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Start-up size: The role of external financing

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Abstract

We investigate the role of external financing in influencing firms' start-up size. The econometric estimates run on a sample of Italian young firms operating in high-tech industries highlight that bank debt-financed firms are not larger than firms created only through founders' personal savings, while firms that received external private equity financing have greater start-up size.

Keywords: Firm start-up size; External financing; Financial constraints; New technology-based firms

JEL classification: L11

1. Introduction

What determines start-up size? The few empirical studies addressing this question have focused attention mainly on specific characteristics of the industry in which new firms are going to operate (Mata, 1996; Mata and Machado, 1996; Görg et al., 2000) and in founders' human capital (Mata, 1996; Åstebro and Bernhardt, 1999; Colombo et al., 2004). The aim of this paper is to consider the effects on start-up size of different modes of financing. Following Modigliani and Miller (1958) in a frictionless capital market, the mode of financing should have no influence on start-up size. On the contrary, according to the "financing hierarchy" hypothesis (Fazzari et al., 1988) the cost of external financing exceeds the opportunity cost of internal finance (i.e. personal capital, including personal savings of

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entrepreneurs, family members and friends); under such circumstances, things may turn otherwise. In fact, if the amount of personal wealth the founding team has access to is lower than the capital required to start the new venture at the optimal size, entrepreneurs will look for bank loans. Nevertheless, the amount of loans that can be obtained by banks may still be insufficient to start operations at the desired scale either because credit is rationed or because beyond a threshold value debt financing becomes too costly. In order to deal with credit constraints, the entrepreneur will then look for external sources of equity capital, such as venture capitalists and other financial and industrial firms. If her search for additional equity financing is successful, financial constraints will be relaxed. Therefore, we expect a positive relation between firm's start-up size and access to both bank loans and external private equity, with the positive impact of the latter being larger than that of the former. While the available empirical evidence suggests that new firms suffer from financial constraints[1] (Evans and Jovanovic, 1989; Evans and Leighton, 1989; Meyer, 1990; Black et al., 1996; Blanchflower and Oswald, 1998) and these constraints limit firms' initial size (Holtz-Eakin et al., 1994; Åstebro and Bernhardt, 1999), this is the first work to our knowledge that directly addresses the role of different modes of external financing in shaping start-up size decision. The remainder of the paper is organized as follows. Section 2 describes the data source. In Section 3, we describe the empirical model specification. Section 4 comments on the empirical results. Summarising remarks in Section 5 conclude the paper.

2. The data

We consider a sample composed of 391 Italian new technology-based firms (NTBFs) that operate both in manufacturing and service industries. Sample firms were established in 1980 or later and were independent at start-up time (i.e. they were not controlled by another business organization). The sample of NTBFs was extracted from the RITA (Research on Entrepreneurship in Advanced Technologies) database developed at Politecnico di Milano. The RITA database contains detailed information on more than 400 Italian NTBFs and more than 1000 of their founders (see Colombo et al., 2004 for a description of the database and the procedure used to collect data).

3. Variables and estimation procedure

Start-up size is measured as the number of firms' employees measured 12 months after the date on which the new firm was incorporated. We define the number of firms' employees as the sum of the number of salaried personnel and the number of founders (i.e. individuals who were shareholders of and took managerial positions in the newly created firm).[2]

We regress the (log) of start-up size on a set of dummy variables (*DDebt* and *DPrivate equity*) indicating the different modes of financing used to constitute firm's initial capital.[3] We control for other

[1] Note however that this view is not unanimously shared in the literature (see for instance Cressy, 1996, 2000).

[2] The inclusion of the number of founders in start-up size is based on the evidence that founders account for a sizeable portion of a new firm's workforce. In our sample the mean number of founders is 2.35, while the mean number of salaried personnel at start-up time is 4.42.

[3] We measure start-up size after 12 months since the date on which the new firm was incorporated while the different modes of financing refer to founding time; so possible reverse causality problems should be very limited.

covariates suggested by previous works (Mata and Machado, 1996; Mata, 1996; Åstebro and Bernhardt, 1999; Görg et al., 2000; Colombo et al., 2004) such as measures of founders' human capital (*Workexp*, *Education*, *DManager*), start-up's specific characteristics (*DIncubated* and *DMother Company*), industry's characteristics (*Mes*, *Suboptimal*, *Uncertainty*) and other variables reflecting the socio-economic environment in which new firms are created (*Rreal* and *Infrastructure*). Table 1 illustrates in detail the explanatory variables. As to financing variables note that the baseline in the estimates is given by firms whose initial capital was exclusively formed by founders' personal savings. Note also that correlation across explanatory variables (available upon request from the authors) suggests the absence of any relevant problem of multicollinearity. In particular the values of correlation coefficients between human capital variables and modes of financing are negligible.

Finally, as highlighted by Mata (1996), OLS estimations are likely to be biased because of the truncated nature of the sample. First, we only observe those firms that were actually founded and we do not have any information on those individuals who wanted to become entrepreneurs but had to give up the idea. The effective size of firms founded by such individuals is zero and naturally it can not be observed. Second, due to the survey-based nature of the data set, we do not have information on firms that entered the market but failed and exited before the survey date. To take into account these factors, in

Table 1
The explanatory variables of firm size

Variable	Description
DDebt	One for firms financed by bank debt
DPrivate equity	One for firms financed by private equity (i.e. external equity provided by business angels, venture capital firms, other financial intermediaries, and other firms)
Education	Average number of years of founders' education before firm's foundation
Workexp	Average number of years of founders' working experience before firm's foundation
DManager	One for firms with one or more founders with a prior management position in a large or medium company (i.e. number of employees greater than 100)
DMother company	One for firms that at start-up time, received some aid by a "mother" company
DIncubated	One for firms located in a technology incubator
Rreal	Real interest rate in the year of firm's foundation[a]
Infrastructure	Value of the index measuring province infrastructures in 1989 (mean value among Italian provinces = 100)[b]
Mes	Minimum efficient scale in the sector of the start-up in the year in which the firm was created (or in the nearest year for which data were available) measured by the log of the average number of employees[c]
Suboptimal	Proportion of employment in the sector of the start-up absorbed by firms that operate at sub-optimal scale in the year in which the firm was created (or in the nearest year for which data were available)[c]
Uncertainty	Industry average of the normalised standard deviation of the market price of newly listed firms in the 50 days following the IPO[d]

[a] Data source: Banca d'Italia (2001).

[b] Index provided by Confindustria Centro Studi (1991) and calculated as the average in 1989 of the following indexes: per-capita value added, share of manufacturing out of total value added, employment index, per capita bank deposits, automobile–population ratio, and consumption of electric power per head. The Italian benchmark value is 100.

[c] Available industry data refer to years 1981, 1991 and 1996. Data are from the ISTAT Census of firms.

[d] Computed using data on 482 IPOs that occurred between 1996 and 2001 in five European new stock markets (Neuer Markt, Nuovo Mercato, Nouveau Marchè, Euro NM, Nmax) extracted from the database on European initial public offerings (IPO) that was jointly developed by Politecnico di Milano and Tilburg University. See Giudici and Roosenboom (2002) for a description of the database.

addition to OLS estimates we also run truncated regressions and sample selection models with incidental truncation (see Bloom and Killingsworth, 1985).[4]

4. Results

The results of the econometric analysis are reported in Table 2. For each model, column (1) presents ordinary least squares (OLS) results, column (2) presents the truncated regression model while column (3) reports estimates of the sample selection model with incidental truncation.[5] Let us initially focus on Model I. In contrast to our expectations, the coefficient of *DDebt* is not significantly different from null. The initial size of firms does not significantly differ according to whether founders have used only personal capital to start the new firm or have managed to obtain a bank loan. If one considers the small mean amount of funds provided by banks to the NTBFs that obtained debt capital (about 47,000 €), this result is not entirely unexpected. Things turn otherwise when we focus our attention to private equity financing. In fact *DPrivate equity* has a positive coefficient significant in all estimates. While venture capitalists and other financial and corporate investors seldom provide seed and start-up capital to Italian NTBFs[6], when they do so their conspicuous investment (on average 280,000 €) generally enables founders to start operations at a relatively large scale. As concerns founders' human capital variables, in accordance with previous works (Mata, 1996; Åstebro and Bernhardt, 1999; Colombo et al., 2004), the working experience gained by founders in previous jobs captured by *Workexp* and managerial competencies possessed by the founding team reflected by *DManager* have a positive and statistically significant impact on initial size. On the contrary, the coefficient of *Education* is positive but statistically insignificant at conventional confidence levels.[7]

In Model II we add interactive terms between variables that refer to external financing (*DDebt* and *DPrivate equity*) and the only statistically significant variables capturing the level of human capital of founders (*Workexp* and *DManager*). Interactive terms between the human capital variables and the bank debt dummy turn out to be insignificant. As to private equity financing, the coefficients of both

[4] As long as regressors affect not only entry but also the probability of survival in the following years, both the truncated and the sample selection model with incidental truncation may also be viewed as attempts to account for the existence of a sample selection bias. In particular, there may be a systematic correlation between the age of sample firms and their start-up size. In fact if failure rates decrease with start-up size, there is the risk that as the firms in the sample get older, we get responses from fewer of them and those that respond were larger at founding. Anyway note that this possibility seems not to be confirmed by both our data (the Pearson correlation index between firms' start-up size and their age at survey date is 0.0186) and by previous work dealing with Italian firms (see Audretsch et al., 1999; Del Monte and Scalera, 2001).

[5] Following Mata (1996), we include as regressors into the selection equation of the sample selection model those covariates that refer to the human capital of founders. Muthen and Jöreskog (1983) and Maddala (1986) have questioned the ability of the model to catch the "selection" decision since estimates of the parameters of the selectivity portion of the model are derived only through functional form and therefore are often unreliable. For this reason, they are not reported in the paper; they are available from the authors upon request. Note also that sample selection model estimates are reported only when it was possible to rule out the non-identification issue (i.e. both the variance of the error term of the regression equation and the covariance between the error terms of the regression and threshold equations are different from zero at 95% level).

[6] Only 4% of the sample firms benefited from a private equity investment at start-up time, while almost 20% obtained a bank loan.

[7] This result partially differs from those of previous works (Mata, 1996; Cabral and Mata, 2003) but is consistent with Åstebro and Bernhardt's (1999) findings.

Table 2
The effect of external financing on start-up size

	Model I			Model II	
	(1) OLS	(2) Truncated	(3) Sample selection	(1) OLS	(2) Truncated
Constant	1.7332 (0.7435)**	1.7192 (0.9519)*	−0.4084 (1.4132)	1.6089 (0.7358)**	1.5774 (0.9202)*
DDebt	−0.0366 (0.0943)	−0.0470 (0.1228)	−0.0238 (0.0874)	−0.0832 (0.1654)	−0.1014 (0.2119)
DPrivate equity	0.6452 (0.1973)***	0.7111 (0.2309)***	0.3311 (0.1579)**	−0.2405 (0.3556)	−0.2387 (0.4353)
Education	0.0111 (0.0157)	0.0132 (0.0202)	0.0654 (0.0478)	0.0072 (0.0156)	0.0085 (0.0196)
Workexp	0.0106 (0.0046)**	0.0134 (0.0059)**	0.0422 (0.0166)**	0.0057 (0.0054)	0.0073 (0.0068)
DManager	0.4774 (0.1385)***	0.5735 (0.1676)***	1.2426 (0.4028)***	0.3492 (0.1459)**	0.4288 (0.1752)**
DDebt × Workexp	–	–	–	0.0024 (0.0101)	0.0028 (0.0126)
DDebt × DManager	–	–	–	−0.0996 (0.7672)	−0.1005 (0.9614)
DPrivate equity × Workexp	–	–	–	0.0477 (0.0238)**	0.0490 (0.0277)*
DPrivate equity × DManager	–	–	–	0.7290 (0.6064)	0.6758 (0.6850)
DMother company	0.5342 (0.1238)***	0.6256 (0.1484)***	0.5498 (0.1275)***	0.5844 (0.1231)***	0.6730 (0.1447)***
DIncubated	−0.1275 (0.1199)	−0.1665 (0.1572)	−0.0377 (0.1388)	−0.1161 (0.1185)	−0.1492 (0.1512)
Rreal	−0.0184 (0.0200)	−0.0236 (0.0251)	−0.0176 (0.0205)	−0.0146 (0.0199)	−0.0185 (0.0244)
Infrastructure	0.0027 (0.0014)*	0.0037 (0.0018)**	0.0022 (0.0015)	0.0025 (0.0013)*	0.0034 (0.0017)*
Mes	0.1856 (0.1165)	0.2305 (0.1459)	0.1361 (0.1164)	0.2450 (0.1162)**	0.2964 (0.1423)**
Suboptimal	−1.3583 (1.6964)	−1.6137 (2.1164)	−0.6856 (1.6410)	−1.1358 (1.6832)	−1.3383 (2.0489)
Uncertainty	−23.1860 (13.3242)*	−31.1662 (17.4734)*	−22.8011 (13.7464)*	−19.0201 (13.2457)	−25.5703 (16.9916)
σ	–	0.8490 (0.0429)***	0.9840 (0.0926)***	–	0.8261 (0.0411)***
ρ	–	–	0.8390 (0.0546)***	–	–
R^2	0.1895	–	0.2190	–	–
Log-likelihood	−437.1872	−415.2363	−427.6171	−429.9492	−410.1241

*Significance level greater than 90%; **Significance level greater than 95%; ***Significance level greater than 99%. Standard errors in parentheses. Sample selection Model II is not identified (i.e. both σ and ρ are not statistically different from zero at 95%). Parameters of the selectivity portion of the sample selection model are not reported (see footnote 5).

interactive terms are positive; the null hypothesis that they are equal to zero can be rejected at 99% in the truncated regression model by an LR-test ($\chi^2_{(2)}=10.20$).[8] In this specification the coefficient of *DPrivate equity* is insignificant. The coefficients of *Workexp* and *DManager* are positive but only the latter one is significant (at 95%). In the truncated regression, an LR-test rejects at 90% the null hypothesis that the coefficients of *Workexp* and the interactive term *Workexp* × *DPrivate equity* are jointly equal to zero ($\chi^2_{(2)}=5.23$). The same is true for the coefficients of DManager and the interactive term *DManager* × *DPrivate equity*, where the null hypothesis is rejected at 95% ($\chi^2_{(2)}=8.69$). Such results point to the complementarity between entrepreneurial ability and external equity financing. With all else equal, entrepreneurs with a high level of human capital that manage to get access to external equity capital are able to start operations at a much larger scale than similarly skilled individuals who only resort to personal savings or bank debt. On the contrary, *DPrivate equity* has no positive impact on the start-up size of firms founded by individuals with low levels of human capital. If we also consider that estimates of probit models reveal that human capital variables are quite poor predictors of recourse to external equity financing (the results are available from the authors upon request), these findings suggest that Italian high-tech firms suffer from binding financial constraints at start-up time.[9] In other words, there seems to be a considerable number of highly skilled entrepreneurs who are forced to start operations at suboptimal size, as they do not have access to external financing.

5. Concluding remarks

Italian NTBFs that at start-up time were financed integrally by the personal savings of founders, founders' family members and friends were found not to be undersized with respect to those that resorted to bank debt. This result may be explained by the limited amount of funds generally provided by banks to Italian new high-tech outfits and points to the capital market imperfections that make debt inefficient in financing this category of firms, an issue that was already raised by previous studies (see for instance Storey, 1994; Westhead and Storey, 1997; Carpenter and Petersen, 2002). The extant literature also claims that external private equity financing plays a key role in overcoming these imperfections. Our findings are supportive of this contention. First, only few sample firms got access to private equity financing but the provision of this type of financing had a strong positive effect on start-up size. Even more interestingly, this holds true only for firms established by individuals with a sufficiently high level of human capital. In fact, highly qualified entrepreneurs that obtained access to external private equity financing started operations at a much larger scale than similarly skilled individuals who only relied on personal capital (and bank debt). Conversely, as to firms established by low human capital individuals, the mode of financing basically made no difference. Note also that the likelihood of receiving seed and start-up equity capital from external sources appears not to be correlated with founders' human capital.

Even though the above findings should be interpreted with caution due to the relatively small size of the sample (and especially the small number of firms that obtained external private equity financing),

[8] *F*-tests run on the OLS estimates give the same results as LR-tests run on truncated regressions. The sample selection model is not identified in this case.

[9] Survey-based evidence on Italian high-tech start-ups also supports this view (see for instance Giudici and Paleari, 2000). If there were no financial constraints and access to external equity financing were simply a signal of the quality of entrepreneurial projects, *DPrivate equity* should exhibit a positive statistically significant coefficient also in Model II.

altogether they suggest that individuals with greater entrepreneurial ability are those who most likely suffer from binding financial constraints, a phenomenon that was already highlighted in the literature in a different context ("the winner's curse of human capital", see Åstebro and Bernhardt, 1999). In Italian high-tech industries, there seems to be a considerable number of new firms that are in such a situation and thus are forced to start operations at a sub-optimal scale.

In addition, one should assume that the quality of NTBFs and the human capital of their founders are unrelated; this is not consistent with the available empirical evidence (for a survey, see Storey, 1994).

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