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Abstract

R&D subsidies constitute a selective policy tool to encourage private R&D. The efficiency and functioning of this tool depends on how the public agency allocates subsidies. This paper studies how subsidies are allocated to small and medium size firms (SMEs) and large firms by the Finnish Funding Agency for Technology and Innovation (Tekes). The results indicate that contrary to theory Tekes has difficulties in tolerating commercial risks especially in the case of SMEs. In addition, Tekes seems to put more emphasis on encouraging incoming than outgoing spillovers.

JEL Classification: D02, D73, H20, O38

Keywords: R&D, subsidies, allocation, bureaucratic decision-making

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1 Introduction

This paper examines the allocation of business research and development (R&D) subsidies by analyzing the determinants of acceptance into an R&D subsidy program. More specifically the question addressed is whether there are differences in how subsidies are allocated to small and medium size firms (SMEs) and large firms. The standard rationales for R&D subsidies, namely spillovers and financial constraints, do not apply equally to SMEs and large firms. The existing literature provides several reasons why information asymmetries underlying financial constraints are more sever in SMEs than in large firms. In addition, appropriability problems linked to spillovers are likely to hamper more the innovative acitivies of SMEs compared to large firms. These differences are increasingly taken into account in the design of R&D subsidy policies.[1] Yet, it is unclear how these principles are reflected in actual decision making. The program under scrutiny is that of the Finnish Funding Agency for Technology and Innovation (Tekes) for which I have unique data on everyone who applied over a two and a half year period including data on internal project evaluations of Tekes.

Finland provides an interesting case to analyze how a key innovation policy instrument, direct R&D subsidies, is designed and implemented. First, Finland has experienced a particularly rapid and successful transformation to a technology intensive economy [25, 34]. Although Finland industrialized relatively late it has gained a leading positions in several recent international comparisons of technological advancement and economic competitiveness. Innovation policy has played a central role in government policy during the transformation and is often praised for contributing to the success of the Finnish economy [13, 27].

Second, direct R&D subsidies constitute a key ingredient of the Finnish innovation policy [10]. Instead of being a marginal and fragmented activity, R&D subsidies are at the core of the Finnish innovation policy. The program has been consistently operated and developed over the past twenty years.

Third, unlike many other countries, the majority of R&D subsidies are administered by a single public agency, Tekes. Instead of several small, relatively focused programs administered by different institutions and adhering to different criteria, Finland has a relatively unified R&D subsidy program open to all innovative firms operating in Finland.

[1] EU regulations allow for different treatment of SMEs and large firms and increasingly programs have different criteria for SMEs and large firms.

Fourth, while Tekes funding is available to all innovative firms operating in Finland, one clear trend in the business funding of Tekes since the beginning of the 90's has been an increasing emphasis on SMEs. The share of applications by firms with less than 100 employees increased from 36 % in 1990 to 69 % in 2000 and the share of business funding allocated to SMEs rose from 22 % in 1990 to 53 % in 2000.[2]

The main contribution of the paper is to increase our understanding of the functioning of R&D subsidy programs. The unique data at hand allows to analyze in detail the bureaucratic decision-making underlying the allocation of R&D subsidies in Finland. The empirical literature analyzing R&D subsidies has focused on establishing the link between subsidies and firm's R&D investments or performance. However, an understanding of the details of how R&D subsidy programs actually function is lacking. In order to assess the functioning and efficiency of R&D subsidy programs in practice, it is crucial to understand the overall allocation of subsidies - who is it that finally participates in the program and why. Given that R&D subsidies constitute a selective innovation policy tool, a central issue in the overall allocation is how government bureaucrats allocate subsidies to applicants. By analyzing the rationals, design and functioning of an R&D subsidy program this paper provides a descriptive account of an R&D subsidy program, but also hopes to provide a more general discussion that is helpful in understanding the operations of R&D subsidy programs and in identifying issues that should be carefully scrutinized.

The framework of the analysis in this study has relevance also in terms of quantitative program evaluation. In order to properly analyze the effects of public R&D subsidies on private R&D activities, the participation process creating the selection has to be well understood (see [16]). The allocation rule of government bureaucrats constitutes a central element of the participation process. Although the allocation rule is different for different R&D subsidy programs and the empirical results in this study are specific to the R&D subsidy program in question, this paper helps to structure our understanding of how the selection is actually created.

So far, relatively little systematic attention has been paid to the allocation rule that government bureaucrats use to allocate R&D subsidies. One reason has certainly been the lack of data. Government agencies allocating R&D subsidies

[2] An enterprise is considered a SME if 1) it has less than 250 employees, 2) large firms ownership is under 25% and 3) its yearly turnover is less than 40 million euros or its balance sheet total is not over 27 million euros.

are not eager to give access to their databases - if they keep one. However, it also seems that the widespread political urge to get plausible evidence about the effectiveness of R&D policies in terms of additionality, productivity and growth has diverted attention from the issue of allocation. Yet, reliable impact estimates are difficult to get without a thorough understanding of the participation process that determines the allocation of R&D subsidies. In addition it is difficult to interpret the impact estimates and draw policy conclusions if the functioning of the policy instrument is not fully understood.

There are a few papers that touch upon the issue of government allocation of R&D subsidies. The two closest to this paper are Feldman and Kelley [8] and Blanes and Busom [5]. Feldman and Kelley study whether the Advanced Technology Program in U.S. has been successful in identifying and awarding funding to firms that are more likely to generate knowledge spillovers. They find that this has indeed been the case. Blanes and Busom in turn analyze how firm characteristics are related to the participation of firms in R&D subsidy programs. Their data does not allow distinguishing between the application and approval phases, nor do they have project-level information.

Of other related papers Aschhoff [4] focuses on analyzing the structure of the subsidy recipients in Germany over time. She finds that participation in the funding scheme is quite stable. However, her data does not allow to distinguish the rejected applicants from the non-applicants. Lichtenberg [19] and Desmet el al. [6] focus on analyzing programs targeted to one specific field. Lichtenberg [19] analyzes the determinants of allocation of public biomedical research expenditure. More specifically, he analyzes how different characteristics of disease burden affect the amount of public research expenditure allocated on a disease. Desmet et al. [6] in turn focus on participants of Spain's National Pharmaceutical Research Program. They analyze how ex-ante announced criteria are related to the ex-post ranking of participants. They find a discrepancy between ex-ante announced and ex-post applied criteria, but argue that the plan's implementation has broadly been in line with its objectives. In addition, this paper has links also to the literature of bureaucratic decision-making that analyzes the preferences of government bureaucrats in various settings [20, 21, 33, 15, 14].

Compared to earlier work this study uses unusually rich project-level data consisting of detailed information on the internal project evaluations of Tekes for both applicants and non-applicants. To my knowledge, differences in allocation of subsidies to SMEs and large firms has not been looked at before. In addition, the data contains information on the granted subsidy-rate (share of costs covered by the subsidy) allowing an analysis of both the acceptance decision and the subsidy-rate decision.

The results indicate that the technological content of a project proposal is an important determinant of the subsidy decisions both for SMEs and large firms. This result may find some basis in economic rationales justifying R&D subsidies. Unlike what the rationales might predict Tekes has difficulties in tolerating commercial risks especially in the case of SMEs. In addition, the results show that collaboration within a project matters more for projects initiated by SMEs. This may suggest that Tekes puts more emphasis on encouraging incoming than outgoing spillovers.

The structure of the paper is the following. Section 2 discusses the theoretical issues related to R&D subsidies namely, the rationales for R&D subsidies and problems related to the design and implementation of R&D subsidy policies. Section 3 describes the design and implementation of the Tekes R&D subsidy program. Section 5 moves toward the empirical analysis by presenting the data. Section 4 goes through the econometric setup and section 6 presents the estimation results. Finally, section 7 offers some concluding remarks.

2 Theoretical premises of R&D subsidies policies

The economic justifications for government intervention in the form of R&D subsidies to the private sector relies on the widely accepted argument that a market economy may fail to provide adequate incentives for firms to invest in innovation [23, 2]. This is due to two familiar market failures that have to do with a) higher social than private benefits of R&D and b) the availability of market finance in the presence of information asymmetries. An identified market failure raises the question of whether government intervention could improve the situation. The efficiency of government intervention depends primarily on two issues:

1. Whether an appropriate policy instrument can be designed.
2. Whether this instrument is efficiently implemented.

Several policy instruments are designed to address one or both of the above market failures. Intellectual property rights are designed to improve the appropriability of knowledge and that way increase the incentives for R&D (see e.g.

[28] for a survey). Tax reliefs in turn aim for the same by reducing the cost of R&D (see [12]). There are also public efforts to increase the functioning of financial markets (e.g. support to venture capital markets) in order to reduce possible financial constraints. A thorough overview and comparison of several technology and innovation policy instruments is, however, beyond the scope of this paper. In this paper the focus is purely on direct R&D subsidies. This section discusses the theoretical premises of the design and implementation of R&D subsidies.

2.1 Rationales for R&D subsidies

Due to the non-rival and non-exclusive properties of knowledge innovation activities of firms are associated with positive externalities. Once new knowledge is created it is difficult to preclude others from using it. Knowledge spills over for the benefit of others without the creator being able to appropriate the full benefit of it. Some of the benefit accrues also to purchasers in the form lower prices or new and improved products. Given these positive externalities or spillovers social benefits from innovative activities may be considerably higher than private ones and a market economy may fail to generate the socially optimal investment in innovation.

In addition to positive externalities, innovation is an inherently uncertain endeavor. Uncertainty gives rise to information asymmetries like agency conflicts [17] and the 'lemons' problem [18, 22] that may generate financing constraints. An innovator has private information about her innovation activities that is difficult to assess by third parties like financiers. These information asymmetries can make external capital more expensive than internal capital. In the absence of internal funds, this may prevent firms from undertaking economically viable projects creating financing constraints.

The above basic rationales underlying business R&D subsidies do not differentiate between large and small firms. However, there are several arguments why especially SMEs may suffer more from the identified market failures. To begin with, the financial constraints argument is more probable for SMEs. Although the development of financial markets has somewhat reduced the appeal of the financial constraints argument, there is evidence that innovation projects of young and small innovative firms may still face financing constraints (see e.g. [30, 11]).

In addition, the literature suggests that from an economy-wide perspective the market may generate too little risk-taking especially in the innovative activities of SMEs [3, 34].[3] The same project conducted in a small firm can be riskier compared to what it would be if conducted in a large firm. SMEs are often focusing on one or a few projects compared to large firms with project portfolios containing a whole range of projects. They are also unlikely to have competencies and experience that are complementary to R&D to the extent that large firms have. Moreover, due to information asymmetries the risk premium imposed on SMEs by external financiers is likely to be larger compared to large firms.

Based on the above it can be concluded that for the allocation of subsidies to be consistent with economic rationales the differences in the allocation of subsidies to SMEs and large firms should reflect the following arguments.

- SMEs are likelier to suffer from financing constraints.
- Subsidizing risk-taking is more justifiable in the case of SMEs.
- Subsidizing large firms relies to a large extent on the spillover justification.

In relation to the last argument, literature suggests that compared to SMEs large firms can better internalize the spillovers [34, 9]. This means that the inappropriability problem may dilute less the innovative activities of large firms. In this sense even the spillover argument may be more pronounced for SMEs. However, the R&D activities of large firms often cover also more basic research oriented R&D. From policy point of view large firms can be considered as an important source of spillovers. As a result public R&D policies towards large firms often emphasize subsidizing outgoing spillovers through collaboration.

2.2 Government failure and bureaucratic decision-making

Government intervention always raises the question of whether an identified market failure is only replaced by government failure. Even if there seems to be scope for government intervention from a theoretical point of view, it is not clear whether the government can improve the situation in practice. Is the government capable of making efficient allocation decisions to correct the market failure? In the case of R&D subsidies, it is unlikely that government intervention could lead to the optimal outcome. The difficult task is to determine whether

[3] In general, corporate finance literature suggests that limited liability encourages corporate risk-taking, and such limited liability considerations should be more relevant for smaller firms, which have stronger incentive to "bet for resurrection".

a certain government intervention is justified when the distortions it brings are taken into account [1]. Stiglitz [29] argues that government intervention is warranted when it is possible to achieve a near-Pareto improvement, i.e. an improvement of which almost everyone benefits. The problem is that in general the outputs generated by government intervention are such that an objective measure of profitability and efficiency is extremely hard to obtain [7, 20].

There are three main issues underlying the possible government failure related to R&D subsidy policies.[4] The first issue concerns the target group for the policy. Even if there is assumed to be room for government intervention in the form of R&D subsidies, it is an open question what kind of activities should be subsidized and how to identify those projects. From a theoretical point of view projects with higher social benefits than private ones should be subsidized. Which are these projects in practice and how to identify them? It is clear that bureaucrats face informational problems in making the allocation decisions, but an open question is whether these informational problems are so severe that a specified market failure cannot be adequately addressed in practice.

The second issue has to do with the incentives that govern bureaucratic decision making. What is it that the bureaucrats are maximizing? Are the bureaucrats motivated merely by goals that benefit only themselves or are they indeed interested in maximizing social welfare as a benevolent social planner should be? Corruption is one obvious force that can distort bureaucratic behavior. In addition, there are other, not so obvious, distorting forces at stake. Heckman and others [14] highlight that performance standards may provide incentives that lead possibly self-interested bureaucrats to e.g. "cream-skimming". Niskanen [24] in turn suggests that bureaucrats are more interested in maximizing the overall budget of their bureau than social welfare. In addition, lobbying by different interest groups could divert the decision-making of government bureaucrats.

The third issue is related to the general equilibrium effects of an R&D policy. Namely, are there associated negative externalities that undermine the positive effects of spillovers?[5] In other words, to what extent subsidizing some projects

[4] This paper focuses on bureaucratic decision-making and problems related to political decision-making are not discussed. McFadden [20] points out that often the general goal set by politicians consists of vague statements and bureaucrats are left with considerable freedom in translating this goal into concrete decision rules. This applies also to innovation policy in Finland.

[5] An obvious addition to the list would be: Do the costs of putting up and administering an R&D subsidy program outweigh the benefits. Although relevant, this question is omitted here.

generate distortions that harm the non-subsidized? This is related to the near-Pareto improvement - are almost everybody benefiting from the subsidy policy or in other words, do the gains from the policy outweigh the losses? It may be for example that subsidies create unwarranted competitive advantage to some firms. Or at the technological level, is it possible that a more promising technology is left unexplored, because subsidies made the exploration of another related technology more attractive?

Given the above problems related to government intervention and the difficulty of assessing the presence and magnitude of these problems, it is not clear whether government intervention is warranted. As Acemoglu and Verdier [1] point out, some would prefer to live with the market failures, while others are willing to accept that there is a trade off between government failure and market failure. From a welfare point of view government intervention may be in some cases optimal even though it is associated with government failure. In relation to corruption, Acemoglu and Verdier show that government intervention with partial corruption is optimal, if corruption is relatively rare and the market failure in question is relatively important.

3 R&D subsidies in practice - the Finnish example

3.1 Introduction of Tekes

Tekes is the principal public promoter of private R&D in Finland and also the most important public financier of business R&D (for an overview of the Finnish innovation support institutions see e.g. [10]). Tekes provides funding and expert services to both business and public R&D. Public R&D consists of research conducted in universities, academic institutions and research institutes. According to the Tekes annual report 2002, Tekes funding decisions amounted to 381 million euros in 2002, of which 237 million euros was allocated to the business sector.[6] In terms of projects this translates into 2017 projects of which 1219 were business R&D projects.

The basic firm-level eligibility criteria for the business R&D funding of Tekes

[6]Given that the sample period used in this study is from January 2000 to June 2002 the figures and funding principles used in the description are also from that period. Despite the somewhat outdated sample period, there are little changes to the main funding practices of Tekes and to large extent the same funding principles still apply.

is that the firm is operating in Finland. Funding is project-based and depends on the initiative of industry to define research projects. Firms submit applications and Tekes' business and technology experts evaluate every proposal. Key funding instruments of Tekes are grants and low-interest loans. In 2002, 66 percent of the business R&D funding consisted of grants. In general, the same funding criteria apply to both grants and subsidized loans. The key element determining the suitable funding instrument is the readiness of the output of a project to be introduced in the market: grants are directed to more basic research oriented R&D and R&D work done at the early phases of the innovation process. Subsidized loans and capital loans are aimed at R&D work in the later stages of the innovation process in which the focus is on developing a complete product or service that can be introduced in the market. In practice the distinction between different phases of the innovation process is not clear-cut and a project can incorporate both stages. As a result, Tekes funding can be a combination of several instruments.

The decision-making process within Tekes starts with allocating an application to a relevant technology field.[7] In general, the relevant technology field is the one that has the best technological and industry knowledge related to the project proposal. The technology field then sets up a group that takes care of the treatment of the application. This group is responsible for the evaluation of the project proposal, and based on its evaluation the group prepares a funding proposal with key arguments supporting the proposal.

The decision-making process within Tekes has several stages depending on the applied amount. At each stage the funding proposal and related arguments are presented and discussed. For smaller applied amounts the final decision is made at the lower decision making levels. Project proposals consisting of larger applied amounts are handled through several stages and lower decision making levels decide on whether the funding proposal can be forwarded to the next stage.

Although the official decision-maker is an individual except in the case of the board, the decision-making process is in practice highly collective. To start with, it is not a single person that is responsible for the evaluation of the projects, but a project group consisting of several employees. In addition, usually several

[7]The description of the decision-making process is based on internal material of Tekes and discussions with Tekes employees to which the author had access during an 11-month stay at Tekes in 2002. The description reflects the decision making process during the sample period in question.

project proposals are dealt with at each decision-making meeting and the discussion concerning a project proposal is open to all participating Tekes officials - not only the project group and the decision-maker. This collective character of the decision-making process reduces the possibilities to make funding decisions based on an individual's own self-interests, given that the self-interests are not in line with the goals of the organization. What remains, though, is the possible ambiguity at the organizational level.

3.2 Funding principles of the R&D subsidy program

According to Tekes its funding is *targeted at projects which produce new knowledge, bear high technological and commercial risks and in which the impact of Tekes' funding is substantial* [32]. More specifically the funding of Tekes is considered to

- *increase customers R&D and controlled risk-taking*
- *enable the creation and utilization of new knowledge and technology*
- *impact the level of challenge, quality, networking and implementation of R&D projects*
- *share technological, commercial and financial risks related to R&D projects [32].*

These extracts highlight that sharing the risk involved in a project and promoting innovative, risk-intensive projects are central elements of Tekes funding.[8]

In making the actual funding decision Tekes pursues its objectives through the following main evaluation criteria:

a) *the business activity to be pursued* - The goal is to promote projects that generate profitable business opportunities for global markets.

b) *the technology, innovation or competence to be developed* - The technology, innovation or competence to be developed should be technologically new

[8]In economic terms a mean-preserving spread could be used to characterize the concept of risk-taking in this setup. Assume that a firm has two projects that generate the same expected return. However, the dispersion of the possible outcomes differ between these two projects. The probability of the more risky project to generate a return considerably higher than the expected one is larger than that of the less risky project. Conversely, the probability of generating outcomes with significantly smaller returns compared to the expected one is higher for the more risky project. A risk-averse firm chooses the less risky project, whereas the public agency would want the firm to choose the more risky one that has a higher probability of generating "a global success story".

and challenging at least to the company itself. In addition, knowledge and know-how created within the project should generate long lasting competitive advantage to the company. Also internationally high-level challenges are appreciated.

c) *the resources available for the project* - To be realistic the project proposal should incorporate adequate human and economic resources and the company should have a sound financial standing.

d) *co-operation within the project* - One central aim of Tekes funding is to promote both domestic and international networking with other companies, universities and research centers.

e) *the effect of Tekes funding on the project* - The aim is that with Tekes funding the companies are willing to carry out more challenging R&D projects than they otherwise would and that by providing resources for efficient networking the funding enhances the widespread use of the benefits of the project in the Finnish economy.

f) *societal benefits of the project* - Societal benefits that favor Tekes funding are: positive environmental effects, balanced regional development, amelioration of the Finnish working and living conditions, improvements to back up the development of social welfare and health-care, promotion of the national energy strategy and promotion of equality.

Besides these general funding principles Tekes puts special emphasis on supporting SMEs by imposing more stringent requirements on large firms. Large firms' projects should fulfill at least one of the following criteria: networking with SMEs, universities or research institutes, participation in a technology program, participation in an international R&D project and network, the project consisting mainly of industrial research, or research outcomes are public. Also the upper bound for the subsidy-rate is lower for firms not fulfilling the official SME criteria.

Almost half of the Tekes funding was steered through technology programs. Companies, research institutes and Tekes plan the technology programs in cooperation. Together they identify specific sectors of technology or industry that are perceived to need focused national support to boost the development of the sector and the diffusion of knowledge. Technology programs aim at creating forums for the exchange of information and networking between companies and research groups in strategically important R&D areas. The same evaluation criteria apply to projects funded through technology programs.

4 Data

Originally the data contain all the business sector applications for R&D subsidies Tekes received from January 1st 2000 to June 30th 2002 and consist of detailed information on the project proposal, the applicant firm and the funding decision of Tekes. This original data covers 3347 applications from 2098 firms. However, Tekes started the extensive collection of project level data in 2001. After cleaning the data of missing values we are left with 1217 projects that constitute the sample analyzed in this paper. 1080 of the applications within the sample, almost 90 percent, are from the years 2001 or 2002 and in total 55 percent of the applications received in 2001 or 2002 are covered by the sample.[9]

4.1 The dependent variable

As mentioned in section 3.1, Tekes funding can be a combination of several instruments. Tekes grants subsidies, subsidized loans and subsidized capital loans. The granted funding can be a pure subsidy, a pure loan, a pure capital loan or a subsidy combined with either a loan or a capital loan. Subsidized loans not only have an interest rate below the market rate but they are also soft: If the project turns out to be a commercial failure, the loan may not have to be paid back. A subsidized capital loan granted by Tekes differs from the standard private sector debt contract in various ways: it is included in fixed assets in the balance sheet, it can be paid off only when unrestricted shareholders equity is positive, and the debtor does not have to give collateral for the loan. Table 1 below shows the share of each instrument of the total funding applied and allocated to business R&D for the original data and the sample used in this paper. The figures indicate that subsidies cover over 80 % of the applied amount while the corresponding figure for granted funding is around 65 %. Some 28 % of applications are rejected.

Tekes grants subsidies ex-ante as a share of to-be-incurred R&D costs. In the application the applicant reports the anticipated costs of the projects. Some-

[9] In order to analyze whether there appears to be some systematic differences between all the applications and applications covered by the sample used, I did some basic comparisons of frequencies across industries, size classes, funding decisions, granted amounts, etc. No major differences were found.

Table 1: The share of each instrument of the total funding applied and allocated.

	Applied		Granted	
	all	sample	all	sample
Total sum, million €	1325	523	606	241
Share of subsidies	84 %	82 %	65 %	64 %
Share of loans	8 %	7 %	20 %	20 %
Share of capital loans	8 %	11 %	15 %	15 %

times Tekes adjusts this proposed budget, both down and up, when an applicant, e.g., applies for subsidies for costs that Tekes cannot cover. In practice an upward adjustment is rare and in principle occurs only if a project significantly changes character during the application process. To-be-incurred R&D costs refer to the costs accepted by Tekes and in the following are called "accepted costs". The actual funding then covers the promised share of incurred costs up to a specified euro limit.

The dependent variable used to describe the size of a subsidy in this paper is the effective subsidy-rate of the granted funding. Effective means that instead of taking into account the absolute value of a loan, only the "subsidized" part of a loan is considered. This is the estimated difference between a market loan and a corresponding Tekes loan. In order to calculate the subsidy-rate of each decision using the exact formula, one would need information on the loan period, redemption free years and interest rates. Unfortunately, the data available has information only on the absolute amount granted. However, Tekes provided illustrative subsidy-rate calculations using a loan period of six years with three redemption free years. These calculations were used to derive the following approximation of the effective subsidy-rate.

$$s_i = (grant + 0.2 * loan + 0.1 * capital\, loan)/(accepted\, costs). \tag{1}$$

This is the dependent variable used to describe the size of subsidy in the analysis.[10] The mean subsidy-rate of the successful applications in the sample is 0.31 (0.32 in the original data).

4.2 Explanatory variables

Explanatory variables consist of both project- and firm-level variables. Firm-level characteristics are mainly used to control for firm specific factors that may indirectly or directly affect the subsidy decisions, namely the acceptance decision and the subsidy-rate decision. These include characteristics like age, size and R&D and export activities. Also the application history of the firm is included. Given the cross-sectional approach the application history is likely to capture at least to some extent unobserved heterogeneity across firms related to their

[10] To get an idea of how adding up grants and loans in the form of effective subsidy-rate may affect the result, I also estimated the model using only grants. Qualitatively the results remain the same, but in general, the estimated coefficients tend to be slightly smaller when only grants are taken into account. However, the results are so close to each other that dropping loans from the analysis is not considered warranted.

Table 2: Description of the explanatory variables.

Variable	Description
Firm-level	
AGE	Age of the firm.
EMPLOYEES	No of employees.
SALES_EMPL	Sales per employee for the year preceeding the application, thousands of €*.
APPL_DUM	Dummy indicating whether the applicant has any previous applications
APPLICATIONS	No of previous applications
GRANT/APPL	No of accepted previous applications / the total number of previous applications
R&D	R&D investments for the year preceeding the application, thousands of €*.
R&D_DUM	Dummy indicating whether the variable *R&D* is greater than 0.
EXPORT	Exports for the year preceeding the application, thousands of €*.
EXPORT_DUM	Dummy indicating whether the variable *EXPORT* is greater than 0.
Project-level	
CHALLENGE	Technological challenge of the project, values from 0 to 5.
RISK_COMPETENCE	Project's risk related to the resources reserved for the project , values from 0 to 5.
RISK_ECONOMIC	Project's risk related to the economic stance of the firm , values from 0 to 5.
RISK_TECHNOLOGICAL	Project's risk related to the technology to be developed , values from 0 to 5.
RISK_MARKETS	Project's risk related to the market opportunities of the output, values from 0 to 5.
NOVELTY_TECH	Dummy indicating whether the technology to be developed is new to the applicant.
NOVELTY_APPL	Dummy indicating whether the application to be developed is new to the applicant.
NOVELTY_BUSINESS	Dummy indicating whether the business activity to be developed is new to the applicant.
NO_MARKET	Dummy indicating whether the market objectives are indirect.
RESEARCH_PARTNERS	No of research partners.
FIRM_PARTNERS	No of firm partners.
PROJECT_SIZE	Proposed costs of the projects, thousands of € .
TECH_PROGRAM	Dummy indicating whether the application is for a technology programme.
EU-SUPPORT REGION	Dummy indicating whether the application is from EU-support region.

* If the figure for the preceeding year was not available, the nearest available figure of the preceeding years back to 1999 was used. There are in total 62 applications for which the preceeding year was not available.

innovative activities. The main interest is in analyzing project-level differences between projects initiated by SMEs and large firms.[11] Do the acceptance and subsidy-rate decisions of Tekes indicate different underlying patterns for SMEs and large firms? Are there differences between SMEs and large firms in how project characteristics are related to subsidy decisions?

Table 2 contains descriptions of the explanatory variables. *CHALLENGE* and different project-level *RISK*-variables are evaluations of the technical advisers of Tekes, and according to Tekes they are the key evaluation criteria in the decision-making. *CHALLENGE* describes the technological challenge of the project and it can have values from 0 to 5 with 0 meaning "no technological challenge", 2 "novelty value only to the applicant", 3 "novelty value to the region or network", 4 "demanding national level", 5 "demanding international level" and 6 "international top-class". *RISK*-measures describe how risky the project is in terms of the economic stance of the applicant, human resources, technological content and market potential. All the *RISK*-indicators are measured on a six-level Likert scale (no risk, small risk, considerable risk, big risk, very big risk, unbearable risk). Given the qualitative nature of these indicators the absolute values are difficult to interpret. It is not clear what small, considerable or big risk means. In addition, they are based on the judgment of technical advisors and different advisors may evaluate these qualitative aspects differently. However, the collective nature of Tekes' decision making is likely to reduce this latter problem. As such, the indicators should be valid for relative comparisons.

Of the *RISK*-measures the main interest is in technological and commercial risk. Risks related to the economic stance of the applicant and human resources reserved for the project are used to control for the ability of the applicant to carry out the project in the first place. If the applicant is facing serious economic problems or clearly lacks adequate competences no project is likely to succeed.

The number of firm and research partners measure the degree of collaboration within a project. *NOVELTY*-measures describe whether the technology, application and/or business to be developed are new to the applicant firm. They are indicative of how radical the project is from the point of view of the applicant firm. *NO_MARKET* gets a value one if market objectives of the project are indirect. *EU-SUPPORT REGION*, *TECHNOLOGY_PROGRAM*

[11] In the empirical analysis an enterprise is considered to be a SME if it has less than 250 employees and its yearly turnover is less than 40 million euros or its balance sheet total is not over 27 million euros. These follow the EU criteria for SME.

and $PROJECT\_SIZE$ are added as project-level control variables. Projects from firms locating in EU-support regions are entitled to a 5 to 10 percentage points higher subsidy-rate than a comparable project from other regions.

Table 3: Descriptive statistics.

	All applicants (827 firms)					At least one successful application (629 firms)					Rejected applicants (198 firms)				
Firm-level	Mean	Median	Std. Dev.	Min	Max	Mean	Median	Std. Dev.	Min	Max	Mean	Median	Std. Dev.	Min	Max
AGE	13,7	10	16	0	113	14,0	10	16	0	106	12,6	10	15	0	113
EMPLOYEES	542,5	22	3316	1	57482	611,0	24	3654	1	57482	324,9	16	1859	1	22804
SALES_EMPL	153,0	92	628	0	17600	168,0	95	716	0	17600	104,0	75	133	0	1495
APPL_DUM	0,6	1,00	0,48	0	1	0,7	1,00	0,47	0	1	0,6	1,00	0,50	0	1
APPLICATIONS	4,1	1	11	0	137	4,7	1	12	0	137	2,1	1	5	0	53
GRANT/APPL	0,5	0,50	0,45	0	1	0,5	0,67	0,45	0	1	0,4	0,00	0,43	0	1
SME	0,7	1	0,45	0	1	0,7	1	0,45	0	1	0,7	1	0,46	0	1
R&D	5885,0	122	97800	0	2700000	6301,0	147	108000	0	2700000	4565,0	66	55200	0	777000
R&D_DUM	0,8	1	0,40	0	1	0,8	1	0,38	0	1	0,7	1	0,46	0	1
EXPORT	59300,0	82	597000	0	1,3E+07	73500,0	119	683000	0	13400000	14300,0	6	88600	0	1100000
EXPORT_DUM	0,6	1	0,48	0	1	0,6	1	0,47	0	1	0,5	1	0,50	0	1
Project-level	All applications (1218)					Successful applications (884)					Rejected applications (334)				
CHALLENGE	3,4	4	1,01	0	5	3,7	4	0,83	0	5	2,7	3	1,09	0	5
RISK_COMPETENCE	1,5	1	0,84	0	5	1,4	1	0,78	0	4	1,5	1	0,99	0	5
RISK_ECONOMIC	1,3	1	1,10	0	5	1,2	1	0,97	0	4	1,6	1	1,35	0	5
RISK_TECHNOLOGICAL	2,1	2	0,93	0	5	2,3	2	0,87	0	4	1,8	2	0,98	0	5
RISK_MARKETS	2,3	2	0,99	0	5	2,2	2	0,95	0	4	2,3	2	1,08	0	5
NOVELTY_TECH	0,4	0	0,48	0	1	0,4	0	0,49	0	1	0,3	0	0,46	0	1
NOVELTY_APPL	0,3	0	0,47	0	1	0,3	0	0,47	0	1	0,3	0	0,46	0	1
NOVELTY_BUSINESS	0,1	0	0,25	0	1	0,1	0	0,22	0	1	0,1	0	0,32	0	1
NO MARKET	0,1	0	0,23	0	1	0,1	0	0,22	0	1	0,1	0	0,25	0	1
RESEARCH_PARTNERS	2,5	2	1,87	0	9	2,6	2	1,94	0	9	2,3	2	1,65	0	8
FIRM_PARTNERS	1,3	1	1,26	0	8	1,5	1	1,28	0	8	1,0	1	1,14	0	8
PROJECT_SIZE	921,0	389	1867	11	27000	1015,0	434	2078	14	27000	670,0	293	110	11	11200
TECH_PROGRAM	0,5	0	0,50	0	1	0,5	0	0,50	0	1	0,4	0	0,49	0	1
EU-SUPPORT REGION	0,2	0	0,43	0	1	0,2	0	0,43	0	1	0,2	0	0,42	0	1

From Table 3 we see that compared to applicants with rejected applications firms that have successful applications are on average larger in terms of number of employees, have higher sales per employee, more exports and more R&D investment, and have higher success rate in their earlier applications. When looking at the project characteristics we can notice that successful project proposals are technologically more challenging and have higher technological risk whereas risk related especially to the economic stance of the applicant firm is on average lower. In addition, successful project proposals incorporate on average more research and firm partners, and the overall size of the project proposal, measured as costs proposed by the applicant, is on average larger for successful applications compared to rejected ones.

4.3 Mapping the data to rationales

Section 2.1 ended with the following arguments.

- SMEs are likelier to face financing constraints.
- Subsidizing risk-taking is more justifiable in the case of SMEs.
- Subsidizing large firms rests to a large extent on the knowledge spillover justification.

Taking these arguments to the Tekes funding is not straightforward, but some simple ex-ante conjectures of the estimated coefficients can be made. Let us first consider financing constraints and risk-taking that are at least partly overlapping. A firm may undertake too little risk in its innovative activity either because it is unwilling or because it faces financing constraints for riskier projects. Both justifications arise from the uncertainty inherent in innovative activities. Higher degree of risk is likely to aggravate information asymmetries between the innovator and external financier increasing the likelihood of financing constraints. As such problems related to risk-taking and the possibility of facing financing constraints are considered to increase with the degree of risk. The two variables that directly attempt to measure the degree of technological and commercial risk of a project are *RISK_ TECHNOLOGY* and *RISK_ MARKET* respectively. In addition, the degree of risk could be expected to increase with challenge and novelty of the project. Therefore *RISK_ TECHNOLOGY, RISK_ MARKET, CHALLENGE, NOVELTY_ TECH,* and *NOVELTY_ BUSINESS* are expected to be positively related to subsidy decisions concerning SMEs.

As discussed by Feldman and Kelley [8] connections to other organizations, namely other firms and universities, are indicative of expected knowledge spillovers from a project. The more collaborating partners there are the greater the potential for knowledge spillovers. More basic research oriented projects are also considered to yield greater potential for knowledge spillovers (see [8]). The data does not contain direct information whether a project is more or less basic research oriented, but given the funding principles of Tekes having indirect market objectives is likely to reflect a more basic research oriented project. In addition, the degree of technological risk, challenge and technological novelty may be linked to knowledge spillovers. It could be considered that technologically more challenging, riskier or radical projects embrace the potential for broader knowledge spillovers. *RESEARCH_PARTNERS, FIRM_PARTNERS, NO_MARKET, RISK_TECHNOLOGY, CHALLENGE,* and *NOVELTY_TECH* are expected to be positively related to subsidy decisions concerning large firms.

5 The econometric setup

The starting point for the econometric analysis is a subsidy-rule derived by Takalo, Tanayama and Toivanen [31] (TTT). TTT build a structural model of the R&D subsidy process that explicitly models the application and investment decisions of firms and the subsidy-rate decision of the agency. In the model the agency allocating subsidies chooses the subsidy-rate s_i to maximize its expected benefits from project i. The specific form of the government agency's utility function is presented in TTT. Using some functional form assumptions TTT show that the optimization problem of the government bureaucrats yields the following unconstrained decision-rule (see TTT for details):

$$s_i^* = 1 - g + Z_i\delta' + \eta_i. \tag{2}$$

g is the constant opportunity cost of the agency's resources. Z_i is a vector of observable applicant and project characteristics that affect the expected benefits from the project to the government. δ in turn is the parameter vector reflecting the effect of Z_i on the subsidy-rate. The subsidy-rate is a share of the R&D investment, and it is subject to minimum and maximum constraints. In the case of Tekes the upper bound for the subsidy share differs between SMEs and larger firms. If a firm fulfills the EU SME criterion (see footnote 2) , the upper bound is 0.6, otherwise 0.5. The lower bound is zero (rejected applications). η_i is the unobserved (by the econometrician) error term. In this study the error term is assumed to follow a normal distribution and to be uncorrelated with applicant characteristics. TTT test the robustness of this distributional assumption in their work by applying a non-parametric CLAD estimator proposed by Powell [26]. The results are very similar to those obtained with the distributional assumption.

This paper concerns equation (2). The estimable equation builds directly on equation (2) with some modifications. First, the minimum constraint of 0 and the maximum constraint of $\bar{s}$ are taken into account and the opportunity cost g is embedded in the overall constant of the estimated equation and thus cannot be identified. These modifications yield the following constrained subsidy-rule:

$$s_i = \begin{cases} 0 & \text{if } s^* \leq 0 \\ Z_i\delta + \eta_i & \text{if } 0 < s^* < \bar{s} \\ \bar{s} & \text{if } s^* \geq \bar{s} \end{cases} \tag{3}$$

As can be noted, equation (3) is censored both below zero and above $\bar{s}$. There is a positive probability mass at zero and at $\bar{s}$ whereas in between, s_i is continuous. An equation like (3) is estimated as a two-limit Tobit model. The two-limit Tobit model, however, assumes that the same process determines both zero and positive subsidies. It may be that actually the subsidy decision consists of two stages: first an application is either accepted or rejected, and second, for accepted applications the actual subsidy-rate is decided. In order to allow for the possibility that the characteristics Z are differently related to the acceptance decision and to the subsidy-rate decision the TTT setup is modified as follows.

$$s_i = \begin{cases} d_i(Z_i\delta + \eta_i) & \text{if } s^* < \bar{s} \\ \bar{s} & \text{if } s^* \geq \bar{s} \end{cases} \tag{4}$$

d_i is a binary variable that gets a value 1 if $s_i > 0$ and a value 0 if $s_i = 0$. d_i is assumed to follow a probit model, that is,

$$P(d_i = 1|Z_i) = \Phi(Z_i\beta) \tag{5}$$

In the first stage a binary probability model is used to describe the acceptance decision and in the second stage a truncated from zero censored above $\bar{s}$ linear regression model is used to describe the size of granted subsidy-rate.

Z consists of explanatory variables presented in Table 2. To analyze differences in the allocation of subsidies to SMEs and large firms Z also includes interactions of all the variables in Table 2 with a dummy indicating a large firm ($LARGE$). To control for industry and time variation both industry and time dummies are added to estimation.

6 Estimation results

To test for the possibility that the subsidy decision is actually made in two steps both a two-limit and a two-part model were estimated. A likelihood ratio test clearly rejected the two-limit model in favor of the two-part model with likelihood ratio statistic getting a value of 490. The result indicates that firm- and project-level characteristics have a disproportionate effect on the probability of an application to be accepted and on the granted subsidy-rate. This suggests that the subsidy-decision can be considered as a two-stage decision problem. First stage consists of the acceptance decision and in the second stage the level of the subsidy-rate is decided. Therefore, the two-part model was chosen.[12]

Due to non-linear models and interaction effects the estimated parameters are difficult to interpret. Therefore marginal effects are computed for each observation and the figure reported is the mean over all observations. Standard errors are bootstrap estimates with 500 replications.

6.1 Acceptance decision

Table 4 presents the estimation results for the acceptance decision. The marginal effects for SMEs reveal that challenge and technological risk have the anticipated sign. More challenging projects and projects with higher degree of technological risk are likelier to receive Tekes funding. Interestingly neither commercial risk nor technological or business novelty are significantly related to the acceptance decision. Unlike the conjecture, all of them get a negative although insignificant marginal effect. Risks related to the resources reserved for the project and economic stance of the applicant firm are negatively associated and thus reduce the probability of an application to be accepted as could be expected. Having indirect market objectives reduces the acceptance probability by 36%, however only 3.5% (26) of the projects initiated by SMEs have indirect market objectives compared to 9% in the case of large firms. The number of both firm and research partners gets a positive sign.

For large firms the results are more in line with the conjectures. Technological challenge, technological risk, technological novelty, indirect market objec-

[12] In order to use a two-part model a conditional independence assumption is needed. That is, it is assumed that conditional on Z the mechanism determining acceptance decision and the subsidy-rate decision are independent. I tested for this assumption by using a Heckman selection model with logit transformation imposed on the subsidy-rate and excluding variables *RISK_ COMPETENCE* and *TECH_ PROGRAM* from the subsidy-rate equation. The conditional independence assumption could not be rejected.

Table 4: Estimation results of the acceptance decision.

	Prob(accepted) with size interactions							
Variable	Coeff.	Std error (robust)	Coeff. for interaction with *LARGE*	Std error (robust)	Marginal effect for SMEs	Std error (bootstrap)	Marginal effect for LARGE	Std error (bootstrap)
CONSTANT	-0,448	0,435	**-2,601**	0,667				
Firm-level								
AGE	-0,005	0,007	0,013	0,008	-0,001	0,002	**0,002**	0,001
ln(EMPLOYEES)	-0,030	0,064	-0,028	0,078	-0,007	0,014	-0,012	0,011
*SALES_EMPL**	0,077	0,086	-0,076	0,085	0,017	0,018	0,000	0,003
APPL_DUM	-0,301	0,198	-0,423	0,397	-0,064	0,042	**-0,129**	0,052
APPLICATIONS	0,016	0,018	-0,019	0,018	0,003	0,004	-0,001	0,001
GRANT/APPL	0,179	0,215	**0,804**	0,409	0,039	0,047	**0,208**	0,075
*R&D***	**-0,253**	0,048	**0,253**	0,048	**-0,055**	0,010	0,000	0,000
R&D_DUM	-0,117	0,163	0,398	0,304	-0,025	0,035	0,063	0,064
*EXPORT***	0,012	0,028	-0,012	0,028	0,003	0,007	0,000	0,000
EXPORT_DUM	0,095	0,154	-0,120	0,263	0,021	0,033	-0,005	0,045
CHALLENGE	**0,767**	0,087	0,056	0,135	**0,168**	0,016	**0,174**	0,019
RISK_COMPETENCE	**-0,184**	0,080	**0,215**	0,127	**-0,040**	0,018	0,006	0,020
RISK_ECONOMIC	**-0,369**	0,072	**0,459**	0,134	**-0,081**	0,015	0,019	0,024
RISK_TECHNOLOGICAL	**0,188**	0,082	0,027	0,125	**0,041**	0,018	**0,045**	0,021
RISK_MARKETS	-0,043	0,083	**0,218**	0,115	-0,009	0,018	**0,037**	0,016
NOVELTY_TECH	-0,122	0,131	**0,553**	0,215	-0,027	0,029	**0,090**	0,035
NOVELTY_APPL	0,194	0,136	-0,318	0,225	0,042	0,029	-0,027	0,040
NOVELTY_BUSINESS	-0,294	0,194	0,007	0,458	-0,068	0,048	-0,064	0,103
NO_MARKET	**-1,405**	0,324	**1,838**	0,414	**-0,359**	0,084	**0,084**	0,044
FIRM_PARTNERS	**0,121**	0,036	-0,052	0,051	**0,027**	0,008	**0,015**	0,008
RESEARCH_PARTNERS	**0,152**	0,066	-0,060	0,093	**0,033**	0,015	0,020	0,014
*PROJECT_SIZE****	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
TECH_PROGRAM	**0,357**	0,127	-0,183	0,207	**0,078**	0,027	0,037	0,035
EU-SUPPORT REGION	0,056	0,148	0,147	0,261	0,012	0,033	0,042	0,047
INDUSTRY DUMMIES	YES							
YEAR DUMMIES	YES							
log likelihood	-467							
T_W	337							
Prob > $\chi 2$(df)	0,000							
df	62							
Obs.	1218							
Correctly classified	84 %							

*Measured in 100 000 euros. ***Measured in 1 000 000 euros.

Figures in bold indicate statistical significance at least at the 10% level. TW = Wald-test statistic, Prob = p-value , df = degrees of freedom.

tives and the number of firm partners all increase the acceptance probability. The number of research partners gets a positive but statistically insignificant marginal effect. Unexpectedly, commercial risk is positively related to the acceptance decision of projects initiated by large firms. Risks related to the economic stance of the applicant firm and to the human resources reserved for the projects do not seem to be related to the acceptance decision in the case of large firms. Looking at the underlying distributions of these risk measures reveals that this is rather due to different overall characteristics of these two group of firms than Tekes valuing these risks differently (see Figure 1 in the Appendix).

Comparing the statistically significant marginal effects between projects initiated by SMEs and large firms indicates that for both groups the impact of technological challenge on the probability of an application to be accepted is equally pronounced. Likewise the magnitude of the marginal effect of technological risk is about the same in both groups. Collaboration in turn seems to matter more for the acceptance of projects initiated by SMEs. At least in the case of firm partners this result is unlikely to arise from different underlying collaboration patterns between SMEs and large firms (see Figure 1 in the Appendix).

6.2 Subsidy-rate decision

Table 5 presents the estimation results for the subsidy-rate conditional on acceptance. As with the acceptance decision, technological challenge and technological risk are positively related to the subsidy-rate. In addition, technological novelty seems to increase the subsidy-rate. These results are all as expected. What is unexpected though is the negative relationship between the subsidy-rate and commercial risk. Collaboration seems to matter also for the subsidy-rate in the case of SMEs. Somewhat confusingly, indirect market objectives now has a large positive marginal effect. Having indirect market objectives increases the subsidy-rate by 10%. As mentioned above, the interpretability of this estimate may be reduced by the fact that only 14 accepted projects intiated by SMEs have indirect market objectives.

For large firms technological challenge, technological risk and technological novelty continue have a parallel role in the subsidy-rate decision as expected. subsidy-rate increases with all of them. Apart from the project-level control variable describing the size of the project no other project level characteristic gets a statistically significant marginal effect. Unlike expectations neither col-

Table 5: Estimation results of the subsidy-rate decision.

	Subsidy with size interactions							
Variable	Coeff.	Std error (robust)	Coeff. for interaction with *LARGE*	Std error (robust)	Marginal effect for SMEs	Std error (bootstrap)	Marginal effect for LARGE	Std error (bootstrap)
CONSTANT	**0,132**	0,044	0,075	0,059				
Firm-level								
AGE	0,0001	0,0005	-0,0005	0,0006	0,0001	0,0005	-0,0003	0,0002
ln(EMPLOYEES)	**0,0193**	0,0063	**-0,0167**	0,0068	**0,0172**	0,0057	0,0023	0,0027
*SALES_EMPL**	0,0033	0,0063	-0,0034	0,0063	0,0029	0,0072	-0,0001	0,0008
APPL_DUM	0,0069	0,0225	0,0243	0,0311	0,0060	0,0212	0,0275	0,0208
APPLICATIONS	0,0016	0,0012	-0,0013	0,0012	0,0014	0,0015	**0,0003**	0,0002
GRANT/APPL	0,0080	0,0227	-0,0146	0,0301	0,0071	0,0226	-0,0058	0,0189
*R&D***	**-0,0182**	0,0074	**0,0183**	0,0074	**-0,0162**	0,0074	**0,0001**	0,0000
R&D_DUM	**-0,0452**	0,0167	**0,0506**	0,0225	**-0,0396**	0,0151	0,0047	0,0146
*EXPORT***	-0,0005	0,0017	0,0005	0,0017	-0,0005	0,0019	**0,0000**	0,0000
EXPORT_DUM	0,0226	0,0151	**-0,0583**	0,0205	0,0198	0,0148	**-0,0313**	0,0129
CHALLENGE	**0,0244**	0,0085	0,0073	0,0111	**0,0217**	0,0080	**0,0282**	0,0066
RISK_COMPETENCE	0,0055	0,0091	0,0012	0,0107	0,0049	0,0084	0,0059	0,0054
RISK_ECONOMIC	**-0,0207**	0,0081	0,0108	0,0106	**-0,0184**	0,0083	-0,0089	0,0062
RISK_TECHNOLOGICAL	**0,0210**	0,0083	-0,0058	0,0105	**0,0186**	0,0079	**0,0135**	0,0061
RISK_MARKETS	**-0,0179**	0,0085	0,0095	0,0098	**-0,0159**	0,0078	-0,0074	0,0046
NOVELTY_TECH	**0,0310**	0,0129	-0,0057	0,0156	**0,0272**	0,0116	**0,0224**	0,0083
NOVELTY_APPL	0,0138	0,0124	-0,0109	0,0159	0,0121	0,0119	0,0026	0,0093
NOVELTY_BUSINESS	-0,0167	0,0259	-0,0051	0,0489	-0,0146	0,0259	-0,0191	0,0444
NO_MARKET	**0,1189**	0,0219	**-0,0977**	0,0257	**0,1035**	0,0247	0,0187	0,0130
FIRM_PARTNERS	**0,0089**	0,0032	**-0,0111**	0,0039	**0,0079**	0,0031	-0,0020	0,0020
RESEARCH_PARTNERS	**0,0126**	0,0058	**-0,0128**	0,0067	**0,0112**	0,0053	-0,0002	0,0032
*PROJECT_SIZE***	**-0,0130**	0,0000	0,0067	0,0000	**-0,0116**	0,0054	**-0,0056**	0,0012
TECH_PROGRAM	0,0083	0,0131	-0,0091	0,0160	0,0072	0,0122	-0,0007	0,0084
EU-SUPPORT REGION	**0,0597**	0,0147	**-0,0703**	0,0187	**0,0526**	0,0147	-0,0094	0,0102
INDUSTRY DUMMIES	YES							
YEAR DUMMIES	YES							
log-likelihood	707							
T_W	543							
Prob > $\chi 2$(df)	0,000							
df	62							
Obs.	884							

*Measured in 100 000 euros. **Measured in 1 000 000 euros.

Figures in bold indicate statistical significance at least at the 10% level.

T_W = Wald-test statistic, Prob = p-value , df = degrees of freedom.

laboration nor indirect market objectives seem to be related to the subsidy-rate granted to large firms.

In line with the acceptance decision, the marginal effects of challenge and technological risk are more or less of equal size for both SMEs and large firms. However, the impact of challenge is now in general less pronounced. In addition, the technological novelty is almost equally related to the subsidy intensity granted to SMEs and large firms. If anything, challenge is weighted more in the case of large firms while technological risk and novelty in the case of SMEs.

6.3 Summary of estimation results

Pulling together the estimation results of both the acceptance and subsidy-rate decisions, several conclusions can be made. First, for both SMEs and large firms Tekes seems to emphasize the technological content of the project when deciding on the subsidy. In addition, there are no major differences in how the characteristics related to the technological content of a project weigh in the subsidy decisions concerning SMEs or large firms. The only notable difference is that the technological novelty does not seem to be a determinant of acceptance for SMEs while it is related to the subsidy-rate.

Unlike expectations, the commercial risk related to a project is positively related to the acceptance decision concerning large firms while negatively related to the subsidy-rate of SMEs. Both results contradict expectations. Based on economic rationales it is hard to justify why government should subsidize commercial risks of large firms. Large firms are unlikely to suffer from financing constraints and in general are in a better position to carry risk compared to SMEs. Commercial risk is neither considered to be related with the potential of a project to generate knowledge spillovers. If anything, subsidizing commercial risk might be justified in the case of SMEs that may face financing constraints and are possibly less prone to risk-taking.

Also the relationship of collaboration with subsidy decisions turns out to divert from the expectation. For SMEs both firm and research partners seem to matter for both the acceptance and the subsidy-rate decisions. In the case of large firms the only statistically significant relationship was the positive impact of firm partners on the acceptance decision. One might expect that since subsidizing innovative activities of large firms relies to a great extent on the spillover argument, collaboration should matter distinctively in the case of large firms. These results may indicate that Tekes puts more emphasis on subsidizing incoming knowledge spillovers than outgoing knowledge spillovers. This interpretation finds further support in the result that research partners weigh somewhat more than firm partners in the subsidy decisions concerning SMEs.

7 Conclusions

This paper examines the allocation of business R&D subsidies by analyzing the determinants of acceptance into an R&D subsidy program. More specifically the question addressed is whether there are differences in how subsidies are allocated to small and medium size firms (SMEs) and large firms. The subsidy decision is considered as a two-stage decision problem. The agency first decisides whether to accept an application and then the subsidy-rate. The program under scrutiny is that of the Finnish Funding Agency for Technology and Innovation (Tekes) for which I have unique data on everyone who applied over a two and a half year period including data on internal project evaluations of Tekes.

The results indicate that the technological content of a project proposal is an important determinant of the subsidy decisions. Technological challenge and - risk are positively associated with both the acceptance probability and the subsidy-rate. This holds for both SMEs and large firms and to similar extent. Technological novelty increases also the subsidy-rate for all, but is positively related to the acceptance only for large firms. If one is willing to accept that on average technological challenge, risk and novelty of a project reflect uncertainty and the potential for knowledge spillovers these result may find some basis in economic rationales justifying R&D subsidies.

Unlike expectations, commercial risk is, if anything, negatively related to the subsidy decisions concerning projected initiated by SMEs. However, in the case of large firms, higher commercial risk increases the probability of an application to be accepted. Based on the economic rationales it is not easy to justify these results. First, possible financing constraints and reluctance towards risk-taking are rooted in the commercial and technological risk of a project. If some group of firms is likely to suffer from these market failures it is especially the SMEs. Second, it is not easy to find arguments that would support subsidizing commercial risks of large firms. Large firms are not likely to suffer from financing constraints and they are better equipped to cope with risk-taking. Nor are there clear reasons to believe that commercial risk is positively related to knowledge spillovers.

Given that Tekes is a government agency redistributing taxpayers' money, the risk-averse attitude towards commercial risk especially in the case of SMEs is probably understandable. Realized high market risk is likely to have more serious consequences for a SME than for a large firm. In addition, it may be that the public opinion is more tolerant of technological failure of a project than of a commercial one. However, neither the Tekes funding principles nor the rationales are in line with this behavior. Maybe this is an example where a perceived market failure is at least partly replaced by government failure.

Collaboration clearly weights in the decision making of Tekes. However, collaboration seems to matter especially for projects initiated by SMEs. Given that subsidizing innovative activities of large firms rests to a large extent on the knowledge spillover argument this is unexpected. This may be an indication of Tekes promoting incoming rather than outgoing spillovers. Subsidizing outgoing spillovers is about providing incentives to share knowledge, subsidizing incoming spillovers is rather about encouraging knowledge absorption.

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Appendix 1

Figure 1: Distribution of economic risk, risk related to resources, research partners and firm partners among SMEs and large firms.