# Does entrepreneurs' human capital exert an imprinting effect on venture performance? An empirical test on new technology-based firms

*Luca Grilli[a], Paul H. Jensen[b], Samuele Murtinu[a]*

[a]Politecnico di Milano, Department of Management, Economics, and Industrial Engineering, Via Lambruschini 4b, 20156, Milano, Italy.
[b]Melbourne Institute of Applied Economic and Social Research, The University of Melbourne, 161 Barry Street, Parkville VIC 3010 Australia.

**Abstract**

In this paper, we aim at investigating the presence of an "entrepreneurial imprinting effect" of founders on new business ventures growth. More specifically, we disentangle between the impact of founders' human capital and the stock of human capital possessed by firm's owners by controlling for the (potential) exit of founders and/or addition of new owner-managers in the top management team along time. We perform our analysis on a panel dataset composed of 468 Italian new technology-based firms (NTBFs) observed from 1995 (or since their foundation) to 2008. We measure NTBF performance by employees growth. We estimate the impact of several dimensions of entrepreneur human capital (at foundation and post entry) on firm growth through a GMM-system estimator to control for endogeneity. Our specification includes controls for new owners entering into the top management team and founders exiting the venture. Overall, our results point to a positive and significant presence of an "entrepreneurial imprinting effect" on venture performance which is robust to a series of controls.

*Keywords*: entrepreneurial ventures, imprinting effect, founder human capital, firm growth

VERY PRELIMINARY DRAFT. PLEASE DO NOT QUOTE WITHOUT AUTHORS' PERMISSION.

## 1. Introduction

The idea that animal and human organisms in the first stages of their life are incredibly receptive and unconsciously learn from the environment on which are embedded, so that these first experiences will indelibly imprint them and have an enduring effect on their behavior embraces a wide spectrum of scientific disciplines. It ranges from ethnology where it originated (e.g. from Douglas Alexander Spalding's and Oskar Heinroth's early studies that inspired the more famous Konrad Lorenz's researches on graylag gooses) to psychology (including Sigmund Freud), passing through evolutionary biology and epidemiology. The "imprinting effect" has also been largely theorized in the field of organization studies. Stinchcombe in his seminal contribution of 1965 was the first one to put forward the "organization imprinting hypothesis", i.e. that initial stages of development of human organizations play a major role in the subsequent progress of the whole organizational organism (including its eventual survival) through their key influence on managerial structure and managers' conducts and the way these factors interact with the external environment. Since then, several organizational sociologists, entrepreneurship researchers and management scholars have emphasized the relevance of the imprinting effect or more generally pointed to the path-dependence of organizational evolution and the consequent importance of considering initial conditions for understanding the evolution of human organizations (e.g. Boeker 1988 and 1989; Baron, Hannan, and Burton 1999).[1] As to entrepreneurial ventures, the focus of the present study, one of the factors most cited for being responsible of an important imprinting effect, other than the environment on which the birth of a new venture takes place ("environmental imprinting", e.g. Boeker 1988), has undoubtedly been the human capital endowment of the founders of the enterprise ("entrepreneurial imprinting"). In this case the argument resembles very much the original one of *filial imprinting* (Lorenz 1937): the members of founding team represent the parents of the new

---

[1] See for example Boeker (1988, p. 34, italics in original): "while organizations undergo modifications and display varying degrees of flexibility, *they are cast at birth into a mold that is discernible in all subsequent stages of their life cycle*".

venture and their actions, knowledge, competences, ideas, implemented strategies (that later on will become consolidated routines) before, during and immediately after the firm's inception will indelibly mark the new entrepreneurial venture for the rest of its life even beyond the actual presence of the original founders within the organization. Building on the competence- and resource-based view of the firm, the argument has actually been considered a theoretical premise (often implicit) in all studies in the industrial organization, entrepreneurship and management fields of research aiming at establishing a relationship between founders' human capital and the performance of new entrepreneurial ventures along time. If overall the empirical evidence suggests a (weak) positive relationship between the two dimensions (see the recent meta-analysis on the topic performed by Unger et al. 2011), most of the analyses, while documenting a positive relationship, can not be invoked at support of a founders' *imprinting* effect. As will be detailed more thoughtfully in Section 2, the typical research design in the field appears as intrinsically unsuitable to effectively and properly test the *imprinting* hypothesis. The main underlying reasons have to be traced back to a lack of information on founders' human capital evolution along time (i.e. exit of founders and/or addition of new owner-managers in the top management team) and/or an insufficiently long time span of observation. As a matter of facts, both motives make arduous to disentangle how much of the (positive) impact of entrepreneurs' human capital is due to the imprinting effect exerted by the human capital of the original team of owner-managers at firm's inception from the impact that entrepreneurs' human capital continues to exert on firm performance due to the on-going involvement of the team of owner-managers in the venture.

Recognizing this interesting gap in the entrepreneurship literature, this paper aims at investigating more accurately than what has been pursued in the recent past, the presence of an "entrepreneurial imprinting effect" on new business ventures performances. Surprisingly, to our knowledge, although many studies are related to the subject here tackled dealing with start-up's success (e.g. Roberts et al. 2011) or firms' alliance network evolution (e.g. Milanov and Fernhaber

2009), no study exists in the entrepreneurship literature focusing explicitly on the test of a possible imprinting effect exerted by founders' human capital on the entrepreneurial venture performance.

We believe that the interest of the research question resides in increasing our understanding on the core dynamics of the entrepreneurial activity and mainly in enlarging our knowledge on the drivers of an entrepreneurial venture performance. Answer to this research question (and obviously our work has to be viewed as only a first step in this direction) would also highlight important and relevant insights from a policy and a social welfare perspective. Entrepreneurial firms, especially when operating in high-tech sectors, represent the key driver for the dynamic efficiency of modern economic systems (Audretsch, 1995; Aspelund et al. 2005). Thus, from a policy perspective, it is important to fully understand the underlying factors that lie behind their economic performance. In this respect, our analysis can contribute to reveal for example if for an economic system could be beneficial to incentivise the phenomenon of professional or serial smart entrepreneurs who imprint with their knowledge capital the initial phases of firm's life.

We perform our analysis on an unbalanced panel dataset composed of 468 Italian new technology-based firms (NTBFs) observed from 1995 (or since their foundation) to 2008. We measure NTBF performance by employees growth. We estimate the impact of several dimensions of entrepreneur human capital on venture growth through a GMM (Generalized Method of Moments) - system estimator for panel data (Blundell and Bond, 1998) to control for endogeneity concerns. The specification also includes controls for new owners/managers entering into the top management team and founders exiting the venture. Overall, results point to a positive and significant presence of an "entrepreneurial imprinting effect" on venture performance which is robust to a series of controls.

The paper proceeds as follows. In the next section, we expose the main challenges from an empirical point of view of investigating the "entrepreneurial imprinting effects". Then, we briefly synthesize the extant literature to which we refer in this study and we derive our research

hypotheses. In the following sections we describe the dataset (Section 4), and the estimation methodologies we use in this work (Section 5). An illustration of the results of the analysis follows in Section 6. Finally, a discussion of the main findings and their implications concludes the paper.

**2. Technical aspects of the empirical test on the imprinting hypothesis**

In psychology and child development studies investigating the relationship between the early phases of development of babies and their subsequent adult behaviour, the use of a "direct" research design is deemed as unsuited to detect a possible imprinting effect. It is in fact unfeasible for individuals to deduce *ex-post* how much initial events and parents' education affected their subsequent behaviour. The same difficulties arise in our context that aims at exploring the existence of a (positive) founders' imprinting effect on an entrepreneurial venture performance. In other words, we can not ask to the present owners/managers of a successful venture to evaluate if and to what extent this success depends on the knowledge possessed and the initial moves made by them or by the original founding team at venture's inception. Due to causal ambiguity (e.g. Lippman and Rumelt 1982; Peteraf 1993) or simply respondents' lack of information and subjectivity, the reliability of this direct approach would be highly questionable. Put simply, the way an imprinting effect is typically investigated in psychological studies is through a more indirect methodology, i.e. individuals' genetic and/or environmental characteristics at birth are put into relationship with subsequent observable and objective individuals' actions and outcomes in order to infer the degree of dependence across time (e.g. Kisilevsky et al. 2003; Rushton and Bons 2005). The use of an indirect approach is indeed used also by the extant empirical literature investigating the impact of human capital characteristics of founders (*in primis* education and work experience) on the performance of entrepreneurial ventures. In fact, the typical model specification employed by econometric studies in the field foresees a dependent variable capturing the performance of firm $i$ at time $t+n$, regressed on a series of variables measuring human capital that founders possess at the

founding time $t$ (e.g. see Unger et al. 2011 for an updated review of the literature). But, normally, this archetypal regression suffers from two important shortcomings that limit its capacity to represent an ideal testbed for investigating the presence of an imprinting effect of founders' human capital on firm performance. First, these empirical analyses are commonly run on samples that hardly present sufficient heterogeneity in terms of founding team evolution (i.e. exit of founders or addition of new owner-managers in the top management team) along time (e.g. Eisenhardt and Schoonhoven 1990; Cooper et al. 1994; Gimeno et al. 1997; Almus and Nerlinger 1999). In other words, $n$ is typically small and consequently $t+n$ close to $t$, [2] so that a positive impact of founders' human capital on entrepreneurial venture performance may simply reflect the fact that skilled and educated entrepreneurs run their ventures better than unskilled and uneducated ones. In this case more than an evidence of the imprinting effect, there would be a confirmation that the continuing involvement in the management of the firm of relatively skilled rather than unskilled entrepreneurs leads to a better performance of the venture. But also if $n$ is sufficiently large and $t+n$ is admittedly far from $t$, the standard model specification if from one side may control for various founder-, firm-, industry- and geographical-specific control variables, from the other side, it does not include any variable capturing (even imperfectly) the evolution of the founding team along time (e.g. Thompson 2005; Colombo and Grilli 2005, 2010).[3] This total lack of information turns out to be crucial in determining the incapacity of the extant studies to investigate the potential imprinting effect exerted by entrepreneurs on their venture. Even if heterogeneity of founding teams evolution normally exists after that a long time period is elapsed since venture's foundation (i.e. the overall probability

---

[2] Most of the studies in the field including those reported above in parentheses analyze firms that are well below the threshold of an age of 10 years from inception, with most of the analyzed samples composed by very young start-ups.

[3] Thompson (2005)'s study on the impact of founders' pre-entry work experience on the survival of US ventures in the iron and steel shipbuilding industry of the nineteenth and twentieth centuries is surely the one embracing the longest $n$ (90 years). His Cox proportional hazard analysis documents that (p. 26): "preentry experience is found to have a large and extremely persistent effect on survival" and in so doing points to a potentially extremely relevant "entrepreneurial imprinting effect". If the study in principle suffers from the limitation advanced in the main text (see *infra*), the extremely wide time horizon analysed makes it less pertinent with respect to other studies embracing long but relatively shorter periods (e.g. Colombo and Grilli 2005, 2010: 25 years). In this respect, Thompson (2005)' study (without explicitly never saying it) can be viewed as a first important evidence on the imprinting exerted by founders' human capital on firm survival.

that a founding team is subjected to some typology of changes increases as time goes by), lack of control in this respect may lead to biased results. In fact, any potential positive relationship found between founders' human capital and venture performance may not be due to an imprinting effect but simply driven by an omitted variable capturing top management team's evolution dynamics which is correlated to founders' human capital. For example, if for whatever reason, a correlation exists between the entry into (or the exit from) the original founding team of smart new owner/managers (founders) and the level of human capital originally possessed by founders, and the researcher is not able to control for these additions and exits, it becomes impossible to discern whether the current performances of the firm are driven by the imprinting of the original founding team or simply be the result of the present managerial conducts and strategies of the contemporary team of owner/managers.

### 3. Related literature and research hypotheses

Many scholars in entrepreneurship have focused on examining relationships between characteristics of entrepreneurs and the performance of new ventures (e.g., Birley and Norburn, 1987; Cooper, 1981; Davidsson and Honig, 2003; Eisenhardt and Schoonoven, 1990; Ensley and Amason, 1999; Ensley, Pearson, and Amason, 2002; Feeser and Willard, 1990; Hornaday and Aboud, 1971; Palmer, 1971; Roberts et al. 2011; Ucbasaran, Lockett, Wright, and Westhead, 2003; Vanaelst et al., 2006; Vesper, 1990). On average, they have shown that entrepreneurs' human capital (education and experience), i.e. owner/managers' skills and technical knowledge and any other skills that might be useful to the firm, is positively related to entrepreneurial venture performance (Unger et al. 2011). In other words: high growth firms are more likely founded and run by teams of entrepreneurs with a high level of human capital (Cooper et al., 1994; Chandler and Hanks, 1994, 1998; McGee et al., 1995; Feeser and Willard, 1990). Moreover, the relationship between entrepreneurs' human capital and firm performance appears to be particularly valuable in

high-tech sectors and research intensive sectors (e.g. Cooper and Bruno 1977, Almus and Nerlinger 1999, Colombo and Grilli 2005, 2010). In such context more than others, the value of an entrepreneurial venture is likely to be determined by the quality of the firm's team of owner-managers.

One of the theoretical reasons is of course that more skilled individuals, ceteris paribus, are better capable to seizing and pursuing business opportunities (Shane 2000; Ucbarasan et al. 2008 among many others) and organize firm accordingly (and this is more important in highly turbulent and risky sectors as typically are those R&D intensive, Eisenhardt and Martin 2000, Tyson 1992).

Therefore we posit the following research hypothesis, which constitutes our starting point on the investigation of the entrepreneurial imprinting hypothesis:

*H1: Entrepreneurs' human capital exerts a positive effect on the performance of entrepreneurial ventures.*

The performance of entrepreneurial ventures (and more specifically NTBFs) is reputed to be strongly influenced by the management decisions especially when these latter are related to initial resources (Boeker, 1988, 1989; Gersick, 1991; McDougall et al., 1994). As suggested by Boeker (1988, 1989) and Bamford et al. (1999), early resources and competences at founding date have lasting effects which imprint the firm, limit its strategic choice, and continue to impact its long-term performance. The early stages of a firm's existence see the development of the organization's routines that guide managerial decisions. These latter can further be traced back to the initial strategic choices made by the founders (Boeker, 1988). An initial strategy is decided by means of the resources at hand at the time of firm inception (Dollinger, 1999). To some extent, Gersick (1991) illustrates the initial strategy through a decision tree: once one decision is made, the resulting strategic options are reduced. Allegedly, one possible reason to explain the relationship between entrepreneurs' human capital and entrepreneurial venture performance, is that skilled entrepreneurs also exert a sort of imprinting effect, that will continue to operate and benefit the firm in the long-

period even independently of their actual presence. The basic argument is that at the start of operations, their capabilities indelibly influence all the organization and all sort of operations. In so doing the ways they organize things become routines that will continue to be active and effective even after their eventual departure (Stinchcombe 1965, Boeker 1988 and 1989, Mullins 1996, Barringer et al. 2005, Heirman and Clarysse 2005, Packalen 2007).

As to the imprinting effect of the founders' human capital, Barringer et al. (2005) tell us about the Walt Disney anecdote (p. 666): "It is widely believed that the founders of a firm place a lasting "stamp" on their companies that influences the cultures and behaviors of their firms (Mullins, 1996). For example, for years after the death of Walt Disney, Disney executives, when confronted with an important decision, would often ask aloud "What would Walt do?" (Collins and Porras, 1994). Similarly, Hewlett–Packard's Rules of the Garage institutionalizes the values of its innovative founders [….]."

As a matter of fact, most of the empirical work studying the relationship between founders' human capital and firm performances actually presumes the existence of this imprinting effect without directly testing its actual presence and relevance (Almus and Nerlinger 1999, Colombo and Grilli 2005, 2010 among many others). As highlighted in the Introduction, such studies are not capable to control for the evolution dynamics characterizing the team of founders. In fact, they do not observe potential entries of new owner-managers and/or exits of founders that may drive the positive effect between (initial) founders' human capital and firm performance. It is worth noting that potential entries and exits are not all equal: the "weight" of the focal entry (exit) in moderating the relationship between founders' human capital and firm performance could be related to the level of human capital possessed by the new owner-manager (founder).

Controlling for potential entries (exits) of new owner-managers (founders) into (from) the original founding team is crucial. In fact, according to the resource-based perspective, firm's endowment of resources and competencies determines firm performance at each point in time (e.g.

Penrose, 1959; Wernerfelt, 1984; Barney, 1991). Moreover, entrepreneurial ventures often need additional external resources and competences (beyond resources and competences of founders) in order to survive and grow. Especially in high-tech sectors, entrepreneurial ventures may possess innovative ideas for new products, processes or services, but often lack at foundation all those resources and competencies necessary for the commercial exploitation of their technologies and business ideas (Teece, 1986; Gans and Stern, 2003). Along this vein, founders may exhibit sophisticated technical skills but lack commercial and managerial competencies, indispensable to understand users requirement and assure firm's success (Colombo and Piva, 2008). Most probably, the easiest way to improve firm's endowment of resources and competencies is the enlargement of the team of owner-managers, by opening firm's equity capital to a new owner. The presence of a new owner may contribute to fill the competence gap from which these companies suffer, enhancing their performance. But, following the above-mentioned imprinting argument it seems that subsequent human capital acquisitions or loss of competencies whether they maybe important, they are less important than if they were in place or occurred at the start-up.

Therefore we posit the following two research hypotheses:

*H2: Founders' human capital exerts an imprinting effect: it has a positive effect on the entrepreneurial venture performance independently from the degree of erosion of the founding team.*

*H3: Injections or loss of human capital in the top management team have significant effects on the entrepreneurial venture performance but they are less relevant than if they occur in the founding team at firm's inception.*

## 4. Data

In this paper, we draw on a sample of 468 entrepreneurial firms that are observed either from 1995 or from their foundation (if it is after 1995) up to 2008. Sample firms were established in

1984 or later, were independent at founding time and have remained so up to 1/1/2009 (i.e. they were not controlled by another business organization even though other organizations may have held minority shareholdings). They operated in the following high-tech sectors in manufacturing and services: computers, electronic components, telecommunication equipment, optical, medical and electronic instruments, biotechnology, pharmaceuticals, advanced materials, avionics, robotics and process automation equipment, multimedia content, software, Internet services, and telecommunication services. All sample firms are privately held.

The sample is drawn from the 2008 RITA directory (Research on Entrepreneurship in Advanced Technologies) developed at Politecnico di Milano. With data on 1,974 high-tech start-ups, this directory is the most detailed and comprehensive source of data on Italian high-tech entrepreneurial firms (for a detailed description of the database, see Colombo et al., 2006). It is important to stress that because of the criteria that are used for inclusion of a firm in the RITA directory, our sample is unlikely to include lifestyle firms and firms that are created purely for tax saving objectives.

Data included in the RITA database originate from two types of sources. The first source is a series of surveys that were administrated in the first semester of 2000, 2002, 2004 and 2008. Data, collected through these surveys, concern the human capital characteristics of firm's founders, the evolution over time of the composition of firms owners' team and their human capital characteristics, and also the (potential) exit of firm's founders and/or new owners. The RITA database also includes financial and accounting data (i.e. extracted from the AIDA and CERVED commercial databases).

The RITA dataset has been used to construct a number of variables used in the empirical model. In Table 2 and Table 3, we provide a comprehensive set of summary statistics on the main variables employed in the empirical analysis (including the firm characteristics, the entrepreneurial characteristics and management team dynamics).

In Table 3, all of the differences are computed through the following formula: Variable_foundation - Variable_t. When you see a negative number, the meaning is that the focal variable at time t is higher than the same variable at foundation, i.e. entry of owner-managers. When you see a positive number, the meaning is that the focal variable at time t is lower than the same variable at foundation, i.e. exit of owner-managers (entrepreneurs). Overall, c.a. 30% of our sample firms experienced a change in the composition of the original founding team, with an injection and/or loss of a member.

## 5. Methodology

*Performance measure*

Studies on growth and performance of start-ups have shown contrasting results (Woo et al., 1989). One possible cause might be the use of different growth measures such as sales growth (Lee et al., 2001), employment growth (Westhead and Birley, 1994), profitability (Spanos and Lioukas, 2001), or total assets (Achtenhagen et al., 2004). Delmar et al. (2003) argue that there is no 'one best way' of measuring growth because firm growth is a multidimensional rather than a one-dimensional phenomenon. They showed that high-growth firms do not grow in the same way and that 'what a high-growth firm is very dependent on the growth measure used'.

Several scholars argue that traditional accounting-based indicators of profitability are inappropriate for NTBFs because most start-ups do not make any profit during their first years (Shane and Stuart, 2002). Sales growth (often measured as growth in total revenues; Hanks et al., 1993) is an often preferred measure of firm growth and financial performance of new ventures (Ardishvili et al., 1998) because it is relatively accessible, it applies to (almost) all sorts of firms, and it is relatively insensitive to capital intensity and degree of integration (Delmar et al., 2003).

For NTBFs, it is however possible that assets and employment will grow before any sales will occur (Delmar et al., 2003). Resource-based view scholars value employment- and assets-based

measures as a highly suitable indicator of firm growth (Penrose, 1959). If firms are viewed as bundles of resources, a growth analysis ought to focus on the accumulation of resources, such as employees and other assets. It is also worth noting that policy makers are especially interested in identifying firms which contribute most to job creation (Westhead and Birley, 1994). For all of these reasons, we resort to employees growth as NTBF performance measure.

*Econometric specification*

To test our research hypotheses, we resort to an augmented Gibrat law specification (Chesher 1979). The starting hypothesis H1 is investigated by the following model:

$$Employees_{it} = \alpha_0 + \alpha_1 Employees_{it-1} + \beta' EntrepreneurialTeamHC_{it} + \alpha_2 X_{it} + W_i + \varepsilon_{it}. \quad [1]$$

Where $Employees_{it}$ is the logarithm of the number of employees at time $t$; $EntrepreneurialTeamHC_{it}$ is a vector of variables capturing the stock of human capital possessed by the owner-managers throughout time. In particular, to the level of competencies possessed by the founding team and observed at firm's inception at time t = 0, the eventual entry or exit of owner-managers each subsequent year modifies the value of this variable by the corresponding injection or loss of human capital; $X_{it}$ is a vector of control variables; $W_i$ are firm-specific fixed effects, and finally $\varepsilon_{it}$ are i.i.d. disturbance terms. The first research hypothesis H1 contemplates that (some of the) variables included in the vector $EntrepreneurialTeamHC_{it}$ are positive and statistically significant (i.e. $\beta > 0$).

For testing hypotheses H2 and H3, we augment equation (1) with the additional vector $FoundingTeamHC_i$ which includes the same variables of $EntrepreneurialTeamHC_{it}$ but these variables are measured only at foundation and remain constant throughout time. Thus, the second model specification is:

$$Employees_{it} = \alpha_0 + \alpha_1 Employees_{it-1} + \beta_1' EntrepreneurialTeamHC_{it} + \beta_2' FoundingTeamHC_i + \alpha_2 X_{it} + W_i + \varepsilon_{it}. \quad [2]$$

In this case, a confirmation of hypothesis H2 requires that (some of the) variables contained in *FoundingTeamHC$_i$* are positive and statistically significant (i.e. $\beta_2 > 0$). In fact, the vector of coefficients $\beta_2$ measures the impact that founders' human capital has on the employees growth of entrepreneurial ventures wiping out the contemporaneous impact that the present level of entrepreneurs' human capital exert on employees growth. In this respect, coefficients $\beta_2$ represent a direct test of the *imprinting hypothesis.*

Turning to the test of hypothesis H3, this requires that (some of the) variables contained in *EntrepreneurialTeamHC$_{it}$* have a lower impact on employees growth than the corresponding covariates included in *FoundingTeamHC$_i$* (i.e. $\beta_1 < \beta_2$). A complete description of the variables is reported in Table 1.

[Table 1 about here]

*Estimation method*

The inclusion in the estimated models of the lagged dependent variable among covariates and the endogenous nature of the relationship between the human capital of entrepreneurs after foundation and firm growth require the use of appropriate estimation techniques. In fact, while the variables included in *FoundingTeamHC$_i$* are exogenous by construction, those included in *EntrepreneurialTeamHC$_{it}$* may be not. For example, a reverse causality concern may arise to the extent that past growth performances influence the dynamics inherent to the composition of the entrepreneurial teams. In order to address this endogeneity problem, following the recent literature on dynamic panel data models (Blundell and Bond, 1998) we resort to the system generalized method of moments (GMM-SYS). In GMM-SYS methodology, other than using lagged levels of the series as instruments for first differences equations, additional moment conditions are employed using first differences as instruments for variables in levels, starting from t-2 for all the endogenous variables. However, the GMM-SYS estimator also has some weaknesses. First, the use of a large

number of instruments can result in significant finite sample bias. Moreover, measurement errors can cause potential distortions. In order to deal with both problems (Bond, 2002; Roodman, 2009), we estimate the model with a reduced instrument set, with moment conditions in the interval between t-2 and t-4. Second, the moment conditions of the GMM-SYS approach are only valid if the instruments are uncorrelated with the error terms. To evaluate the relevance of all the GMM-SYS estimates, we applied different (standard GMM-context) tests. First, we implemented the Arellano and Bond test for first- and second-order serial autocorrelations of residuals (AR(1), AR(2)). If $\varepsilon_{it}$ was not serially correlated, the difference of residuals should have been characterized by a negative first-order serial correlation and the absence of a second-order serial correlation. Then, the Hansen test for the validity of overidentifying restrictions was implemented for each regression. These statistics tested the null hypothesis that the specified orthogonality conditions are equal to zero (Hansen, 1982). The failure to reject the null hypothesis indicated that the instruments are valid. All these tests reassure us on the feasibility of the GMM approach.

## 6. Results

Table 4 shows the (preliminary) results[4] of the estimation of equation [1] and equation [2] in the first and second column, respectively. Finally, the autoregressive coefficient is not close to the unity ($\chi^2(1)=19.36$ and $\chi^2(1)=18.09$ in columns I and II, respectively), thus excluding stationarity problems.

[Table 2 about here]

---

[4] We are in the process of enlarging our sample and inspecting new data. So results here exposed should be considered as very preliminary.

As to control variables, the estimates show that NTBF age has a positive significant impact on employees growth. In other words, in accordance with the resource-based view, relatively more mature firms have had more time to accumulate resources than very young ones. Conversely, neither being an academic start-up nor the receipt of an external equity financing are found to impact on firm growth.

With regard to our first hypothesis, we find a (weak) confirmation that owners' human capital exerts a positive effect on the growth in employees of entrepreneurial ventures. In fact, H1 contemplates that (at least some of the) variables included in the vector are positive and statistically significant ($\beta > 0$). The only statistically significant impact (at 1% level) is exerted by the economic and managerial educational background of owner-managers, while all the other human capital variables, albeit prevalently positive (with the exception of *NManagers* which has a negative impact), are always not statistically significant at conventional confidence levels. Although, when we perform a test on the linear combination of all of the parameters of the vector *EntrepreneurialTeamHC$_{it}$*, our test rejects at 5% the null hypothesis that the sum of the coefficients representing the human capital is null (see the bottom of Table 4). Thus, H1 finds weak support.

With regard to H2, we find that founders' human capital exerts an imprinting effect. The test on all of the coefficients of the vector *FoundingTeamHC$_i$* (see the bottom of Table 4) rejects the null hypothesis that founders' human capital does not impact firm performance (albeit only at 10% statistical significance level). Founders' human capital's endowment has a positive effect on the entrepreneurial venture performance independently from the degree of erosion of the founding team along time. When we look at single coefficients of the vector *FoundingTeamHC$_i$* we can see that founders' economic-managerial education and their previous experience in the same sector of that in which the focal NTBF operates greatly contribute to firm growth (both at 5% statistical significance level).

With regard to H3, it does not seem to find strong support. In fact, the test on the parameter cobinations of the vector *EntrepreneurialTeamHC$_{it}$* accepts the null hypothesis that the evolution of human capital in the top management team have no significant effects on the entrepreneurial venture performance ($\beta_1 = 0$), once controlled for the founders' human capital' endowment at firm's inception. Moreover, as reported above, the linear combination of parameters of variables included in the vector *FoundingTeamHC$_i$* is positive and significant, albeit at 10% statistical level ($\beta_2 > 0$). However, the Wald test on the difference between the sum of coefficients of the two vectors $\beta_1$ and $\beta_2$ do not show (at least from a statistical point of view) that injections and/or losses of human capital in the top management team are less relevant than if they occur in the founding team at firm's inception.

To sum up, according to our estimates the average treatment effect of human capital of firm's owners on employees growth is positive but it depends on: i) the type of human capital provided; and ii) the stage of the lifecycle of the firm (foundation year vs. post-entry). It seems that the economic-managerial education of firm's owners and their previous experience in the same sector is more important in the initial period. While the work experience of owners in other sectors than the one of the focal firm engenders a positive impact on employees growth in subsequent years after firm inception.

## 7. Conclusions

In this paper, we have directly investigated the presence of an "entrepreneurial imprinting effect" on new business ventures growth. More specifically, we have disentangled the impact of the human capital of founders from the stock of human capital possessed by firm's owners after a (potential) founding team evolution (exit of founders or addition of new owner-managers in the top management team) along time. Previous studies have generally found a positive effect of education attainments and the prior work experience of founders on firm growth. But such studies are not able

to test the potential imprinting effect exerted by entrepreneurs on their venture. The positive effect they found may simply reflect the fact that more skilled and more educated entrepreneurs run their ventures better than less skilled and less educated ones. This is due to the fact that such studies do not have variables (or at least proxies) to capture the dynamics of the founding team along time. This way, any potential positive impact of founders' human capital on venture performance might be driven by the evolution of owners' human capital along time.

Our contribution is to provide the first large scale evidence of the impact of imprinting effects (i.e. the effect of initial human capital of founders) on new ventures (employees) growth. Moreover, we disentangle between different types of human capital and we show which are the most important characteristics of human capital of owner-managers (either at foundation or post-entry) that the entrepreneurial venture needs.

We have departed from previous literature in two respects. First, we have taken advantage of a more fine-grained description of the complete evolution of owners' human capital than the one available in most previous studies based on the estimates of econometric models relating to large samples of firms. Second, we properly control for unobserved factors that may affect the relationship between the human capital of founders and new owners and firm growth.

The findings of the paper support the importance of entrepreneurs' human capital in fostering firm performance. More interestingly, initial resources and competences of founders seem to boost the growth (in employees) of new high-tech ventures. Looking at the different types of founders' human capital, both founders' economic-managerial education and their work experience in the same sector in which the focal firm operates were found to positively affect firm growth. Our results also suggest that, as concerns NTBF performances, once controlled for the initial endowment in terms of human capital of founders, the evolution of competences possessed by the present owner-managers team does not exert a statistically great influence on the performance of NTBFs. Thus, always

considering the preliminary nature of our empirical analysis, altogether, our findings point to the presence of an important "entrepreneurial imprinting effect" on venture growth.

**References (to be completed)**

Achtenhagen L., Melin L., Naldi L. (2004), "Towards a Re-conceptualization of Firm Growth", Proceedings of the Annual Babson Entrepreneurship Research Conference, Strathclyde, Scotland.

Almus, M., Nerlinger, E.A., 1999. Growth of new technology-based firms: which factors matter? Small Business Economics 13, 141–154.

Ardishvili, A., Cardozo, S., Harmon, S., & Vadakath, S. 1998. Towards a theory of new venture growth. Paper presented at the 1998 Babson Entrepreneurship Research Conference, Ghent, Belgium.

Aspelund, A., Berg-Utby, T., Skjevdal, R., 2005. Initial resources' influence on new venture survival: a longitudinal study of new technology-based firms. Technovation, 25(11), 1337-1347.

Audretsch, D., 1995. Innovation and Industry Evolution. MIT Press, Cambridge MA.

Bamford, C.E., Dean, T.J., McDougall, P.P., 1999. An examination of the impact of initial founding conditions and decisions upon the performance of new bank start-ups. Journal of Business Venturing, 15(3), 253-277.

Barney J. 1991. Firm resources and sustained competitive advantage. Journal of Management 17(1): 99-120.

Baron, J.N., Hannan, M.T., Burton, M.D. 1999. Building the Iron Cage: Determinants of Managerial Intensity in the Early Years of Organizations. American Sociological Review 64(4): 527-547.

Barringer, B.R., Jones, F.F., Neubaum, D.O., 2005. A quantitative content analysis of the

    characteristics of rapid-growth firms and their founders. Journal of Business Venturing 20,

    663–687.

Birley, S. Norburn, D. 1987. Owners and managers: The venture 100 vs the fortune 500. Journal of

    Business Venturing, 2(4): 351-363.

Blundell, R.W., Bond, S.R., 1998. Initial Conditions and Moment Restrictions in Dynamic Panel

    Data Models. Journal of Econometrics, 87, 115-143.

Boeker, W., 1988. Organizational origins: entrepreneurial and environmental imprinting at the time

    of founding. In: Carroll, G.R. (Ed.), Ecological Models of Organizations. Ballinger,

    Cambridge MA, pp. 33–52.

Boeker, W., 1989. The development and institutionalization of subunit power in organizations.

    Administrative Science Quarterly 34, 388–410.

Bond, S., (2002). "Dynamic panel data models: a guide to micro data methods and practice",

    Portuguese Economic Journal 1, 141-162.

Chandler G.N., Hanks S.H. 1994. Market attractiveness, resource-based capabilities, venture

    strategies, and venture performance. Journal of Business Venturing, 9(4): 331-349.

Chesher, A. 1979. Testing the Law of Proportionate Effect. The Journal of Industrial Economics

    27(4): 403-411.

Collins, J.C., Porras, J.I. 1994. Built to last. New York: Harper Business.

Colombo, M.G., Grilli, L., 2005. Founders' human capital and the growth of new technology based

    firms: a competence-based view. Research Policy 34, 795–816.

Colombo, M.G., Grilli, L., 2010. On growth drivers of high-tech start-ups: Exploring the role of

    founders' human capital and venture capital. Journal of Business Venturing, 25, 610-626.

Colombo MG, Grilli L, Piva E. 2006. In search of complementary assets: The determinants of

    alliance formation of high-tech start-ups. Research Policy 35(8): 1166-1199.

Colombo MG, Piva E. 2008. Strengths and weaknesses of academic start-ups: A conceptual model.

    IEEE Transactions on Engineering Management 55(1): 37-49.

Cooper, A.C. 1981. Strategic management: New ventures and small business. Long Range

    Planning, 14(5): 39-45.

Cooper, A.C., Bruno, A.V., 1977. Success among high-technology firms. Business Horizons 20,

    16–22.

Cooper, A.C., Gimeno-Gascon, F.J.,Woo, C.Y., 1994. Initial human capital and financial capital as

    predictors of new venture performance. Journal of Business Venturing 9, 371–396.

Davidsson, P., Honig, B. 2003. The role of social and human capital among nascent entrepreneurs.

    Journal of Business Venturing 18(3): 301-331.

Delmar, F., Davidsson, P., Gartner, W.B., 2003. Arriving at the high-growth firm. Journal of

    Business Venturing 18, 189–216.

Dollinger, M.J., 1999. Entrepreneurship: Strategies and Resources. Richard D. Irwin, Homewood,

    IL.

Eisenhardt KM, Martin JA. 2000. Dynamic capabilities: what are they? Strategic Management

    Journal 21(10–11): 1105–1121.

Eisenhardt, K.M., Schoonhoven, C.B., 1990. Organizational growth: linking founding team,

    strategy, environment and growth among U.S. semiconductor ventures, 1978–1988.

    Administrative Science Quarterly 35, 504–529.

Ensley, M.D. & Amason, A.C. (1999) 'Entrepreneurial team heterogeneity and the moderating

    effects of environmental volatility and team tenure on new venture performance', in P.D.

Reynolds, Bygrave, W.D., Manigart, S., Mason, C.M., Meyer, G.D., Sapienza, H.J. & K.G. Shaver (eds.) Frontiers of entrepreneurship research 1999. Babson Park, Massachussetts: Babson College. pp. 505-517

Ensley, M.D., Pearson, A.W. & Amason, A.C. (2002) 'Understanding the dynamics of new venture top management teams. Cohesion, conflict, and new venture performance', Journal of Business Venturing 17: 365-386.

Feeser, H.R., Willard, G.E., 1990. Founding strategy and performance: a comparison of high and low growth high tech firms. Strategic Management Journal 11, 87–98.

Gans, J.S., Stern, S., 2003. The product market and the market for "ideas": commercialization strategies for technology entrepreneurs. Research Policy, 32(2), 333–350.

Gersick, C.J.G. 1991. Revolutionary Change Theories: A Multilevel Exploration of the Punctuated Equilibrium Paradigm. The Academy of Management Review 16(1): 10-36.

Hanks, S., Watson, C., Jansen, E., & Chandler, G. N. 1993. Tightening the life -cycle construct: A taxonomic study of growth stage configurations in high-technology organizations. Entrepreneurship: Theory & Practice. 18(2): 5-29

Heirman, A., Clarysse, B. 2005. The imprinting effect of initial resources and market strategy on the early growth path of start-Ups. Universiteit Gent Working Paper No. 310.

Hornaday, J.A., Aboud, J. 1971. Characteristics of successful entrepreneurs. Personnel Psychology, 24(2): 141–153.

Lee, C., Lee, K., Pennings, J.M., 2001. Internal capabilities, external networks and performance: a study on technology-based ventures. Strategic Management Journal 22, 615–640.

Lorenz, K.Z. 1937. The companion in the bird's world. The Auk, 54(3): 245-273.

McDougall P., Shane S., Oviatt B.M. 1994. Explaining the formation of international new ventures: The limits of theories from international business research. Journal of Business Venturing, 9(6): 469-487.

McGee, J.E., Dowling, M.J., Megginson, W.L., 1995. Cooperative strategy and new venture performance: the role of business strategy and management experience. Strategic Management Journal 16, 565–580.

Milanov, H., Fernhaber, S.A., 2009. The impact of early imprinting on the evolution of new venture networks. Journal of Business Venturing, 24(1), 46-61.

Mullins J.W. 1996. Early growth decisions of entrepreneurs: The influence of competency and prior performance under changing market conditions. Journal of Business Venturing, 11(2): 89-105.

Packalen, K.A., 2007. Complementing capital: the role of status, demographic features, and social capital in founding teams' ability to obtain resources. Entrepreneurship Theory and Practice 31, 873–891.

Palmer, M. 1971. The application of psychological testing to entrepreneurial potential. California Management Review, 1971, 13(3), 38.

Penrose ET. 1959. The theory of the growth of the firm. Basil Blackwell: Oxford.

Roberts, P.W., Klepper, S., Hayward, S., 2011. Founder Backgrounds and the Evolution of Firm Size. Industrial and Corporate Change 20: 1515-1538.

Roodman, D., 2009, A note on the theme of too many instruments. Oxford Bulletin of Economics and Statistics 71: 135-158.

Shane, S. 2000. Prior Knowledge and the Discovery of Entrepreneurial Opportunities. Organization Science 11(4): 448-469.

Shane, S., Stuart, T., 2002. Organization endowments and the performance of university start-ups. Management Science 48: 154–170.

Spanos, Y.E., Lioukas, S. 2001. An examination into the causal logic of rent generation: contrasting Porter's competitive strategy framework and the resource-based perspective. Strategic Management Journal 22(10): 907–934.

Stinchcombe, F., 1965. Social structure and organizations. In: March, J. (Ed.), Handbook of Organizations. Rand McNally, Chicago, pp. 142–193.

Teece, D.J., 1986. Profiting from technological innovation: implications for integration, collaboration, licensing, and public policy. Research Policy, 15, 285–305.

Thompson, P. Selection and firm survival: evidence from the shipbuilding industry, 1825–1914. 2005. The Review of Economics and Statistics, 87(1): 26–36.

Tyson, L. 1992. Who's Bashing Whom? Trade Conflict in High Technology Industries, Washington, D. C.: Institute for International Economics.

Ucbasaran, D., Lockett, A., Wright, M., Westhead, P. 2003. Entrepreneurial Founder Teams: Factors Associated with Member Entry and Exit. Entrepreneurship Theory and Practice, 28(2): 107–128.

Ucbasaran, D., Westhead, P., Wright, M. 2008. Opportunity Identification and Pursuit: Does an Entrepreneur's Human Capital Matter?. Small Business Economics, 30(2): 153-173.

Unger, J.M., Rauch, A., Frese, M. Rosenbusch, N. 2011. Human capital and entrepreneurial success: A meta-analytical review. Journal of Business Venturing, 26(3): 341-358.

Vanaelst, I., Clarysse, B., Wright, M., Lockett, A., Moray, N., S'Jegers, R. 2006. Entrepreneurial Team Development in Academic Spinouts: An Examination of Team Heterogeneity. Entrepreneurship Theory and Practice, 30(2): 249–271.

Vesper, K.N. 1990. New venture strategies, revised ed. Englewood Cliffs, N.J.: Prentice-Hall.

Wernerfelt B. 1984. A resource-based view of the firm. Strategic Management Journal 5(2): 171–180.

Westhead, P., Birley, S. 1994. Environments for business deregistrations in the United Kingdom, 1987-1990. Entrepreneurship and Regional Development, 6(1), 29-62.

Windmeijer, F., (2005). "A finite sample correction for the variance of linear efficient two-step GMM estimators", Journal of Econometrics 126, 25-51.

Woo, C.Y., Cooper, A., Dunkelberg, W., Daellenbach, U., Dennis, W. 1989. Determinants of Growth for Small and Large Entrepreneurial Startups. Frontiers of Entrepreneurship Research, 1989, 134-147.

# Tables

## Table 1 - Definition of variables

| Variable | Definition |
|---|---|
| **Dependent variable** | |
| $Employees_{it-1}$ | Logarithm of the number of employees of firm $i$ at time $t$ |
| **Founding team variables** | |
| $NFounders_{i0}$ | Number of founders of firm $i$ |
| $EcoEduc_{i0}$ | Average number of years of economic and/or managerial education at graduate and post-graduate level of founders of firm $i$ |
| $TechEduc_{i0}$ | Average number of years of scientific and/or technical education at graduate and post-graduate level of founders of firm $i$ |
| $SpecWorkExp_{i0}$ | Average number of years of work experience of founders in the same sector of firm $i$ before firm's foundation |
| $OtherWorkExp_{i0}$ | Average number of years of work experience of founders in other sectors than the one of firm $i$ before firm's foundation |
| $NManager_{i0}$ | Number of founders of firm $i$ with a prior management position in a company |
| **Entrepreneurial team variables** | |
| $NOwners_{it-1}$ | Number of owners of firm $i$ at time $t$ |
| $EcoEduc_{it-1}$ | Average number of years of economic and/or managerial education at graduate and post-graduate level of owners of firm $i$ at time $t$ |
| $TechEduc_{it-1}$ | Average number of years of scientific and/or technical education at graduate and post-graduate level of owners of firm $i$ at time $t$ |
| $SpecWorkExp_{it-1}$ | Average number of years of work experience of owners in the same sector of firm $i$ before firm's foundation at time $t$ |
| $OtherWorkExp_{it-1}$ | Average number of years of work experience of owners in other sectors than the one of firm $i$ before firm's foundation at time $t$ |
| $NManager_{it-1}$ | Number of owners of firm $i$ at time $t$ with a prior management position in a company |
| **Controls** | |
| $Age_{it}$ | Number of years since firm's foundation at year $t$ |
| $DEquity_{it-1}$ | One for firms that up to year $t-1$ have obtained equity financing |
| $DASU_i$ | One for academic start-ups (i.e. firms with at least one founder with previous research work experience in a university or other public research organization), and zero otherwise |

**Table 2. Descriptive statistics of explanatory variables**

| Variable | Mean | S.D. | Min | Max |
|---|---|---|---|---|
| $Employees_{it-1}$ | 10.6741 | 35.1206 | 0 | 1200 |
| $NFounders_{i0}$ | 2.3075 | 1.2068 | 1 | 12 |
| $EcoEduc_{i0}$ | 0.2405 | 0.8070 | 0 | 8 |
| $TechEduc_{i0}$ | 1.7252 | 2.1697 | 0 | 9 |
| $SpecWorkExp_{i0}$ | 3.5778 | 6.5489 | 0 | 36.5 |
| $OtherWorkExp_{i0}$ | 12.4063 | 8.1129 | 0 | 50 |
| $NManager_{i0}$ | 0.4333 | 0.7805 | 0 | 5 |
| $NOwners_{it-1}$ | 2.3350 | 1.2883 | 0 | 12 |
| $EcoEduc_{it-1}$ | 0.2175 | 0.7639 | 0 | 8 |
| $TechEduc_{it-1}$ | 1.6019 | 2.0897 | 0 | 9 |
| $SpecWorkExp_{it-1}$ | 3.3369 | 6.2359 | 0 | 36.5 |
| $OtherWorkExp_{it-1}$ | 11.0377 | 8.0803 | 0 | 50 |
| $NManager_{it-1}$ | 0.3585 | 0.7137 | 0 | 5 |
| $Age_{it}$ | 7.8972 | 6.2069 | 0 | 30 |
| $DEquity_{it-1}$ | 0.1096 | 0.3124 | 0 | 1 |
| $DASU_i$ | 0.1018 | 0.3024 | 0 | 1 |

**Table 3: Dynamics of Entrepreneurial Teams**

| Variable | Mean | S.D. | Min | Max |
|---|---|---|---|---|
| $\varDelta NOwners$ | 0.03 | 0.62 | -5 | 10 |
| $\varDelta EcoEduc$ | 0.02 | 0.24 | -2 | 4 |
| $\varDelta TechEduc$ | .11 | 0.56 | -2 | 7 |
| $\varDelta SpecWorkExp$ | 0.20 | 1.61 | -15 | 21.3 |
| $\varDelta OtherWorkExp$ | 1.03 | 3.76 | -15 | 35 |
| $\varDelta NManager$ | 0.027 | 0.25 | -2 | 3 |

**Table 4 - Econometric results**

|  | Model 1 |  | Model 2 |  |
| --- | --- | --- | --- | --- |
| *Employees$_{it-1}$* | 0.7840 (0.0491) | *** | 0.7806 (0.0516) | *** |
| ***Founding team variables*** |  |  |  |  |
| *NFounders$_{i0}$* | - |  | 0.0395 (0.0795) |  |
| *EcoEduc$_{i0}$* | - |  | 0.1538 (0.0722) | ** |
| *TechEduc$_{i0}$* | - |  | 0.0271 (0.0324) |  |
| *SpecWorkExp$_{i0}$* | - |  | 0.0191 (0.0093) | ** |
| *OtherWorkExp$_{i0}$* | - |  | - 0.0136 (0.0090) |  |
| *NManager$_{i0}$* | - |  | 0.0386 (0.0937) |  |
| ***Entrepreneurial team variables*** |  |  |  |  |
| *NOwners$_{it-1}$* | - 0.0165 (0.0293) |  | - 0.0397 (0.0616) |  |
| *EcoEduc$_{it-1}$* | 0.2558 (0.0842) | *** | 0.0650 (0.1127) |  |
| *TechEduc$_{it-1}$* | 0.0362 (0.0292) |  | - 0.1111 (0.0394) |  |
| *SpecWorkExp$_{it-1}$* | 0.0025 (0.0099) |  | - 0.0225 (0.0157) |  |
| *OtherWorkExp$_{it-1}$* | 0.0007 (0.0070) |  | 0.0201 (0.0119) | * |
| *NManager$_{it-1}$* | - 0.0251 (0.0736) |  | - 0.0532 (0.1144) |  |
| ***Controls*** |  |  |  |  |
| *Age$_{it}$* | 0.0165 (0.0060) | *** | 0.0170 (0.0061) | *** |
| *DEquity$_{it-1}$* | 0.0757 (0.0866) |  | 0.0817 (0.0958) |  |
| *DASU$_{i}$* | - 0.1389 (0.0882) |  | -0.1215 (0.0881) |  |
| *Industry dummies* | Yes |  | Yes |  |
| *Year dummies* | Yes |  | Yes |  |
| *Constant* | - 0.0164 (0.2845) |  | - 0.0123 (0.3091) |  |
| Observations | 3211 |  | 3211 |  |
| Groups | 468 |  | 468 |  |

***Tests (Parameters combination)***

| | | |
|---|---|---|
| $\beta = 0$ | 0.2538** (0.1198) | |
| $\beta1 = 0$ | | -0.0414 (0.1653) |
| $\beta2 = 0$ | | 0.2645* (0.1538) |
| $\beta1 - \beta2 = 0$ | | -0.3059 (0.2905) |

Note: standard errors in parentheses; degrees of freedom in square brackets. ***, ** and * indicate significance levels of <1%, <5% and <10%, respectively. Estimates are derived from two-step system GMM with finite sample correction (Windmeijer, 2005). Sargan is a test on the validity of the overidentifying restrictions based on the efficient two-step GMM estimator.