-0.03*
Size	-0.03	-0.03	-0.03	-0.03
Age	-0.11*	-0.11*	-0.12*	-0.11*
Leverage	-0.01	-0.01	-0.02	-0.01
Profitability	0.12***	0.12***	0.08**	0.07**
Electro	0.03	0.03	0.02	0.02
Pharma	0.01	0.01	0.02	0.02
IT	0.10***	0.08**	0.08**	0.08**
UK	-0.03	-0.04	-0.06	-0.12
Germany	0.05	0.05	0.03	0.04
IPO behaviour				
Market To Book	0.01	0.01	0.02	0.02
Dilution Ratio	0.12**	0.11**	0.10**	0.12**
Participation Ratio	-0.04	-0.02	0.01	0.02
Substantial shareholders divestment	-0.10*	-0.11*	-0.12*	-0.11*
TMT divestment	-0.17*	-0.17*	-0.18*	-0.15
Institutional affiliation				
VC backed		-0.01	-0.01	-0.02
University Affiliation		-0.01	-0.02	-0.01
Innovation				
R&D			-0.01	0.01
Patents			-0.03***	-0.03***
Patents × Pharma & Electro			-0.07**	-0.07**
Human capital and TMT structure				
Education				-0.02
Experience				0.11*
Independent				-0.06
Directors				0.04
Constant	0.15**	0.16**	0.14**	0.07*
Instruments	32	34	36	40
χ^2	238.58***	237.14***	253.11***	254.12***
AR(1) Test (z) (p value)	0.00***	0.00***	0.00***	0.00***
AR(2) Test (z) (p value)	0.87	0.87	0.81	0.81
Hansen Overid. restrictions (p value)	0.21	0.21	0.23	0.24
GMM Instruments Tests				
Hansen Test excluding groups (p value)	0.53	0.53	0.51	0.46
Difference (null H = exogenous) (p value)	0.21	0.21	0.35	0.21
Exogenous Instruments tests				
Hansen Test excluding groups (p value)	0.35	0.34	0.45	0.42
Difference (null H = exogenous) (p value)	0.22	0.22	0.35	0.37

GMM-System model where the dependent variable is the ratio between capital expenditures and fixed assets in the five years after the IPO.
*** 1% significance level; ** 5% significance level; * 10% significance level.

Table 28 shows a strong positive effect of the IPO on the level of capital expenditures in the first two year after the floatation and a higher attitude to invest for younger and more profitable companies. Being a young company means indeed to be in an early stage of the life cycle, with better possibilities to express significant growth rates. At the same time, a high level of profitability is connected with a higher availability of internally generated cash which can be used to fuel capital expenditures. The behaviour of incumbent investors at the IPO and the offer structure seem to give some indications on the future attitude of the company toward investments. In particular, companies with a higher dilution ratio and a lower divestment level at the IPO by substantial shareholders seem to be more committed to pursue growth strategies. Finally, it is interesting to note the higher attitude of IT companies to invest in new assets and the strong negative correlation between patents held at the IPO and post-IPO capital expenditures. We interpret this result suggesting that patents are a good indicator of "business maturity" in innovative industries. Accordingly, firms going public with a large portfolio of patents show a lower attitude to grow.

This result holds also for acquisitions with a negative correlation between patents and acquisitions volume (Table 29). The existence of a negative relationship between external technology acquisition and the level of internally available resources has been empirically documented by Jones et al. (2001). Companies with internally available resources are expected to show less interest in seeking external technology acquisitions through M&As and, at the same time, they may be more frequent targets in the M&A market. On the other hand R&D expenditures are positively correlated to acquisitions. Probably, firms with high R&D expenses use intra-industry deals to acquire technological competencies and improve their capacity to innovate, while firms with patents have already finalized their research efforts and are less interested in technology development. As for internal expenditures, we find that a high level of divestment by incumbent shareholders at the IPO indexes a lower attitude to grow after the floatation. Referring to the role of institutional affiliation on the acquiring behaviour, results are robust: university affiliation is negatively related to propensity to acquire. The same applies to VC affiliation. There is, therefore, a lower attitude of university-based or VC-backed firms to use acquisitions.

Table 29: The investment decision: external growth strategies

Acquisitions Volume [a]	Model 1	Model 2	Model 3	Model 4
Baseline				
Size	0.49***	0.49***	0.42***	0.42***
Age	-0.11	-0.20	-0.21	-0.21
Leverage	0.31	0.28	0.24	0.25
Profitability	-0.51***	-0.59***	-0.62***	-0.59***
Electro	-0.49	-0.38	-0.41	-0.43
Pharma	-0.62	-0.59	-0.76	-0.76
IT	0.68	0.71	0.61	0.61
UK	-0.13	-0.18	-0.15	-0.16
Germany	-0.04	-0.21	-0.29	-0.32
IPO behaviour				
Market To Book	-0.27*	-0.15	-0.14	-0.14
Dilution Ratio	-0.51	-0.61	-0.76	-0.82
Participation Ratio	-2.04*	-2.59*	-2.62*	-2.39*
Substantial shareholders divestment	-1.98**	-1.96**	-2.11**	-2.29**
TMT divestment	-0.23	-0.15	-0.13	-0.08
Institutional affiliation				
VC backed		-0.11	-0.09	-0.05
University Affiliation		-1.01***	-1.18***	-1.17***
Innovation				
R&D			3.23***	3.73***
Patents			-0.12*	-0.11*
Patents × Pharma & Electro			-0.09	-0.09
Human capital and TMT structure				
Education				-0.45
Experience				0.14
Independent				-0.39
Directors				0.79
Constant	-5.32*	-5.02*	-3.85	-3.85
R2 % [b]	22.12***	26.32***	30.13***	30.43***

OLS regression with White robust standard errors where the dependent variable is the ratio between the total monetary volume of acquisitions and the availability of deals values.
[a] t-Test for significance of the independent variables.
[b] F-Test for significance of the regression.
*** 1% significance level; ** 5% significance level; * 10% significance level.

The lower propensity to acquire of VC-backed companies may be due to the financial aims of venture capitalists, which typically consider the IPO as an exit strategy (Black and Gilson, 1998) rather than a means to financial growth. Referring to university affiliation, according to Bonardo et al. (2008) the lower attitude of university-affiliated companies (in particular spin-offs) to acquire may be due to the limited management-based for academic managers-owners. Their academic background may indeed limit their appetite for growth, as they may be less tempted by managerial imperialism, or may have been partially driven in their entrepreneurial venture by return expectations on

their academic position. The lower propensity of university-based firms to pursue acquisitions may also be due to their lower need for external technological resources.

4.3 Market dynamicity

In this section we want to understand if going public is a step in the lifecycle of innovative firms that really improves their visibility and exposition to the external world of investors. Once public, our sample firms are really "public"? Are these firms liquid, do they stimulate the interest of external investors and are they able to survive on the stock markets? To this aim, we analyse how the IPO influences the evolution of our sample firms in terms of changes in the control of the company, failure probability and stock liquidity. As evidenced in Table 24 (Panel A) the level of divestment at the IPO by substantial shareholders and TMT members is low (16% and 12% respectively) with an average participation ratio of 9%. Thus, the IPO seems to be typically used by innovative SMEs to finance business growth rather than as a divestment/diversification opportunity for initial owners who stay firmly in control at IPO time. However, in the five years after the IPO more than 58% of companies are targeted by external investors resulting in a 29% of sample firms changing control. Therefore, the floatation can be also considered a first step toward having a company taken over at an attractive price (Brau et al., 2003) with original shareholders preferring a post-IPO exit, more than selling their ownership stakes directly at the IPO. Referring to the nature of the acquirers of our sample companies there is a significant incidence of financials acquirers (43% of deals), with a proportion of intra-industry deals of 24% and cross-border ones of 33%. This high level of control transfers is associated with a low level of failures, despite the high level of risk associated with innovative businesses. As shown in Table 25 (Panel C) our sample firms have a delisting rate of 20% in the years after the IPO considered. However, delistings occur for a variety of reasons, only some of which can be classified as failures. Delistings can occur as a result of transfers to the other markets, acquisitions, or redemptions (investment funds redeeming or closing their funds). Genuine failures can arise from the liquidation of the company; from restructuring because of financial strains. For our innovative SMEs among delistings, 10% are caused by the failure of the company, comparable with the failure rate identified by Bhabra and Pettway (2003) using a random sample of IPOs from 1987

through 1991. Finally, liquidity after a yearly value of 51% in the year of the floatation is quite stable with an average value of 30% that compares favourably with that of alternative markets of the world, where turnover ranges between 15 per cent and 50 per cent (Arcot et al., 2007). As a whole, these statistics suggest us that going public is an important step in the lifecycle of an innovative SME that really exposes the firm to the attention of investors.

Focussing on the characteristics of innovative SMEs at the IPO which can indicate a particular attitude to transfer control, we find that firm size is positively related to the probability to transfer control. In comparison, the negative coefficient of profitability may be interpreted as an evidence of the matching theory of ownership change, with less efficient firms more subjected to being the target of other companies (Lichtenberg and Siegel, 1987 and 1989). Also, the offer structure is indicative of the propensity to transfer control in the post-IPO period. In particular, companies with a higher level of fresh capital inflow and a lower divestment by original shareholders and TMT members at the IPO, show a lower attitude to transfer control. As for affiliation, we find a positive correlation with the probability of being acquired for both university and venture capital backing (although the statistical significance is lower for the latter). According to Bonardo et al. (2008), university-based companies may be attractive targets in acquisition due to their superior innovative capacity; or their university affiliation may carry out a certification role, enhancing their attractiveness in the eyes of other firms. Similarly, the presence of VCs may improve the attractiveness of a firm (Ragozzino and Reuer, 2007). Moreover, from an internal perspective, the M&A market provides academic founders or Venture Capitalists, less interested in maintaining a position in a mature firm (Meyer, 2003), with an exit opportunity, resulting in a higher rate of control transfers. There is, in addition, a positive relation between intellectual capital and M&A deals, with the number R&D investments increasing the probability of being targeted. This last result supports the theoretical hypothesis that M&A can also be used as a means for acquiring technological capabilities (Blonigen and Taylor, 2000). Accordingly, for biotech and electronic companies, we detect a higher probability of being acquired for companies with more patents. This result confirms the crucial role played by innovation capital in these industries.

Table 30: Market dynamicity: probability of take-over

Control transfer [a]	Model 1	Model 2	Model 3	Model 4
Baseline				
Size	0.14*	0.13*	0.12*	0.11*
Age	-0.15	-011	-0.11	-0.14
Leverage	0.32	0.31	0.31	0.31
Profitability	-0.28*	-0.28*	-0.27*	-0.27*
Electro	-0.25	-0.27	-0.26	-0.27
Pharma	0.17	0.26	0.25	0.23
IT	0.11	0.13	0.10	0.09
UK	-0.75	-0.73*	-0.72	0.68
Germany	0.08	0.09	0.10	0.09
IPO behaviour				
Market To Book	-0.17	-0.16	-0.15	-0.18
Dilution Ratio	-2.45**	-2.19**	-2.34**	-2.42**
Participation Ratio	2.15*	2.16*	2.34*	2.48*
Substantial shareholders divestment	1.98**	2.01**	2.11**	1.88*
TMT divestment	3.13**	2.89**	2.78**	3.15**
Institutional affiliation				
VC backed		0.64**	0.74**	0.56**
University Affiliation		1.02***	1.13***	0.95***
Innovation				
R&D			1.98*	1.97*
Patents			0.38	0.45
Patents × Pharma & Electro			0.51**	0.49*
Human capital and TMT structure				
Education				0.21
Experience				-0.17
Independent				-0.16
Directors				0.11*
Log-Likelihood [b]	-267.61***	-260.46***	-258.05***	-257.02***

Cox model where the dependent variable is equal to 1 if the control equity stake of the firm is acquired in an M&A deal and the time variable measures the time elapsing between the IPO and the control transfer.
[a] z-Test for significance of the independent variables.
[b] Wald χ^2-Test for significance of the regression.
*** 1% significance level; ** 5% significance level; * 10% significance level.

Last, our empirical analysis focuses on the determinants of failure probability that clearly shows the effect of three variables: leverage, VC financing and patents. In particular, more indebted companies show a higher probability to fail, while being VC-backed and having a large patents portfolio substantially reduce the risk of failure. These results confirm the unsuitability of debt as a source of financing for innovative businesses which need patient and committed capital. On the other hand, the involvement of a VC at the time of an IPO seems to be a good signal of the quality of the firm. The involvement of a venture capitalist can signal the quality of an entrepreneurial firm in a number of ways. VCs typically fund less than 1% of the

proposals they receive (Megginson and Weiss, 1991), and this highly-selective screening process can be a useful tool for investors to weed out the "lemons". Moreover, venture capitalists not only provide capital for the entrepreneurial firms they choose to fund, they often add directly to the quality of a firm by serving on its TMT, assisting in the formulation and implementation of strategy, contributing their network of relations, and hiring key personnel (e.g. Hellman and Puri, 2000).

Table 31: Market dynamicity: probability of bankruptcy

Failure Probability [a]	Model 1	Model 2	Model 3	Model 4
Baseline				
Size	-0.12	-0.11	-0.09	-0.08
Age	-0.18	-0.13	-0.14	-0.13
Leverage	1.28***	1.28***	1.25**	1.21**
Profitability	-0.14	-0.21	-0.22	-0.22
Electro	-0.78	-0.62	-0.36	-0.29
Pharma	-0.52	-0.25	-0.25	-0.29
IT	0.27	0.28	0.18	0.19
UK	0.94	0.91	0.77	0.72
Germany	-0.75	-0.82	-0.82	-0.75
IPO behaviour				
Market To Book	-0.14	-0.11	-0.08	-0.08
Dilution Ratio	-2.76	-1.73	-1.61	-1.56
Participation Ratio	-1.88	-1.54	-1.64	-1.52
Substantial shareholders divestment	0.68	0.67	0.74	0.78
TMT divestment	2.18*	2.12*	2.11*	2.09*
Institutional affiliation				
VC backed		-1.84***	-1.75***	-1.74***
University Affiliation		-0.08	-0.11	-0.02
Innovation				
R&D			2.33	2.14
Patents			-1.05**	-0.97**
Patents × Pharma & Electro			-1.29***	-1.12**
Human capital and TMT structure				
Education				-0.59
Experience				-0.73*
Independent				-0.74**
Directors				-0.47*
Log-Likelihood [b]	-96.91***	-93.39***	-90.94***	-87.33***

Cox model where the dependent variable is equal to 1 for companies delisted for bankruptcy and the time variable measures the time elapsing between the IPO and the delisting.

[a] z-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

Also, patents are a good index of firm's ability to survive in the long-run. Having patents may be indeed a signal of a firm that has already overcome the riskiest phase of

the innovative process, finalising its R&D efforts in some profitable assets. Patents are indeed a source of cash-flow for the firm, reducing the probability of financial strains. Table 31 also shows that a high level of divestment by TMT members at the IPO improves the probability of a failure, while TMT experience and the presence of independent directors reduce the likelihood of a delisting for negative reason.

Finally, as shown in Table 32, we find that stock liquidity is positively related to the level of divestment at the IPO by TMT members, substantial shareholders (not statistically significant) and also to the participation and dilution ratio.

Table 32: Market dynamicity: liquidity

Liquidity [a]	Model 1	Model 2	Model 3	Model 4
Baseline				
Size	0.08	0.07	0.08	-0.02
Age	-0.14*	-0.15*	-0.14*	-0.14*
Leverage	-0.48**	-0.43**	-0.45**	-0.46**
Profitability	-0.31	-0.30	-0.25	-0.19
Electro	-0.26	-0.21	-0.18	-0.23
Pharma	-0.16	-0.22	-0.16	-0.26
IT	0.23*	0.16*	0.25*	0.27*
UK	-0.33	-0.31	-0.26	-0.22
Germany	0.16	0.12	0.14	0.18
IPO behaviour				
Market To Book	0.07*	0.08*	0.07*	0.08*
Dilution Ratio	1.31***	1.38***	1.35***	1.12**
Participation Ratio	2.17***	2.21***	2.28***	2.35***
Substantial shareholders divestment	0.59	0.36	0.34	0.61
TMT divestment	1.38***	1.42**	1.35**	1.27**
Institutional affiliation				
VC backed		-0.08	-0.05	-0.07
University Affiliation		-0.63***	-0.57***	-0.56***
Innovation				
R&D			1.65***	1.49**
Patents			0.05	0.03
Patents × Pharma & Electro			0.09	0.08
Human capital and TMT structure				
Education				0.08
Experience				0.16
Independent				0.24
Directors				0.15**
Constant	-0.75	-0.82	-0.85	-0.89
R2 % [b]	11.48***	22.94***	26.42***	27.81***

OLS model with White robust standard errors where the dependent variable is equal to the turnover in the five years after the IPO.

[a] t-Test for significance of the independent variables.

[b] F-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

Thus, complementing primary portion with secondary shares helps to secure a sufficiently large free float, achieving higher liquidity. Young and small growth firms are likely to benefit most from investor recognition, deriving from an appropriate level of liquidity. The reason is that because of their growth prospects, these firms presumably will use the stock exchange repeatedly for financing their investment projects. Moreover, beyond providing cheaper and ongoing access to capital stock, liquidity allows venture capitalists and early stage investors to exit their investment, gives founders the ability to diversify their risk, and increases the transparency of the firm (Celikyurt et al., 2008). Also, our results show that stock liquidity is negatively related to leverage and university affiliation, while it is positively correlated to R&D investments. These evidences may be explained suggesting that firms with lower growth rates (university-based and more indebted firms) show a lower liquidity, in comparison to companies with superior attitude to grow (firms more committed in R&D efforts).

5. Conclusions

Financial constrains may hamper the innovative capacity of firms. In this context, the IPO can reduce information asymmetries between the company and potential investors, improving the ability to raise equity and debt capitals. More generally, the IPO could be a fundamental step in the lifecycle of a company that improves its capacity to pursue either growth or divestment strategies. In this paper, we empirically investigate the effect of going public on the evolution of innovative SMEs, focussing in particular on the interaction between innovation variables and strategies adopted by sample companies in terms of capital raising, investment activities and market dynamicity.

Our results show the existence of a relationship between innovation and financial strategies, suggesting that firms with different level of innovative activity decide to go public for different reasons. We find that firms with higher levels of R&D expenditures view the IPO as a mechanism to raise external equity used to pursue growth strategies thorough acquisitions. This attitude to acquire may be explained by the necessity to create alliances and collaborations to improve the innovative capacity of the firm, or by the necessity to reduce a technological gap. On the other hand, innovative SMEs with a consolidated portfolio of patents have an easier access to debt capital and a higher

attitude to transfer control. For these companies, the IPO is not seen as an opportunity to remove financial constrains to innovation, but as a mechanism to capitalize their research efforts. Therefore, we suggest that having patents is an index of maturity in innovative industries that helps investors to individuate firms with a lower level of risk.

Other characteristics of the human capital embodied in firms are indicative of the strategies pursued after going public. For instance, venture backed and university-based companies are more interested in divestment strategies. One possible reason lies in the nature and aims of original shareholders of this typology of 'affiliated' firms. Also, VC-backed firms and companies with a larger patent portfolio have a lower risk of failure. For the formers, this is supportive of the validity of the selection process pursued by VCs in the screening of companies that require to be financed. For the latter, it confirms that patents are intangible assets that assure a source of cash generation for innovative companies, reducing their probability of financial distress.

On the whole, results presented in this paper confirm that going public is a fundamental step in the lifecycle of high-tech SMEs. However, its role is twofold, being a stimulus both for growth and divestment strategies. External equity raised at the IPO and in the follow-on seem to be used to finance growth more than to reduce leverage, that remains rather constant in the years considered, while the effect on both internal and external investments is considerable. Furthermore, the status of public company gives visibility to the company facilitating divestment strategies. From this perspective, the IPO can be also considered as a first step in the process of selling a company through the M&A market. Indeed, going public also represents a good exit strategy for original shareholders of our sample firms. After the IPO, high-tech SMEs enjoy a good level of stock liquidity and stimulate the interest of external investors, with about one third of the sample transferring control.

In conclusion, our study shows that European stock markets, as in the aims of policymakers, play an important role in the process of financing and growth of high-tech companies. The market vitality of our sample firms suggests that the status of public company succeeds in reducing information asymmetries between the firm and investors. This is fundamental to find proper source of financing and proper investors for the different stages of the lifecycle of innovation. From this perspective, giving an exit strategy to early stage investors, stock markets also contribute to the development of the VC and private equity industries, essential for the creation of high-tech firms.

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Appendix

Table A.6: The financing decision: the evolution of firm's debt

Debt Growth	Model 1	Model 2	Model 3	Model 4
Baseline				
Y_(t-1)	0.67***	0.67***	0.66***	0.66***
IPO_1	-0.16*	-0.16*	-0.16*	-0.16*
IPO_2	-0.02	-0.02	-0.02	-0.02
IPO_3	0.03	0.04	0.04	0.05
IPO_4	0.11	0.12*	0.12*	0.12*
Size	0.13**	0.13**	0.12**	0.12**
Age	0.09*	0.10*	0.09*	0.09*
Leverage	_	_	_	_
Profitability	-0.25**	-0.25**	-0.25**	-0.27**
Electro	-0.09	-0.05	-0.15	-0.14
Pharma	-0.12	-0.06	-0.13	-0.16*
IT	-0.30**	-0.31**	-0.28**	-0.28**
UK	-0.11	-0.09	-0.11	-0.07
Germany	-0.02	-0.02	-0.03	-0.03
IPO behaviour				
Market To Book	-0.05	-0.04	-0.05	-0.04
Dilution Ratio	1.03***	1.01***	1.01***	1.02***
Participation Ratio	0.41	0.34	0.18	0.12
Substantial shareholders divestment	0.21	0.21	0.28	0.32
TMT divestment	0.59	0.55	0.48	0.45
Institutional affiliation				
VC backed		0.03	0.02	0.05
University Affiliation		-0.24*	-0.25*	-0.25*
Innovation				
R&D			-0.31	-0.33
Patents			0.11**	0.12**
Patents × Pharma & Electro			0.09*	0.09*
Human capital and TMT structure				
Education				0.05
Experience				0.06
Independent				0.48**
Directors				-0.02
Constant	2.03***	2.05***	2.13***	2.11***
Instruments	32	34	36	40
χ^2	780.12***	867.39***	958.26***	985.15***
AR(1) Test (z) (p value)	0.00***	0.00***	0.00***	0.00***
AR(2) Test (z) (p value)	0.63	0.63	0.63	0.63
Hansen Overid. restrictions (p value)	0.51	0.51	0.51	0.50
GMM Instruments Tests				
Hansen Test excluding groups (p value)	0.26	0.26	0.26	0.25
Difference (null H = exogenous) (p value)	0.90	0.88	0.89	0.88
Exogenous Instruments tests				
Hansen Test excluding groups (p value)	0.33	0.35	0.49	0.48
Difference (null H = exogenous) (p value)	0.75	0.75	0.73	0.69

GMM-System model where the dependent variable is the value of debt in the five years after the IPO.
*** 1% significance level; ** 5% significance level; * 10% significance level.

Table A.7: The investment decision: the evolution of firm's fixed assets

Fixed Assets Growth	Model 1	Model 2	Model 3	Model 4
Baseline				
Y_(t-1)	0.78***	0.79***	0.79***	0.79***
IPO_1	0.42***	0.42***	0.44***	0.45***
IPO_2	0.47***	0.47***	0.48***	0.48***
IPO_3	0.13**	0.13**	0.13**	0.13**
IPO_4	0.08**	0.08**	0.08**	0.08**
Size	0.09***	0.09***	0.09***	0.09***
Age	0.02	0.01	0.01	0.02
Leverage	0.09***	0.09***	0.09***	0.09***
Profitability	-0.19**	-0.19**	-0.18**	-0.17**
Electro	-0.21**	-0.21**	-0.21**	-0.21**
Pharma	-0.12*	-0.11	-0.11	-0.11
IT	-0.18*	-0.15*	-0.15*	-0.14
UK	-0.01	-0.01	-0.01	-0.01
Germany	-0.07	-0.05	-0.09	-0.08
IPO behaviour				
Market To Book	0.04	0.04	0.05	0.05
Dilution Ratio	0.16*	0.15*	0.14*	0.15*
Participation Ratio	-0.09	-0.06	-0.06	-0.07
Substantial shareholders divestment	-0.16	-0.13	-0.11	-0.13
TMT divestment	-0.04	-0.05	-0.09	-0.05
Institutional affiliation				
VC backed		-0.01	-0.01	-0.03
University Affiliation		-0.04	-0.05	-0.06
Innovation				
R&D			-0.05	-0.02
Patents			-0.02	0.01
Patents × Pharma & Electro			-0.05	-0.05
Human capital and TMT structure				
Education				-0.04
Experience				0.02
Independent				-0.05
Directors				0.01
Constant	0.79	0.70	0.66	0.65
Instruments	32	34	36	40
χ^2	2722.19***	3018.27***	3310.34***	4046.22***
AR(1) Test (z) (p value)	0.00***	0.00***	0.00***	0.00***
AR(2) Test (z) (p value)	0.81	0.80	0.80	0.80
Hansen Overid. restrictions (p value)	0.21	0.18	0.22	0.23
GMM Instruments Tests				
Hansen Test excluding groups (p value)	0.34	0.33	0.34	0.38
Difference (null H = exogenous) (p value)	0.23	0.22	0.26	0.25
Exogenous Instruments tests				
Hansen Test excluding groups (p value)	0.18	0.15	0.18	0.15
Difference (null H = exogenous) (p value)	0.21	0.22	0.22	0.23

GMM-System model where the dependent variable is the value of fixed assets in the five years after the IPO.

*** 1% significance level; ** 5% significance level; * 10% significance level.

Table A.8: The investment decision: external growth strategies

Acquisitions Number [a]	Model 1	Model 2	Model 3	Model 4
Baseline				
Size	0.11*	0.12*	0.12*	0.11*
Age	-0.15*	-0.16*	-0.15*	-0.15*
Leverage	-0.02	-0.05	-0.07	-0.09
Profitability	-0.28*	-0.33**	-0.36**	-0.35**
Electro	-0.24	-0.14	-0.12	-0.14
Pharma	-0.59**	-0.47**	-0.57**	-0.42**
IT	0.12	0.21	0.18	0.17
UK	-0.03	-0.05	-0.03	-0.03
Germany	0.35*	0.38*	0.37*	0.26*
IPO behaviour				
Market To Book	-0.36***	-0.33***	-0.32***	-0.27***
Dilution Ratio	-1.12*	-1.01	-1.06	-1.11
Participation Ratio	-1.47*	-0.95	-0.91	-0.89
Substantial shareholders divestment	-0.69*	-0.59*	-0.62*	-0.54*
TMT divestment	-0.19	-0.15	-0.06	-0.11
Institutional affiliation				
VC backed		-0.29**	-0.31**	-0.24**
University Affiliation		-0.45***	-0.51***	-0.46***
Innovation				
R&D			0.96**	0.97**
Patents			-0.12**	-0.15**
Patents × Pharma & Electro			-0.10*	-0.12*
Human capital and TMT structure				
Education				-0.26*
Experience				0.22*
Independent				-0.17
Directors				0.04
Constant	1.73	1.82	1.78	2.18
Pseudo R2 % [b]	14.48***	17.15***	19.14***	20.31***

Poisson regression where the dependent variable is the number of deals as acquirer pursued by each company.

[a] *z*-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

Table A.9: Market dynamicity: the cumulative volume of money used in targeting deals

Target Volume [a]	Model 1	Model 2	Model 3	Model 4
Baseline				
Size	0.67***	0.64***	0.65***	0.64***
Age	0.02	0.01	0.02	0.01
Leverage	0.08	0.08	0.12	0.15
Profitability	-0.27*	-0.26*	-0.31*	-0.29*
Electro	-0.34	-0.34	-0.36	-0.35
Pharma	-0.17	-0.17	-0.21	-0.21
IT	-0.84*	-0.84*	-0.92*	-1.01*
UK	0.29	0.29	0.29	0.25
Germany	0.51	0.58	0.66*	0.68*
IPO behaviour				
Market To Book	-0.45***	-0.45***	-0.49***	-0.48***
Dilution Ratio	-1.31**	-1.35**	-1.54**	-1.54**
Participation Ratio	-0.48	-0.52	-0.65	-0.69
Substantial shareholders divestment	-0.56	-0.56	-0.67	-0.72
TMT divestment	0.26	0.29	0.42	0.43
Institutional affiliation				
VC backed		0.49*	0.41	0.38
University Affiliation		0.81***	0.68**	0.71**
Innovation				
R&D			1.13***	1.23***
Patents			0.15	0.14
Patents × Pharma & Electro			0.21*	0.21*
Human capital and TMT structure				
Education				-0.03
Experience				0.32
Independent				0.30
Directors				0.07
Constant	-8.92***	-8.98***	-7.78***	-7.78***
R2 % [b]	23.03***	27.06***	29.53***	30.33***

OLS regression with White robust standard errors where the dependent variable is equal to the ratio between the total volume of deals as target and the availability of deals values.

[a] t-Test for significance of the independent variables.

[b] F-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.

Table A.10: Market dynamicity: probability of delisting after acquisition

Delisted Acquired [a]	Model 1	Model 2	Model 3	Model 4
Baseline				
Size	0.23	0.21	0.23	0.28
Age	0.05	0.16	0.17	0.16
Leverage	0.03	0.20	0.26	0.23
Profitability	-0.21	-0.19	-0.22	-0.25
Electro	-1.59	-1.18	-1.27	-1.19
Pharma	0.87*	0.31	0.35	0.35
IT	0.15	-0.36	-0.34	-0.31
UK	0.61	0.47	0.52	0.66
Germany	0.24	0.28	0.32	0.35
IPO behaviour				
Market To Book	-0.47*	-0.50*	-0.68*	-0.93**
Dilution Ratio	-2.71**	-2.65**	-3.01**	-3.05**
Participation Ratio	1.71	1.67	1.28	1.23
Substantial shareholders divestment	2.16	2.36	2.69	2.49
TMT divestment	2.23**	2.25**	2.24**	2.29**
Institutional affiliation				
VC backed		0.83*	1.01*	1.04*
University Affiliation		1.24***	1.36***	1.74***
Innovation				
R&D			3.81*	3.82*
Patents			0.02	0.02
Patents × Pharma & Electro			0.10	0.11
Human capital and TMT structure				
Education				0.50
Experience				-0.34
Independent				-0.23
Directors				-0.01
Log-Likelihood [b]	-104.15***	-99.83***	-98.14***	-97.24***

Cox model where the dependent variable is equal to 1 if the company was delisted after its acquisition and the time variable is the time elapsing between the IPO and the delisting.

[a] z-Test for significance of the independent variables.

[b] Wald χ^2-Test for significance of the regression.

*** 1% significance level; ** 5% significance level; * 10% significance level.