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## Founder's human capital, entry strategies and start-up size

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## **Non-Technical Summary**

This paper analyzes empirically the determinants of new born firms' initial size. As survival prospects of young firms tend to be linked to a firm's start-up size, a better understanding of the factors influencing start-up size is crucial. Most of the rare literature on initial firm size focuses on industry characteristics. We contribute to the understanding of the determinants of initial firm size by analyzing firm specific factors such as founders' human capital composition and entry strategies.

We find that in addition to industry effects start-up size is considerably influenced by the human capital of firm founders. We distinguish between generic and specific human capital. Generic human capital refers to the general knowledge acquired through formal education and professional experience and usually coincides with a higher personal wealth. Specific human capital comprises competences that can be directly applied to the entrepreneurial job. For generic human capital we find that having a university degree has a positive influence on start-up size. The same applies for general working experience proxied by the founder's age. For the specific human capital components we find that successful entrepreneurial experience and managerial experience gained in dependent employment support a higher start-up size. Altogether, specific human capital tends to have a larger impact on initial size than generic human capital.

Entry strategies are expected to have a crucial influence on start-up size, because objectives of market entry largely determine the resources a firm requires. We distinguish between different types of entry strategies. On the one hand, we look at entry strategies based on innovation. We measure innovation by a variable which indicates if a firm carries out continuous R&D. On the other hand, entry is classified according to the main motive of the founders for firm formation. We conclude that different motives are accompanied by diverse entry strategies. The four main groups of entry strategies are independency entrepreneurship, opportunity entrepreneurship, spin-out entrepreneurship and necessity entrepreneurship.

The results indicate that firms conducting R&D continuously start larger than others when measuring initial employment in full-time equivalents. We do not observe a significant effect on start-up size measured in head counts. This suggests that R&D tasks are mostly carried out by full-time employees and to a lesser extent by persons working part-time for the firm. Further, firms with entry strategies based on the exploitation of new market opportunities as well as spin-out entrepreneurship exhibit a higher initial size while start-ups established from necessity appear to start at a smaller scale.

## Das Wichtigste in Kürze

In diesem Papier untersuchen wir empirisch, welche Faktoren die Startgröße eines neu gegründeten Unternehmens bestimmen. Vor dem Hintergrund, dass die Überlebens- und Erfolgsaussichten stark von der Startgröße beeinflusst werden, ist es besonders wichtig, nähere Erkenntnisse über die die Startgröße bestimmenden Faktoren zu erhalten. Der Großteil der bisher zu diesem Thema veröffentlichten Studien stellt den Einfluss verschiedener Branchencharakteristika in den Mittelpunkt. Aufbauend dazu trägt diese Untersuchung zum Verständnis der die Startgröße eines Unternehmens beeinflussenden Faktoren bei, indem sie auch den Einfluss unternehmensspezifischer Größen, insbesondere den Einfluss des Humankapitals der Gründer und deren Markteintrittsstrategien untersucht.

Wir kommen zu dem Ergebnis, dass neben branchenspezifischen Einflussfaktoren das Humankapital der Gründer, bei dem wir zwischen allgemeinem und spezifischem Humankapital unterscheiden, wesentlich zur Erklärung der Startgröße beiträgt. Das allgemeine Humankapital bildet im Wesentlichen die formale Ausbildung und allgemeine Berufserfahrung der Gründer ab und stellt üblicherweise ebenso die private Vermögenssituation der Gründer dar. Im Gegensatz dazu repräsentiert das spezifische Humankapital die Fähigkeiten, die in direktem Zusammenhang mit der Gründung und Leitung eines Unternehmens stehen. Die Ergebnisse dieser Untersuchung zeigen, dass das allgemeine Humankapital einen positiven Einfluss auf die Startgröße hat. Sowohl ein höherer Bildungsabschluss in Form eines abgeschlossenen Hochschulstudiums als auch eine längere allgemeine Berufserfahrung der Gründer, die wir durch das Alter abbilden, führen zu einer höheren Startgröße. Unternehmen, deren Gründer über spezifisches Humankapital in Form von eigener erfolgreicher unternehmerischer Erfahrung und Erfahrungen als abhängig Beschäftigter in der Geschäftsführung eines Unternehmens verfügen, werden ebenfalls größer gegründet. Vergleicht man den Einfluss des allgemeinen Humankapitals mit dem Einfluss des spezifischen Humankapitals, gibt es Anzeichen dafür, dass das spezifische Humankapital der Unternehmensgründer einen größeren Einfluss auf die Startgröße eines Unternehmens hat als das allgemeine Humankapital.

Da zu vermuten ist, dass die Ziele, die mit dem Markteintritt verfolgt werden, einen wesentlichen Einfluss auf die benötigten Ressourcen eines Unternehmens haben, kann von einem starken Einfluss der Markteintrittsstrategien auf die Startgröße eines Unternehmens ausgegangen werden. Man muss dabei zwischen verschiedenen Typen von Markteintrittsstrategien unterscheiden. Wir unterscheiden in diesem Zusammenhang zwischen einer innovationsgetriebenen Markteintrittsstrategie und vier unterschiedlichen Zielen, die mit der Unternehmensgründung verfolgt werden: selbstbestimmtes Arbeiten, das Ergreifen einer unternehmerischen Gelegenheit, die Gründung betrieben auf Initiative eines anderen Unternehmens oder einer notgetriebenen Selbstständigkeit. Diese Ziele sollten sich in unterschiedlichen Markteintrittsstrategien widerspiegeln.

Diesen vermuteten Zusammenhang zwischen Markteintrittsstrategien und der Gründungsgröße finden wir bestätigt. Unternehmen, die sich grundsätzlich dafür entschieden haben, Forschung und Entwicklung zu betreiben, starten mit einer größeren Anzahl vollzeitäquivalenter Mitarbeiter, jedoch nicht mit einer größeren Anzahl von Personen. Dieses Ergebnis führen wir darauf zurück, dass Forschung und Entwicklung eher von Mitarbeitern ausgeführt wird, die Vollzeit im Unternehmen arbeiten und weniger von Mitarbeitern in Teilzeit oder geringfügig Beschäftigten. Des Weiteren zeigen unsere Ergebnisse, dass Markteintrittsstrategien, die darauf basieren Marktlücken oder neue Geschäftskonzepte zu nutzen, die Gründungsgröße positiv beeinflussen. Gleiches gilt für Gründungen, die aus einem anderen Unternehmen hinaus betrieben worden sind, während Notgründungen zum Gründungszeitpunkt signifikant weniger Mitarbeiter beschäftigen.

# **Founder's Human Capital, Entry Strategies and Start-Up Size**

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**Keywords:** firm start-up size, human capital, firm foundation

**JEL:** L11, L26, J24

## Introduction

One of the stylized facts of entry we know is that new firms are typically small. Furthermore, the firm size distribution of new firms is mostly positively skewed.

As the results of many studies indicate that initial founding conditions matter for firm success it is desirable to get a better understanding of firms' start-up size. More precisely, the probability of survival is positively related to the initial firm size (see e.g. Audretsch and Mahmood, 1995). Furthermore, start-up size seems to have a rather persistent effect on survival (Geroski et al., 2007). Since most studies testing Gibrat's Law for young firms (e.g. Almus and Nerlinger, 1999, 2000; Lotti et al. 2009) arrive at a rejection of Gibrat's Law, i.e. young firms do not grow proportionally and independently of their size, not only survival but also firm growth is substantially influenced by start-up size.

Theoretical considerations state that a firm's start-up size is determined by the minimum of its desired (optimal) size and the entrepreneurs' resource constraints. Optimal firm size is largely determined by the extent of economies of scale in the industry. The fact that newly founded firms are mostly established below their optimal size may not only be caused by financial constraints but also by "ability constraints". Founders' uncertainty about their true entrepreneurial abilities, combined with the existence of sunk costs, is another reason why firms may choose to start small (Mata, 1996). The belief in one's own entrepreneurial competence will be linked to human capital. Individuals with a higher degree of human capital are likely to perform better than other entrepreneurs. As a consequence, they should be more confident about the future prospects of their firm and desire a higher initial size. Thus, as human capital should increase the expected efficiency of a firm, it should increase the start-up size, too. Furthermore, it might be easier for more educated and experienced founders to hire qualified personnel and to find suitable team members.

Research on the determinants of start-up size has been rather limited up to now. Only a few empirical studies have built the basis about the facts we know today. Most of these studies focus mainly on industry characteristics (Resende, 2007; Mata and Machado, 1996; Arauzo-Carod and Segarra-Blasco, 2005). They find that a firm's start-up size is positively influenced by minimum efficient scale, industry growth as well as turbulence inside the industry.

Studies which control for human capital or explicitly investigate the influence of entrepreneurs' human capital are rare (Mata, 1996 and Colombo et al., 2004) and to the best of our knowledge there are still none for Germany. Both Mata and Colombo et al. were able to find a crucial positive influence of entrepreneurs' human capital on start-up size. Better educated founders are not only more likely to be efficient managers. They are also assumed to be wealthier individuals. Hence, they suffer to a lesser extent from financial constraints. Using entrepreneur's age and educational level as proxies for wealth Cabral and Mata (2003) found a significant influence on a firm's size in early years.

We contribute to the literature by analyzing the role of founders' human capital on initial firm size for Germany based on a large sample of newly established firms. We distinguish between generic and specific human capital. Generic human capital refers to the general knowledge acquired through formal education and professional experience. Specific human capital comprises competences that can be directly applied to the entrepreneurial job.

A second focus is put on the impact of a firm's entry strategy on start-up size. The choice of a particular entry strategy can have an influence on the resources a firm requires. Using information on firms' activities in research and development and on the major motive for firm formation we distinguish different types of entry strategies, namely entry based on innovation, opportunity entrepreneurship, necessity entrepreneurship, independency entrepreneurship and spin-out entrepreneurship.

Our empirical analysis is based on a newly generated and unique database in Germany, which contains around 5,000 firms established in the years 2005 to 2007. Industries cover span manufacturing and services and include both high-tech and low-tech sectors. Information about a founder's

human capital, firm characteristics and market entry strategies was retrieved by computer-assisted telephone interviews. As we include only very young firms (up to an age of three years) in our analysis we are hardly exposed to a survival bias of the surveyed firms.

Like many similar studies we measure start-up size by the number of employees and founders when the firm is created. More specifically, start-up size is measured both in full-time equivalents and in head counts. Since the workload in extremely young firms is rather volatile and employees have to be highly flexible, the number of individuals engaged in a firm may be more important than formal working hours agreed in work contracts. Start-up size is explained by an entrepreneur's human capital as well as by market entry strategies. Since previous studies have provided some evidence for the importance of industry characteristics in determining a firm's initial scale we also include industry variables in our analysis.

Our regression results show that both generic human capital, such as the formal educational degree of the founders, and specific human capital, such as successful entrepreneurship, is positively related to a firm's start-up size. We further find that the inclusion of variables intended to capture entry strategies help substantially to explain the heterogeneity in start-up size. All in all, our results show that it is important to account for founder-specific, firm-specific as well as industry-specific factors in order to better understand the size distribution of new born firms.

The paper is organized as follows. In the next section, we give an overview of the relevant literature. In the subsequent theoretical part we derive hypotheses concerning the effect of founder's human capital, the firm's entry strategy and industry characteristics on start-up size. In the empirical part we describe the econometric model, the data and variables used and the empirical findings. We give a summary of our results in the final section.

## Literature Review

Although it is well-known that a firm's initial size has a crucial influence on a firm's performance in the years after the market entry (see Audretsch and Mahmood, 1995; Geroski, 2007), not that much empirical work which investigates the determinants of a firm's size at its founding date has yet been done.

Theoretically, firm's initial size is determined by the minimum of its desired optimal size and founders' financial constraints (Cabral and Mata, 2003). Most of the somewhat rare empirical studies which investigate the determinants of start-up size concentrate on industry characteristics (Resende 2007; Arauzo-Carod and Segarra-Blasco 2005; Görg et al. 2000; Görg and Strobl 2002; Mata and Machado, 1996). This is presumably due to lack of detailed information about founders in firm-level data. Based on the first study by Mata and Machado (1996) these works relate start-up size to the minimum efficient scale (MES) in the respective industry, the proportion of employment in that industry operating below the minimum efficient scale, the size of the industry, the growth of the industry and the extent of simultaneous entry and exit (turbulence) in the industry. MES and turbulence are found to have a significant positive influence. Industry growth is often found to be also positively related to start-up size, but not always in a significant way. The other way around, as expected, the proportion of employment in an industry working at suboptimal scale exerts a negative influence on the start-up size. Industry size is mostly expected to have a positive influence on the start-up size, but it often turns out to be insignificant in empirical studies. In fact, it is found to have a significant negative effect in some studies (e.g. Resende, 2007)

Quantile regressions of this type of studies show that scale economies are more important the larger the entrant. "[I]t seems that small new firms appear everywhere, while relatively large ones only appear where economies of scale make it crucial [...]" (Mata and Machado, 1996, p. 1321).

The first study not focusing solely on industry characteristics but taking also the influence of entrepreneur's attributes into account when analyzing the size of new firms was done by Mata (1996). He finds education, measured by the years of schooling, to positively influence the start-up size. The influence of a founder's age, which is supposed to be a proxy for labor market experience



after controlling for education, is found to be inversely u-shaped. Mata therefore concludes that the size of new firms increases with an entrepreneur's human capital.

Colombo et al. (2004) explicitly focus on the influence of an entrepreneur's human capital on firms' start-up size. Following Becker (1975), they distinguish between generic and specific human capital. From theoretical reasoning they draw the hypothesis that firms' start-up size is positively related to the human capital of a firm's founders. First, imperfections in capital markets may lead to financial constraints which force the founders to start below their optimal start-up size. Human capital, independently of its specific or generic nature, usually comes along with a higher personal wealth and hence less exposure to financial constraints, so that founders with greater human capital can achieve their desired initial firm size more easily. Secondly, the specific human capital of a founder will be positively related to his entrepreneurial ability, his confidence in the firm's post-entry performance and hence to the desired initial size. According to this reasoning, the generic human capital component is only a proxy for wealth, while the specific component also captures founders' greater entrepreneurial ability and self-confidence. Consequently, Colombo et al. (2004) claim the impact of specific human capital on initial firm size to be greater than of generic human capital. Controlling also for industry-specific influences on initial firm size they find their hypothesis to be confirmed. Both specific human capital, which is captured by industry-specific working experience, entrepreneurial and managerial experiences, and generic human capital, which is proxied by education and general working experience, positively influence a firm's start-up size measured by the salaried employees (plus founders) twelve months after the firm has started its operations. The variables reflecting the specific component of human capital are found to exhibit greater explanatory power than those reflecting the generic component.

Åstebro and Bernhardt (2005) analyze the impact of various human capital variables on the start-up capital of firms which can be considered as an alternative measure of initial firm size. They find that firm capital is generally increasing with human capital. Similar to the results of Colombo et al. (2004), the effects of variables reflecting specific human capital (here: entrepreneurial ability, managerial experience) are larger in magnitude than the effects of variables reflecting generic human capital (here: education and [general] work experience).

## **Determinants of Start-Up Size**

In deriving our hypotheses we build on a framework which perceives initial size as being determined by the desired size and resource constraints the start-up is facing. All factors influencing either the desired (initial) size or the resource constraints therefore determine the start-up size. In this paper we focus on three particular groups of factors which presumably influence the start-up size: the founder's human capital, the firm's entry strategy, and industry characteristics.

The founder's human capital is presumed to exert a positive influence on start-up size. First, generic human capital usually coincides with a higher personal wealth. Furthermore, founders with higher generic and specific human capital should be able to attract external funding more easily. Those founders should thus be less exposed to financial constraints. Second, persons endowed with specific human capital, i.e. knowledge and skills which can be directly applied to entrepreneurial tasks, are more likely to be efficient managers. They are supposed to have greater confidence in their entrepreneurial success and to assess failure to be less likely. Therefore, they have less reason to keep sunk costs low and to start smaller than at the optimal scale. Compared to specific human capital, generic human capital is supposed to have a much smaller effect on entrepreneurial competence and self-confidence.

Subsuming the arguments, both the generic and specific components of founders' human capital should have a positive effect on a firm's start-up size. However, we closely follow the argumentation by Colombo et al. (2004) in stating that while both types of human capital will help to ease financial constraints, it is primarily the specific human capital which should increase a firm's efficiency and an entrepreneur's confidence in firm success. Therefore, we expect the influence of the specific human capital to be greater than that of generic human capital. The first hypothesis is stated as:

*Hypothesis 1: Start-up size is positively influenced by the generic and specific human capital of the founders. The effect of specific human capital is higher than the effect of generic human capital.*

Apart from founders' human capital, entry strategies are expected to have a crucial influence on start-up size, because objectives of market entry largely determine the resources a firm requires. We distinguish between different types of entry strategies. The first entry strategy we discuss is entry which is based on innovation: A firm aims to develop new technologies or innovative products which allow the start-up to find a niche position in the market in which they operate. The leading decision to be active in research and development forces the start-up to take high investments in technologies and (especially high qualified) personnel to realize their R&D projects. Therefore, start-ups which have made the leading decision to be active in R&D are hypothesized to have a larger initial size.

Entry is furthermore classified according to the main motive of the founder for firm formation. We conclude that different motives are accompanied by diverse entry strategies. The four main groups of entry strategies are independency entrepreneurship, opportunity entrepreneurship, spin-out entrepreneurship and necessity entrepreneurship.

Start-ups formed because of necessity, i.e. the firm foundation was mainly driven by avoiding unemployment or the absence of an adequate dependent employment, are hypothesized to exhibit the smallest start-up size on average. These founders would prefer to work as paid-employed rather than being self-employed and thus often regard self-employment as a temporary state. It is then rational for them to keep sunk costs low and to enter at small scale. They are presumably first and foremost interested in creating a job for themselves and in ensuring a certain income level. Their entrepreneurial aspirations and their willingness to take major investments can be assumed to be rather low. According to the results of Niefert and Tchouvakhina (2006) regarding foundations from unemployment, we therefore expect that start-ups driven by necessity will have a smaller initial size than others.

If the founders are mainly driven by the motive to work self-determined and independently one can refer to this strategy as independency entrepreneurship. Profit maximization and growth is mostly not the prior objective of those founders. They are mainly out to build up an economically viable business in order to earn their living. Since employing personnel requires managerial capacities and thus the engagement of managerial staff, start-ups driven by independency entrepreneurship might prefer to start at a smaller scale.

Opportunity entrepreneurship can be defined if the firm is founded because of a precise business idea or an opened up market gap. Expecting that these firms are more convinced of their business idea than the average firm and consequently dare to take higher risk, initial investments will be larger. One may further argue that a lot of these foundations will also follow an innovation strategy because the probability to develop a market novelty in the first years after foundation has been found to be higher among foundations based on a precise business idea than among other new firms (Gottschalk et al., 2008).

Spin-out entrepreneurship is defined as a firm formation which originates from previous activities in dependent employment. We expect that these firms, just as the foundations by opportunity entrepreneurs, start their business following a precise plan. Financial constraints might be less severe since firm formation was pushed by the former employer who might be able to support the founders with valuable management advice during the seed stage. They might even receive some form of financial assistance or take over qualified personnel from their former employer. Moreover, the founders should be quite certain about the sustainability of the business idea because probably they have insider knowledge about the corresponding market and are already experienced in the field the new firm is operating in.

To sum up, our hypotheses about entry strategies are as follows:

*Hypothesis 2a: An innovation-based entry occurs at a larger scale.*

*Hypothesis 2b: Firm foundations based on opportunity entrepreneurship and spin-out entrepreneurship start larger than independency entrepreneurship and necessity entrepreneurship where necessity entrepreneurship exhibits even a smaller start-up size than independency entrepreneurship.*

Finally, the size of new firms is expected to vary across industries. Since highly different technologies are employed in the production process and in service delivery, scale economies do not only form established firms' size distribution but also influence new firms' start-up size. Given the entry decision, firms will start larger if they start their operations in industries with a high minimum efficient scale (MES). Moreover, the effect of economies of scale is related to the size of the market or industry. Following Mata and Machado (1996) one can say that the larger the MES relative to industry size, the greater the probability that firm entry occurs at the expense of incumbents. Founders have then an incentive to start relatively small in order to avert retaliation. Thus, for a given MES, start-up size will increase with industry size. The wage level in the industry is supposed to impact start-up size, too. Wages are often determined by collective agreement on the industry level. Even if a start-up is not bound by a collective agreement, it might be forced to pay similarly high wages because otherwise it will be faced with severely restricted labor supply. In any case, the wage level in the industry influences the labor cost of the new firm and is likely to be negatively related to start-up size as measured by initial employment.

Our third hypothesis is stated as follows:

*Hypothesis 3: Start-up size is positively related to the extent of economies of scale in the industry and to industry size. It is negatively related to the wage level in the industry.*

## Empirical Analysis

We quantify start-up size by the number of employees and founders at the time the firm is created. Specifically, start-up size is measured both in full-time equivalents and in head counts. As argued above, the number of persons engaged might be a more meaningful measure of employment than the number of working hours agreed for very young firms with a highly volatile workload. Moreover, we are interested in explaining the effective number of working-places – be they full-time or part-time – created by the firms.

### The Econometric Models

Accordingly, we estimate the determinants of a firm's start-up size using two different models. In the first model, we measure start-up size of firm  $i$  -  $y_i$  - as the full-time equivalent of the sum of the number of founders and the number of employees in logarithm. The linear model is expressed by:

$$\ln(y_i) = x_i' \beta_1 + z_i' \beta_2 + f_i' \beta_3 + w_i' \beta_4 + u_i \quad \forall i = 1 \dots n$$

where  $n$  is the number of firms in our estimation sample,  $x_i$  are the variables reflecting the human capital of the founders,  $z_i$  represents market entry strategies of the firms,  $f_i$  indicates public funding, and  $w_i$  is a set of industry specific factors (see table 1 for a variable description);  $\beta_1, \beta_2, \beta_3$  and  $\beta_4$  are the vectors of parameters to be estimated. The disturbances  $u_i$  are assumed to follow a normal distribution  $N(0, \sigma_u^2)$ . We compute ordinary least squares (OLS) estimates.

In the second model, we look at employment measured in head counts and use a count-data model to estimate the parameters of interest. The Poisson regression model might be used to compute estimates. But one assumption of the Poisson model that the variance of the dependent variable equals its mean is violated here. The variance of start-up size is larger than their mean ("overdispersion"). The most common alternative of the Poisson model is the negative binomial

model, which relaxes the assumption and generalizes the Poisson model by introducing an individual, unobserved effect into the conditional mean (Greene, 2003, pp 744 ff). We choose the Negbin II model (Cameron and Trivedi, 1986) to model the conditional variance of the dependent variables<sup>1</sup>:

$$Var(y_i|x_i, z_i, f_i, w_i) = E(y_i|x_i, z_i, f_i, w_i) [1 + \alpha E(y_i|x_i, z_i, f_i, w_i)] \quad \forall i = 1 \dots n$$

where  $y_i$  represents the start-up size in head counts.  $\alpha$  is an estimate of the degree of overdispersion. When  $\alpha$  is zero, negative binomial has the same distribution as Poisson. The larger  $\alpha$  is the greater the amount of overdispersion in the data. A test of the Poisson distribution is carried out by testing the hypothesis  $\alpha = 0$  using a likelihood-ratio test. The hypothesis is denied and the negative binomial model should be preferred to the Poisson model.

Measuring the effect of aggregate variables on micro units by merging aggregate industry data with micro observations using OLS or other regression models can lead to standard errors that are seriously biased downward. Failing to account for correlation of errors within the different industry groups (here: NACE 2 digits), which is a consequence of this bias, can result in spurious findings of statistical significance of the aggregate variables (see Moulton, 1990). Therefore, we control for the within-group disturbance correlation by computing the correct covariance matrix of the estimator. To take into account that firms from new technology-based industries<sup>2</sup> are oversampled in the survey we run weighted regressions using sample weights.

### *The Data*

The dataset used for the empirical analysis consists of more than 5,000 German firms which were established between 2005 and 2007. It is part of the “KfW/ZEW Start-Up Panel”, a newly launched panel of German start-ups in various industries.

The panel is a joint activity of the “KfW-Bankengruppe”, a public owned bank, the Centre for European Economic Research (ZEW) and Creditreform, Germany’s biggest credit rating agency. The underlying population, from which a stratified<sup>3</sup> random sample was drawn, is composed of all start-ups recorded by Creditreform which are operating in manufacturing, construction and services and which were founded in the years 2005 to 2007. In the following years these firms shall be observed up to a firm age of seven years.

The first survey wave, on which this analysis relies on, was conducted in 2008. Detailed information about the founders, their human capital, a firm’s labor demand and other firm characteristics were retrieved by means of computer-assisted telephone interviews.

In order to be able to ascertain the effect of industry characteristics we add industry data to each firm observation according to its industry classification code (NACE) and its year of foundation. Industry data was retrieved on the 2-digit level of the annual enterprise statistics of industry, trade and services publicly available from Eurostat and merged with the firm level data of the KfW/ZEW Start-Up Panel. One of the industry variables (minimum efficient scale) was calculated using the Mannheim Enterprise Panel (MUP), the most comprehensive existing firm-level data-base of nearly all German companies. The underlying data for the Mannheim Enterprise Panel are provided by Creditreform.

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<sup>1</sup> We prefer the Negbin II model to the Negbin I model as the log likelihood for Negbin II is larger than that for Negbin I in our model.

<sup>2</sup> Here, new technology-based (NTB) industries are composed of high-tech manufacturing, technology-intensive services and software firms. In order to have enough observations for viable empirical analyses of new technology-based industries, new technology-based start-ups were oversampled. The sample consists of NTB start-ups and non-NTB start-ups in equal share.

<sup>3</sup> Stratification criteria were the year of establishment, the industry and KfW-funding.

## The Variables

We define the initial size of the firm by the total number of employees and founders at the date of foundation. The group of employees includes full-time and part-time employees, who are included in the German social insurance system, and marginally employed persons, who do not earn more than 400 EURO per month and therefore are not included in the social insurance system. Family members, who take an active part within the new born firm, freelancers, trainee students, subcontracted workers, and apprentices, are counted among the employees, too. We calculate full-time equivalents as well as head counts.

A key explanatory variable for start-up size in our models is the founders' human capital. We distinguish between *generic* and *specific* human capital. Generic human capital is measured by the education of the founders or the founding team, respectively: *Graduate* has value 1 if the single founder or at least one member in the team of founders is a university graduate, otherwise it is zero. Due to this definition, nearly 40% of the surveyed firms are graduate foundations (see table 2). The age of the founders (or oldest founder's age in case of a team foundation) (measured in logarithms: *Log (age)*) approximates the general professional experience and is a second factor of generic human capital. These variables reflect general knowledge of the founders which cannot be directly applied to the entrepreneurial tasks in the newly established enterprise. They are also supposed to be proxies of personal wealth.

We measure specific human capital by factors indicating experience which can directly be utilized in business operations. One of these factors is the specific professional experience of the founder(s) measured in logarithms of the number of years of professional experience in the same industry the new born firm is operating in (*Log (experience in industry)*)<sup>4</sup>. In addition, we operationalize managerial experience by three dummy variables: The first one indicates that at least one founder has been employed as a top manager in another firm before foundation (*top manager*), hence has gathered experience as a firm's executive. The other two dummy variables indicate that at least one of the founders has been an entrepreneur before foundation. *Successful entrepreneurial experience* denotes that the previous business still exists (either it is still managed by the founder or it has been transferred or sold to someone else). In contrast, *not successful entrepreneurial experience* is assigned to founders who were entrepreneurs prior to firm foundation but the previous business has become a bankrupt or has been liquidated.

We expand our analysis of the determinants of start-up size in examining the role of entry strategies. On the one hand, we look at an entry strategy based on innovation. An innovation-based entry strategy relies on new technologies or innovative products which allow firms to find a niche position in the market. Our survey allows us to operationalize an innovation strategy by a variable which indicates if a firm carries out research and development activities (R&D) continuously. In our sample, 16% of the firms are conducting continuous R&D.

On the other hand, we consider the main motive of the founders to start the firm. We distinguish between four types of motivations which can be associated with different start-up size decisions: independency entrepreneurship, *necessity entrepreneurship*, *opportunity entrepreneurship*, and *spin-out entrepreneurship*. We declare independency entrepreneurship to be the base category. Independency entrepreneurship represents founders who state that being self-employed itself was the main reason for founding the new firm which is true for one half of the firms in our sample.

*Opportunity entrepreneurship* stands for firm foundations which were based on a precise business idea or an opened up market gap. Almost one third of the firms in our sample stated to have followed this entry strategy. *Spin-out entrepreneurship* denotes firm foundations which are pushed by the founders' former employer. Spin-out entrepreneurship comprises three percent of our sample firms. *Necessity entrepreneurship* suggests that the firm foundation was mainly driven by avoiding unemployment or the absence of an adequate dependent employment. This last motive plays a role for one fifth of the firms in our sample.

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<sup>4</sup> In case of a team foundation, we observe the years of experience of the founder who has worked the largest time in the relevant industry.

Table 1: Description of variables

Variable	Description
Dependent variables	
Log (start-up size)	Logarithm of total employment at firm foundation measured in full-time equivalents.
Start-up size (head count)	Total employment at firm foundation measured as head count.
Independent variables	
<i>Human capital</i>	
<i>Generic human capital</i>	
Graduate	Single founder is a university graduate / at least one graduate in the team of founders.
Log (age)	Logarithm of the (oldest) founders' age.
<i>Specific human capital</i>	
Entrepreneurial experience (not successful)	Single founder has entrepreneurial experience / at least one founder has entrepreneurial experience in the team of founders. The founder's previous business has become insolvent or has been liquidated.
Entrepreneurial experience (successful)	Single founder has entrepreneurial experience / at least one founder has entrepreneurial experience in the team of founders. The entrepreneur's previous business still exists.
Top manager	Single founder has been a top manager / at least one founder has been a top manager in the team of founders before firm foundation.
Log (experience in industry)	Logarithm of the years of professional experience in the same industry.
<i>Entry strategies</i>	
Continuous R&D	Firm is conducting R & D continuously.
Necessity entrepreneurship	Motives: Firm foundation was driven by necessity (unemployment or no adequate dependent employment).
Opportunity entrepreneurship	Motives: Firm foundation was based on a precise business idea or market gap.
Spin-out entrepreneurship	Motives: Firm foundation was pushed by the former employer.
<i>Public funding</i>	
Public funding (BA)	Firm has received initial funding from the federal employment agency.
Public funding (non BA)	Firm has received initial funding from other public agencies than the federal employment agency.
<i>Industry variables</i>	
Log (industry size)	Logarithm of the number of employees in the same industry (NACE 2 digits) in the year prior to firm foundation.
Log (labor costs)	Logarithm of the average labor cost per employee in the same industry (NACE 2 digits) in the year prior to firm foundation.
MES	Minimum efficient size (median size of a firm in the same industry; NACE 2 digits).
NTB industries	Firm belongs to the new technology-based industries (NACE 4 digits).

**Table 2:** Descriptive statistics of the variables included in the estimations

Variable	Mean	Std. dev.	Min	Max
Dependent variables				
Start-up size (fte)	2.525	2.484	1	25
Start-up size (head-count)	3.028	3.232	1	26
Independent variables				
<i>Human capital</i>				
<i>Generic human capital</i>				
Graduate	0.392	0.488	0	1
Age	39.118	9.754	16	92
<i>Specific human capital</i>				
Entrepr. experience (not successful)	0.127	0.333	0	1
Entrepr. experience (successful)	0.214	0.410	0	1
Top manager	0.212	0.409	0	1
Experience in industry	14.517	9.323	0	55
<i>Entry strategies</i>				
Continuous R&D	0.158	0.365	0	1
Necessity entrepreneurship	0.191	0.393	0	1
Opportunity entrepreneurship	0.320	0.466	0	1
Spin-out entrepreneurship	0.028	0.166	0	1
<i>Public funding</i>				
Public funding (BA)	0.376	0.484	0	1
Public funding (non BA)	0.269	0.443	0	1
<i>Industry variables</i>				
NTB industries	0.424	0.494	0	1
Industry size	1,414,110	1,151,945	19,352	3,440,098
Labor costs (in thousand Euros)	34.284	13.745	11	82
MES (median)	2.018	1.447	1	10

Source: KfW/ZEW Start-Up Panel, Eurostat and MUP, authors' calculations

We further control for public financial support received by the firms since we expect that it influences start-up size via relaxing the financial constraints firms are facing. More than one half of the new born firms in our sample got external financing from public agencies. In our models, we differentiate between two different sources of public funding: programs following industrial policy and labor market programs. In Germany unemployed persons can apply for funding from the German Federal Employment Agency (Bundesagentur für Arbeit – BA) to start-up their own business. The volume of financial support from the BA is just intended to ease the step into self-employment and to ensure the founder's living in the first months. This type of funding (*Public funding (BA)*) is comparatively low<sup>5</sup> and is not expected to have a noticeable effect on start-up size. By contrast, financial support from other public agencies (*Public funding (non BA)*), e.g. the KfW-

<sup>5</sup> For the first nine months after founding a business, beneficiaries of the foundation grant ("Gründungszuschuss") which is provided by the BA to previously unemployed founders receive a grant at their personal level of unemployment insurance benefits, plus 300 Euros per month to help to meet social security costs.

Mittelstandsbank or regional authorities, stems from governmental spending programs which are intended to foster the competitiveness and growth in the economy by supporting start-ups. Funding of this kind may reach a large amount of money and thus should enable founders to take substantial investments.

The industry variables are selected to capture some important industry characteristics which are assumed to affect start-up size: industry size, level of labor cost and the extent of economies of scale in the industry. *Log (industry size)* is the logarithm of the number of employees and *Log (labor costs)* is the logarithm of the average labor cost per employee in the industry to which a start-up belongs in the year prior to firm foundation. The minimum efficient scale (*MES*) is measured by the medium size of a firm in the same industry. The *MES* is computed by using the firm micro-data of the Mannheim Enterprise Panel (MUP) of the ZEW. Firms belonging to the new technology-based (*NTB*) industries – which are 42% of our estimation sample – are marked by a dummy to control for special features of these firms which cannot be covered by the other industry variables used.

### *Estimation Results*

First we look at the results of the OLS regression using start-up size measured in full-time equivalents as a dependent variable. We find significant effects of both generic and specific human capital components on initial employment. As to the generic human capital components, results reveal that founders who are university graduates start larger firms than less educated founders. Moreover, start-up size increases with a founder's age which is supposed to mirror a founder's general work experience. Both the graduate and the age coefficient might also reflect a wealth effect, since the personal wealth usually increases with the level of education and with age. Wealth relaxes possible financial constraints forcing founders to start their firm below the desired size.

As to the specific human capital components, we find that having been successful as an entrepreneur previously (i.e. the prior business still exists) increases the start-up size of the new venture. By contrast, having been unsuccessful as an entrepreneur prior to firm foundation (i.e. the prior business has become insolvent or has been liquidated) does not have any significant influence on initial size. This indicates that entrepreneurial experience only leads to a higher start-up size if the previous entrepreneurial activity has been successful. Another result is that founders who have gathered managerial experience working as a firm's executive before foundation tend to start larger firms than other founders. Altogether, it seems that having (successfully) led a company previously, be it as self-employed or employed worker, gives founders trust in their own entrepreneurial abilities and the future performance of the new firm and thereby induces them to choose a larger start-up size. Finally, professional experience in the same industry the new firm is operating in does not have a significant influence on start-up size. In consideration of the significant effect of founders' age on start-up size this would imply that it is rather general work experience than industry-specific experience which makes founders feel confident about their venture and choose a larger initial size. Nevertheless, comparing the coefficients of the generic and specific human capital components altogether, the estimation shows that specific human capital has a larger impact on initial size than generic human capital. This confirms our hypothesis 1 and the results of Colombo et al. (2004).



**Table 3:** Determinants of start-up size: results of the OLS and Negbin models

Variables	(1)		(2)	
	start-up size (fte)		start-up size (head count)	
	coef	se	coef	se
<b><i>Human capital</i></b>				
<b><i>Generic Human Capital</i></b>				
Graduate	0.133 ***	(0.040)	0.135 **	(0.062)
Log (age)	0.170 **	(0.076)	0.245 **	(0.110)
<b><i>Specific Human Capital</i></b>				
Entrepr. experience (not successful) <sup>(1)</sup>	0.035	(0.064)	0.114	(0.092)
Entrepr. experience (successful) <sup>(1)</sup>	0.248 ***	(0.055)	0.308 ***	(0.072)
Top Manager	0.191 ***	(0.071)	0.249 ***	(0.093)
Log (experience in industry)	0.005	(0.010)	0.004	(0.015)
<b><i>Entry strategies</i></b>				
Continuous R&D	0.105 **	(0.049)	0.113	(0.069)
Necessity entrepreneurship <sup>(2)</sup>	-0.073	(0.045)	-0.153 **	(0.065)
Opportunity entrepreneurship <sup>(2)</sup>	0.154 ***	(0.037)	0.089 *	(0.051)
Spin-out entrepreneurship <sup>(2)</sup>	0.35 ***	(0.087)	0.586 ***	(0.143)
<b><i>Funding</i></b>				
Public funding (BA)	-0.04	(0.039)	-0.088 *	(0.052)
Public funding (non BA)	0.158 ***	(0.040)	0.237 ***	(0.067)
<b><i>Industry variables</i></b>				
NTB industries	0.101	(0.068)	0.178 *	(0.102)
Log (industry size)	-0.068 **	(0.029)	-0.078 **	(0.039)
Log (labor cost)	-0.357 ***	(0.108)	-0.553 ***	(0.132)
MES (median)	0.081 ***	(0.017)	0.108 ***	(0.023)
Constant	1.688 **	(0.709)	2.504 ***	(0.934)
Observations	4,748		4,748	
# cluster	105		105	
R-squared	0.179			
Log Likelihood			-	
chi2			1,077,776	
			605.3	

Notes: Reference category: (1) no entrepreneurial experience, (2) motives: independency entrepreneurship

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Clustered standard errors in parentheses. Weighted estimations.

Source: KfW/ZEW Start-Up Panel, Eurostat and MUP, authors' calculations

The OLS results further indicate that firms conducting R&D continuously start larger than others. This can be explained by the fact that the implementation of R&D activities requires more personnel. It supports our hypothesis 2a that an entry strategy based on innovation tends to have an increasing effect on initial size.

The primary motivation of the founders to start their firm affects start-up size, too. Opportunity entrepreneurs and spin-out entrepreneurs tend to choose a larger initial size than founders that are first of all motivated by independence (reference group). We find that the positive effect on start-up size is larger for spin-out entrepreneurs than for opportunity entrepreneurs. If the foundation is primarily driven by necessity, it has an insignificant negative effect on start-up size. Thus, hypothesis 2b is confirmed insofar as opportunity and spin-out entrepreneurs indeed tend to start larger firms than independency and necessity entrepreneurs. However, we do not find evidence for our assumption that necessity entrepreneurs choose an even smaller start-up size than independency entrepreneurs.

We further observe that funding from the federal employment agency has no significant effect on initial size. By contrast, we find that funding from other public agencies increases the start-up size. These results seem to be in line with our conjecture that the amount of funding provided by the BA is too small to affect the level of initial investment but that public funding of a certain order of magnitude relaxes financial constraints and thereby enables founders to start larger firms. However, one should be somewhat cautious with this interpretation because of the endogenous character of the funding variable. The scale of the start-up project may influence the probability of both applying for and receiving public funding.

As to the industry variables, the results confirm our hypothesis 3 insofar that the extent of economies of scale is positively related to start-up size and the average labor cost is negatively related to it. However, we find that start-up size tends to decrease with industry size which is contrary to our hypothesis. The fact of operating in the NTB industries does not significantly affect start-up size.

The results of the negative binomial model using start-up size measured by head counts as dependent variable mostly confirm the results of the OLS regression. There are no differences regarding the sign of the parameter estimates between the two models and only a few variations concerning their significance. For example, the positive effect of continuous R&D on initial size is no longer significant in the negative binomial model. Accordingly, hypothesis 2a stating that an innovation-based entry strategy leads to a larger start-up size is not confirmed when initial employment is measured in head counts. Thus, firms performing R&D continuously seem to have a higher initial employment as measured in full-time equivalents but not as measured in head counts. This suggests that R&D tasks are mostly carried out by full-time employees and to a lesser extent by persons working part-time for the firm such as marginally employed persons, freelancers, trainee students and apprentices.

Another difference is that necessity entrepreneurship exerts a significant negative effect in the negative binomial model so that hypothesis 2b is now fully confirmed. It seems that necessity entrepreneurs tend to employ a smaller number of persons at the start-up than the reference group of independency entrepreneurs, whereas the initial employment volume as measured in full-time equivalents does not differ significantly. Thus, necessity entrepreneurs do not generally start smaller firms but – given a certain employment volume – aim to keep the number of employees low. Similar results are obtained for founders who receive funding by the federal employment agency and who – just as necessity entrepreneurs – are often motivated by the aim to escape from unemployment. The effect of being funded by the BA is (weakly) negatively significant only in the negative binomial model and not in the OLS model.

All in all, the results reveal that it does not make big difference for explaining initial firm size whether employment is measured in full-time equivalents or in head counts. This seems to confirm our supposition that due to the highly variable work load in very young firms the working hours agreed in labor contracts are not necessarily a more meaningful indicator of employment than the number of persons employed.

## Conclusions

In this paper we examined how specific and generic human capital of a new born firm's founders affects the choice of initial size. Since it is well known that initial size has a positive impact on

early firm survival, getting a more detailed picture of the determinants of initial firm size is desirable. As most of the rare literature on initial firm size focuses on industry characteristics we contribute to the understanding of the determinants of initial firm size by drawing attention to firm-specific factors such as founders' human capital composition and entry strategies. We apply two different models, the first explaining the determinants of start-up size measured in full-time equivalents, the second using head counts.

For generic human capital we find that having a university degree has a positive influence on total employment for both full-time equivalents and head counts. The same applies for general working experience proxied by the founder's age. For the specific human capital components we find that successful entrepreneurial experience and managerial experience gained in dependent employment support a higher start-up size. Altogether, specific human capital tends to have a larger impact on initial size than generic human capital.

Furthermore, the chosen entry strategy crucially determines initial size. Both models reveal that firm formations driven by opportunity as well as spin-out entrepreneurship start at a larger scale.

In order to provide comparable results we controlled for various industry variables. Our results are by and large in line with the existing literature. Industry size and average labor costs in the industry are found to have a negative effect on the start-up size while operations start at a larger scale if the minimum efficient scale observed in the respective industries is higher.

Our results show that it is useful to account for founder-specific, firm-specific as well as industry specific factors for a better understanding of the size distribution of new born firms.

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