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**A theoretical and empirical contribution  
for a better understanding of academic  
spin-offs’ growth patterns**

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## 1. Introduction

With the progressive development of the knowledge-based economy, a growing attention is being devoted to the phenomenon of spinning-off new High Technology Based Firms (HTBFs) from academia to industry, through the creation of academic spin-off companies (which in the following part of this project will be also named 'spin-offs')<sup>1</sup>.

The generation of new ventures from universities is a long established phenomenon (Mustar 1995). However, the number of spin-off firms has increased significantly in recent years (Roberts 1991; Gartner and Shane 1995; Saxenian 1994; Mustar et al., 2006).

Universities differ significantly in the support provided to spin-off processes as well as in the number of spin-off ventures created (Di Gregorio and Shane 2003) and in their growth processes (Clarysse et al. 2005). At present, there is little evidence about the determinants of growth processes of academic spin-offs. This gap in the literature can be ascribed to the fact that only recently have scholars become aware of the heterogeneity in spin-offs' growth processes. Since then, several attempts (Autio and Yli-Renko 1998; Mustar 1997; SQW 2000; Delapierre et al. 1998; Mustar 1995; Heirman and Clarysse 2004b) have been made in order to explain how spin-offs differ in their early growth, with a specific focus on the determinants of firms' success. However, there is still a gap in the literature with regard to the identification of the critical variables determining the diversity in growth processes of spin-off firms, and the Italian context is not an exception. In fact, in Italy, although the first spin-off firms appeared in the early-1970s, only recently this phenomenon has started to be supported concretely by both universities and other institutions, through the progressive creation of Technology Transfer Offices (TTOs), as well as through the definition of specific policy measures.

This paper aims at closing this gap by identifying the critical variables determining growth processes of academic spin-offs in the Italian context. More specifically, by building on previous research which argues that founding conditions can have a long-term effect on firm growth and performance (Boeker 1989), this study investigates the starting resources, as well as the market strategy and the institutional links with the parent Public Research Organisations (PROs), which are related to growth. With regard to growth measures, the annual average growth in employment, revenues and total assets of Italian academic spin-off companies are considered.

The remainder of the paper is organized as follows. *Section 2* sets the theoretical framework and introduces the research question. *Section 3* describes in detail our conceptual model for spin-off growth, by formulating specific research hypotheses. *Section 4* introduces the control variables included in the model. *Section 5* describes the research method. *Section 6* discusses the results of our multivariate analysis. *Section 7* includes a discussion of the limitations of this paper and the directions for future research.

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<sup>1</sup> Research on spin-offs has been conducted under many labels. We refer to the method section for an overview. To overcome confusion we adopt the term 'academic spin-off companies' in this paper.

## 2. The theoretical framework

### 2.1. Literature review

The important role that academic spin-offs have in supporting economic and technological growth and as a channel for TT has been widely recognized in the literature. Since they are technology-based, these firms have been often perceived in the literature as critical drivers of technological development, social progress and economic growth (Utterback et al. 1988). Several researchers indicate that, once they have reached a certain critical mass, academic spin-offs exhibit faster average employment growth rates than non high-tech (HT) start-ups (Cooper et al. 1986; Mustar 1995; Licht and Nerlinger 1998; Storey and Tether 1998b; Delapierre et al. 1998; Autio and Parhankangas 1998), have a higher probability of survival after founding (Autio 1998) and tend to be more internationally oriented than less innovative firms (Storey and Tether 1998b).

The relevance of academic spin-offs has initially contributed to very optimistic perceptions about their growth potentials (Heirman and Clarysse 2004a), on the basis – among others – of the highly visible success stories (the so-called ‘gazelles’) in the early- and mid-Nineties and the success of HT clusters such as Silicon Valley and Route 128 in the US and Cambridge in the UK. However, several researchers have later expressed doubts about the real extent of rapid growth potentials of all academic spin-offs: the indiscriminate attribution of this characteristic was not corroborated by sufficiently robust evidence (Oakey 1995; Storey and Tether 1998a). These remarks have been indeed confirmed by several empirical studies (Rickne and Jacobsson 1999; Autio and Yli-Renko 1998; Mustar 1997; Chiesa and Piccaluga 2000), showing that the vast majority of spin-off companies remains very small. Several scholars also indicate that the overall impact of academic spin-offs for employment generation might be lower than the popular perception (Delapierre et al. 1998; Mustar 1995). Consequently, at present, relatively little is known about the determinants of growth processes of academic spin-offs and, more particularly, about the distinguishing factors between fast growing and not (or slowly) growing firms. The identification of potential causes of spin-offs’ growth processes is one of the least understood aspects in entrepreneurial research (Cooper et al. 1994; Gartner 1985; Kazanijan and Drazin 1990; Helm and Mauroner, 2007). Since growth is argued to be a complex and multidimensional phenomenon (Westhead and Birley 1994), there is no single theory which can fully explain spin-offs growth processes (Gibb and Davies 1990). However, as observed by several scholars, the growth patterns of academic spin-offs are not completely random and unpredictable; rather, they are systematically related to the characteristics of the firms and to their environment (Smallbone et al. 1993; Delmar et al. 2003). In particular, previous research argues that founding conditions may have a long-term effect on firm growth and performances (Boeker 1989; Stinchcombe 1965).

In the literature, there are three theoretical approaches which can help in the identification of critical factors for the growth of academic spin-offs: i) the Resource-Based View (RBV); ii) the Market-Led Perspective (MLP); iii) the Institutional Link Perspective (ILP).

According to the *RBV*, spin-off performance depends on the characteristics of the firm’s resources bundle (Barney 1991; Chandler and Hanks 1994; West and DeCastro 2001), all instrumental in the development of an initial resource base, and which therefore play a key role for their survival and success (Carter et al. 1994; Gartner et al. 1998; Roberts 1991). In this perspective, the entrepreneurial challenge consists in the identification and assembly of the starting resources (Penrose 1959), including: a) *human resources* (Roberts 1991; Shane and Stuart 2002; Burton et al. 2002); b) *technology* (Bollinger et al. 1983; Utterback et al. 1988); c) *finance* (Roberts 1991; Hellman and Puri 2000; Manigart et al. 2002).

By adopting a *MLP*, two key aspects of the market strategy are: i) the breadth of the targeted market (niche strategy versus diversification strategy; Porter 1980; Cooper et al. 1986; Biggadike 1979; MacMillan and Day 1987; McCann 1991) and ii) the international orientation of the new venture (local approach versus international and global approach from the start; Shrader et al. 2000; Autio et al. 2000).

The *ILP* is based on the embeddedness of academic spin-off companies in their parent PROs, as they are typically founded to exploit university Intellectual Property (IP) (Mustar et al. 2006). Since each parent PRO has its own culture, incentive systems, rules and procedures (Moray and Clarysse 2005), the institutional context is suitable to shape spin-offs' growth processes (Dacin 1997). The role of initial conditions in determining heterogeneity in growth processes of spin-off firms has been recently investigated in the literature in order to build some classifications. In particular, by examining the initial resources on which academic spin-offs are based (RBV) and how these resources interact with the parent universities (ILP) and market environment (MLP), Heirman and Clarysse (2004b) developed a multidimensional taxonomy of spin-off firms, finding four different typologies of academic spin-offs: (i) *VC-backed spin-offs*, which usually are a negligible number, since market complexity and growth prospects seem to influence the probability of starting the business activity with VC funds; (ii) *prospectors*, which are the majority and are characterized by a lack of clarity of the product market at founding; (iii) *product spin-offs*, which mostly have an almost market-ready product, targeted at an international niche market; (iv) *transitional spin-offs*, which initially commercialize know-how through consulting and become product-oriented later on. Once the awareness among scholars about the heterogeneity in growth processes experienced by academic spin-off firms has been achieved, there have been several attempts to explain why spin-offs differ in their early growth stage, with a specific focus on the identification of the determinants of firms' success (Heirman and Clarysse 2004b). However, entrepreneurship literature has exclusively analysed the independent effects of single resources on the survival rate and growth processes of the firms, neglecting inter-resources relationships (Carter et al. 1994; Lee et al. 2001). In particular, empirical studies have so far mainly focused: i) on the characteristics of both the entrepreneurs and the organisations for which they have been working (Roberts 1991; Rogers 1986; Steffensen et al. 1999; Smilor et al. 1990; Grandi and Grimaldi 2003); ii) on a complex of external influences, including VC availability, supporting services, economic climate, market and technology opportunities, industrial relationships and complementary assets (Chiesa and Piccaluga 2000; Segal 1986; Niosi 2006). However this focus on the direct effects of single resources provides a limited understanding of growth phenomena, because it does not take into consideration inter-resource configurations (Lee et al. 2001). Moreover, it is also in contrast with the RBV of the firm, according to which spin-offs' long-term competitive advantage lies in resource configuration that managers build using dynamic capabilities.

## **2.2. Research question**

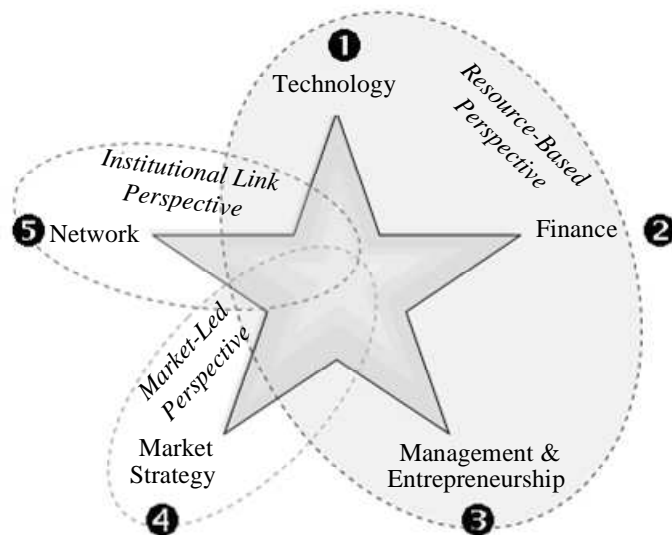
In Italy, the spin-off phenomenon is still in its infancy. The first academic spin-offs were created in the early-1970s, but they were accepted with reluctance by their parent universities. Only recently (since the mid-Nineties), universities and policy makers have realized the strategic role that private R&D laboratories and PROs can play, through their ability to create and diffuse knowledge, in fostering a region's capacity to innovate (Cesaroni et al. 2005). Since a significant proportion of the products and processes that are currently sold and used could not have been developed without academic research, most universities and research centres have progressively realized the exploitation potential deriving from their own research results by promoting and sustaining the creation of new ventures. In addition, isolated and successful initiatives of valorisation of the research activities initially fostered by pioneer universities have determined an 'imitation effect' among other national PROs, so that approximately since the year 2000 spinning-off new ventures from Italian academia has become a fashionable practice (Piccaluga 2006). Moreover, the institutional changes occurred in the national legislative framework have further facilitated TT activities from universities, and in particular, support initiatives to spin-off processes. In this respect, the national law nr. 297/1999 has been the first legislative measure to contemplate - even though indirectly - the case of academic spin-offs. Also, the national laws about academic researchers' IPRs have contributed to attract attention on the spinning-off processes, by stimulating the debate on the issue (Cesaroni et al. 2005; Balderi et al. 2009). Not surprisingly, spin-off

gemination processes in Italy have reached a dramatic relevance over the last ten years: about 90% of the overall 806 spin-off firms identified within the national context have been set up since the year 2000 (Netval 2010). They are characterized by an astonishingly high (about 97%) survival rate (Piccaluga and Balderi 2006) and they tend to remain small (they seldom employ more than ten people; Cesaroni et al. 2005). At present, the need to better understand the determinants of spin-offs' growth processes in Italy is therefore widely recognized by both scholars and policy makers. In consideration of this, the present paper aims at identifying the critical variables determining early growth processes of academic spin-offs in the Italian context.

### 3. The starlike model of spin-off growth: research hypotheses

In order to study how different resource configurations of Italian spin-off companies at the moment of founding relate to growth in employment, revenues and total assets, a configurational model based on the three theoretical perspectives available in the literature with regard to the issue of spin-offs' growth has been designed. This conceptualization effort led to the definition of a 'Starlike Model of Spin-Off Growth' (figure 1).

**Figure 1 – A Starlike Model of Spin-Off Growth, basing on firms conditions at founding**  
(source: authors' elaboration)



#### 3.1. RBV: technology

With regard to growth determinants in a RBV perspective, this study uses different measures of the spin-off's technological base, by including in the model both i) the New Product Development (NPD) stage at founding and ii) the firm's patents and licenses portfolio.

With regard to the *NPD stage at founding*, previous empirical evidence on academic spin-offs (Roberts 1991; Delapierre et al. 1998) shows that firms which start by offering their own product(s) and/or technology(-ies) significantly outperform those which begin as consultants or Research and Development (R&D) contractors. Moreover, Leifer et al. (2002) found that successful NTBFs are earlier in identifying their market applications and in defining an appropriate business model. Finally, focusing on the Flanders region (Belgium), Heirman and Clarysse (2004a) found that the NPD stage at founding is not significantly related with growth in employees or revenues, whereas it is positively associated with growth in total assets. By building upon this contrasting evidence, it is possible to advance the following research hypothesis about Italian spin-off companies.

*Hypothesis 1: Italian academic spin-offs which are further in the NPD cycle at founding will grow more in terms of employees, revenues and total assets than Italian spin-off firms which are earlier in the product development cycle at founding.*

With regard to the *IPRs granted to the new ventures*, Grandi and Grimaldi (2003) adopt the number of patents as well as the licences assigned to the academic entrepreneurs as indicators of the 'technological excellence' of the new venture, as related to the quality of applied research activities carried out by the promoting partners during the period spent in doing research at the university of origin. Moreover, IPRs are considered to be fundamental building blocks of an academic spin-off aspiring to become a successful company (British Venture Capital Association - BVCA 2005). In line with this perspective, empirical evidence about success factors in Canadian spin-off ventures (Niosi 2006) found that spin-offs' growth seems to be related to patent portfolios of the new ventures. In fact, spin-offs with more patents tend to be larger as well as more successful. Hence, the following research hypothesis can be formulated for the Italian context:

*Hypothesis 2: Italian academic spin-offs which have been granted IPRs (patents and/or licences and/or trademarks) will grow more in terms of employees, revenues and total assets than Italian spin-off companies showing neither patents or licences or trademarks in their portfolio.*

### **3.2. RBV: finance**

With regard to financing this project investigates the effects of both: i) the amount of the starting capital and ii) the involvement of VC investors in Italian academic spin-offs.

In fact, insufficient *financial resources* are often cited as a primary reason for the failure of new ventures. Consequently, the amount of the starting capital at founding is argued to be a source of competitive advantage for spin-off companies (Heirman and Clarysse 2004b). In fact, spin-offs with higher levels of investments at the beginning of their activity will tend to collect a greater amount of strategic assets than their low-investing counterparts (Lee et al. 2001). Moreover, well-funded spin-offs can devote higher amounts of money to product/service development and have stronger resistance in case of liquidity constraints (Heirman and Clarysse 2004b). As previous research suggests that the amount of initial capital invested is positively related to the spin-off firm survival and success (Cooper et al. 1994), the following research hypothesis about Italian academic spin-offs can be presented.

*Hypothesis 3: Italian academic spin-offs which have higher starting capital at founding will grow more in terms of employees, revenues and total assets compared to Italian spin-off companies which start with more modest financial resources.*

Moreover, Davila et al. (2003) found a positive association between the presence of VC and high growth, attributable to VCs' ability to select firms with high growth potential or to post-investments benefits that accrue to VC-backed spin-offs (Baum and Silverman 2004). In particular, Heirman and Clarysse (2004a) found a positive and significant relationship between large amounts of VC at founding (1 to 6 millions Euros raised in the first year) and growth in spin-offs' employees and revenues, whereas a significant and negative association can be observed between small amounts of VC and with spin-off growth. In a study on Canadian spin-off firms, Niosi (2006) registers the existence of a positive relationship between spin-offs' growth and the availability of public incentives, whereas no significant effect on spin-offs' growth depending on the availability of VC can be identified. By building upon this diversified evidence, it is worth to test at least the impact of the formal involvement of VC among the company shareholders during the first year of operation, by advancing the following research hypothesis about Italian academic spin-offs.

*Hypothesis 4: Italian academic spin-offs which raised VC during their first year of operation will grow more in terms of employees, revenues and total assets compared to Italian spin-off companies which start without the formal involvement of VC.*

### **3.3. RBV: management and entrepreneurship**

With regard to human resources, this study will analyse the management and entrepreneurship dimension, that is both: i) the experience of the promoting partners in different business functions and ii) the involvement of an industrial shareholder in the firm since the first year of company operation.

Firm-specific human capital in newly established spin-off firms is contained within the management know-how and experience of the founders (Welbourne and Andrews 1996). The *quality (experience) of the founding team* represents also an important criterion for ventures funding (MacMillan et al. 1985), which suggests that human capital is a relevant predictor for spin-off success. In line with this, several researchers report that the academic entrepreneurs' skills and experiences are positively related to spin-offs performances (Roberts 1991; Cooper et al. 1994). Heirman and Clarysse (2004a) found that the entrepreneurial culture of the promoting partners is positively related to growth processes: more experienced founding teams grow faster. In particular, commercial experience leads to high growth, but it is often lacking in the mostly technical founding teams of academic spin-off companies. Therefore, the fifth research hypothesis will be as follows:

*Hypothesis 5: Italian academic spin-offs started by founding teams with previous experience in different functional domains (R&D, commercial, other) will grow more in terms of employees, revenues and total assets compared to Italian spin-off companies started by less experienced teams.*

On the basis of the above depicted considerations, the formal involvement of an industrial shareholder among the promoting partners of the spin-off company or at least its entry in the spin-off's equity during the first year of company operation, would provide the firm with a significant inward flow of knowledge and professional skills in different functional domains and it is therefore likely to impact positively on the early growth paths. In this respect, Roberts (1991) argues that promoting partners with previous entrepreneurial experience (namely *industrial partners*) have a better understanding of both the market and the financial community. In line with this, Roure and Keeley (1999) argue that in order to grow, a firm should accept and manage growth processes, including the willingness to add new shareholders. Moreover, Aggarwal et al. (2004) observe that interaction with industry through the promoting partners is more effective than knowledge acquisition through hiring experienced employees. In consideration of this, the sixth research hypothesis may be advanced:

*Hypothesis 6: Italian academic spin-offs in which one or more industrial partners took an equity stake during their first year of operation will grow more in terms of employees, revenues and total assets if compared with Italian spin-off companies without such shareholders.*

### **3.4. MLP: market strategy**

With regard to MLP, there are two important aspects of the market strategy to take into account: i) the breadth of the targeted market and ii) the international orientation of the new venture.

With regard to the *breadth of the targeted market*, it may range from a niche market to a mass market (Cooper et al. 1986; Romanelli 1989). Sometimes, spin-off companies start with a niche focus and plan to enlarge their target market later on (Tiler et al. 1993). If on the one side targeting a niche market allows newly established ventures to avoid larger scale competitors (Porter 1980; Cooper et al. 1986), on the other side a broad market focus since the beginning may lead new ventures to achieve greater performances (MacMillan and Day 1987). Roberts (1991) argues that an early niche focus plays a key role for new HT ventures to sell their products on the market, and that they are able to target a broader market later on. This suggests that spin-off companies with an early niche focus are likely to outperform firms targeting broad markets since their inception. The evidence provided by Heirman and Clarysse (2004a) about Flanders region confirms these findings about growth in total assets. Consequently, our seventh research hypothesis will be as follows.

*Hypothesis 7: Italian academic spin-offs targeting well defined niche markets at start-up will show higher growth in terms of employees, revenues and total assets than Italian spin-off companies with a broader, less focused market strategy.*

The *international orientation* of academic spin-offs may differ significantly, ranging from a local market focus to international new ventures and eventually to truly global start-ups (Oviatt and McDougall 1994). Previous research (McDougall 1989; Storey and Tether 1998b) found that spin-off companies tend to be more internationally oriented early on in their lifecycle compared to non-

HT new ventures. Shrader et al. (2000) observe that since the start of the new millennium, internationalization processes of academic spin-offs are getting more rapid. Autio et al. (2000) argue that the decision about when to start the internationalization process (at founding or later on) is a critical issue for new ventures. According to previous research (Shrader et al., 2000; Autio et al., 2000), spin-offs characterized by a early international orientation are more likely to exhibit growth trends. The evidence provided by Heirman and Clarysse (2004a) confirm these findings for growth in terms of revenues and total assets, whereas no significant effect could be observed on employment growth in the first years. Hence, the following research hypothesis may be advanced:

*Hypothesis 8: Italian academic spin-offs with an international market orientation from the start will show higher growth in terms of employees, revenues and total assets than Italian spin-off companies focusing on local markets.*

### **3.5. ILP: network**

Finally, from the ILP, this study analyzed the network of relationships - both formal and informal - between each academic spin-off and its parent university or other Italian PROs, also including every support service (housing, consultancy, incentives, and so on) benefited by the new venture. More specifically, 'formal' means that there is some kind of licence relation, be it equity-based or not, with the parent university, whereas 'informal' means that the relation is not institutionalized (Mustar et al. 2006).

Among the different *informal support mechanisms* activated by universities which may shape spin-off growth processes there is the foundation of Technology Transfer Offices - TTOs (or Industrial Liaison Offices - ILOs) as well as the introduction of business incubators (Mian 1997), STPs and subsidy programs (Shane 2002). Cooper (1985) argued that incubators may impact positively on spin-off creation and growth processes, by mentoring them and by providing human capital support. However, the evaluative literature on STPs is not conclusive about their effectiveness (MacDonald 1987; Miller and Cote 1987; Massey et al. 1992). Moreover, universities can still informally offer a supportive organisational culture towards entrepreneurship (Henrekson and Rosemberg 2001), by offering to their academics entrepreneurship courses, seminars, workshops and mentoring (Birley 2002). However, a significant relationship between programmes and spin-offs' performances has not yet been found (Kolvereid and Moen 1997). Another recent trend is the organisation of Business Plan (BP) competitions to foster entrepreneurial culture within the institutions. Still no research is known to provide proof of the effects of BP competitions on spin-offs performances (Djokovic and Souitaris 2004). Moreover, universities organise networking events, as well as spin-off clubs, to nurture partnerships in the financial, scientific and technological field (Mustar 1997). The exact effect of these events on network-building of academic entrepreneurs and eventually on spin-offs' growth is an interesting area for further research. By basing on these considerations, this paper aims at testing the following hypothesis:

*Hypothesis 9: Italian academic spin-offs with a strong network of informal relationships with the parent universities will show higher growth in terms of employees, revenues and total assets than Italian spin-off companies de-linked from the parent institution from the start.*

Regarding *formal relationships*, a number of universities are currently developing spinning off procedures, often involving the participation of the parent PROs to spin-offs' equity and/or the TT through licensing of IPRs and/or the carrying out of joint research activities (Birley 2002). Moray and Clarysse (2005) found that the degree to which the technology is 'formally' transferred from the parent organisation to the academic spin-off firm has both a direct impact on the starting resources of the firm and on its later growth path. Therefore, it is possible to formulate the following research hypothesis.

*Hypothesis 10: Italian academic spin-offs with a strong network of formal relationships with the parent universities will show higher growth in terms of employees, revenues and total assets than Italian spin-off companies de-linked from the parent institution from the start.*



#### **4. Control variables**

We control for several variables, which are suitable to affect the early growth of academic spin-offs but which however fall outside our conceptual model.

##### ***4.1. Industry***

The identification of the industrial sector in which each spin-off will operate represents a key decision for the success of the newly established venture (Compagno and Pittino 2006). In the literature, there is some evidence about dissimilarity of spin-offs' growth paths depending on the sectors in which they are involved (Delmar et al., 2003). In fact, previous research (Niosi 2006) observes that the growth of Canadian spin-off companies seems to be related - among other factors - to their field of activity. By focusing on a UK sample of Small and Medium Enterprises (SMEs), Smallbone et al. (1993) found that growth is more difficult to achieve in some industries than in others. With regard to the Italian context, previous research (Piccaluga and Balderi 2006; Netval 2010) observes that the preferred areas of TT processes from academia to industry through spinning-off of new ventures have progressively changed, by switching the focus from the involvement in the fields of mechanics, electronics, industrial automation, energy and environment in the early Seventies to the growing interest nowadays shown for biotechnologies, pharmaceutical, biomedical, nanotechnologies, ICT. However, there is a lack of evidence about the existence of significant differences in growth processes experienced by Italian academic spin-offs operating in different industry fields. Thus, assuming industry differences is not straightforward might not be a bad first approximation. Therefore, we also control for industry differences in this study.

##### ***4.2. Competitive forces***

The Industrial Organization (IO) literature argues that a firm's performance is not only dependent on the industry in which the firm is active but also on how the firm positions itself in this industry. In this perspective, the firm is a bundle of strategic activities aimed at positioning the venture on the market (Porter 1980). Porter's framework of competitive strategy emphasizes the actions a firm can take to defend their positions against competitive forces such as threat of entry, threat of substitution, bargaining power of buyers, bargaining power of suppliers and competitive rivalry among industry incumbents. Sandberg and Hofer (1987) found that venture strategy as well as competitive forces in the industry have an impact on the success of new ventures. Therefore, we control for four competitive forces, namely: (i) threat of new entrants, (ii) threat of substitutes and bargaining power of both (iii) buyers and (iv) suppliers. Controlling for direct competitors can be difficult and even misleading in the context of academic spin-offs because of the extreme novelty of their products and services for which industry boundaries are very vague.

##### ***4.3. Local context***

The support provided by the local context to spinning-off activities from academia to industry may have a significant impact on their creation and growth processes. In fact, at regional/local level initiatives aimed at fostering the development of academic spin-off companies (i.e. introduction of public subsidies, and so on) may be carried out. In a recent study on Canadian spin-off firms, Niosi (2006) registers the existence of a positive relationship between spin-offs' growth and the local availability of public incentives. More specifically it emerged from the study that academic spin-off companies not supported by public subsidies are more likely to be stagnant. By building upon this evidence, we included in the model a control variable measuring the supportive level of the local context to academic entrepreneurship.

##### ***4.4. Firm size***

Firm's age and size are likely to impact on firm's growth pattern (Penrose 1959; Stinchcombe 1965). Population ecologists also study the relationships between firm size, age, survival and growth in context of analyses of firm size distribution in organizational populations (Carroll and

Hannan 2000). The best known relationship between an organization's size and its growth rate is Gibrat's (1931) law or the Law of Proportionate Effect, holding that proportional growth rates are independent of size. However, this view has been challenged by several scholars (Evans 1987a,b; Dunne et al. 1989; Barron et al. 1994), arguing that – among firms of the same age – the higher the size, the lower the growth rates. Therefore, we control for firm size in this study. Following previous work on firm growth, we use the firm's employment size at founding as our control measure (Lee et al. 2001; Heirman and Clarysse 2004a).

#### **4.5. Firm age**

Empirical evidence in the literature shows that – among firms of the same size – the older the firms, the lower their growth rates, regardless of the number of industries included in the sample (single industry versus multiple industries; Sutton 1997). Moreover, the younger the firms, the more apparent are their growth perspectives (Storey and Tether 1998; Delmar et al. 2003), especially in terms of employment (Reynolds 1987). Therefore, the available literature indicates that the younger the firms, the higher their growth rates. However, in considering the effect of age on growth of academic spin-offs, it must be emphasized that all firms in this study are quite young (the average age being 4.6 years) and that the age variation is low. We therefore include firm age at time of survey as a control variable in our analysis.

### **5. Research Method**

#### **5.1. Defining issues**

Most authors in the literature do not clearly define what a spin-off company is. The adoption of different definitions could lead to situations where researchers use the same concept for studying and describing different realities. Moreover, by reviewing the studies where a definition is precisely stated, it emerges that at present there is not a universally accepted meaning for spin-off companies (Degroof and Roberts 2004; Piccaluga and Balderi 2006). In fact, some authors (Di Gregorio and Shane 2003; Shane 2004) identify academic spin-offs as IP-related phenomena, by taking into consideration only those ventures founded to exploit university-assigned IPRs. Other authors (Alistair et al. 1993) adopt an equity-related perspective, by classifying as spin-off ventures only those firms in which the parent university is a shareholder. Finally, other scholars (Clarysse and Moray 2004; Clarysse et al. 2005) introduce a broader concept of academic spin-offs (TT perspective), by including in the definition all business based on knowledge generated by a parent university, but not necessarily dependent on licensing or assignment of the PRO's technology or on PRO participation to the firms' equity<sup>2</sup>. This paper adopts the 'TT perspective' - which nowadays is widely diffused among scholars – for the definition of academic spin-off. More specifically, Italian spin-off companies are defined as follows:

*'New HT firms localized in Italy, which have been founded by professors and/or researchers and/or PhD students who have carried out their personal research activities in Italian universities and/or other PROs<sup>3</sup>, focusing on the same technology and/or industry fields in which the ventures are operating'.*

According to this definition, any Italian firm may be qualified as an Italian academic spin-off as long as it simultaneously fulfils four conditions: i) the presence of professors and/or researchers and/or D.Phil. students among the promoting partners; ii) the exploitation of results from multi-year research activities carried out in the parent Italian university and/or other PRO; iii) the start of an entrepreneurial activity, in a profit-making perspective; iv) the production and/or commercialisation of HT products and/or technologies and/or services, related to the research activities carried out by the academic founders.

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<sup>2</sup> For a more detailed review of the great variety of 'spin-off' definitions available in the literature, as well as of several definitional ambiguities, please, refer to Pirnay et al. (2003) and Mustar et al. (2006).

<sup>3</sup> It is worth to point out that this paper takes into consideration all the spin-off companies gemmated from Italian universities and other PROs which have been officially acknowledged as such by the Italian Ministry for University and Research (MIUR).

Hence, the existence of the bulk of these four elements represents a necessary and sufficient condition for an Italian firm to be considered as an Italian academic spin-off, notwithstanding the missing fulfilment of other conditions, such as: i) the transfer activities from the parent university to the firm of IPRs (such as licensing); ii) the participation of the parent PRO to the venture's equity; iii) the housing of the venture during its start-up phase in the parent university incubator and/or other STP; iv) the formal acknowledgement by the parent PRO of the firm as one of its spin-off companies and/or the inclusion of the firm in the spin-off club created by the parent PROs. In fact, the occurrence of one or more of these five elements may represent a sufficient condition for an Italian firm to be considered as an Italian academic spin-off<sup>4</sup>, but it is not a necessary condition for the identification of a firm as an academic spin-off<sup>5</sup>.

### ***5.2. Identification of academic spin-off companies in Italy, sampling and data collection***

The identification of the universe of Italian spin-off companies was achieved by collecting information from a very diversified range of sources: i) phone contacts with all Italian universities and other PROs; ii) phone contacts with all Italian business incubators, business accelerators and other STPs; iii) constant monitoring activity of all the BP competitions; iv) emergographic analysis; v) web search; vi) informal sources. As a result of this empirical process of identification and validation of the information, a database of over 800 spin-off companies has been built.

The primary data source was a structured questionnaire specifically designed by the authors in order to enable the reconstruction of the firm's history and particularly focusing on the firm's resources, products, market characteristics, employees and link with the parent PRO. For each item, data were collected on both the initial conditions (during their first year of operations) and on the current situation (time of interview). The questionnaire was conducted during Computer Assisted Telephone Interviews (CATI method) with either the founders or the Chief Executive Officers (CEOs). A total number of 291 interviews (with an incidence of 36.1% on the total population of academic spin-off companies identified in Italy) were carried out during the months of November-December 2009<sup>6</sup>.

### ***5.3. Measures for outcome variables***

The clear specification of the growth criteria adopted is critical for the interpretation of the results and the comparison with other studies. In this respect, the occurrence of different results depending on the growth measures adopted emphasizes the relevance of using multiple criteria, especially for newly established ventures (McDougall et al. 1994; Delmar et al. 2003). For this reason, in this paper, employment, revenue and total assets growth have been adopted as outcome variables. In particular, employment growth is important for policy makers, in a job creation perspective; revenue growth is the most diffused measure of small and new ventures (Brush and VanderWerf 1990; McDougall et al. 1994; Delmar et al. 2003); total assets growth plays a key role for newly established companies, where especially at the beginning total assets can grow without registering any revenue (Achtenhagen et al. 2004).

Another key issue is about the use of measures of absolute or relative growth (Achtenhagen et al. 2004). As small firms are more likely to exhibit astonishing percent growth rates (Delmar et al. 2003), in this paper absolute growth has been adopted. In particular, we use: 'Annual Absolute Employment Growth [AAEG]', 'Annual Absolute Revenue Growth [AARG]', and 'Annual Absolute Total Asset Growth [AATAG]' as objective measures of the annual absolute employee, revenue and total asset change (Hanks et al. 1993; Westhead and Birley 1994; Delmar et al. 2003; Heirman and Clarysse 2004). A description about how each one of the outcome variables is calculated is reported in table 1.

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<sup>4</sup> For instance: the inclusion of the firm among the spin-offs acknowledged by its parent university implies its spin-off identity.

<sup>5</sup> Several authentic spin-off companies do not appear in the list of spin-offs acknowledged by their parent universities, but this does not question their nature.

<sup>6</sup> Not all respondents answered to the bulk of the questions included in the questionnaire. As a consequence, the sample size varies from question to question.

**Table 1 – Outcome variables: labels and description**

<b>Variable Label</b>	<b>Variable Description</b>
AAEG	Annual Absolute Employee Growth = $(\text{Employees}_{2008} - \text{Employees}_{\text{year of founding}}) / \text{Firm's Age}$
AARG	Annual Absolute Revenue Growth = $(\text{Revenues}_{2008} - \text{Revenues}_{\text{year of founding}}) / \text{Firm's Age}$
AATAG	Annual Absolute Total Assets Growth = $(\text{Total assets}_{2008} - \text{Total assets}_{\text{year of founding}}) / \text{Firm's Age}$

#### 5.4. Measures for predictor variables

We already discussed the predictor variables in this study in the formulation of the hypotheses. In particular, basing on the empirical findings available in the literature, we consider five dimensions which have been found suitable to influence early growth processes experienced by spin-off companies, namely (i) technology, (ii) finance, (iii) management and entrepreneurship (within the RBV theoretical framework); (iv) market strategy (within the MLP framework); (v) network (within the ILP framework). For each one of these dimensions, several predictor variables measuring different elements which are suitable to be proxies of different aspects of the considered dimensions have been introduced in the model. A schematic representation of the predictor variables included in the model is reported in table 2.

**Table 2 – Predictor variables: link with both theoretical approaches and research hypotheses, variable label, type and description**

Theoretical approaches	Res. Hyp.	Variable Label	Variable Type	Variable Description
RBV: Technology	1	NPD	Ranking	Ranking variable about the stage of NPD at founding, ranging from : (0) = no-prototype; (1) = prototype; (2) = standardised, market-ready product; (3) = product immediately commercialized
	2	IPR	Quant.	Total number of active patents (both applications and grants) owned by the company at founding + active patents licensed to the company at founding (active licensing in) + trademarks owned at founding (proxy for the number of products)
RBV: Finance	3	EQUITY	Quant.	Financial amount of capital raised in the first year (in Euros)
	4	VC	Ranking	Dummy indication whether VC funds were raised during the first year
RBV: Management & Entrepreneurship	5	RD_EXPE	Ranking	Dummy indication about the eventual experience ripened by all the promoting partners in R&D function
		PROD_EXPE	Ranking	Dummy indication about the eventual experience ripened by all the promoting partners in the production function
		COMM_EXPE	Ranking	Dummy indication about the eventual experience ripened all the promoting partners in commercial function
		MGMT_EXPE	Ranking	Dummy indication about the eventual experience ripened by all the promoting partners in a management function
6	INDU	Ranking	Dummy indication about the presence of an industrial partner as a shareholder during the first year	
MLP: Market strategy	7	MKT	Ranking	Breadth of the targeted market at founding, ranging from: (1) niche or focus strategy; (2) temporary niche, with specific intention to penetrate larger market later on; (3) large and broadly defined market
	8	INT_OR	Ranking	Geographic coverage of the market at founding, ranging from: (1) regional focus; (2) national focus; (3) European focus; (4) global orientation
ILP: Network	9	INFORM_SUP*	Ranking	Ranking variable (varying from 0 to 10) of the informal support mechanisms provided by the parent PRO to the academic spin-off
	10	FORM_SUP**	Ranking	Ranking variable (varying from 0 to 4) of the formal relationships existing between the academic spin-off and the parent PRO.

*Notes:* (\*) [INFORM\_SUP] is calculated as the algebraic sum of ten different dummy variables (where 1=yes; 0=no), regarding the offer by the parent PRO to the academic spin-off company of the following informal support mechanisms: (1) existence of personal/informal relationships; (2) interactions with the university TTO; (3) possibility to use university offices, laboratories, facilities, infrastructures and/or to be hosted in academic incubators; (4) consultancy services; (5) financial support; (6) marketing and organizational support; (7) fiscal and administrative support; (8) availability of courses, seminars, workshops and mentoring activities; (9) networking events (ie: spin-off clubs); (10) support aimed at taking part to BP competitions; (\*\*) [FORM\_SUP] is calculated as the algebraic sum of four different dummy variables (where 1=yes; 0=no), regarding the offer by the parent PRO to the academic spin-off company of the following formal support mechanisms: (1) participation of the parent PRO to the spin-off's equity; (2) existence of formal licensing agreements between the parent PRO (licensor) and the spin-off company (licensee); (3) existence of formal agreements for the carrying out of joint/collaborative contracted research between the parent PRO and the academic spin-off; (4) formal acknowledgment of the company among the university's spin-offs

### 5.5. Measures for control variables

Basing on the empirical findings available in the literature, we consider five dimensions which have been found suitable to be controlled for, and namely: (i) industry, (ii) competitive forces, (iii) local context; (iv) firm size; (v) firm age. For each one of these dimensions, control variables measuring different elements which are suitable to be proxies of different aspects of the considered dimensions have been controlled for in the model. A schematic representation of the control variables included in the model is reported in table 3.

**Table 3 – Control variables: link with both theoretical approaches and research hypotheses, variable label, type and description**

	Variable Label	Variable Type	Variable description
Industry	NANO	Ranking	Dummy variable indicating whether the firm is active in the nanotechnology and advanced materials sector
	CHEM	Ranking	Dummy variable indicating whether the firm is active in the chemical sector
	LIFE	Ranking	Dummy variable indicating whether the firm is active in the life sciences sector
	MECH	Ranking	Dummy variable indicating whether the firm is active in the advanced mechanics sector
	ELECT	Ranking	Dummy variable indicating whether the firm is active in the electronics sector
	ICT	Ranking	Dummy variable indicating whether the firm is active in the ICT sector
	INNOV	Ranking	Dummy variable indicating whether the firm is active in the innovation services sector
	EN_ENVI	Ranking	Dummy variable indicating whether the firm is active in the energy and environmental sector
Competitive forces	ENTRY	Ranking	Barriers to entry the industry at founding, ranging from: (0) = very low (very easy to enter) to (7) = very high (very difficult to enter)
	SUBS	Ranking	Threat of substitutes, ranging from: (0) = not at all (no threats) to (7) = very high (very high threats)
	BUY	Ranking	Power of the customers of the firm, ranging from: (0) = very weak (high bargaining power of the firm) to (7) = very strong (low bargaining power of the firm)
	SELL	Ranking	Power of the suppliers of the firm, ranging from: (0) = very weak (high bargaining power of the firm) to (7) = very strong (low bargaining power of the firm)
Local context	CONT	Ranking	Supportive level of the local context to academic entrepreneurship, ranging from: (0) = not at all (low support) to (7) = very high (strong support)
Firm size	SIZE	Quant.	Number of FTEs during first year of operation of the company
Firm age	AGE	Quant.	Numbers of years since founding (N) = [2009 – (year of foundation of the company)]

### 5.6. Sample characteristics

The spin-offs in the sample are between zero<sup>7</sup> and thirty years old with an average age of 4.6 years and a median age of 3 years. At start-up (during their first year of operation), these firms employed

<sup>7</sup> It means that they have been founded in year 2009.

1,817 FTEs (Full Time Equivalent units) in total. In 2008, these firms employed 2,896 FTEs in total, meaning that they have grown their employment base by almost 60%. The mean employment size in 2008 is 10 FTEs (it was 6.2 FTEs during the first year of company's operation), with the majority of the firms employing no more than 6 FTEs. However, the growth is not uniform across the sample. As expected, the 30 fastest growing spin-offs (about 10% of our sample; n=291) account for 53.8% of net additional jobs. Overall, the spin-offs included in the sample appear to be a group of firms of particular interest to policy-makers. In fact, in a relatively short time, they have created apparently viable growing businesses in a wide range of technologies, including ICT (25.2%), energy and environmental sector (20%), life sciences (17.9%), advanced mechanics (9.7%), electronics (9.3%), nanotechnologies and advanced materials (8.3%), innovation services (6.9%) and chemical sector (2.8%). Table 4 gives an overview of the descriptive statistics about all the variables included in the model.

**Table 4 – Descriptive statistics - all variables**

Variable name	Mean	Median	Min.	Max.	S.D.	n
AAEG	0.9	0.0	-6.7	25.0	2.4	291
Log_AAEG	0.2	0.0	-2.8	3.2	1.1	140
AARG	232,877.8	26,666.7	-19,000,000.0	30,000,000.0	3,185,348.0	133
Log_AARG	10.7	10.6	5.9	17.2	1.7	107
AATAG	40,875.0	3,666.7	-737,500.0	1,335,000.0	204,905.1	78
Log_AATAG	9.9	10.0	7.4	14.1	1.7	50
NPD	1.0	1.0	0.0	3.0	0.9	290
IPR	0.6	0.0	0.0	16.0	1.9	290
EQUITY	546,709.3	12,000.0	500.0	10,400,000.0	2,034,941.2	204
VC	0.1	0.0	0.0	1.0	0.2	291
RD_EXPE	0.9	1.0	0.0	1.0	0.3	291
PROD_EXPE	0.3	0.0	0.0	1.0	0.5	291
COMM_EXPE	0.2	0.0	0.0	1.0	0.4	291
MGMT_EXPE	0.2	0.0	0.0	1.0	0.4	291
INDU	0.2	0.0	0.0	1.0	0.4	291
MKT	1.6	1.0	1.0	3.0	0.7	291
INT_OR	1.6	1.0	1.0	4.0	0.8	290
INFORM_SUP	3.4	3.0	0.0	9.0	2.0	290
FORM_SUP	1.2	1.0	0.0	4.0	1.0	290
NANO	0.1	0.0	0.0	1.0	0.3	290
CHEM	0.0	0.0	0.0	1.0	0.2	290
LIFE	0.2	0.0	0.0	1.0	0.4	290
MECH	0.1	0.0	0.0	1.0	0.3	290
ELECT	0.1	0.0	0.0	1.0	0.3	290
ICT	0.3	0.0	0.0	1.0	0.4	290
INNOV	0.1	0.0	0.0	1.0	0.3	290
EN_ENVI	0.2	0.0	0.0	1.0	0.4	290
ENTRY	4.8	5.0	0.0	7.0	1.9	291
SUBS	3.5	4.0	0.0	7.0	2.0	291
BUY	3.9	4.0	0.0	7.0	1.7	291
SELL	2.9	3.0	0.0	7.0	1.8	291
CONT	3.0	3.0	0.0	7.0	1.9	291
SIZE	6.2	5.0	1.0	150.0	10.5	291
AGE	4.6	3.0	0.0	30.0	4.2	290



## 6. Results and discussion

### 6.1. Reliability statistics

Table 5 presents the Pearson Product-Moment correlation coefficients for the three outcome variables, namely the absolute annual growth in employment [AAEG], revenues [AARG] and total assets [AATAG]. The correlation coefficients range between 0.54 and 0.63. The Cronbach's Alpha for these three growth measures is 0.74 on unstandardized items and 0.80 on standardized items.

Hence, the data indicate that the three growth measures are strongly correlated.

**Table 5 – Pearson's Product-Moment Correlation Coefficients between outcome variables**

		1	2	3
1	Log_AAEG	--		
2	Log_AARG	.622***	--	
3	Log_AATAG	.537***	.553***	--

Note: (\*\*\*) Correlation is significant at the 0.01 level (2-tailed).

## 6.2. Multivariate regression analysis

In order to assess the combination of factors at founding that best explains early growth processes of academic spin-off companies, General Least Squares (GLS) regression analysis has been carried out. In fact, this statistical technique allows association of each predictor variable with the outcome variable while controlling for the effects of other predictor variables. As the outcome variables (i.e. our growth measures: [AAEG], [AARG], [AATAG]) are not normally distributed (table 6)<sup>8</sup>, statistical tests on the absolute growth measures could be invalid (Hair et al. 1984). The logarithms of the growth measures ([Log\_AAEG], [Log\_AARG], [Log\_AATAG]), which are normally distributed, are therefore considered in the analysis.

**Table 6 – Results of the normality tests (all variables – listwise method)(\*\*\*)**

Variable name	Variable type	Variable role	Kolmogorov-Smirnov (**)			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
AAEG	Quant.	Outcome	0.23	28	0.00	0.76	28	0.00
Log_AAEG	Quant.	Outcome	0.10	28	0.20(*)	0.98	28	0.81
AARG	Quant.	Outcome	0.29	28	0.00	0.51	28	0.00
Log_AARG	Quant.	Outcome	0.08	28	0.20(*)	0.97	28	0.49
AATAG	Quant.	Outcome	0.38	28	0.00	0.44	28	0.00
Log_AATAG	Quant.	Outcome	0.08	28	0.20(*)	0.97	28	0.45
NPD	Ranking	Predictor	0.27	28	0.00	0.81	28	0.00
IPR	Quant.	Predictor	0.46	28	0.00	0.29	28	0.00
EQUITY	Quant.	Predictor	0.34	28	0.00	0.58	28	0.00
VC	Ranking	Predictor	0.54	28	0.00	0.29	28	0.00
RD_EXPE	Ranking	Predictor	0.54	28	0.00	0.29	28	0.00
PROD_EXPE	Ranking	Predictor	0.48	28	0.00	0.51	28	0.00
COMM_EXPE	Ranking	Predictor	0.47	28	0.00	0.54	28	0.00
MGMT_EXPE	Ranking	Predictor	0.51	28	0.00	0.42	28	0.00
INDU	Ranking	Predictor	0.45	28	0.00	0.57	28	0.00
MKT	Ranking	Predictor	0.30	28	0.00	0.75	28	0.00
INT_OR	Ranking	Predictor	0.27	28	0.00	0.79	28	0.00
INFORM_SUP	Ranking	Predictor	0.17	28	0.04	0.90	28	0.01
FORM_SUP	Ranking	Predictor	0.21	28	0.00	0.88	28	0.00
NANO	Ranking	Control	0.53	28	0.00	0.36	28	0.00
CHEM	Ranking	Control	0.54	28	0.00	0.29	28	0.00
LIFE	Ranking	Control	0.50	28	0.00	0.47	28	0.00
MECH	Ranking	Control	0.53	28	0.00	0.36	28	0.00
ELECT	Ranking	Control	0.54	28	0.00	0.29	28	0.00
ICT	Ranking	Control	0.48	28	0.00	0.51	28	0.00
INNOV	Ranking	Control	0.51	28	0.00	0.42	28	0.00
EN_ENVI	Ranking	Control	0.53	28	0.00	0.36	28	0.00
ENTRY	Ranking	Control	0.16	28	0.06	0.92	28	0.03
SUBS	Ranking	Control	0.17	28	0.03	0.91	28	0.02
BUY	Ranking	Control	0.21	28	0.00	0.94	28	0.10
SELL	Ranking	Control	0.17	28	0.05	0.90	28	0.01
CONT	Ranking	Control	0.14	28	0.20	0.95	28	0.20
SIZE	Quant.	Control	0.22	28	0.00	0.86	28	0.00
AGE	Quant.	Control	0.29	28	0.00	0.58	28	0.00

<sup>8</sup> Showing that the outcome variables are not normally distributed, while their log-transformed counterpart are normally distributed. The variables which are normally distributed are highlighted in grey in table 6).

*Notes:* (\*) This is a lower bound of the true significance; (\*\*) Lilliefors Significance Correction; (\*\*\*) By basing on this method, cases have been excluded listwise, which means that if a subject has a missing value for any variable, then they are excluded from the whole analysis (Field 2000).

Table 7 shows the results of three GLS regression models, one for outcome variable in this study (i.e. log employment growth [Log\_AAEG], log revenue growth [Log\_AARG] and log growth in total assets [Log\_AATAG]). Each GLS model includes both the predictor and the control variables. The results from the different growth measures adopted reveal a reassuring consistency. Predictor variables explain 32.8% of the variance in employment growth (R Square for [Log\_AAEG] model), 40.1% of revenue growth (R Square for [Log\_AARG] model) and 72.6% of growth in total assets (R Square for [Log\_AATAG] model).

The Durbin-Watson statistics<sup>9</sup> is equal to 2.0 for the model about the log employment growth [Log\_AAEG]; to 2.1 for the model about the log revenue growth [Log\_AARG]; to 1.9 for the model about the log growth in total assets [Log\_AATAG]. The F-ratio<sup>10</sup> is equal to 1.5 ( $p < 0.10$ ) for the model about the log employment growth [Log\_AAEG]; to 1.4 ( $p < 0.10$ ) for the model about the log revenue growth [Log\_AARG]; to 1.7 ( $p < 0.10$ ) for the model about the log growth in total assets [Log\_AATAG].

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<sup>9</sup> Informing us about whether the assumption of independent errors is tenable.

<sup>10</sup> Representing the ratio of the improvement in prediction as a result of fitting the model relative to the inaccuracy that still exists in the model.

**Table 7 – Multiple regression models - listwise method(\*\*\*\*)**

	Critical dimensions	Res. Hp.	Variables	Log_AAE G	Log_AAR G	Log_AATA G
			Intercept	.917 (.661)	9.489*** (1.180)	11.128*** (1.461)
Predictor variables	RBV: Technology	1	NPD	-.111 (.123)	.035 (.179)	-.296 (.265)
		2	IPR	-.056 (.067)	-.119 (.094)	-.257* (.132)
	RBV: Finance	3	EQUITY	.000 (.000)	.000 (.000)	.000 (.000)
		4	VC	.099 (.345)	.349 (.742)	.548 (.979)
	RBV: Management & Entrepreneurship	5	RD_EXPE	-.123 (.334)	.206 (.596)	-1.434* (.767)
			PROD_EXPE	.020 (.240)	-.095 (.488)	-1.283** (.497)
			COMM_EXPE	-.128 (.262)	.720 (.463)	.365 (.562)
			MGMT_EXPE	-.143 (.313)	-.413 (.521)	.426 (.644)
	MLP: Market strategy	6	INDU	.402* (.230)	.390 (.375)	.108 (.512)
		7	MKT	.057 (.164)	.207 (.282)	.610* (.330)
ILP: Network	8	INT_OR	.025 (.118)	.074 (.210)	.126 (.266)	
	9	INFORM_SUP	-.072 (.058)	-.200** (.091)	-.277** (.121)	
	10	FORM_SUP	.130 (.103)	.328* (.190)	.552** (.249)	

	Critical dimensions	Variables	Log_AAE G	Log_AAR G	Log_AATA G	
Control variables	Industry	NANO	.126 (.353)	.438 (.597)	-.484 (.888)	
		CHEM	-1.442* (.779)	-.442 (1.220)	-2.673* (1.386)	
		LIFE	-.479 (.307)	-.045 (.613)	.593 (.706)	
		MECH	-.345 (.336)	-.760 (.602)	-.140 (.812)	
		ELECT	.350 (.417)	-.543 (.616)	-.404 (.852)	
		ICT	.146 (.263)	.065 (.523)	-.005 (.412)	
		INNOV	-.245 (.466)	-.353 (.750)	-1.237 (.945)	
		EN_ENVI	-.099 (.366)	-.406 (.595)	-.315 (.679)	
	Competitive forces	ENTRY	-.121** (.057)	.022 (.101)	.076 (.129)	
		SUBS	.033 (.054)	-.030 (.090)	.159 (.121)	
		BUY	-.051 .055	-.079 .106	-.005 (.130)	
		SELL	-.007 (.052)	.119 (.086)	-.139 (.125)	
	Local context	CONT	.037 (.052)	.129 (.087)	-.224* (.119)	
	Firm's size	SIZE	.055* (.030)	.100* (.056)	.029 (.024)	
	Firm's age	AGE	-.044** (.021)	.035 (.039)	-.135** (.054)	
		R Square		.330	.372	.570
		Durbin-Watson		2.021	2.062	1.879
	F-ratio		1.549*	1.418*	1.705*	
	n		117	96	47	

Notes: coefficients are reported; S.E. are in parentheses; (\*) p<0.10; (\*\*) p<0.05; (\*\*\*) p<0.01; (\*\*\*\*) by basing on this method, cases have been excluded listwise, which means that if a subject has a missing value for any variable, then they are excluded from the whole analysis.

The results of the multivariate analysis show that firms' conditions at founding impact significantly on their growth path, even if not always in the expected direction. In particular, in the previous section, relying on sound evidence provided by previous empirical studies available in the literature about the factors suitable to influence spin-offs' early growth processes, we advanced ten research hypotheses. In this respect, by basing on the research hypotheses previously advanced, table 8 reports the expected results of the GLS regression models, whereas table 9 shows the estimated results through the carrying out of multivariate regression analysis.

We found a significant correlation between growth in employees, revenues and total assets are (see again table 5). In particular, some predictor variables - such as the support mechanisms, both formal

[FORM\_SUP] and informal [INFORM\_SUP], provided by the parent PROs to the academic spin-off companies - explain for more than one form of growth (being significant for both revenue [Log\_AARG] and total asset [Log\_AATAG] growth), while other predictors - such as the experience ripened by all the promoting partners in both R&D function [RD\_EXPE] and production function [PROD\_EXPE] - explain just for one form of growth (being significant only for total asset [Log:AATAG] growth).

**Table 8 – Research hypotheses: expected results(\*) – multivariate regression analysis (all variables, listwise method)**

	<b>Critical dimensions</b>	<b>Res. Hp.</b>	<b>Variables</b>	<b>Log_AAEG</b>	<b>Log_AARG</b>	<b>Log_AATAG</b>
<b>Predictor variables</b>	RBV: Technology	1	NPD	+	+	+
		2	IPR	+	+	+
	RBV: Finance	3	EQUITY	+	+	+
		4	VC	+	+	+
	RBV: Management & Entrepreneurship	5	RD_EXPE	+	+	+
			PROD_EXPE	+	+	+
			COMM_EXPE	+	+	+
			MGMT_EXPE	+	+	+
	MLP: Market strategy	6	INDU	+	+	+
		7	MKT	-	-	-
ILP: Network	8	INT_OR	+	+	+	
	9	INFORM_SUP	+	+	+	
<b>Control variables</b>	Industry	10	FORM_SUP	+	+	+
			NANO			
			CHEM			
			LIFE			
			MECH			
			ELECT			
			ICT			
			INNOV			
	Competitive forces		EN_ENVI			
			ENTRY			
		SUBS				
		BUY				
Local context		SELL				
Firm's size		CONT				
Firm's age		SIZE				
		AGE				

Note: (\*) [+] = positive and significant regression coefficient (b); [-] negative and significant regression coefficient (b)..

**Table 9– Research hypotheses: estimated results(\*); multivariate regression analysis (all variables, listwise method)**

	<b>Critical dimensions</b>	<b>Res. Hp.</b>	<b>Variables</b>	<b>Log_AAEG</b>	<b>Log_AARG</b>	<b>Log_AATAG</b>
<b>Predictor variables</b>	RBV: Technology	1	NPD			
		2	IPR			-
	RBV: Finance	3	EQUITY			
		4	VC			
	RBV: Management & Entrepreneurship	5	RD_EXPE			-
			PROD_EXPE			-
			COMM_EXPE			
			MGMT_EXPE			
	MLP: Market strategy	6	INDU	+		
		7	MKT			+
ILP: Network	8	INT_OR				
	9	INFORM_SUP		-	-	
	10	FORM_SUP		+	+	
<b>Control variables</b>	Industry		NANO			
			CHEM	-		-
			LIFE			
			MECH			
			ELECT			
			ICT			
			INNOV			
			EN_ENVI			



Critical dimensions	Variables	Log_AAEG	Log_AARG	Log_AATAG
Competitive forces	ENTRY	-		
	SUBS			
	BUY			
	SELL			
Local context	CONT			-
Firm's size	SIZE	+	+	
Firm's age	AGE	-		-

Note: (\*) [+] = positive and significant regression coefficient (b); [-] negative and significant regression coefficient (b)..

### 6.3. RBV: technology

*Hypothesis 1* is rejected for the Italian case, the regression coefficients being not significant. Indeed, the empirical evidence available in the literature about this issue is contrasting. The Italian evidence provided by this paper shows that being further in NPD does not significantly influence employment, revenues and total asset growth of spin-off companies.

*Hypothesis 2* is also rejected, as the multivariate analysis indicates that firms with less IPRs grow significantly more in total assets [Log\_AATAG] during the first years than firms exhibiting a greater volume in the IPR's portfolio at founding (the regression coefficient is negative and significant). Moreover, the Italian evidence provided by this paper shows that the number of IPRs granted to the spin-off at founding does not significantly affect employment [Log\_AAEG] and revenues [Log\_AARG] growth processes (the regression coefficients being not significant). These findings about the Italian case are in contrast with previous evidence available in the literature (Niosi 2006). The negative, significant relationship between the total number of IPRs [IPR] and the total asset growth [Log\_AATAG] experienced by Italian spin-off companies can be attributed to the fact that spin-off companies with a high number of IPRs at founding already possess the knowledge and the technology in order to develop their own products/services without further investing big amount of money in R&D activities. On the other side, spin-off companies starting their activities without being granted any IPR do need to invest massively in R&D activities. In these cases, the growth in total assets is not due to increased sales activities (the revenue growth being not significant) but to increasing investments in R&D. As a consequence, firms that are heavily investing in R&D grow in total assets even if their 'market' activities are not increasing (Heirman and Clarysse 2004a). The accounting practice of activating R&D costs therefore explains the significant negative coefficient of the IPRs on total asset growth.

### 6.4. RBV: finance

*Hypothesis 3* is rejected for the Italian case, the regression coefficients being null and not significant. This finding - which is contrasting with the empirical evidence provided by the available literature (Cooper et al. 1994; Heirman and Clarysse 2004b) - must be interpreted by analyzing more in depth the characteristics of the responding companies in respect of the amount of their starting capital [EQUITY] at founding (n=204). The minimum value is 500 Euros while the maximum value is over 10 million Euros, the average value being about 550 thousand Euros. However the distribution is highly left-skewed, the median value being 12 thousand Euros (meaning that for 50% of the responding companies the amount of starting capital at founding was less than 12 thousand Euros), the 75th percentile's value being 50 thousand Euros and the 90th percentile's value being about 290 thousand Euros. We further investigated the characteristics of the upper decile of the distribution by basing on the amount of starting capital at founding and we found that it includes very young firms (1 to 2 years old), which physiologically did not experience dramatic growth trends yet. Therefore, the absence of any significant relationship between the amount of the starting capital at founding and annual absolute growth is mainly attributable to this situation, in

which most Italian spin-offs (both the growing and the non growing ones) were founded with a very small amount of starting capital. It is just in the last two years that cases of highly capitalized companies at founding can be spotted, but it is still too early to find association with growth trends. *Hypothesis 4* is rejected, the regression coefficients being positive but not significant. This finding - while being in contrast with the empirical evidence provided by some scholars (Davila et al. 2003; Baum and Silverman, 2004) - is in line with the evidence reported by Niosi (2006) for Canadian spin-off companies, registering no significant effect on spin-offs' growth depending on the availability of VC. Similarly to our Italian case, Niosi (2006) found that Canadian VC-backed spin-offs are not significantly different from their non VC-backed counterparts in terms of growth performances. In order to better understand the dynamics leading to such a result for the Italian case, we analyzed more in depth the characteristics of the responding companies in respect of the formal involvement of a VC among the company's shareholders [VC] in the first year of operations (n=291). In particular, just a small minority (n=16) of the sample (the incidence being 5.4%) registered the entry of a VC in the companies equity in the first year of activity. Just in one case the starting capital was equal to 10 million Euros, while for the other 15 companies it was not greater than 100 thousand Euros. By looking at the age of the VC-backed spin-off companies in our sample, we found that the average age is 3.6 years, while the median age is 2 years (meaning that 50% of the VC-backed responding companies have been founded 2 years ago). This result confirms that in the Italian context, VC taking an equity state in academic spinoff companies is a recent phenomenon (Netval 2010). Indeed, the evidence shows that the subset of VC-backed spin-off in our sample includes very young firms, which physiologically did not experience yet dramatic growth trends. Therefore, similarly to what observed regarding the amount to the starting capital [EQUITY], the absence of any significant relationship between the formal involvement of VC among spin-offs' shareholders and annual absolute growth is mainly attributable to this situation, in which most Italian spin-offs (both the growing and the no-growing ones) were no VC-backed in their first year of operations. It is just in recent years that VC started investing more frequently in academic spin-off companies, but it is still too early to find association with growth trends.

### **6.5. RBV: management and entrepreneurship**

Hypothesis 5 is rejected, as the multivariate analysis indicates that Italian spin-offs whose promoting partners exhibited at founding previous experience in R&D [RD\_EXPE] and production [PROD\_EXPE] functions firms grow significantly less in total assets [Log\_AATAG] during the first years than firms started by non-experienced promoting partners, the regression coefficient being negative and significant. Moreover, the Italian evidence provided by this paper shows that previous experience ripened by the promoting partners in both commercial [COMM\_EXPE] and managerial [MGMT\_EXPE] functions does not significantly affect employment [Log\_AAEG], revenue [Log\_AARG] and total asset [Log\_AATAG] growth processes, the regression coefficients being not significant. This result is contrasting with most of the evidence provided in the available literature (Roberts 1991; Cooper et al. 1994; Heirman and Clarysse 2004a). Similarly to the above-expressed considerations pointed out while commenting the testing of hypothesis 2, the negative, significant relationship between the previous experience ripened by promoting partners in R&D [RD\_EXPE] and production [PROD\_EXPE] function and the total asset growth [Log\_AATAG] experienced by Italian spin-off companies can be attributed to the fact that spin-off companies started by experienced promoting partners are more likely to already possess the knowledge and the technology which are necessary to develop their own products/services without further investing big amount of money in R&D activities. On the other side, spin-off companies started by non-experienced promoting partners do need to invest massively in R&D activities. In these cases, the growth in total assets is not due to increased sales activities (the revenue growth [Log\_AARG] is not significant) but to increasing investments in R&D. The accounting practice of activating R&D costs therefore explains the significant negative coefficient of the previous experience ripened by promoting partners in R&D [RD\_EXPE] and production [PROD\_EXPE] functions on total asset

growth [Log\_AATAG]. Firms which do not possess yet the knowledge and/or the technology in order to develop their products/services need to invest more in R&D and, since these costs are activated, they grow more in total assets.

*Hypothesis 6* is accepted just with regard to total employment growth [Log\_AAEG] (the coefficient being positive and significant) while the Italian evidence provided by this paper shows that the formal involvement of an industrial partner [INDU] does not significantly affect revenue [Log\_AARG] and total asset [Log\_AATAG] growth processes (the regression coefficients are in fact positive yet not significant). Therefore, the involvement of an industrial partner among spin-offs' shareholders [INDU] turns out to be a main determinant of early employment growth [Log\_AAEG], our results showing that founding teams including an industrial partner grow significantly more in terms of employment. These findings are in line with the empirical evidence available in the literature (Roberts 1991; Feeser and Willard 1990; Aggarwal et al. 2004) arguing that the greater is the prior entrepreneurial experience of the promoting partners, the higher is the firm's growth rate.

### **6.6. MLP: market strategy**

*Hypothesis 7* is rejected. In fact, the multivariate analysis indicates that firms targeting well defined niche markets at start-up [MKT] grow significantly less in total assets [Log\_AATAG] during the first years than firms with a broader, less focused market strategy, the regression coefficient being negative and significant. Moreover, the Italian evidence provided by this paper shows that the breadth of the target market [MKT] at founding does not significantly affect employment [Log\_AAEG] and revenues [Log\_AARG] growth processes (the regression coefficients are positive, but not significant). As previously pointed out, the evidence available in the literature about this issue is quite diversified, exhibiting different results. If on the one side, a broader market focus has been found suitable to achieve higher growth results (Biggadike 1979; MacMillan and Day 1987); on the other side, it has been observed (Porter 1980; Cooper et al. 1986; Roberts 1991; Heirman and Clarysse 2004a) that an initial niche focus could help newly established companies to reach the market without facing directly larger-scale competitors. The positive, significant relationship between the breadth of the target market [MKT] and the total asset growth [Log\_AATAG] experienced by Italian spin-off companies can therefore be understood by considering that newly established firms with a broader, more aggressive market strategy are more likely to sustain higher initial investments (which are suitable to increase the amount of total assets [Log\_AATAG]) than their niche-focused counterpart, as they will have to compete directly with incumbent Large Scale Enterprises (LSEs), eventually in sectors characterized by high entry barriers.

*Hypothesis 8* was advanced by basing on the empirical evidence available in the literature, according to which spin-offs' international orientation from the start provides them with growth opportunities (Shrader et al. 2000; Autio et al. 2000; Heirman and Clarysse 2004a). However, our data do not support this hypothesis for the Italian case: the regression coefficients are positive but not significant. We found no effect of the geographic scope of the market at founding [INT\_OR] on employment, revenue and total assets growth. In consideration of the peculiarities of the Italian context, one possible explanation for this result may be that, due to initial difficulties that academic spin-off companies encounter in their start-up and take-off phases (i.e.: financial and managerial gaps to cope with), during their first year of operations they may not be able to achieve for their activities the geographic scope they are aiming at.

### **6.7. ILP: network**

*Hypothesis 9* was advanced by basing on the contributions available in the literature from several scholars (Mian 1997; Shane 2002; Cooper 1985; Henrekson and Rosemberg 2001; Birley 2002) supporting the contention about the existence of strong informal network of relationships with the parent PRO has a significant positive effect on growth. However, the evaluative literature

(MacDonald 1987; Miller and Cote 1987; Massey et al. 1992) is not conclusive on their actual effectiveness, suggesting that the exact effect of such informal relationships on spin-offs' growth is an interesting area for further research. The empirical evidence provided by this paper does not support hypothesis 9. On the contrary, the multivariate analysis indicates that spin-offs with a strong network of informal relationships with the parent universities [INFORM\_SUP] grow significantly less in both revenues [Log\_AARG] and total assets [Log\_AATAG] during the first years than companies de-linked from the parent institution from the start. Moreover, the Italian evidence provided by this paper shows that the existence of informal relationships with the parent PROs [INFORM\_SUP] does not significantly affect employment [Log\_AAEG], the regression coefficient being negative, yet not significant. In order to better understand the reasons underlying such results in the Italian context, it is advisable to previously comment the outcome of the GLS analysis with regard to research hypothesis 10.

*Hypothesis 10* is accepted with regard to total revenue growth [Log\_AARG] and to the total asset growth [Log\_AATAG], the coefficients being positive and significant. However, the Italian evidence provided by this paper shows that the existence of formal relationships with the parent PROs [FORM\_SUP] does not significantly affect employment [Log\_AAEG], the regression coefficient being positive, yet not significant. Therefore, the existence of a strong network of formal relationships with the parent PROs [FORM\_SUP] turns out to be a main determinant of early growth in revenues [Log\_AARG] and total assets [Log\_AATAG]. These results are in line with the empirical evidence provided by previous research (Birley 2002; Moray and Clarysse 2005), finding that the network of formal relationships with the parent PROs is significantly associated with spin-offs' growth paths.

An interesting question at this point is why the existence of relationships between the academic spin-offs and the parent PROs is suitable to produce so contrasting impacts on growth processes depending on the nature of such relationships (either formal or informal). The answer lies in the core of the distinction between formal and informal relationships, as pointed out by Mustar et al. (2006): 'formal' means that there is some kind of IP-based relation, with the parent university, whereas 'informal' means that the relation is not framed in any agreement. In fact, the existence of strong formal relationships [FORM\_SUP] between the academic spin-offs and the parent PROs is the signal of an actual transfer of knowledge/technology from the academic environment to the new venture and/or of the actual involvement of the parent PRO in the spin-off's equity and/or of the formal inclusion of the company among the acknowledged PRO's spin-offs. Such institutionalized relationships do produce significant and positive impacts on both the revenue [Log\_AARG] (ie: by improving the companies' image and reputation on the market, fostering the market acceptance for the spin-offs' products and services and increasing significantly the revenues) and total asset [Log\_AATAG] growth<sup>11</sup>. On the other hand, the existence of strong informal relationships [INFORM\_SUP] between the academic spin-offs and the parent PROs is suitable produce negative and significant impacts on both the revenue [Log\_AARG] and total asset [Log\_AATAG] growth experienced by spin-off companies. In fact, the occurrence of frequent, not institutionalized forms of support provided by the parent PROs to their spin-offs are likely to produce 'relaxing effects' on the run carried out by companies to reach the market with their products and services, therefore impacting negatively on revenues growth [Log\_AARG]. Moreover, the availability of offices, laboratories, infrastructures and facilities provided by parent PROs is likely to induce spin-off companies to use such forms of support, therefore reducing direct investment in such areas, with a physiological detrimental impact on the value of total assets [Log\_AATAG].

Another possible interpretation of such results is that parent PROs are finally succeeding in ripening a successful selection capability among the different entrepreneurial initiatives put in place by their academic personnel, instauring strong formal relationships and providing institutionalized forms of support just to the most promising companies (this would explain the positive association between

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<sup>11</sup> For instance, through the conclusion of joint research contracts between the spin-offs and their parent PROs, whose amount is suitable to increase the value of total assets over time)

the formal support mechanisms provided by the parent PROs [FORM\_SUP] and the growth in both revenues [Log\_AARG] and total assets [Log\_AATAG]) and offering not institutionalized support services along with informal kind of relationships to the least promising ones (this would explain the positive association between the informal support mechanisms provided by the parent PROs [INFORM\_SUP] and the growth in both revenues [Log\_AARG] and total assets [Log\_AATAG]).

### **6.8. Control variables**

Regarding the *industry*, we found that spin-offs operating in the chemical sector [CHEM] grow significantly less in terms of both employment [Log\_AAEG] and total assets [Log\_AATAG] during their early growth path than spin-offs companies involved in other technologies.

Concerning *competitive forces*, a negative significant effect of entry barriers [ENTRY] on the early growth of academic spin-offs in terms of employment [Log\_AAEG] can be observed. In other words, those firms which encountered at founding higher level of entry barriers tend to grow less in terms of number of employees than the academic spin-off companies which did not find so difficult to enter the market. This inverse relationship is physiological if we consider that in cases of high levels of entry barriers at founding, firms have to sustain very significant costs to enter the market and therefore in the first years of operations they are likely not to be able to increase their size (in terms of human resources employed).

With regard to the *local context*, the support provided by the local environment in which the academic spin-off companies are embedded [CONT] has a negative and significant effect on growth in terms of total assets [Log\_AATAG]. Such a negative relationship can be interpreted by adopting an 'open innovation' perspective (Chesbrough 2003). In fact, those spin-off companies which embedded in local contexts being more conducive to entrepreneurial activities and more vibrant in terms of ideas generation, knowledge exchange, public subsidies offers and so on, are more likely to benefit from such supportive environment rather than investing directly further money in order to develop internally what is needed, with physiological negative effects on total assets growth.

Concerning *firm's size*, we found a significant positive effect of size (in terms of FTEs) at founding [SIZE] on growth in employment [Log\_AAEG] and revenues [Log\_AARG], indicating that larger firms at founding grow more in terms of both employees and revenues than their smaller counterparts. Such results seem to confirm for the sample of Italian spin-offs the validity of the Gibrat's (1931) Law of Proportionate Effect, holding that (absolute) growth is proportional to size and that the proportionality factor is random. In other words, according to this law, proportional growth rates are size-independent.

Regarding *firm's age*, we found a significant negative effect of age in year 2009 [AGE] on growth in employment [Log\_AAEG] and total assets [Log\_AATAG], indicating that older firms grow less in both employment and total assets than their younger counterparts. This finding is strongly supported by previous empirical evidence available in the literature (Sutton 1997; Barron et al. 1994; Evans 1987b; Jovanovic 1982; Storey and Tether 1998; Delmar et al. 2003; Reynolds 1987), suggesting that younger firms are likely to have higher annual growth rates than older firms.

## **7. Conclusions and implications**

In recent years, academic spin-offs received a lot of academic and political attention, primarily due to their perceived potential for job creation, economic growth and wealth creation. Empirical evidence has shown, however, that just a small percentage of them exhibit actual growth paths, whereas most of them tend to be stagnant (Storey et al. 1987; Reynolds 1987; Storey and Johnson 1986). This paper aimed at identifying the critical variables determining early growth processes of academic spin-off in the Italian context, in terms of employees, revenues and total assets.

Our results indicate that a bundle of assets, and in particular (a) the formal involvement of an industrial partner among the company's shareholders during the first year of firm's operation, (b) the targeting of a large and broadly-defined market at founding stage and (c) the availability of a strong network of formal relationships with the parent PROs are lying at the heart of the firm's

growth prospects. On the contrary, the size of the IPRs' portfolio at founding; the experience previously ripened by the promoting partners in R&D and production functions and the availability of informal support mechanisms from the parent PROs do impact negatively and significantly on growth processes (mostly in terms of total assets).

Finally, the stage of new product development at founding; the initial amount of the starting capital; the formal involvement of a VC among the company's shareholders during the first year of firm's operation; the experience ripened by the promoting partners in commercial and managerial functions and the breadth of the target market since company's inception do not affect growth processes.

We found that production and R&D experience previously ripened by the promoting partners has a strong negative impact on the early growth of academic spin-offs in terms of total assets while the majority of spin-off companies are started by purely technical founding teams, often lacking in market orientation. The importance of having an industrial partner taking an equity stake in the spin-offs is still often undervalued by technical entrepreneurs, TTOs and policy makers. This study clearly shows that also for spin-offs, the impact of entrepreneurial experience on growth is stronger than the impact produced by R&D experience. Prospective entrepreneurs should first assess their own readiness for starting a new business, by checking their market competencies and – if lacking – by (eventually) waiting for an industrial partner or build a proper set of own skills before creating the new venture.

Regarding limitations of the present paper and directions for further research, our study only contains data on Italian academic spin-off companies. A positive consequence of analyzing a national geographic coverage is that it reduces the influence of non-measured variance. The trade-off, however, is that one might question the external validity of this national context and our findings.

Secondly, we focus on the effects of firms' conditions at founding on the early growth path of academic spin-off companies. Of course, both the outcome variables and the predictor variables are not static. A more dynamic definition of the predictor variables would therefore be more realistic (Davidson and Wiklund 2001).

Thirdly, in the future, research could deepen the analysis of the growth issue, by investigating its links with the literature about spin-off survival, failure and long-term competitive advantage. Our results indicate that an interesting research question would be to study more in-depth spin-offs' business models, by investigating the characteristics of their revenue streams, of their human resources and employment structure, of their business functions.

Finally, a stimulating research topic for future would be the formation of the entrepreneurial teams. In fact, our data clearly show that adding an industrial partner to the promoting partners of the spin-offs facilitate their early employment growth. However, functional heterogeneity brings with it various challenges, increasing both cognitive conflict and affective conflict within the decision-making team. At present, there is little evidence in the literature about this issue and what can be done to facilitate these interactions.

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