

What factors determine the use of venture capital?
Evidence from the Irish software sector

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Abstract

We address the venture capital financing issue from the firm's perspective. Using survey data for 110 new technology-based firms (NTBFs) in the Irish software sector, we assess the extent to which 5 human capital and 3 other variables determine the firm's use of venture capital. Education of the lead founder to degree level is the only significant human capital variable, and it is directly related to the likelihood of being venture capital-backed. Venture capital-backed firms have significantly higher start-up costs, and their founders are less averse to loss of control than non-venture capital-backed firms. We conclude that the use of venture capital is dictated largely by the willingness of founders to relinquish control.

1. Introduction

It is widely agreed that technology-based small and medium-sized enterprises (SMEs) are becoming increasingly important sources of employment generation and economic growth. These new technology-based firms (NTBFs)¹ are major conduits for translating scientific knowledge into commercial products and processes, and play a vital role in the development and diffusion of innovation. In order for such firms to be established and to grow, it is crucial that they receive appropriate finance at start-up, through to commercialisation and growth.

Academics and practitioners agree that venture capital is the most appropriate source of finance for NTBFs. The venture capital appraisal and selection process is reasonably well understood. Venture capitalists tend to favour firms with competent, experienced management teams in growth industries. In contrast, there is little evidence on the demand side in the venture capital equation. Using survey data for 110 privately held indigenous Irish software companies,² of which 54 are venture capital-backed and 56 are not, we investigate what factors determine the use of venture capital in NTBFs. The venture capital literature suggests that variations in human capital are critical determinants of equity investment in high technology ventures. Similarly, the entrepreneurship literature places human capital factors, such as the educational background and management experience of founders, at the centre of its analysis of the foundation, survival and growth of new ventures. We use 5 human capital variables as potential explanatory variables in our model. Four relate to traits of the lead founder: education to degree level and to post-graduate level, prior start-up experience, and management experience in the software sector. The fifth human capital variable is the size of the founding team.

Three additional factors complete our set of explanatory variables. It is well understood in the NTBF literature that the longer the product lead time, the greater the necessary initial capital injection, and therefore the more likely that the firm will require external funding (Oakey, 1984 and 1995; Roberts, 1991; Bank of England 2001). We include product lead time and start-up costs as explanatory variables in our model. The final variable measures the extent to which NTBF owner-managers are prepared to cede control of their businesses. One of the truisms of entrepreneurship theory and evidence is the goal of independence (Bolton, 1971). To obtain venture capital backing, owner-managers must relinquish considerable independence in decision-making and control of their businesses.

¹ NTBFs are defined by Little (1977) as independent ventures less than 25 years old that supply a product or service based on the exploitation of an invention or technological innovation.

² Irish-based manufacturers produce over 40 percent of all packaged software and 60 percent of all business software sold in Europe. The Irish software industry generated over €8.5 billion in export revenue in 2000 (National Informatics Directorate, 2001).

Our study yields three particularly interesting findings. *First*, we find that venture capital-backed firms have higher start-up costs than firms that are not venture capital-backed. However, this cannot be explained by longer product lead times requiring greater initial capital, because we find no relation between venture capital backing and product lead times. The software sector may be unique amongst high-technology sectors in this respect because software products have rather short lead times (the median lead time in our sample is 12 months). The most plausible explanation for the positive relation between start-up costs and venture capital backing amongst our sample of software firms is that venture capitalists tend to avoid smaller start-ups.

Second, only one human capital factor – education of the lead founder to degree level – is significantly related to venture capital backing. This may be explained by superior education enabling founders to better negotiate with potential financiers (Oakey, 1984). Alternatively, educated founders may be keener to see their businesses grow, in which case it is likely that external funding will be required to support this growth. Growth firms tend to be more highly geared than non-growth firms (Chittenden, Hall and Hutchinson, 1996), and external equity is more likely to feature as a source of financing in fast-growth firms (Cosh and Hughes, 1994). The explanatory variables relating to founders' work background – prior start-up experience and management experience in the software sector – are not significant determinants of venture capital use. We investigate and reject one possible explanation for this finding; that founders with prior experience bring sufficient accumulated wealth to the business that they do not need to seek outside finance.

Third, the most important determinant of venture capital backing for our sample of Irish software firms is the owner-manager's willingness to relinquish control. The 'control' variable is a measure of the extent to which founders express a preference to maintain ownership of 50 percent or more of their firm's equity. Consistent with prior findings for SMEs, this shows that NTBF owner-managers' motivations and goals play a key role in the financing decision. While venture capital finance may be the most appropriate source of finance for high technology firms, it is clear that many NTBF founders do not seek venture capital finance because they are unwilling to relinquish control.

The remainder of our paper is structured as follows. The next section presents hypotheses for the relation between our eight independent variables and venture capital funding. Section 3 discusses our survey methodology and presents summary data on the characteristics of the sample firms and on the explanatory variables. Section 4 contains a univariate analysis of each explanatory variable with respect to venture capital funding, and section 5 presents the results of our multivariate analysis. Section 6 summarises and concludes.

2. Hypotheses

Empirical studies of the venture capital selection process stress the importance of human capital variables in investment appraisal (Tyebjee and Bruno, 1981 and 1984; MacMillan, Siegel and SubbaNarasimha, 1985; Zackarakis and Meyer, 1998; Muzyka, Birley and Leleux, 1996; Manigart et al, 1997). Similarly, human capital variables have been found to be important determinants of the foundation, survival and growth of new ventures. Human capital variables can be divided into three main categories: educational background, prior work experience, and the size and composition of the founding team. In addition to 5 human capital variables, we include 3 additional explanatory variables drawn from the SME and high-technology firm literature: initial start-up costs, product lead time, and a measure of the extent to which founders are willing to cede control of their businesses. The NTBF literature demonstrates that product lead time and start-up costs are positively related to external financing, and the 'willingness to cede control' variable is included because there is very strong evidence from the SME literature that independence and control are the most important objectives of owner-managers.

Educational background

Academic qualifications are not seen as an important venture capital selection criterion. In contrast, education is often used as a potential explanatory variable in research on the performance and growth of small firms. In a review of 18 studies looking at the determinants of SME growth, Storey (1994) concluded that education and growth are directly related. In high-technology industries, education to degree level has a positive effect on both growth (Van der Ven and Schroeder, 1984; Roberts, 1991; Jo and Lee, 1996; Almus and Nerlinger, 1999; Wilbon, 1999) and firm performance (Van der Ven and Schroeder, 1984; Jo and Lee, 1996). This significantly positive relation, however, does not hold for education beyond degree level (Almus and Nerlinger, 1999; Roberts, 1991).

How might educational background impact on the founders' demand for funds? Poutziouris, Chittenden and Michaelas (1998) found a positive relation between education and gearing in SMEs generally. Insofar as founders with degrees are keen to see their businesses grow, it is likely that such firms will require external funding in order to support this growth. Growth firms tend to be more highly geared than non-growth firms (Chittenden, Hall and Hutchinson, 1996), and external equity is more likely to feature as a source of financing in fast-growth firms (Cosh and Hughes, 1994; Storey et al, 1989). Oakey (1984) argued that the superior educational background of technology entrepreneurs gives them advantages over their blue-collar counterparts because they are better equipped to prepare loan applications and to negotiate with professional agencies. Some researchers have postulated that educational attainment may be an important factor in contributing to lower levels of failure reported in high technology new firms (Roberts 1991; Storey and Tether, 1998; Almus and Nerlinger, 1999), in which case firms with highly educated founders may find it easier to obtain finance. We therefore hypothesise that education to degree level will be directly related to venture capital backing, and as

education beyond degree level appears to have no impact on the performance of high technology firms, education beyond degree level will be unrelated to venture capital financing.

Hypothesis 1: Human capital, as measured by education to degree level, is positively related to the firm's probability of being venture capital-backed.

Hypothesis 2: Human capital, as measured by education beyond degree level, does not impact on the firm's probability of being venture capital-backed.

Prior work experience

The prior industry experience of the lead entrepreneur is critical in the venture capital selection process. MacMillan, Siegel and SubbaNarasimha (1985) found that amongst the most important selection criteria used by venture capitalists, the lead entrepreneur's track record and knowledge of the market were ranked eighth and second respectively. Similarly, Muzyka, Birley and Leleux (1996) found the management team's industry experience, track record, sales experience and administrative capabilities among the top 10 selection criteria. These findings support the received wisdom that venture capitalists like to back 'strong teams.'

Stinchcombe (1965) argued that new organisations have high failure rates because founders can encounter problems adjusting to new roles and working relationships, and because they lack a track record. Prior start-up experience should therefore improve the firm's chance of survival. Stuart and Abetti (1990) found a strong positive relation between entrepreneurial experience and performance. Consistent with Stinchcombe's (1965) *liability of newness* argument, founders who have previously started a business should have a greater knowledge of financing issues and familiarity in dealing with potential providers of finance.

Hypothesis 3: Prior experience in starting a business is positively related to the software product firm's probability of being venture capital-backed.

Studies of the venture capital appraisal process show that venture capitalists tend to favour firms founded by people with relevant experience in the industry (MacMillan, Siegel and SubbaNarasimha, 1985; Muzyka, Birley, and Leleux, 1996). Cooper and Bruno (1977), Feeser and Willard (1990), Jo and Lee (1996) and Wilbon (1999) reported a positive relation between prior experience in a similar industrial sector and the performance of the new venture. In contrast, Van der Ven and Schroeder (1984) and Stuart and Abetti (1990) found no relation. Stinchcombe (1965) argued that it is not merely industry experience that is important in improving the chance of success of a new business, but that experience as a supervisor and coordinator of co-workers and

employees is critical. We therefore hypothesise that prior management experience in the software sector will be positively related to being venture capital-backed.

Hypothesis 4: Human capital, as measured by the number of years of management experience in the software sector, is positively related to the software product firm's probability of being venture capital-backed.

Size of the founding team

The venture capital literature is unanimous in its support for venture teams. There is a strong intuitive argument for the benefits of multi-founder businesses, in that 'many hands make light work'. A few studies have examined the relation between the size of the founding team and small business performance, but there is little consistency in these findings. Two studies reported no impact (Stuart and Abetti, 1990; Almus and Nerlinger, 1999), one reported a negative relation (Van de Ven and Schroeder, 1984), and two reported a positive relation (Cooper and Bruno, 1977; Roberts, 1991).

Because starting a business is a complex and multi-tasking process, a founding team ought to increase the new venture's chances of survival and subsequent growth (Roure and Maidique, 1986; Roure and Keeley, 1990; Eisenhardt and Schoonhoven, 1990). Insofar as firms with founding teams are more likely to grow, it might be expected that teams would have a greater propensity to seek outside financing in order to support the anticipated growth. While the 'team' variable in explanatory models has been operationalised in several different ways, we follow Cooper and Bruno (1977), Van der Ven and Schroeder (1984), Roberts (1991) and Almus and Nerlinger (1999), and used the number of founders as an independent variable.

Hypothesis 5: Human capital, as measured by size of founding team, is positively related to the firm's probability of being venture capital-backed.

Product lead time and start-up costs

NTBFs differ from the general population of start-ups in that they are characterised by an intensive period of research and development early in their life cycle. There is considerable evidence that the longer the product lead time, the more likely it is that the firm will require external funding (Oakey, 1984 and 1995; Roberts, 1991; Bank of England 2001). NTBFs in the biotechnology sector, for example, are more likely to require venture capital funding than firms in other high-tech industries because they face longer product lead times and take longer to reach break-even point than their counterparts in the electronic and software sectors (Oakey, 1995).

Hypothesis 6: The longer the lead time, the more likely it is that the firm is venture capital-backed.

As a corollary to this hypothesis, firms with longer product lead times will have higher start-up costs. Biotechnology start-ups are less likely than other NTBFs to be fully funded by their founders in the early stages. Oakey (1995) found that 76 percent of software companies were totally internally funded in their first year of operation, compared to 45 percent of biotechnology firms. We test the hypothesis that founders facing higher start-up costs will be more likely to be venture capital-backed.

Hypothesis 7: The higher the start-up costs, the more likely it is that the firm will be venture capital-backed.

The non-financial objectives of founders

One of the strongest stylised facts from the entrepreneurship literature is that independence is the primary objective of owner-managers in small firms (Boyer and Roth, 1978; Cooley and Edwards, 1983; Ang, 1991 and 1992; Mac Mahon et al, 1993; LeCornu et al, 1996). The unwillingness of owner-managers to relinquish control will predispose them to self-funding (Cosh and Hughes, 1994; Poutziouris, Chittenden and Michaelas, 1998; Berger and Udell, 1998). LeCornu et al (1996) demonstrated the significance of this motivation by testing the importance of a series of non-financial objectives to small firm owner-managers, based on their willingness to sacrifice financial return on investment. While various non-financial objectives were considered important, owner-managers were unwilling to give up financial reward to achieve these objectives, with the exception of independence and control. Owner-managers must give up a substantial equity stake in return for venture capital support – typically 50 percent (Kaplan and Stromberg, 2003). Founders in venture capital-backed firms must therefore be willing to cede control of their businesses.

Hypothesis 8: The willingness of NTBF founders to cede control of their businesses is positively related to venture capital backing.

3. Survey and sample characteristics

The software sector is sub-divided into 'products' and 'services'. Software products refer to packaged software that is generally produced in large volumes for mass markets,³ while software services include consulting, implementation, support services, operations management and training. We define software product companies as those that are primarily involved in the development and commercialisation of their own products. There is no comprehensive database of independent software firms in Ireland. Our sample population was therefore compiled using a variety of information sources, including lists provided by the Irish Software Association (now the National Informatics Directorate), lists of occupants of innovation parks, lists of participants in a national technology

³ This can be distinguished from 'bespoke' software, which is provided on a client-by-client basis.

entrepreneurship award program, and firms cited in specialist journals. At the end of 2001 there were 257 indigenous software product SMEs in Ireland.

We based our survey design on self-administered questionnaires using the tailored design method (Dillman, 1976 and 2000). The survey was administered by mail and addressed to named CEOs or managing directors. A covering letter requested that the surveys be completed by the founder, or by the lead founder if the company had been founded by a team. Respondents were given the choice of completing either a paper or web version of the questionnaire. The first follow-up contact was also by mail, and the second follow-up was by telephone. The final contact was via e-mail, and it contained a link to the web version of the questionnaire. The number of valid questionnaire returns was 117, giving an impressive response rate of just under 46 percent.⁴ The number of venture capital-backed and non-venture capital-backed firms in the study is similar: 56 of the 110 firms (51 percent) for which data is available have not received venture capital backing, and 54 (49 percent) were funded by venture capitalists.⁵

The survey was successful in targeting the lead founders of indigenous software companies. Most respondents described their position as either founder and CEO (54 percent), or founder, technical director and CEO (28 percent). The remaining 18 percent held other key positions in the company. Seven percent described their roles as founder and technical director, 6 percent said they were founder and sales/marketing director and 2 percent were founder and chief operations officer. 'Other' included two founders who were chairpersons and two founders who described their role as joint CEO.

A summary of the eight independent variables used in our analysis, together with a brief description of how they have been operationalised and their predicted relation to venture capital backing, is presented in Table 1. Table 2 provides summary information on the sources of finance for current investment requirements (as at the time of the survey) for the 96 firms in the sample that provided detailed funding information. The figures for the full sample show a 50/50 divide between internal and external sources. A mere 4 percent of financing was sourced from banks, and the remaining outside finance (46 percent of the total financing requirement) was equity (39 percent) and grants (7 percent). Venture capital comprised an average of 28 percent of financing for the sample firms, with the largest representation amongst firms 2-4 years old. This figure is considerably higher than the 10 percent found by Moore (1994) for British high technology firms.

⁴ Response rates of 10 percent and less are commonly reported in small business mail surveys (Curran and Blackburn, 2001).

⁵ Seven firms were excluded on the basis that they provided insufficient information on whether or not they had received venture capital funding.

Human capital variables

Table 3 summarises the human capital characteristics of the sample respondents. Panel A relates to first degree qualifications, and Panel B presents the proportion of the lead founders with post-graduate qualifications. Panels C and D summarise the findings on prior experience; the former relating to prior start-up experience and the latter reports whether or not the lead founder had had prior management experience in the software sector. Panel E, presents the data on team size – that is, the number of founders.

Software firm founders in Ireland are highly educated. Eighty-five percent are educated to degree level, and close to half (48 percent) have post-graduate qualifications. These proportions are slightly higher but comparable to those reported by Westhead and Storey (1994), who found that 78 percent of high technology entrepreneurs had a primary degree and 44 percent had a higher degree. As well as being highly educated, the sample firm founders have considerable experience. Almost half (44 percent) are ‘serial founders’ (Panel C). This is higher than the comparable finding by Westhead and Storey (1994) that 31 percent of founders in high technology manufacturing and services had previously been involved in starting a business. Panel D shows that the majority of founders – 61 percent – have at least 3 years prior management, of which two-fifths have more than 5 years software management experience. One-quarter of the sample have no previous management experience.

Panel E shows that a rather high three-quarters of sample firms were founded by teams. This is consistent with prior research showing that NTBFs are more likely to be started with teams rather than single founders (Cooper 1971, and Roberts, 1991). A popular way of starting a business is with a pair of founders (one-third), but the sample is dominated by teams of 3 or more (more than 40 percent).

Other variables

Table 4 reports the summary findings on product lead time (panel A), which is the time it took the firm to produce its first product beta, start-up costs (panel B) and the responses for the survey question relating to control (panel C). Panel A shows that the software products produced by the sample firms have relatively short lead times. In 5 percent of cases, a fully developed product beta was available at start-up, and over half had a product beta available by the end of their first year in business. Ninety percent had their first product beta ready by the third year after formation. Panel B of Table 4 shows that almost half had very low start-up costs of less than €63,500. However, while most businesses – almost 60 percent – began with less than €63,500, 10 percent had large initial capital injections of over €1.27 million.

Panel C reports the responses to the statement “Prefer to retain a majority stakeholding (50% or more) in the business for founder(s).” Founders were asked to respond on a scale from 1 to 5, where 1 is ‘not at all’ and 5 is ‘to a large extent,’ implying that the

higher the response number, the more control-oriented is the founder, and the less willing he or she is to relinquish control of the business. Unlike entrepreneurs in general, many of the sample software founders were not concerned about retaining control. In fact, the sample is split very close to 50/50 between those who were very concerned about retaining control (points 4 and 5, totalling 32.2 percent) and those who were clearly willing to relinquish control (points 1 and 2, totalling 29.6 percent).

4. Univariate analysis

Education

Figure 1 shows that lead founders with venture capital backing are more likely to be educated to degree level than founders without first degrees. Only 3 out of 54 firms with venture capital backing have founders who are not educated to degree level, compared with 15 out of 56 founders in firms without venture capital backing. This difference is significant at the 1 percent level ($p = 0.00$) using a z-test for difference in proportions, providing support for hypothesis 1. Figure 2 is the equivalent graph for post-graduate qualifications. Consistent with hypothesis 2, there does not appear to be a significant difference between the venture capital-backed and non-venture capital-backed founders in their post-graduate qualifications. Thirty-one out of 54 venture capital-backed (57 percent) founders and 34 out of 56 (61 percent) non venture capital-backed founders have post-graduate qualifications. A z-test for difference in proportions confirms no significant difference ($p = 0.72$).

Previous experience in start-ups

Figure 3 depicts the relation between the respondents' previous experience in starting a business and venture capital backing. Perhaps surprisingly, and contrary to hypothesis 3, venture capital backing appears to be more likely when the founder has not previously been involved in a start-up. Twenty-seven out of 56 (48 percent) non venture capital-backed firm founders had previously been involved in a start-up, whereas only 21 out of 54 (39 percent) venture capital-backed founders had started a business in the past. This difference, however, is not significant using a z-test for difference in proportions ($p = 0.32$).

Prior management experience in the software industry

Figure 4 depicts our findings on prior management experience in the software sector, separated into venture capital and non venture capital-backed. Contrary to hypothesis 4, the figure shows that in each 'years of experience' category there is very little difference between the proportion that is venture capital-backed and non-venture capital-backed. In contrast to the evidence from the venture capital industry – for whom management experience is a crucial variable in the appraisal process – it would appear that this variable has little impact on the founder's decision to use venture capital funding.

Size of the founding team

Similarly to the prior experience variable, there appears to be a difference in team size between firms that are venture capital-backed and those that are not. Figure 5 depicts the relation between team size and venture capital funding. Eleven out of 26 (42 percent) single founder firms, and 43 out of 84 (51 percent) firms founded by teams of 2 or more, were venture capital-backed. The difference in proportions venture capital-backed is not significant ($p = 0.43$). This finding is inconsistent with hypothesis 5, which suggests a positive relation between venture capital backing and team size.

Product lead-time

Figure 6 depicts the sample firms by lead time. Contrary to the prediction of hypothesis 6, there appears to be little difference in lead times for venture capital-backed versus non-venture capital-backed firms. This is confirmed by a two-tailed Wilcoxon test, which found that there is no significant difference between the median lead times of the two groups ($p = .23$).

Start-up costs

Although venture capital-backed firms do not have longer product lead times than non-venture capital-backed firms, consistent with hypothesis 7, they do appear to have higher start-up costs. The median non-venture capital-backed firm had start-up costs in the lowest range of less than €63,500, while the median venture capital-backed firm is in the range €127,000 to €317,000. Figure 7 shows that the difference in start-up costs between venture capital-backed and non-venture capital-backed firms is most dramatic in the smallest cost category ($<€63,500$), and in the largest ($>€1,270,000$). Of the 49 firms in the lowest start-up cost category, 63 percent were not venture capital-backed; and of the 10 firms with start-up costs greater than €1,270,000, only 2 were not venture capital-backed. The difference in median start-up costs between venture capital and non venture capital-backed firms is significant at the 1 percent level using a two-tailed Wilcoxon test ($p = .01$).

Control

Hypothesis 8 predicts that founders' willingness to cede control is positively related to venture capital funding. The variable *control* measures the extent to which the founders expressed a preference to maintain ownership of 50 percent or more of the shares of their companies. This variable is measured using a relational scale, where 1 denotes that the respondent is 'not at all' in agreement with the statement and 5 denotes that the respondent is in agreement 'to a large extent', so that higher values for the response to this question imply less willingness to relinquish control. Figure 8 depicts the response for the variable *control*, separated into venture capital-backed and non-venture capital-backed firms. Consistent with hypothesis 8, the figure shows a very strong relation between the founders' willingness to relinquish control and venture capital backing. The mean (median) response to this question for the non-venture capital-backed firms is 3.4 (3.5),

and the equivalent statistics for the venture capital-backed firms is 2.7 (3.0). This difference is significant using a one-tailed Wilcoxon test ($p = 0.00$).

5. Multivariate analysis

In our univariate analysis, we find that only 3 of the 8 variables – education to degree level, start-up costs and willingness to relinquish control – are significantly related to venture capital backing. In addition to providing a more complete investigation of the relative strengths of the extent to which the independent variables influence the likelihood of venture capital use, our multivariate analysis also acts as a robustness check on the univariate findings.

The dependent variable in the multivariate analysis is binary, with zero denoting non venture capital-backed and one denoting venture capital-backed firms. We use the logistic regression (logit model) approach, because the independent variables (see Table 1) comprise a mix of continuous and categorical variables. Usefully, the logit model makes no assumptions about the distribution of the independent variables.⁶

The standard logistic regression model takes the following form:

$$\{ \text{EMBED Equation.3} \} \quad [1]$$

or alternatively, in semi-log format it is conveniently written as

$$\{ \text{EMBED Equation.3} \} \quad [2]$$

Here, p is the probability of observing a ‘success’ given a particular value for each independent variable, X_1, \dots, X_k denote the independent variables, and the β s are the coefficients to be estimated.

The model we estimate is as follows:

$$\{ \text{EMBED Equation.3} \} \quad \{ \text{EMBED Equation.3} \} \quad [3]$$

where p is the probability of observing a venture capital-backed firm.

Using the logit model, a positive coefficient indicates that an increase in the value of the particular independent variable is associated with a higher probability of the event occurring. Thus a variable that displays a positive coefficient implies a direct relation between its value and the likelihood of venture capital funding, and a negative coefficient

⁶ The best-known alternative for modelling binary variables is discriminant analysis, but this is inappropriate because it assumes that the independent variables are multivariate normally distributed (Sharma, 1996).

implies an inverse relation. In estimating our logit models, we maximise the log likelihood function using the Newton-Raphson iterative procedure, together with robust standard errors to allow for any non-spherical disturbances. We begin with the most general specification, including all the independent variables in equation [3]. We then sequentially restrict the model by eliminating the variable of least significance, and re-estimating until we arrive at our parsimonious model. In all iterations convergence was achieved rapidly, occurring after 5 iterations.

The results are presented in Table 5. The first equation includes all 8 independent variables: *degree*, *postgrad*, *startup*, *experience*, *team*, *leadtime*, *costs*, and *control*. Looking at the unrestricted model (Model 1), one explanatory variable is significant at the 1 percent level (*control*), and two are significant at the 6 percent level (*degree* and *costs*). All three have the expected sign. The rest of the variables – *postgrad*, *startup*, *experience*, *team* and *leadtime* are clearly not significant. These findings are completely consistent with those for the univariate analysis.

As can be seen in the results for models 1 to 6, the signs and magnitudes of the coefficients remain robust in the face of this re-specification. Our final parsimonious model is model 6, and it is clear that the same variables that are significant in Model 1 remain significant in Model 6, in which venture capital use is explained by *costs*, *degree* and *control*. These variables have retained their relative coefficient magnitudes and relative significance throughout the sequential restricting of our general model, giving us considerable faith in the robustness of our final result. The variable *control* remained significant at the 1 percent level throughout, but *degree* went from being significant only at the 10 percent level in model 1 to being significant at the 1 percent level in model 6. The variable *costs* remained significant at the 10 percent level, with a p-value of between 0.06 and 0.07.

Human capital variables

Consistent with the results from the univariate analysis, the variable *degree* is the only significant human capital variable the model, and it has the predicted positive sign. The founder having a primary degree is positively related to the firm being venture capital-backed. This finding is consistent with Poutziouris, Chittenden and Michaelas (1998), who found a positive relation between education and gearing in small private and public limited companies.

The education variable *postgrad* was not found to be significant, and was dropped out of the estimation after Model 3. This insignificance supports hypothesis 2, and is consistent with prior research on the relation between a higher degree qualification and NTBF performance (Roberts, 1991, and Almus and Nerlinger, 1999). In the software industry, it is probably true to say that a first degree gives the programmer or engineer a sufficient

start in knowledge and confidence for success in business, and more advanced formal education yields little marginal benefit.

Consistent with the findings from the univariate analysis, the three other human capital variables – start-up experience, prior management experience and team size – are not significant. Hypotheses 3, 4 and 5 cannot, therefore, be accepted.

Prior start-up experience

The argument behind hypothesis 3 is that businesses started by founders with previous start-up experience are less likely to fail, and will therefore have greater success in attracting venture capital. In addition, founders with previous experience in running their own business would have experience in business financing and negotiating with potential financiers. The insignificant finding for *startup* is perhaps not surprising given that prior research using this variable provides mixed evidence. Stuart and Abetti (1990) found that prior experience as an owner-manager was the most important determinant of performance in NTBFs, but Jo and Lee (1996) found a negative relation between these two variables. Storey (1994) found no significant relation between experience as an owner and the use of bank finance at start-up.

One possible explanation for the insignificant finding for *startup* is that founders previously involved in start-ups have considerable wealth to bring to the new business, earned perhaps from accumulated retained earnings or from the proceeds of a trade sale. If the ‘serial starter’ founder brings more wealth to the new venture, this would, *ceteris paribus*, reduce the need for external funding. To examine this possibility, we test whether ‘serial starter’ firms had greater initial start-up costs than firms with founders who had no start-up experience. The median start-up cost for both was in the band €63,500 to €127,000, and a paired Wilcoxon test confirms that this difference is not significant ($p = 0.73$).

In conducting this test, we are assuming that the total funding requirement at start-up was provided purely by the personal resources of the founders. Our capital structure data, however, comprise information on current funding requirements, rather than financing at start-up. We do, however, have information for 89 sample firms on when they received their first external finance. As might be expected, few sample firms started with significant external sources of finance. Only 11 (12 percent) claimed to have external financing at start up. The start-up cost data, therefore, is reasonably representative of the quantity of savings brought into the firms by founders.

Prior management experience in the software sector

Our findings for the management experience variable run contrary to the received wisdom of the venture capital industry, which promotes the importance of experienced management teams. It is also inconsistent with the evidence on venture capital selection criteria, in which the lead entrepreneur’s industry experience is consistently found to be

very important (MacMillan, Siegel and SubbaNarasimha, 1985, Muzyka, Birley and Leleux, 1996). As for the findings regarding prior start-up experience, this suggests that the factors considered important pre-requisites for venture capital support are not the same as those affecting the founder's demand for venture capital.

This finding of no significant explanatory power for the variable *experience* may be explained in the same way as for the variable *startup*, because it is possible that these two variables are related. A z-test for difference in proportions confirms that they are. A higher proportion of the firms whose founders had prior start-up experience also had management experience (18/52 or 35 percent), than firms whose founders had management experience but not start-up experience (10/65 or 15 percent). These proportions are significantly different at the 1 percent level ($p = 0.01$).

Size of the founding team

The variable *team* is negatively signed, indicating (contrary to hypothesis 5) that as team size increases, there is less likelihood that the firm is venture capital-backed. It is, however, not significant in any of the 4 iterations in which it appears. The most likely explanation for this finding is that teams of founders have greater combined financial resources, and are less likely to need external finance. Roberts (1991) reports that teams start with significantly more initial capital than single-founder firms. Dividing the sample into small (less than €63,500 initial capital) and large firms (greater than €63,500 initial capital), we can conclude that team size is positively related to initial capital. The median team size for firms starting with less than €63,500 is 2, and for those with more than €63,500, median team size is 3. This difference is significant at the 1 percent level ($p = 0.01$) using a Wilcoxon test. However, while teams appear to bring more money into the business, this does not imply that firms with greater start-up capital are less likely to be venture capital-backed – the *cost* variable being positively rather than negatively signed, and significant at the 10 percent level in all the multivariate models.

Lead time and start-up costs

The assumption behind hypothesis 6 is that firms with longer product lead times require a greater investment in research and development, and consequently need greater initial capital and therefore outside financing in the form of venture capital. Figure 9 plots mean and median product lead times against the start-up cost categories. The figure clearly shows very little variability in lead time across the start-up cost categories. The mean (median) product lead time for small firms with start-up costs of less than €63,500 of 21.5 (13.5) months is slightly higher than that for larger firms (start-up costs greater than €63,500) of 18.4 (10) months lead time. A paired Wilcoxon test confirms that this difference is not significant ($p = .28$).

The evidence from the NTBF literature is that the longer the product lead time, the more likely it is that the firm will require external funding (Oakey, 1984 and 1995; Roberts,

1991; Bank of England, 2001). Oakey (1984) found that biotechnology firms are more likely to have venture capital funding because they face longer product lead times and take longer to reach break-even point than their counterparts in the electronic and software sectors. Our results indicate that this finding does not hold in the software product sector. Perhaps we can conclude that the positive relation between lead time and external finance holds across rather than within NTBF sectors.

The significance of the cost variable provides support for hypothesis 7 – that firms with higher start-up costs are more likely to be financed by venture capital. Clearly this finding is not due to longer product lead times requiring greater initial capital injections. Rather, it can probably be explained by the fact that the venture capital industry tends to avoid very small new firms. Gompers (1995), for example, found that between 1961 and 1992 the mean venture capital investment was \$2.2 million. Gompers and Lerner (2003) argue that venture capital investments tend to be relatively large, because the venture capitalist is under pressure to raise large fund pools:

Because each firm in his portfolio must be closely scrutinized, the typical venture capitalist is typically responsible for no more than a dozen investments. Venture organizations are consequently unwilling to invest in very young firms that only require small capital infusions (Gompers and Lerner, 2003: 291).

This is confirmed for our sample of indigenous Irish software firms using a z-test for difference in proportion of firms using venture capital, separated into small firms (less than €63,500 initial capital) and large firms (greater than €63,500 initial capital). The proportion of large firms using venture capital – 36/61 or 59 percent – is significantly greater than the proportion of small venture capital recipients (18/48 or 38 percent), with a p-value of 0.03.

Control

The variable *control* is highly significant in all models ($p = 0.00$), confirming hypothesis 8. Founders who are willing to cede control are clearly more likely to use venture capital funding. In order to obtain outside equity, owner-managers must cede some control and considerable freedom in decision-making. In the SME literature, independence is usually cited as the main motive for starting a business, and it is well established that the owner-manager's desire to remain independent affects the decision-making process (Boyer and Roth, 1978; Cooley and Edwards, 1983; Ang, 1991 and 1992; Mac Mahon et al, 1992; LeCornu et al, 1996).

In summary, the multivariate analysis confirms our univariate findings. The only human capital variable that has a significant effect on venture capital use is whether or not the lead founder is degree qualified, and the strongest effect comes from the variable *control*.

6. Summary and conclusions

Using survey data for 110 Irish indigenous software product firms, of which 54 are venture capital-backed and 56 of which are not, we examine the extent to which 8 firm-specific factors affect the use of venture capital finance. The only human capital variable that has a significant effect on venture capital use is whether or not the lead founder is degree qualified. This finding is at variance with the venture capital literature, which demonstrates that venture capitalists tend to downplay formal qualifications, and emphasise 'track record' variables such as the strength of the team and prior experience in the industry. Education may not be considered important by venture capitalists, but it appears to be an important demand-side determinant of venture capital backing. There are several potential explanations for this finding. Owner-managers educated to degree level are more likely to grow their businesses, and to support this growth there would be a greater need for external funding (Cosh and Hughes, 1994). Alternatively, well-educated founders are better equipped to negotiate with potential providers of finance (Oakey, 1984), and degree qualified founders may be better able to understand the tradeoffs involved in accepting venture capital finance.

Our other human capital variables – prior start-up experience, management experience in the software sector, and size of the founding team – are not significant determinants of venture capital backing. This is a rather curious result because it appears to be contrary to the findings in the venture capital appraisal literature. While venture capitalists claim to favour firms with strong, experienced teams, it would appear that many experienced teams eschew venture capitalists. Our findings question whether venture capitalists actually follow their own advice in appraising management teams, or whether they rely on more subjective approaches to appraisal – like 'gut instinct.'

We find a significantly positive relation between start-up costs and venture capital backing. But longer product lead times do not imply that venture capital use is more likely, suggesting that product lead time is not the main driver of start-up costs in software product companies. This is contrary to the evidence from the NTBF literature that the longer the product lead time, the greater the initial capital required, and the more likely it is that the firm will require external funding. However, prior studies compared lead times across industries, whereas we look at the issue within the software sector. Our findings that lead time is very short, and that external financing is at its maximum for 2 to 4 year-old firms – when it comprises 68 percent of total funding – suggest that the greatest demand for finance in software product firms is during the commercialisation phase.

The most significant explanatory variable in our modelling is the willingness of the founders to relinquish control of their businesses. Consistent with one of the best-understood stylised facts from the entrepreneurship literature, a substantial proportion of Irish indigenous software firm founders view independence and control as critical

motivators. If independence is the most important factor behind NTBF financing decisions, perhaps we can conclude that founders bring in venture capital partners reluctantly, or at least after very carefully weighing up the costs and benefits of venture capital finance. Our findings also suggest that founders may initiate ventures with others in order to reduce the requirement for external funding. We find that the bigger firms – those with start-up capital of more than €63,500 – had been started with significantly larger teams than the start-ups with less than €63,500. Not only does starting a business with a team increase access to ‘internal’ resources at start-up. Because software development is a labour-intensive rather than a capital-intensive activity, it can be undertaken by the founding team, allowing the reduction or postponement of labour expense. Software firm founders may thus have considerably more financial flexibility than their counterparts in other NTBF sectors.

It is clear that the factors affecting the demand for venture capital financing differ from those affecting the supply. Venture capitalists minimise the risk of their portfolio of investments by choosing firms that they perceive are likely to prosper and grow. This manifests as client firms with teams of founders who have strong experience in the industry and in starting small businesses. However, it is clear from our findings that many NTBFs that may well meet venture capitalists’ requirements do not make themselves available for venture capital funding. The implication for investors in venture capital funds is that they do not have access to the full population of young, high technology firms.

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Table 1 Variable definitions

		Expected sign if VC-backed
<i>Panel A: Human capital variables</i>		
Degree	Whether or not the founder had a bachelors degree; yes = 1, no = 0.	+
Startup	Whether or not the founder was previously involved in starting a business; yes = 1, no = 0.	+
Team	Number of founders.	+
Experience	Number of years of management experience the founder had in the software sector prior to start-up: mid points derived from management experience ranges.	+
<i>Panel B: Other variables</i>		
Leadtime	Time to production of first beta in months.	+
Costs	The start-up costs: mid points derived from start-up cost ranges.	+
Control	The extent to which founders expressed a preference to maintain 50 percent or more of the shares of the business in the hands of the founders; 1 = not all; 5 = to a large extent.	-

Table 1 Sources of finance for current investment requirements

Stage	Internal sources (%)			External sources			
	savings	other internal	total internal	bank loans	venture capital	other external	total external
Start-up (<2 years)	43.0	29.5	72.5	0.0	13.0	14.5	27.5
Commercialisation (2-4 years)	10.0	22.0	32.0	3.0	38.0	27.0	68.0
Growth (5-10 years)	9.5	46.0	55.5	6.5	28.0	10.0	44.5
Mature (>10 years)	10.0	66.0	76.0	5.0	11.0	8.0	24.0
Full sample	14.0	36.0	50.0	4.0	28.0	18.0	50.0

Table 3 Human capital variables

<i>Panel A: degree qualifications</i>		
	count	%
Yes	99	84.6
No	18	15.4
Total	117	100.0
<i>Panel B: post-graduate degree qualifications</i>		
Yes	48	48.5
No	51	51.5
Total	99	100.0
<i>Panel C: Start-up experience</i>		
Yes	52	44.4
No	65	56.4
Total	117	100.0
<i>Panel D: management experience in the software sector</i>		
No experience	28	24.0
0 – 1 years	7	6.0
1 – 2 years	11	9.0
3 – 4 years	24	21.0
6 – 10 years	20	17.0
10 + years	27	23.0
Total	{ =SUM (ABO VE) }	100.0
<i>Panel E: Number of founders</i>		
Sole founder	28	24.0
Two	40	34.0
Three	32	27.5
Four or more	17	14.5
Total	{ =SUM (ABO VE) }	{ =SUM(ABOVE) } .0

Table 4 Other variables

	count	%
Panel A: Product lead-time (n = 109)		
zero	5	4.6
1-6 months	30	27.5
7-12 months	23	21.1
1-2 years	25	22.9
2-3 years	15	13.8
3-5 years	5	4.6
> 5 years	6	5.5
Panel B: Start-up costs (n = 115)		
< €63,500	53	46.1
€63,500 - €127,000	15	13.0
€127,000 - €317,500	16	13.9
€317,500 - €635,000	11	9.6
€635,000 - €1,270,000	9	7.8
> €1,270,000	11	9.6
Panel C: Control (n = 115)		
not at all	11	9.6
2	23	20.0
3	44	38.3
4	21	18.3
to a large extent	16	13.9

Notes. Start-up cost figures were requested in Irish punts because the questionnaire was sent out just after the full introduction of the Euro in early 2002. They have been converted into euro (Panel B) at the €/£ exchange rate of 1.27. Panel C reports the response to the statement "(prefer to) retain a majority stakeholding (50% or more) in the business for the founders," separated into venture capital-backed and non-venture capital-backed firms. Survey participants were asked to respond on a scale from 1 to 5, where 1 is 'not at all' and 5 is 'to a large extent,' implying that the higher the response number, the less willing is the respondent to relinquish control of the business.

Figure 1 Degree qualifications

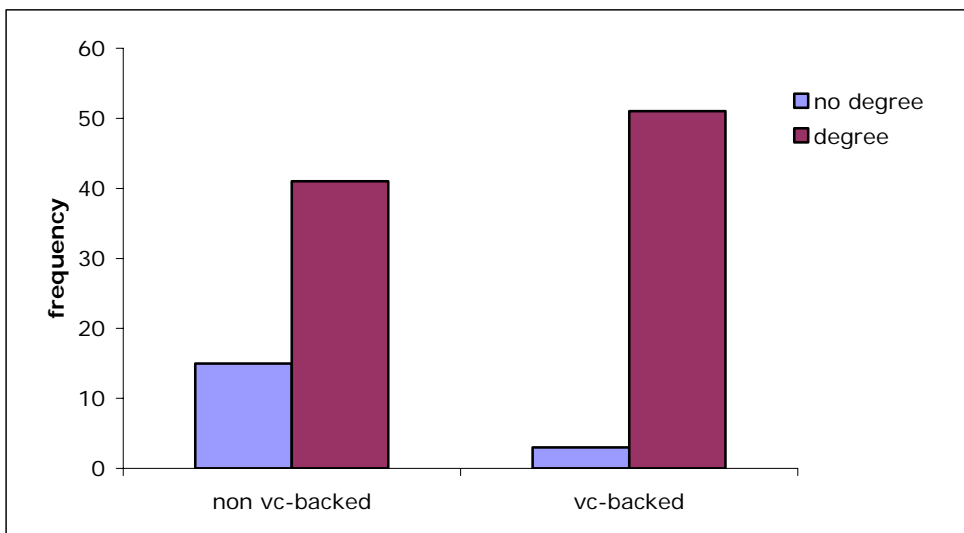


Figure 2 Post-graduate qualifications

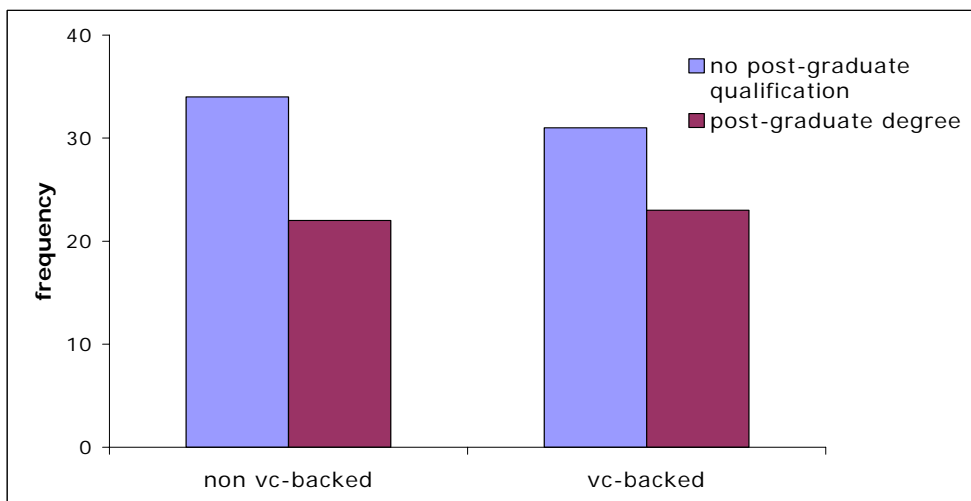


Figure 3 Experience in prior start-ups

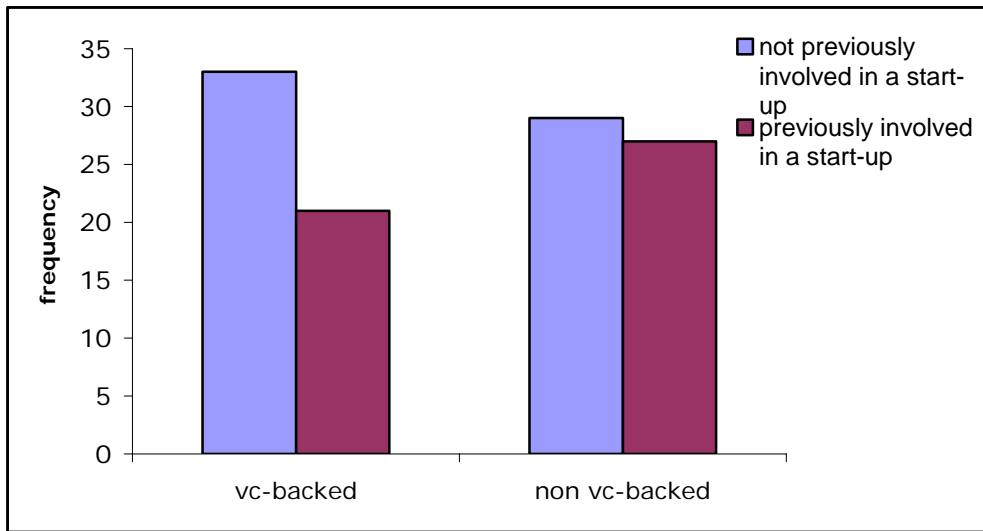


Figure 4 Prior management experience in the software industry

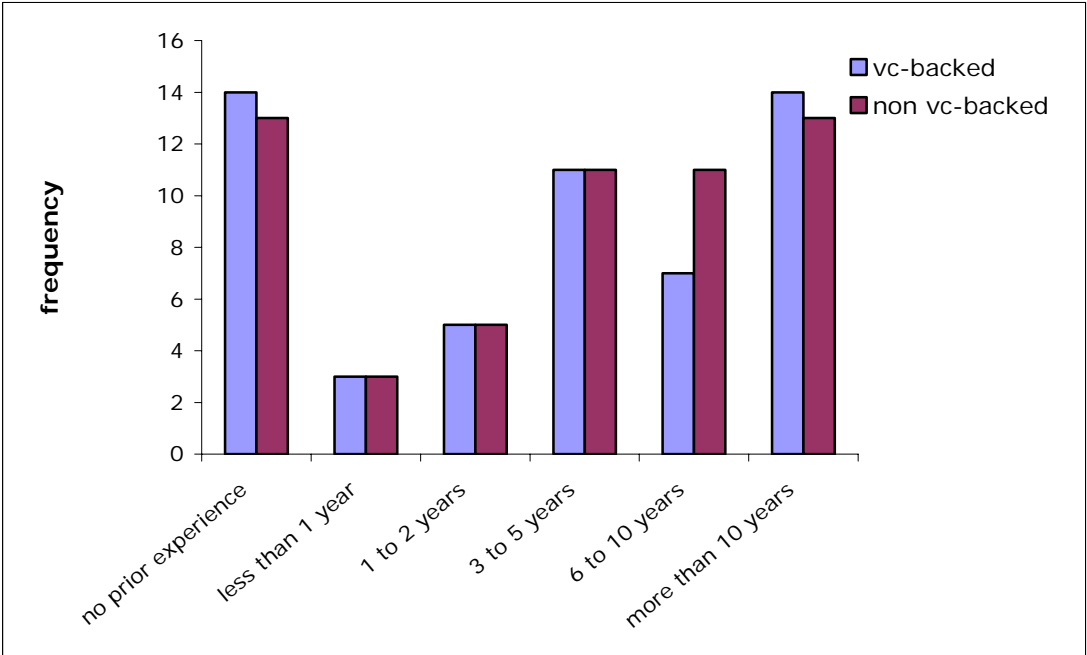


Figure 5 Size of the founding team

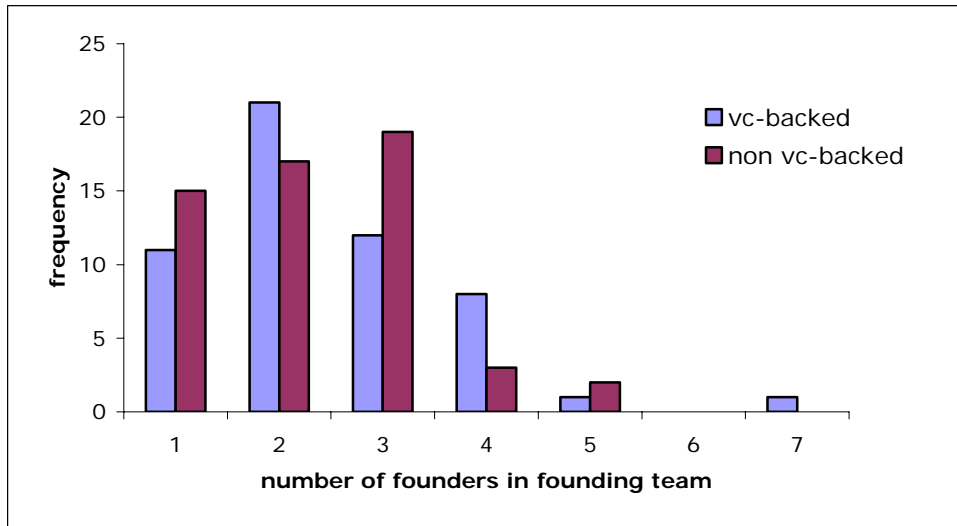


Figure 6 Product lead time

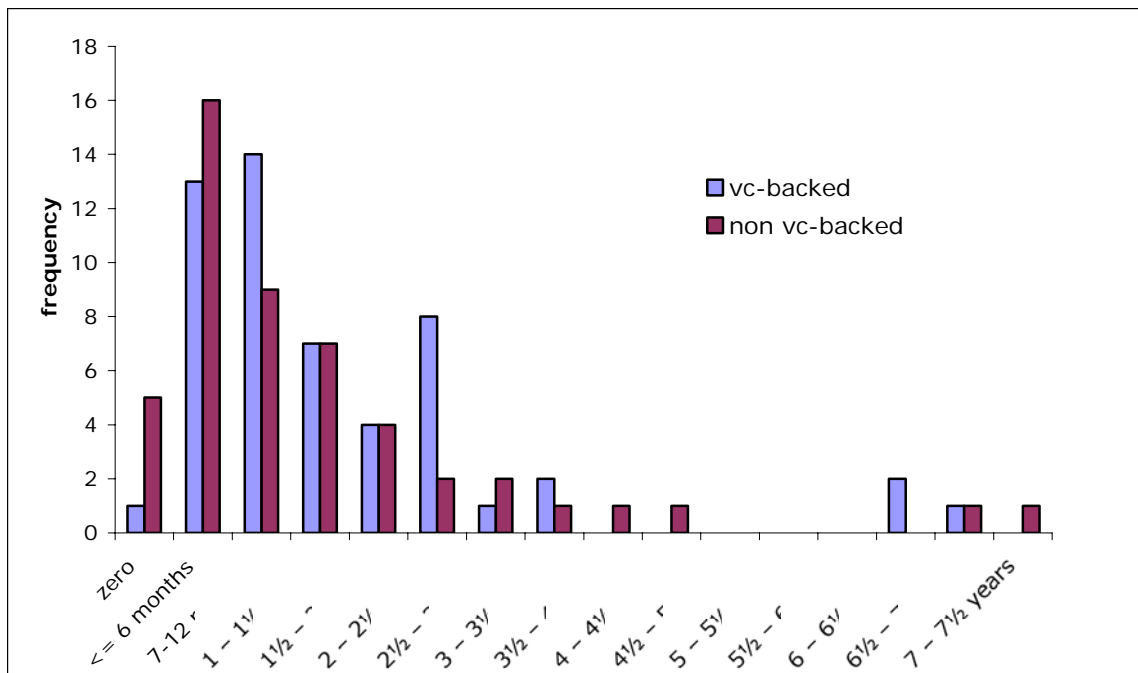


Figure 7 Start-up costs

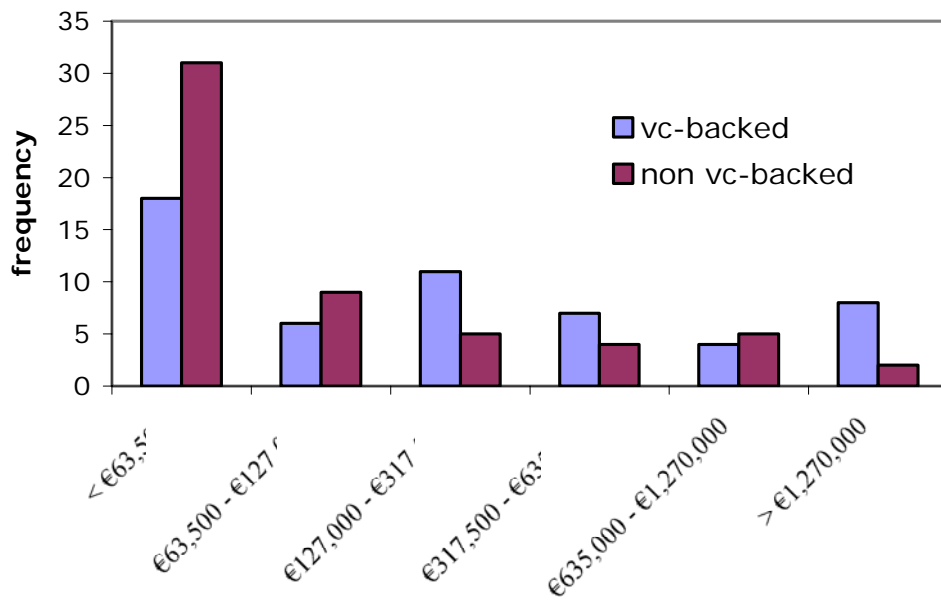
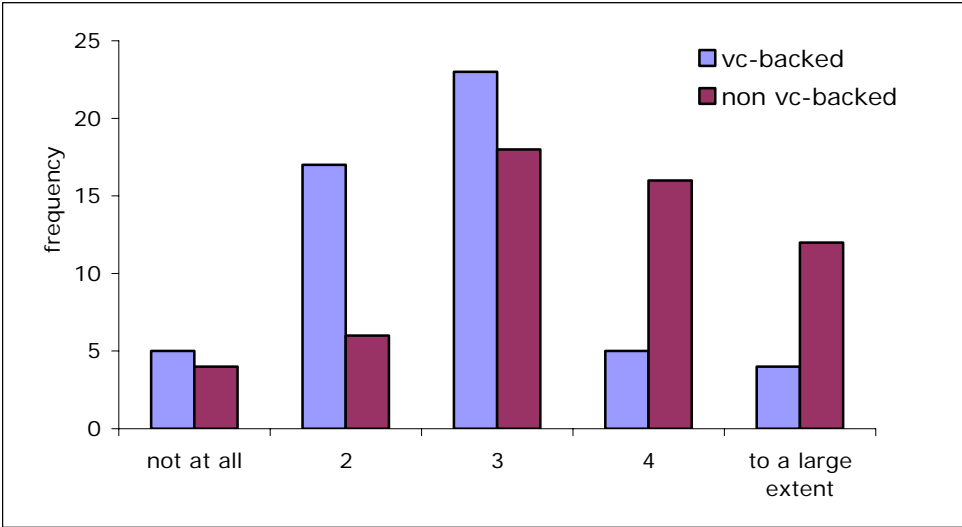


Figure 8 Willingness of founders to cede control



Notes. This figure reports the response to the statement “(prefer to) retain a majority stakeholding (50% or more) in the business for the founders,” separated into venture capital-backed and non-venture capital-backed firms. Survey participants were asked to respond on a scale from 1 to 5, where 1 is ‘not at all’ and 5 is ‘to a large extent,’ implying that the higher the response number, the less willing is the respondent to relinquish control of the business.

Figure 9 Product lead times versus start-up costs

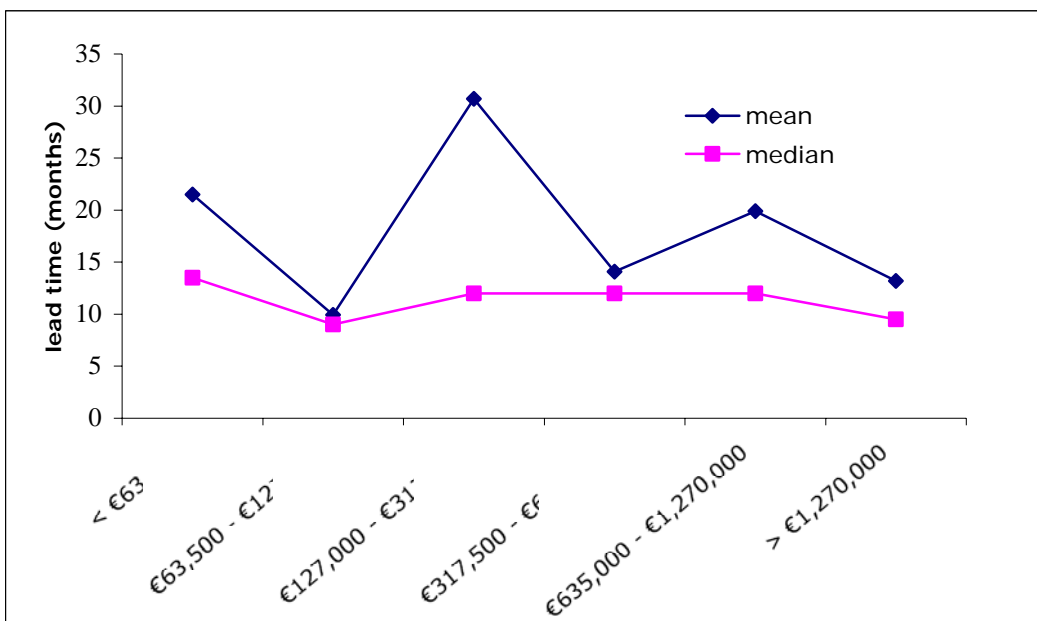


Table 5
Results for the logit modelling

	Coefficients for independent variables								Pseudo-R ²
	Startup <i>B</i> ₃	Experience <i>B</i> ₅	Postgrad <i>B</i> ₂	Team <i>B</i> ₄	Leadtime <i>B</i> ₆	Degree <i>B</i> ₁	Costs <i>B</i> ₇	Control <i>B</i> ₈	
Model 1	0.167 (0.77)	0.031 (0.61)	-0.261 (0.61)	-0.183 (0.36)	0.024 (0.26)	2.484 (0.06)	0.000 (0.06)	-0.819 (0.00)	0.21
Model 2		0.026 (0.65)	-0.259 (0.61)	-0.186 (0.36)	0.022 (0.23)	2.567 (0.05)	0.000 (0.06)	-0.806 (0.00)	0.21
Model 3			-0.297 (0.55)	-0.175 (0.39)	0.021 (0.27)	2.718 (0.03)	0.000 (0.06)	-0.814 (0.00)	0.20
Model 4				-0.173 (0.41)	0.018 (0.30)	2.611 (0.03)	0.000 (0.06)	-0.817 (0.00)	0.20
Model 5					0.017 (0.36)	2.093 (0.03)	0.000 (0.07)	-0.776 (0.00)	0.19
Model 6						2.307 (0.01)	0.000 (0.07)	-0.747 (0.00)	0.18

Notes. This table reports the coefficients for the 8 independent variables in estimating the logit model in equation [3]:

{ EMBED Equation.3 } { EMBED Equation.3 }

In brackets under the coefficients are the p-values for each variable. The model in equation [3] was first estimated in full (Model 1). It was then re-estimated using the general-to-specific modelling strategy, whereby the least significant variable is sequentially removed, leading to the parsimonious model (Model 6).