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Fishing for carps in a goldfish pond? An analysis of R&D subsidy applicants and beneficiaries

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ABSTRACT

The current policy debate on R&D subsidies has mainly focussed on the effectiveness of R&D subsidies, whereas the academic literature has to a large extent looked into which companies receive R&D subsidies and why. The latter has acknowledged the need to control for a potential sample selection issue, caused by the fact that not all companies apply for R&D subsidies, and has proposed the use of control groups and treatment effect models. The application of these models remains however scarce, given the limited understanding of which factors drive companies to apply for R&D subsidies. Using a Heckman selection model, this paper analyzes which young technology based firms receive R&D subsidies, while taking into account the likelihood of application. Analyzing a sample of 225 young technology based firms in Flanders, we found that entrepreneurial firms disposing of less financing were more likely to apply for R&D subsidies, whereas firms led by teams disposing of higher levels of commercial experience were less likely to apply for R&D subsidies. Controlling for likelihood of application, we found that more heterogeneous teams were more likely to receive R&D subsidies.

INTRODUCTION

Government programs that subsidize commercial R&D are justified on the grounds that firms underinvest in R&D (David et al., 2000; Wallsten, 2000). Typically, empirical studies have analysed to which extent private R&D expenditures have increased as a result of the subsidy. If R&D grants just substitute private R&D expenditures that would otherwise also have taken place, then this is considered to be a crowding out effect, else it is not. Many of the earlier studies do find a correlation between subsidies and R&D expenditures, but fail to recognize a crowding out or not; they fail to provide an understanding of whether firms which receive grants increase their levels of R&D expenditures or whether more R&D intensive firms simply are better in obtaining grants (David et al., 2000).

As a result, the econometric literature has focussed on the sample selection issue, which means that if one wants to analyse the additionality of subsidies, the sample should be corrected for those companies which perform R&D but do not get any grants. For instance, Criscuolo et al. (2007) have shown that studies which fail to account for this selection bias do suffer from a large downward bias. In order to correct for such a bias, a more in depth insight is needed into the factors which can explain which firms do receive a grant and which ones do not get grants although they belong to the population of eligible companies (for instance because they engage in R&D activities).

In line with this, received empirical literature started to analyse the differences between companies that receive grants and those that do not receive grants. Czarnitzki and Licht (2005) show that supported firms in Germany tend to differ from those which did not receive R&D subsidies. More specifically, subsidized firms were larger, had a separate R&D department more frequently, usually had applied for a patent and were more likely to be active internationally. In line with this, Gonzalez and Pazo (2008) and Gonzalez et al. (2005) apply matching estimators to distinguish between firms that perform R&D and those that do not, using the size of the firm and the R&D history of the firm as predictors of receiving R&D grants.

Despite the plea for control groups and treatment effect models, the application of such models remains rather scarce. The reason for this is that we do not really understand which factors determine whether a given eligible firm *applies* for a grant or not and, if it applies for such a grant, which factors determine whether it will receive the grant or not. Especially if we hold size constant and for instance analyse this question in a population of SMEs, eligible for R&D grants, the determinants of application and success in receiving the grant are unknown. This paper addresses this gap in the literature and investigates which factors explain whether a young technology based firm will apply for a grant or not and, if it applies, which ones tend to predict its chances of success.

We investigate these questions by analysing the application behaviour and the application success of a homogeneous population of 225 young technology based firms in Flanders. We use organisational theory and more specifically, the resource dependency and self efficacy theories as theoretical guidelines in building our hypotheses. Resource dependency theory views the firm as an open system, which is dependent on external organizations for the supply of key resources (Pfeffer and Salancik, 1978). The more resource constraint a company is, the more it will need to look for extra resources such as R&D grants to survive. Self efficacy theory complements resource dependency theory and predicts that managers in resource constraint companies will look for additional resources in environments they are most familiar with. In other words, their background will determine their search process.

The remainder of the paper is organised as follows. First, we discuss the relevant received literature. Second, we present our theoretical framework. In a third section, we discuss the sample, the data and the data characteristics. Fourth, we present our analyses of the main research questions. Finally, we present the conclusions, limitations of this study and suggestions for further research.

1 LITERATURE REVIEW

The literature on the impact of R&D subsidies has been focused on the so-called question of crowding out. Crowding out means that the public subsidy at least partly substitutes the private R&D expenditures of the firms which receive the study. Wallsten (2000) showed that a subset of publicly traded, young, technological-intensive firms, reduced their R&D spending in the years following the award of a Small Business Innovation Research grant, which suggests at least a partial crowding out effect. Busom (2000) even reports a full crowding out in about 30 percent of their sample of Spanish firms. This is in contrast with for instance Klette and Moen (1997), who report that there is little tendency for crowding out in their sample of Norwegian firms.

The inconclusive results with respect to the impact of R&D subsidies have been attributed to the lack of control for "non-treated firms", i.e. those firms that do not make use of subsidies. Still, the few studies which have compared subsidized and non-subsidized firms conclude that subsidized firms differ in many aspects from the non-subsidized ones. Lach (2002) for instance finds that subsidized firms in a sample of Israelian firms tend to be larger than non-subsidized firms. Subsidized firms spend on average three times more on R&D than non-subsidized ones in Israel and employ 400 employees on average, whereas the non-subsidized ones only employ 200 employees, on average. Building on these results, Czarnitski and Licht (2006) also find in a sample of German firms that subsidized firms are larger in terms of employees (500 vs 240). Furtheron, they find that subsidized firms do have a separate R&D department whereas the non-subsidized ones do not tend to have such a department. Further, they find that older firms are less likely to participate in R&D subsidy programs than younger firms, at least in Eastern Germany. They also indicate that firms which do apply for R&D subsidies have more international exposure than those which do not get into the R&D subsidy game. Finally, they find that firms which receive R&D subsidies tend to have significantly more patents than those which do not have subsidies. Gonzalez et al. (2005, 2008) come to similar conclusions in a sample of Spanish firms when they compare firms which do receive and do not receive R&D subsidies. Only the age variable seemed to play an important role. They

find that age has a positive impact on the likelihood of applying for an R&D subsidy. They argue that the more experienced firms might be more likely to know how to apply for these grants. They also find some sectoral differences but do not get into detail as of which sectors differ from each other.

The studies above do suggest that firms which participate in R&D programs do significantly differ on a number of dimensions from the ones that do not apply for such subsidies. Criscuolo et al. (2007) argue that micro-econometric studies which do not take this into account significantly underestimate the impact of R&D subsidies. They also suggest that scholars have to be careful when they construct a model which controls for the likelihood of applying for a subsidy. Since subsidy applications are not distributed ad random among a population of firms, but tend to focus on very specific subgroups of firms which are eligible for a subsidy, it is not sufficient to analyse the likelihood of applying for a subsidy in an ad random group of companies as the incidence rate might be quite different from the experimental group in which the impact of the subsidy is studied. In other words, scholars should match the experimental sample and the control sample quite carefully if robust conclusions are to be drawn. The most recent papers by Gonzalez et al. (2008) and Czarnitski and Licht (2006) do use such an approach of matching samples. Usually, sector and size information is used to match samples of companies which apply for R&D subsidies.

In summary, we can conclude from the above that understanding which firms do apply for R&D subsidies and which ones do not apply for these subsidies will greatly contribute to our understanding of which impact these subsidies have on the total R&D efforts of these firms. However, the received literature gives very little insights into why companies apply for subsidies and why other ones do not apply. Part of this might be attributed to the fact that the empirical research so far has focused on very heterogeneous populations of companies which are representative for the industry rather than on homogeneous subpopulations such as innovative SMEs, high tech start-ups, ...of which each company is in theory eligible of receiving an R&D grant. This lack of a homogeneous approach has lead to the introduction of matched pair models which mainly re-

veal that larger firms do apply more for subsidies than smaller ones.

In addition, most micro-econometric studies have not made a distinction between the factors which determine whether a given company will apply for a subsidy and those determinants which just distinguish between successful and non successful applications. They assume that not having received any R&D subsidies equals not having applied for these subsidies. Wallsten (2000)'s study is to our knowledge one of the only studies which has made a clear distinction in a sample of US innovative SMEs which had applied for SBIR grants between those which applied for a grant and those which were successful in receiving the grant. He found that the average size of the beneficiaries was larger than of those which got rejected. However, the largest innovative SME's were found in the group of eligible companies which never applied for a grant. A similar pattern was found for the number of patents these companies had applied for. Unfortunately, data limitations restricted the external validity of the Wallsten study. This study indicates that not making a distinction between these two phases in the grant application process might introduce an oversimplification in the sample correction.

In summary, the micro-econometric literature tends to overlook the subtle difference between those companies that *do not apply for R&D grants, but are not eligible* and *those that do not apply for R&D grants, but belong to the targeted population of the R&D granting institutes*. Second, in those studies where a control group of 'non-applicants' is used to match those that *do* receive R&D subsidies, the non-applicants equal the non-recipients. In other words, the difference between not getting an R&D grant (although applying for it) and not applying for the R&D grant is ignored. A third shortcoming in the received literature in addition to the aforementioned empirical shortcomings, appears to be a lack of theoretical understanding about why companies do or do not apply for grants. The grant application equation has been treated as a statistical correction of the crowding out analysis which has a clear theoretical rationale. However, the choice of instruments used to predict the probability of applying for/receiving a grant was seemingly motivated by empirical rather than theoretical justifications. While the market failure paradigm might justify the existence of R&D subsidies and the specific elements of market failure might further explain why certain groups of companies are targeted with an R&D subsidy program, industrial economic theory has difficulties to explain why companies of a certain eligible population might apply or not apply for such a grant. To explain such a form of organisational behaviour, hypotheses need to be derived from other theoretical streams such as organisational economics and organisational behaviour. Whereas the first theoretical stream uses individualism and rational choice as an explanation of organisational choices, the second one takes the collective of individual decision makers as the point of departure. In the next section of the paper, we will use both literature streams to explain why we expect some young technology based firms to apply for grants or others not.

2 THEORETICAL FRAMEWORK

2.1 Applying for R&D subsidies

Young technology based firms typically face major difficulties in raising financing from traditional sources such as banks and public capital markets due to a lack of track record and tangible assets which are usually required by these finance providers to reduce the uncertainty of the financing round (Da Rin et al., 2006). Therefore, young technology based firms usually turn to external sources of capital such as venture capital (Wright et al., 2006) and angel financing (Mason and Harrison, 2003; Ueda, 2004) to get access to sufficient funds to realize their growth ambitions. Sohl (2007) estimates that in the US 39% of all angel investments and 11% of all venture capital investments are made in young innovative firms. This shows the importance of this source of financing for young technology based firms. Moreover, both angel and venture capital investments are often considered to be "smart" forms of capital. Angels for instance are usually persons with extent managerial or entrepreneurial experience who invest in these companies not only because of financial reasons but also because they think that they can make an important contribution to the further development of the company (Mason, 2006). VCs play an active role in their portfolio companies and are involved in value adding activities, next to the monitoring role that they fulfil (Sapienza et al., 1996; Fried et al., 1998; Knockaert et al., 2006). Entrepreneurs specialize in the development of knowledge about combining resources to exploit new opportunities (Kirzner, 1973) and in the day-to-day development of new business activities (MacMillan et al., 1989), while VCs focus mainly on creating networks to reduce the cost of acquiring capital, to find customers and suppliers and to establish the venture's credibility (MacMillan et al., 1989; Lam, 1991). VCs also advise their ventures, by helping entrepreneurs to formulate their business strategy, and identifying appropriate management (Steier and Greenwood, 1995).

As a result of this, we would expect venture capital and business angel financing to be the most likely forms of capital young technology based firms aim for. Only those young technology based firms, which do not succeed in finding venture capital nor business angel financing will try to access less flexible forms of capital such as R&D grants. R&D grants require that the money is invested to further develop the technology, not to commercialize an innovative product and as such do put a number of constraints on the expenditure pattern of the grant money. . Further, R&D grants often bring along an administrative expense which is difficult to support for a young technology based firm. Therefore, we assume that only if the young technology based firm does lack other forms of capital, it will apply for an R&D grant.

This leads us to the following hypothesis:

> H1: *the more capital constraint a young technology based firm is, the higher the likelihood that it will apply for R&D grants*

When studying behaviour (in this case, the decision to apply for R&D subsidies), however, the individual level should not be overlooked. The theory of planned behaviour operates on the premise that the best way to predict behaviour is to measure behavioural intention, which in turn is seen to be a function of three variables: attitude, subjective norm and perceived behavioural control (Azjen, 1985; 1988). Self-efficacy is a function of perceived behavioural control and frequently emerges as the most significant predictor of both intention and behaviour (Armitage and Conner, 2001). Self-efficacy influences the motivation and ability to engage in specific behaviour (Bandura, 1977), as well as the pursuit of certain tasks (Bandura, 1986). Self-efficacy suggests that people who think they can perform well at a task do better than those who think they will fail (Gist and Mitchell, 1992). Thus, people perform activities and pick social environments they judge themselves capable of managing (Wood and Bandura, 1989). Following the similar-to-me hypothesis (Franke et al., 2006), these environments would be environments in which people operate that are similar to them. Similarity is perceived as rewarding and dissimilarity works as a negative reinforcement (Lefkowitz, 2000). The theory of planned behaviour and the concept of self-efficacy originated in psychology (Byrne, 1971), and has been applied recently in behaviour economics and management studies, for instance to explain post-investment behaviour by venture capi-

talists (Knockaert et al., 2006), to explain attitudes and intention towards self-employment (Souitaris et al., 2007), and to explain the career decision-making process (Giles and Rea, 1999). The latter study for instance found that, based on self-efficacy, men were less likely to apply for jobs in female-dominated occupations. Finally, Tierney and Farmer (2002) examined self-efficacy to understand creative actions in organisational settings.

Based on self-efficacy, we hypothesize that entrepreneurs who feel their chances of success when applying for R&D subsidies are minimal, will not apply for R&D subsidies, given the resource constraints they are already faced with and that force them to direct their efforts into activities with potential success. This will not only be the case for the lead entrepreneur, but will apply to all top management team members, given that strategic issues are rarely diagnosed and/or addressed by a single individual but rather by a top management team (Dutton et al., 1983). Building on the similarity hypothesis, we hypothesize that high tech entrepreneurs will feel their chances of success are minimal in case of dissimilarity between the entrepreneur and the R&D subsidy evaluator. Given that the latter mainly disposes of technical human capital (all R&D subsidy evaluators predominantly dispose of technical human capital), we argue that teams mainly disposing of technical human capital will feel confident of their potential success given the similarity of their human capital with that of the R&D subsidy evaluator, and will therefore be more likely to apply for R&D subsidies. Subsequently, teams with more commercial human capital will feel less confident on their chances of success given the dissimilarity between their human capital and that of the R&D subsidy evaluators. Therefore, we offer the following hypotheses:

H2: *management teams disposing of technical human capital are more likely to apply for R&D subsidies than the average*

H3: *management teams disposing of commercial human capital are less likely to apply for R&D subsidies than the average*

2.2 Getting R&D Subsidies

Earlier on in this paper, we argued that most econometric studies do not make a distinction between applying for and successfully receiving a grant. Whereas the decision to apply for a grant or not is made by the young technology based firm itself, the decision whether the focal firm also will receive a grant or not is made by government bureaucrats. Although the theoretical justification for R&D subsidies is to be found in the argumentation that otherwise these projects would not have been undertaken, Jaffe et al. (1998) observe that in practice government programs usually are not designed to be evaluated in such a way. Therefore, politicians are quite unlikely to continue to support a program which picks many projects that fail or refuses to select commercially attractive proposals. Therefore, government bureaucrats who manage these funds will act more as external financiers, trying to fund projects with higher success probabilities and with clearly identifiable results, i.e. private rates of return (Lach, 2002).

We might thus assume that the criteria which are seen to be key in the selection behaviour of a private investor providing financing to young technology based firms will be similar to those that determine whether the young technology based firm receives an R&D grant or not. The venture capital literature has had a long tradition in analysing which criteria venture capitalists find important when evaluating a potential deal (Hall and Hofer 1993; McMillan et al. 1985; 1987; Muzyka et al. 1996). The two most important ones which seem to be consistently reported by these studies relate to a) the quality of the team which presents the proposal and b) the product/market characteristics of the deal.

In line with these findings, the quality of the team in explaining the success of a young technology based firm has been the subject of empirical research in the entrepreneurship literature. Heirman and Clarysse (2007) show that teams with a balance of technical and commercial skills are more successful in bringing products to the market in young technology based firms. A finding which was confirmed in Wright et al. (2007)'s work on academic entrepreneurship. Teams with a mix of technical and commercial skills are better able to adapt to the opportunities offered by complex environments and have better decision making skills than homogeneous teams. Therefore we hypothesize:

H4: *young technology based firms managed by a management team with balanced human capital will have a higher probability of successful application than those applied for by unbalanced teams.*

The second characteristic, which ranks high on the list of criteria which is used by the VC community is the attractivity and size of the product market segment in which the company is situated. To assess the market potential, venture capitalists usually undertake a due diligence of the venture's business. During such a due diligence, experts are hired to evaluate the market opportunity and customers or potential customers are interviewed to validate the assumptions made in the venture's business plan. Doing so, venture capitalist tries to reduce the information asymmetry related to the new venture. In contrast to venture capitalists, who do have sufficient resources to perform a lengthy and thorough due diligence, government bureaucrats cannot afford this kind of investment. Instead, they tend to base their decision on observable characteristics that are often correlated with the unobserved quality of the venture (Stuart et al., 1999)

Raising venture capital financing therefore can be seen as a signal of quality to other stakeholders. According to Davila et al. (2003), VC funding events are important signals about the quality of the new venture, diminishing uncertainty for employees, and increasing credibility, and thus enhancing the likelihood of new employees joining the company. Megginson and Weiss (1991) indicate that the reputation of some long-existing VC companies is second to none, and their presence in the capital structure sends a strong positive signal to other investors and stakeholders. Stuart et al. (1999) found that privately held biotech firms with, amongst others, organizational equity investors went to IPO faster and earned greater valuations at IPO than firms that lack such connections. Therefore, we propose:

H5: *young technology based firms which have attracted venture capital at the moment of application will have a higher probability of successful application than those which have not.*

Although the venture capital literature is instrumental in understanding which ventures do seem promising on a commercial site and which do not, the received literature on VC investments did not really investigate the role of VCs in 'technology' ventures'. Still, the technology component adds an additional dimension to these ventures. For instance, Mc Cann (1991) and Lee et al. (2001), highlight the importance of technological protection through patents to create value in high tech new ventures. Their argument is that the future of some of these new ventures does not lie in the commercialization of a product and the related realization of organic growth. Instead, value is created through building up a patent portfolio and collaborating with other parties, and playing on a market of ideas instead of a market for products (Gans and Stern, 2003). In line with this argument Decheneaux et al. (2008) show that patents are very important if high tech firms want to appropriate the rents of their R&D investments. Stuart et al. (1999) show that patents shorten the time to IPO for young technology based firms.

Building on the literature above, Hausler et al. (2009) show in a population of German and British young biotech firms that having a patent gives a signal to the investment community, which then leads to a shorter time to receiving venture capital. Having filed at least one patent reduces the time to the first VC investment by 76%. Although these results are achieved in an industry where the appropriability regime is rather tight (Gans and Stern, 2003), they still are impressive and suggest that patents might have a signalling effect in a broader population of young technology based firms as a quality label that convinces not only private investors but also R&D granting institutes. We therefore propose :

H6: *young technology based firms which have filed a patent at the moment of application will have a higher probability of successful application than those which have not.*

3 METHODOLOGY

We study young technology based firms in Flanders, which is a small, export-intensive economy located in the Northern part of Belgium. The advantage of focusing on one homogeneous region is that it reduces the non-measured variance resulting from environmental conditions. We used four different databases on start-ups in Flanders identify the young technology based firms and compile our sample: (1) a database of all firms founded since 1991 in high tech and medium high tech sectors, (2) a database of spin-offs from the different Flemish universities, (3) a database of all firms that received R&D subsidies from the IWT, (4) lists of 189 companies in the portfolio of Belgian venture capital investors. We conducted telephone interviews to a random sample of 500 firms in the first database and to all firms in the other databases to check whether the firms met the definition of young technology based firm and to ask the founder's cooperation in this research project. Based on the random sampling procedure we estimate the total population of young technology based firms in Flanders founded between 1991 and 2005 to comprise about 750 firms. We interviewed 354 of these RBSUs. For this paper on growth, we use the data on the 224 firms founded between 1991 and 2005.

The mean total employment size is 21 with the majority of the firms employing less than 7 people. Overall, the young technology based firms appear to be a group of firms of particular interest to policy-makers. In a relatively short time, they have created apparently growing businesses in a wide range of technologies, including software (42%), micro-electronics (12%), medical-related technologies, including biotech (17%) and others (29%).

4 DATA COLLECTION

We reconstructed the life histories of the young technology based firms during personal interviews with the founders. To do so, we used milestone events to reconstruct the company history. During each interview, we asked the founder to talk about the start-up and the key events that marked the early life of their companies. Next, we further questioned the founder about the starting resources. Using concrete events makes it easier to solicit more reliable retrospective information. Next, we used a structured questionnaire[1] to collect quantitative data on the firm's starting resources. We targeted the founders because they typically posses the most comprehensive knowledge on the organization's history, strategy, and performance (Carter et al., 1994). We also collected secondary data (such as company balance sheets, press releases, yearly reports, company brochures,...) as much as possible to double-check information and enhance the reliability of the data. The combination of in-depth qualitative interview data and detailed archival and survey data makes it possible to bring new insights as well as to test our hypotheses statistically. The information obtained during the interviews was cross-checked with secondary data sources such as Belfirst where possible.

The main R&D granting institute in Flanders (IWT) provided us with information on the year of first R&D subsidy application, and whether or not the R&D subsidy was granted. Of the 220 companies, 158 companies, or 76% had applied for an R&D subsidy. 120 of these 158 companies (or 76%) received the subsidy.

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1 The questionnaire as well as the manual for the database (i.e. the list of variables and how they are coded) can be obtained from the first author upon request.

5 R&D GRANTS IN FLANDERS: IWT

The institute for Innovation by Science and Technology (IWT) is the innovation agency of the Flemish government. IWT was established in 1991 with the purpose of stimulating innovation in Flanders in multiple ways. On the one hand IWT offers innovation-related services to Flemish companies, such as to find cross-border partners or technology transfer support, and encourages close collaboration of all actors engaged in innovation through the Flemish Innovation Network. On the other hand IWT grants every year more than 260 million euro in the form of subsidies to companies, research institutes, individual researchers. About 30% of the direct financial support measures are R&D/innovation grants for individual companies via the industrial R&D funding program. This program provides direct support to firms for research and development projects initiated with the purpose of developing innovative solutions. With innovation is meant that the projects must result in new knowledge that has practical applications leading to the creation of economic added value and possibly other benefits for Flemish society. Large companies based or with an active branch in Flanders as well as SMEs are eligible for these subsidies. For SMEs there is also a specific SME programme for innovation studies and innovation projects, with adapted procedures and projects. It is also possible to submit the R&D/innovation project with other companies or research institutes. The funding awarded by IWT is a percentage of the eligibility costs of the project. Industrial R&D projects may also be part of a larger international project with parties outside Flanders.

Within the industrial R&D funding programme the basic funding rate is 15% for development projects and 40% for research projects. The first type of project is mainly focused on the application of knowledge for the development of new or modernized products, processes or services, while research projects are primarily focused on the production of new knowledge that might eventually lead to innovation. Additional support may be granted on various grounds. A project that meets specific policy objectives may be eligible for an additional 10%. Small firms (SEs) may be eligible for an additional 20% and mid-sized firms (ME's) for an additional 10%. If the project involves substantial collaboration with either a large firm or at the international level, it may be eligible for an additional 10%. The subsidy goes from a minimum of 15% to a maximum of 80%. SMEs can, in addition to their subsidy, also apply for a subordinated loan. For SME innovation studies and SME innovation the basic funding rates are respectively 50% and 35%. The maximum subsidy amounts respectively to 25.000 EUR and 200 EUR. However for both cases additional support is possible on various specific grounds.

6 OPERATIONALISATION OF VARIABLES AND MODEL SPECIFICATION

In order to model the determinants of the IWT to grant R&D subsidies to high tech SMEs, and to take into account a potential selection bias problem caused by the fact that the likelihood of applying for R&D subsidies may affect the model, we used a Heckman two-step procedure (see, for example, Greene 2000: 926-937). The first step involves estimating the likelihood of application using an instrumental model. Stage two involves estimating likelihood of R&D grant with the coefficients adjusted according to the results of the first stage.

The instrumental regression (called selection equation in the Heckman model) estimates the probability that a young technology based firm will *apply* for a grant (in line with hypotheses 1-3).

> *Application for R&D subsidy (0/1)*
>
> *= F(technical experience, commercial experience, level of finance)   (1)*

Commercial Experience. Commercial experience was defined as commercial experience within a company, ranging from sales management to business development, and was measured as the number of years cumulative experience of the management team. The founding teams in the overall sample on average had 4.46 years of commercial experience (with a standard deviation of 7.55 years).

Technical Experience. Technical experience is defined as experience in a technical function within a corporate environment or in research in a research institution, and was measured as the number of years cumulative technical experience of the management team. The founding teams in the overall sample on average had 14.06 years of technical experience (with a standard deviation of 14.55 years)

Amount of finance. Given the relatively low reliance by high tech start-ups on own financing, financing was measured as the amount of external financing (including equity and debt financing). We used the log of the amount of financing raised within the first year after founding. The companies in our sample had on average raised 482 216 Euro of financing within the first

eighteen months after start-up (standard deviation of 1 430 576 Euro).

The main regression model takes the following form.

> *Grant of R&D subsidy (0/1)*
>
> *= F(controls, financing, VC, team heterogeneity, patent application) (2)*

The controls took the form of a vector which included the growth of the company and the standardized residual of the auxiliary regression (equation 1). Dependent variables are financing, measured in the same way as in equation 1, a VC dummy, team heterogeneity and a patent application dummy.

Venture capital. The VC dummy indicates whether or not the venture raised VC financing before applying for the grant. 47 companies raised VC financing.

Degree of team heterogeneity. Following Ucbasaran et al. (2003) we employ Teachman's (1980) scale to measure the heterogeneity of the team: $(H) = -\Sigma P_i (\ln P_i)$. This measure takes into account how team members are distributed among the different categories of a variable. The total number of categories of a variable equals 3, namely R&D experience, commercial experience and financial experience. P_i is defined as the number of years experience in function over the total team experience (measured as the number of years).

Patent application. Dummy variable indicating whether or not the R&D subsidy applicant had applied for a patent at the moment of R&D subsidy application. In total, 23 of the R&D subsidy applicants also applied for a patent. 13 of these companies applied for a patent before applying for the R&D subsidy.

Further, we checked for risks of multicollinearity of the independent variables by calculating the variance inflation factors for each regression model. All variance inflation factors were below 3.0, indicating that multicollinearity is not an issue (Hair et al., 1998).

The descriptives for each of the variables are presented below.

Table 1. Descriptives and univariate analyses

Mean (s.d.)	Application for R&D subsidy (0)	Application for R&D subsidy (1)	
Technical experience (number of years)**	11.0 (16.6)	15.2 (14.6)	
Commercial experience (number of years)***	6.1 (10.6)	3.5 (6.5)	
Amount of finance (Euro)	212 470.1 (691 950)	587 613.8 (1 662 234)	
N	62	158	
		R&D subsidy granted (0)	R&D subsidy granted (1)
Financing (Euro)*		468 073 (1 022 930)	626 411 (1 824 327)
VC (0/1)		0.24 (0.44)	0.23 (0.42)
Team heterogeneity		0.15 (0.26)	0.23 (0.32)
Absolute yearly growth in FTE's		7.21 (12.10)	18.91 (32.80)
N		38	120

Kruskal Wallis Test levels of significance: * p< .10; ** p<.05; *** p<.01; **** p<.001

Applicants of R&D subsidies tended to have significantly higher levels of technical experience (11 years on average for non-applicants, 15.2 years for applicants), and significantly lower levels of commercial experience (6.1 years for non-applicants, compared to 3.5 years for applicants). We did not find significant differences in founding capital between the two groups. Young technology based firms that received R&D subsidies tended to dispose of more initial financing (0.6 million compared to 0.45 million Euro). The univariate analyses provided no indication of differences in team heterogeneity, growth rates nor VC funding between those that received R&D subsidies and those that did not. In table 2, we present the results of our multivariate analysis using the Heckman two stage selection model.

Our first hypothesis is clearly supported: the more capital constraint a young technology based firm is, the higher the likelihood it will apply for R&D subsidies.

This suggests that IWT as an R&D granting institute does substitute the need for external finance. The findings do indicate that those new technology based firms which do not have external finance are likely to apply for an R&D grant. However, once external capital has been attracted, the likelihood of applying for an R&D grant decreases. So, grant money is seen as less interesting than external finance obtained from the commercial markets.

The results show that teams with high levels of commercial experience are less likely to apply for R&D subsidies (results significant at p<.001 level). Technical experience in the team does not make a difference. In other words, the self efficacy hypothesis *does* not tend to be symmetric. A commercial background does make a difference in the sense that founder / managers with such a commercial background do not consider the R&D granting institute as an option where

they make a lot of chance of getting their project. During our interviews, one founder/managers repeatedly stated that IWT was an institute for engineers, not for innovative companies. This opinion tends to change at the moment these founder/managers have somebody in the team who has been working in a research environment and therefore has some familiarity with the IWT. At that moment, the perception changes. The amount of technical experience does not matter anymore afterwards. It is not because they have a longer research experience that they are more likely to apply for a project than those who have worked less long in a research environment. Just the fact of *having worked* in the research environment seems to be the most important.

 The determinants which predict application tend to be different from the ones that have an influence on the fact whether a project gets granted or not. We hypothesized that the granting process follows much more the classic determinants which are found in the selection of projects by investors. Investors tend to attach a lot of attention to the team variable. In line with this, we find that heterogeneous teams experience a higher likelihood of receiving subsidies compared to more homogeneous teams, and therefore we find support for hypothesis four. Also the examination procedure in the R&D granting institute does take the quality of the team into account and therefore tends to select the projects which are anticipated to perform better. In contrast however to our hypothesis 5, we do not find support for the fact that IWT would see the projects which have already received venture capital as qualitatively better than those which have not received it. The univariate statistics suggested that the amount of capital might have a positive impact on the probability of effectively receiving a subsidy, but the Heckman model does not confirm this. This is surprising as having sufficient capital to complement the subsidy which is limited to 50% of the total size of the project is one of the preconditions upon receiving such a subsidy. Further analysis is needed to explore this result. Neither do we find support for our hypothesis that having a patent application at the moment of grant application does matter to obtain the grant. This implies that patents are not considered a necessary indicator of quality by R&D granting institutes. This supports the idea that R&D grants are obtained *before* venture capitalists or business angels do invest in a high tech start-up.

Table 2. Heckman Selection Model Results

Heckman selection model -- two-step estimates (regression model with sample selection)

Number of obs   =   215

Censored obs   =   89

Uncensored obs   =   126

	Full model
DV=subsidy granted (0/1)	
Absolute yearly growth in FTE's	.14**
	(.06)
Team heterogeneity	.24*
	(.13)
VC(0/1)	-.18
	(.12)
Patents(0/1)	.13
	(0.15)
Constant	.65****
	(.15)
Select	
Technical experience	.01
	(0.01)
Commercial experience	-.03****
	(0.01)
Amount of Finance	-.05*
	(0.03)
Constant	.47
	(0.15)
Mill's Lambda	-0.1
	(0.12)
LF test of indep Eqs	Chi2
Mill's ratio	-.10
	(.26)

Levels of significance: *p<.10; **p<.05; ***p<.01; ****p<.001

8 CONCLUSIONS AND IMPLICATIONS

This paper started off from the premise that studying the impact of R&D subsidies requires a treatment effect model which controls for the probability that a given company applies for a subsidy. Received literature using these treatment effect models suffers from a lack of theoretical understanding why companies apply for R&D grants. Further the received literature does not make a difference between the determinants of applying for and those that impact the probability of *getting* an R&D subsidy. Still, the granting process might take very different aspects into account than those which determine the application behaviour. Finally, we stated that the received literature tends to look at large populations of companies that are very heterogeneous in terms of size and industry.

In this study, we tried to address this gap in the literature by a) focusing on a very well defined and homogeneous group of young, technology based firms ; b) theorizing about their application behaviour and their chances of receiving a subsidy and c) by making an explicit distinction between the application process and granting process. We find that organisational theories such as self efficacy theory do explain the behaviour of young technology based firms in terms of their likelihood of applying for R&D grants. We find that young technology based firms of which the management has no experience with technology development and working in a research environment does consider the IWT to be an institute at which they have very little chance of receiving the grant. Therefore, they do not even apply for a subsidy. This finding suggests that simply promoting the IWT as an innovation subsidy shop might not be sufficient to trigger these companies. Instead, more emphasis might be needed on the non-technical part of IWT. Recruiting bureaucrats with a non-technical background to perform subsidy evaluations might make the IWT more appealing.

In addition to the self efficacy argument, we find indications that the more capital constraint the company is, the more it will try to attract subsidies as a substitute for external finance on the private market. This is a clear hint, but not a real test yet, that IWT attracts young technology based firms which cannot attract money on the private market. However, this also means that IWT *does not* complement external finance on the private market. One can question whether there is not a lot of potential for the IWT to support young technology based firms which have already a significant capital basis but which at the same time do make significant investments in R&D of which the risk could be diversified between private and public sources of money. In other words, the IWT could subsidize their R&D efforts to a greater extent than it does today.

We clearly show in the paper that the factors which determine whether a young technology based firm will get subsidies are clearly different from the ones where the young technology based firm does apply for R&D grants. In line with received literature, we find that also IWT tends to select the most promising projects at the commercial level. Doing so, they are very much in line with the venture capital community. Interestingly however, having venture capital does not seem to be a quality signal despite the lengthy due diligences which the latter actors tend to do. This is strange and might indicate that both communities do not know each other and, moreover, do not trust each others competencies. This is confirmed by the fact that having venture capital seems to decrease the likelihood of applying for R&D subsidies as well.

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