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ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 358-9-609 900
Telefax 358-9-601 753 World Wide Web: http://www.etla.fi/

Keskusteluaiheita – Discussion papers

No. 1143

Heli Koski*

PUBLIC R&D SUBSIDIES AND EMPLOYMENT GROWTH – MICROECONOMIC EVIDENCE FROM FINNISH FIRMS

* The Research Institute of the Finnish Economy (ETLA) and Scuola Superiore Sant Anna, Pisa. E-mail: heli.koski@etla.fi

The research reported in this paper was mostly undertaken within the project “Tilasto-analyysi Tekesin hankkkeiden kannustinvaikutuksista”. This paper is also part of a larger research program "Finland in Global Competition", financed by the Technology Industries of Finland Centennial Foundation and Tekes.

ISSN 0781-6847 11.08.2008

KOSKI, Heli**, PUBLIC R&D SUBSIDIES AND EMPLOYMENT GROWTH – MICROECONOMIC EVIDENCE FROM FINNISH FIRMS,** ETLA, The Research Institute of the Finnish Economy, Elinkeinoelämän Tutkimuslaitos, 2008, 24 p. (Discussion Papers, Keskusteluaiheita, ISSN 0781-6847; No 1143).

ABSTRACT: This study empirically explores whether the public financial support for entrepreneurial R&D affects employment growth at the firm level. The data from the Finnish companies suggests that the firms that have received public R&D funding have not generally witnessed any greater employment growth than other companies. However, we find that the public R&D support targeted to the certain types of R&D activities notably contribute to the creation of new jobs: employment in those firms that have received public funding for the R&D projects targeted to the new business areas has clearly grown relatively more than in other companies. The relationship between the firm's total innovation and employment growth is not statistically significant.

JEL Classification: J23, L10, O33, O38

Key words: public R&D subsidies, technology policy, employment growth

1. Introduction

Employment growth and creation of new jobs form some of the key policy goals in the industrial countries.[1] Public support for innovation and knowledge creation facilitating the firms' growth, enabling the entry of new firms and giving rise to the totally new markets is seen as one of the means to foster employment growth. The economic theory suggests that the relationship between innovation and employment growth at the firm level is not straightforward. The direction of the effect of innovation on employment may depend not only on the type of the innovation (product vs. process innovation) but also on the competitive conditions and the firms' strategic actions. Product innovation may increase a firm's output and consequently create new jobs but if innovation gives the firm market power, the firm may set higher prices and reduce the output and employees. Process innovation, instead, may increase the firm's efficiency in production and lead the firm to cut down the number of employees but if the firm passes efficiency gains to the consumers by lowering the prices, the demand for its products may increase facilitating also the employment growth.

In Finland, Tekes (the Finnish Funding Agency for Technology and Innovation), the principal government organization providing public research and development (R&D) funding for the firms[2], has explicitly set employment growth as one of the objectives of its R&D support allocation policy. Tekes officers use the employment impacts of the entrepreneurial R&D projects seeking public financial support as one of the selection criteria while deciding upon whether to fund the proposed R&D project. This study empirically explores the relationship between the public R&D funding and employment growth using data from 976 Finnish

[1] Employment growth is also set to be one of the top priorities in the coordinated policy actions of the European Commission (see Community Lisbon Program; Commission of the European Communities, 2005).

[2] In 2007, Tekes provided in total 269 million euros for 2120 entrepreneurial R&D projects. During the second half of the 1990s Tekes finance covered over 15% of the Finnish firms' total R&D expenditures, whereas since 2000 the corresponding share has been around 11%.

companies that received public R&D finance for the projects ending during the years 1999-2003. We aim at answering to the questions whether the public R&D support has generally positive employment effects and whether certain types of subsidized R&D projects result in greater employment growth than others. We also explore the relationship between the firm's total innovation and its employment growth.

The paper is organized as follows. Section 2 introduces the data. Section 3 briefly outlines the theoretical arguments underlying the empirical investigation and discusses the variables used in the empirical analysis. Section 4 presents and discusses the results of the empirical analysis. Section 5 concludes.

2. Data compilation and characteristics

The data comprise information from the follow-up reports[3] of 976 Finnish companies that received funding from Tekes for, in total, 1618 projects ending during the years 1999-2003. We also have data from 259 firms that applied for Tekes funding but their application was rejected and no public financial support granted. Moreover, we have information on the key characteristics of the planned projects, both accepted and rejected, that the officers of Tekes have used while making a decision whether to grant financial support for the project. This pre- and post-project information extracted from the database of Tekes is combined with the Asiakastieto financial data concerning the sampled firms during the years 1999-2004 and with the data on the firms' patents that is obtained from the database of National Board of Patents and Registration of Finland. The compiled database provides a rich set of information based on both the firms' subjective reporting and the official statistics concerning their functioning.

[3] The follow-up reports designed by Tekes to evaluate the effectiveness of their funding are filled by each project leader after the completion of the subsidized project.

The majority of the projects that Tekes chose to fund obtained subsidies, whereas about one quarter were funded by the loans and 13% by the capital loans. Quite commonly, for almost 28% of the projects, the firm received both the subsidy and the loan/capital loan from Tekes. About one third of the projects that were granted Tekes financial support were R&D projects, while the rest focused merely on the development activities. Almost all (i.e. 95%) of the R&D projects received subsidies, while 14% of them had a loan from Tekes. One third of the development projects were funded by the loan and 20% of them by the capital loan offered by Tekes. The average subsidy per project exceeded 140 000 euros, while the average orders of magnitudes of the loans and the capital loans were somewhat higher, about 180 000 and 160 000 euros, respectively. The average total funding per project, including often both subsidy and loan, was almost 180 000 euros. The data show a very large variation in the size of the funded projects: the smallest project received less than 10 000 euros from Tekes, while the public finance of the largest one exceeded 3.5 million euros.

Table 1. Sampled firms with Tekes financed projects ending 1999-2003

Year	Number of firms undertaking Tekes project	Share of firms undertaking Tekes project	Share of firms that had not yet began any Tekes project (%)	Average number of projects	Max number of projects
1999	666	68.66	30.31	1.52	41
2000	694	71.40	28.60	1.47	38
2001	646	66.53	3.91	1.42	30
2002	475	48.92	0.31	1.31	15
2003	243	25.00	0.00	1.20	5
2004	0	0.00	0.00	0.00	0

Table 1 illustrates the characteristics of the data concerning the distribution of Tekes funded projects over the sampled firms and years. More than two thirds of the firms were undertaking

one or more Tekes funded projects during the years 1999-2001, and about half of the companies had no Tekes projects after 2001. There were also a substantial number of firms – almost 30% of companies (i.e. 278 firms) - that did not began their first Tekes financed project until the year 2001.

As our database comprises information on the activities of the sampled firms for the years 1999-2004, it enables us to study the employment growth in companies before and after they received public R&D support. Moreover, as the data further comprise 259 companies which had filed a funding application to Tekes but had it rejected, we can also compare the subsidized companies to those that didn't receive any financial support from Tekes. Annex 1 takes a more detailed look on how the data are distributed by the beginning and ending years of the projects among the sampled firms.

Figure 1. Employment growth in the firms before, during and after public R&D funding

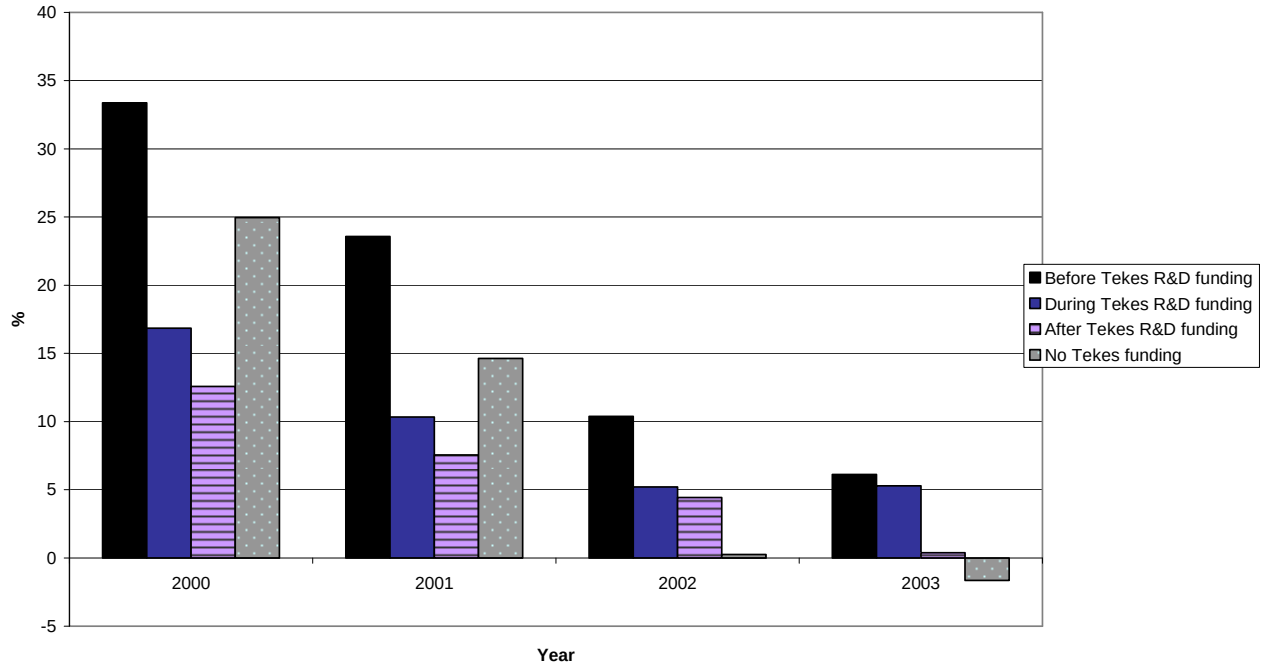

Figure 1 shows the differences in the average employment growth rates before, during and after public R&D funding and among the firms that didn't receive any public R&D funding from

Tekes during the sampled years. The firms that received funding from Tekes seem to perform better than all others prior to their publicly funded R&D projects. T-test, however, indicates that this difference is not statistically significant. Among the firms that received public R&D funding, the firms that have ended their Tekes funded projects have, however, performed clearly worse than before, and t-test shows this difference also to be statistically significant.

We next explore the relationship between public R&D funding and employment growth more detailed using the econometric analysis that allows us to control simultaneously multiple factors potentially affecting the firms' employment growth.

3. Public R&D funding and employment growth

We investigate the relationship between the public R&D funding and firms' employment growth using the framework developed by Hall et. al. (2007), and model the employment growth as a function of the growth of the old product sales and the new products and process innovations. It is an empirical question – and the empirical evidence is mixed (see, e.g., Brouwer et al, 1993; Doms et al. 1995; Klette and Forre, 1998; Peters, 2004; Ali-Yrkkö, 2005) - whether new technologies facilitate labor growth. New products and innovations that increase the quality of a firm's existing products may boost the firm's sales and consequently have a positive influence on its employment, but particularly process innovations enhancing labor productivity may, instead, negatively affect the firm's employment. The relationship between process and product innovation and employment growth is not so straightforward, however, but it depends also on the market structure and the firm's strategic actions. If the efficiency gains from process innovation are mediated to consumers via lower prices, process innovation may increase demand for the firm's products and its employment. And if the firm sets, due to its

temporary monopoly power gained via innovation, higher prices that maximize its profits and reduces its output, the employment effect of product innovation may be negative.

In this study, the growth of the production of the firm's existing products is captured by turnover growth (variable TURNOVER_GROWTH). We are not able to distinguish product and process innovations but only the firm's R&D expenditures and the R&D funding it received from Tekes, that can be used as a proxy of the firm's total innovation, assuming that the order of magnitude of a firm's R&D activities are closely correlated with its innovation output. We estimate the model for the firm's employment growth using the R&D intensity (variable RD), the relative order of magnitude of funding a firm has obtained from the public sector financer, Tekes (variable PUBLIC_RD) and the characteristics of the firm's projects receiving public R&D finance as the explanatory variables that capture different dimensions of innovation. We also estimate a model in which the order of magnitude of Tekes funding is replaced by the dummy variable TEKES_PROJ that takes value 1 if the firm is undertaking Tekes financed project at year t, 0 otherwise.

The growth in the demand for a firm's old products and thus the variable TURNOVER_GROWTH is likely to be positively related to the firm's employment growth. As becomes apparent from the above discussion, it is an empirical question whether the variable RD relates positively or negatively to the employment growth. The positive employment effect of the funded entrepreneurial R&D project is one of the criteria that Tekes' officers consider while they decide whether to fund the proposed entrepreneurial R&D project so the estimated coefficients for the variables PUBLIC_RD and TEKES_PROJ may be expected to be positive.[4] However, as Tekes has also other project selection criteria of

[4] Source: http://www.Tekes.fi/eng/Tekes/rd/evaluation_criteria.htm (see Annex 2 for details).

which relative importance compared to the employment effects are not known to us, the sign and significance of these coefficients can only be determined empirically.

We also explore whether certain firm and project characteristics that Tekes, the allocator of the public support for firms' R&D projects, tends to favor in the funding decisions are positively related to the employment growth. The *networking and collaboration* criteria are strongly stressed in Tekes' funding decisions. We measure the networking dimension of the suggested project by three variables: i) the dummy variable that gets value 1 if the planned project is part of a technology program of Tekes and 0 othewise (the variable TECH_PROGRAM), ii) the dummy variable that gets value 1 if part of the firm's project funding is allocated to a research organization (e.g. university) and 0 otherwise (the variable RES_ORG_COLLAB) and iii) the dummy variable that gets value 1 if part of the large firm's project funding is allocated to the SMS firm and 0 otherwise (the variable SMS_COLLAB_LARGE). The first dummy variable measures the importance of the firm's participation to the research programs in the key R&D areas that Tekes has selected and within which it allocates money for the companies and research organizations. The primary aim of Tekes research programs is to facilitate collaboration with research and business on the selected technology fields, and to further accelerate creation and production of innovations on them. The second dummy variable measures whether the applicant firm's planned collaboration with the university or research institute affects to the success of its project application. The third variable is used for investigating whether the large companies' collaboration with the SMS firms has impact on the acceptance of their Tekes project plan. It is uncertain what types of innovations tend to be created within the collaborative research and development projects and what kind of strategic actions results in. Consequently, the employment effects of all three variables maybe positive or negative; this is an empirical question that can be answered only with the help of the data.

***Tekes technology programmes**:* "Tekes technology programmes are forums for the exchange of information and networking between companies and research groups. They provide opportunities to carry out ambitious R&D projects and develop business expertise and international cooperation. Technology programmes are a gateway to best researcher groups and innovative R&D companies in Finland. Half of the Tekes funding is channelled through the technology programmes. The programmes are established in strategically important R&D areas that Tekes has identified together with the business community and researchers. A typical programme lasts five years. Tekes generally finances about half of the project costs. The other half comes from companies and research units. Every year companies participate in about 2,500 projects and research universities in about 1,500 projects." (http:// www.Tekes.fi)

Tekes supports firms' research and development activities that are related to the promising entries to the new business areas. We have information on whether *the business to be generated* within the planned project is new or existing. We create a dummy variable NEW_BUSINESS that gets value 1 in case of new business and 0 otherwise. A firm's research and development activities related to the entry to the new business area are likely to generate product innovations that form a new source of growth for the firm increasing its production and possibly also creating pressure to hire new employees. Thereby, we expect variable NEW_BUSINESS to be positively related to the employment growth.

The study of Koski (2008) shows that the top ten firms that have obtained R&D funding from Tekes clearly deviate from the other subsidized firms, and form a group of outliers in the sample. We control for the ten largest obtainers of Tekes project funds by the dummy variable TOP10_FIRM that gets value 1 if the firm is among the top ten receivers of Tekes funding among the sampled projects and 0 otherwise.

Instrumental variables:

We use the above Tekes funding criteria as the instrumental variables for the endogenous Tekes funding variable, as they are likely to determine whether or not and how much funding the firm receives from Tekes. In addition, we use as instruments a set of other selection criteria, discussed next, that we have information in our dataset. The expected positive long-term export impact of the funded project is one of the decision criteria of Tekes that improves the chances of the firms targeting their products to the international markets to receive funding. We use the dummy variable EXPORT that takes value 1 if the firm exports products or services and 0 otherwise.

Tekes also expects that the applicants have *sufficient resources* available to undertake the planned project. Capital constraints are typically limiting the R&D investments of the small and medium sized companies but as a part of Tekes funds are specifically targeted to the SMS firms, the firm size does not seem to be a reasonable measure here. We use, instead, a measure of company's financial strength: the variable RATING_CLASS get values from 0 to 6 according to the debt rating class[5] of the firm from, respectively, "poor"=C to "Excellent"=AAA. This variable controls for the firm's ability to meet its financial obligations. The literature suggests that also the firm's likely future success and profitability may affect its chance to obtain public R&D funding as the allocators of public funds may have incentive to select firms that would be successful innovators even without the public R&D support (see, e.g., Wallsten, 1996; Lerner, 1999). We measure the firm's profitability by the firm's return on its total equity (the variable RETURN_EQUITY) that is a firm's profit as a percent share of its total shareholder equity.

[5] See description of variables in Annex 2 for detailed information concerning this debt classification.

It is also possible that some firms have a more advantageous position in the public funding applications procedure due to their greater resources for filing and lobbying the application for Tekes finance. We control for the firm size by the two dummy variables MEDIUM and LARGE that get value 1, respectively, when the firm is medium sized and large, and 0 otherwise.

Unfortunately our data concerning various project-specific factors (such as the riskiness of the project) is limited to the set of less than one hundred most recent Tekes financed projects ending in 1999-2003, and thus cannot be used in predicting the acceptance of the project.

The industrial and regional technology policies may affect the distribution of the public funds across the industrial sectors and geographical locations, and via this the chances of an individual company to obtain public R&D support. In Finland, the regional technology and science policy has promoted equality across regions, whereas the Tekes technology policy has favored certain technology areas resulting in an unequal distribution of public R&D support across industries. We therefore also control for the industry and location of the companies that have applied for Tekes R&D finance.

4. Empirical analysis

4.1 Estimation results

We estimate separate models for the firms that have received public R&D funding during (some of) the sampled years (Table 2) and for all firms (Table 3) as we lack information on the R&D expenditures as well as the characteristics of the undertaken R&D projects of those

firms that have not received any funding from Tekes. We replace the variable RD with the log number of patents firm's have applied in Finland (variable PATENTS) during the current year while estimating the model using the whole sample of the data.[6]

The estimation results show that the variable TURNOVER_GROWTH is clearly positively related to the employment growth in all of the estimated models. This means that the growth in the firms' existing products contributes notably to the employment growth as the theory suggests. The order of magnitude of a firm's R&D expenditures is not statistically significantly related to the employment growth suggesting that total innovation does not significantly contribute to the employment growth among the Finnish firms. It is likely that variation in our measure of total innovation arise from the mixture of product and process innovation that have opposite effects on the employment. Various previous empirical studies have found that the product innovation tends to create positive employment growth, whereas the evidence in regard to the employment effects of process innovation is more mixed (see Hall et al., 2007). However, though we can't distinguish here the effects of product and process innovation our study hints that greater total investments in innovation does not tend to create more jobs among the sampled Finnish firms. This empirical finding is consistent with the one of Klette and Forre (1998): they find that in Norway, that is also a small economy like Finland, there has been no more job creation among the more R&D-intensive firms than in other companies.

We do not find statistically significant relationship between the presence or the order of magnitude of Tekes funding and employment growth. However, we find that certain R&D project characteristics are related to the greater growth at the firm level. Companies that were

[6] We also estimated the models with the data only from those firms that have received funding from Tekes using the variable PATENTS instead of the R&D intensity but this did not substantially affect the estimation results.

focusing on new business areas with the help of the public R&D funding witnessed clearly a greater employment growth than the sampled firms on average. This result complements the empirical finding of Koski (2008) that the firms obtaining financial support for their R&D activities in the new business areas tend to produce more innovations than other firms. It seems thus that the public R&D support of Tekes has successfully provided incentives to undertake risky R&D in new business areas resulting in innovations that have further created substantial new demand for the firm and materialized as a notable growth in the firm's employment. When the employment growth is an important object of the technology policy makers and the allocators of the R&D subsidies, the recognition and selection of R&D projects that have potential to innovative in new business areas, as well as the selection of innovative start up companies, are thus likely to be more effective policy means than just allocating more money for entrepreneurial innovation activities.

The top 10 companies receiving about 13% of the allocated public R&D funding among the sampled firms appeared to have lower labor growth than other companies. Descriptive look at the data further shows that the employment growth has been negative among these firms - i.e. they have reduced the number of employees - while the average employment growth rate among the other companies has been positive. The top ten public R&D support receivers are all relatively large, and the descriptive analysis and the estimation results on the firm's patenting behavior indicated that they were also more likely to introduce patentable innovations than other companies, both before and after receiving Tekes funding (see Koski 2008 for the details). Altogether, these findings suggest that the R&D activities of these companies that have obtained substantial public subsidies may have either resulted in efficiency improvements that enable them to reduce the number of employees or, if there have been significant product innovations, possibly replacing the firm's old products, provided the firms monopoly power in the market.

Table 2. The estimation results of the random effects instrumental variable model for employment growth: firms that have received public R&D finance

Variables	Random effect IV model Dependent variable: EMP_GROWTH	Random effect IV model Dependent variable: EMP_GROWTH
Constant	-21.47 (-17.00)	-21.32 (-1.25)
PUBLIC_RD	-0.32 (0.13)	
TEKES_PROJ		22.01 (1.57)
RD	0.24 (0.14)	-0.20 (-0.22)
TURNOVER_CHANGE	0.18 (6.72)	0.18 (6.88)
RD_PROJECT	3.00 (0.47)	3.99 (0.79)
TECH_PROGRAM	-1.32 (0.40)	-1.84 (0.56)
RES_ORG_COLLAB	3.93 (1.02)	2.57 (0.67)
SMS_COLLAB_LARGE	-5.97 (-1.15)	-6.09 (-1.32)
NEW_BUSINESS_DMY	8.03 (2.52)	7.34 (2.32)
TOP10FIRM	-16.27 (-1.93)	-15.03 (-1.79)
+ industry dummies + regional dummies + year dummies		
Number of observations	621	679

T-values that are calculated by using the estimated robust firm cluster-specific standard errors are reported in the parantheses.

Top 10 firms financed by Tekes also obtained a greater number of positive project funding decisions from Tekes than the average subsidized firms during the sample years. The number of Tekes funded R&D projects ending during the years 1999-2003 varied between 10 and 59 among the top ten companies financed by Tekes. This empirical finding thus also hints that supporting multiple R&D projects of one firm provides no significant benefits in terms of the

employment growth. Similar to this study, Lerner (1999) reports, using data from small U.S. high-technology firms between 1983 and 1997, that multiple awards or larger subsidies for firms did not notably affect the subsidized firms' employment though, unlike in this study, Lerner reports a positive relationship between firm growth and public finance.

Table 3. The estimation results of the random effects instrumental variable model for the employment growth: all sampled firms

Variables	Random effect IV model Dependent variable: EMP_GROWTH	Random effect IV model Dependent variable: EMP_GROWTH
Constant	27.18 (2.21)	0.67 (0.07)
PUBLIC_RD	1.66 (1.32)	
TEKES_PROJ		-0.44 (-0.04)
PATENTS	0.16 (0.43)	0.06 (0.16)
TURNOVER_CHANGE	0.17 (10.34)	0.18 (10.40)
+ industry dummies + regional dummies + year dummies		
Number of observations	1557	1558

T-values that are calculated by using the estimated robust firm cluster-specific standard errors are reported in the parantheses.

The firm's participation to the one of the Tekes technology programs launched for enhancing collaboration with business and academia, and the greater degree of collaboration with universities/research institutes measured by the variable RES_ORG_SHARE, seem to have no notable impact on their employment. This does not necessarily mean that there are no positive spillovers between academia and business materializing as commercially valuable new products. One possibility for this empirical result is that part of the links between academia and business are formed rather independently on the public R&D

funding.[7] Then, our collaboration variables that get positive values only during the years when a firm is undertaking publicly funded R&D projects, may not correctly measure whether the firm collaborates with academia before and during the Tekes funded project.

The estimation results using the whole sample confirm our previous findings: the sales growth relates strongly to the firms' employment growth, and firms' innovation and public R&D funding do no not explain statistically significantly variation in their employment growth.[8]

4.2 Are firms' subjective assessments consistent with data?

The empirical analysis of the firm-level employment effects was based on the official statistics on the firm's number of employees. We also have information on the firm-level employment effects of Tekes R&D funding - subjective evaluation reported to the financer after the completion of the project - provided by the leaders of the projects. It is an interesting question how useful and accurate this post-project information that Tekes uses to evaluate the effectiveness of their funding is, and whether the policy makers can trust the research based on the firms' subjective reporting. A tendency towards overly optimistic reports of the positive impacts of Tekes funding seems quite natural given that the repeat Tekes customers are common - more than half of the companies that received financial support from Tekes obtained funding for more than one research and/or development project, and almost 40% for more than two projects - and the firms are likely to apply funding from Tekes (and likely to deal with the same officers) for their subsequent R&D projects.

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[7] According to the project follow-up reports, in 59% of the projects, the number of firm's collaborators has changed as a consequence of Tekes funding. Unfortunately, the data do not tell us the order magnitude of this change, neither we do not know whether or not the firms collaborated with external R&D partners prior to their Tekes funding.

[8] We also took into account that the employment effects of a firm's own R&D and public R&D support may materialize with the lag of years and tested the lagged values of the R&D variables but these neither were statistically significant.

To assess how well the firms' reported subjective evaluations of the employment effects of public R&D finance correspond to the official statistics, we first compare the distributions of the firm's subjective evaluations and the actual rates of employment growth. The firms evaluated the impacts of Tekes finance on the employment growth by using the following four categories: "decrease", "no impact", "some increase" and "notable increase". Table 4 shows the mean actual growth in the firm's turnover and the number of employees at the end year of the Tekes funded projects in these four reporting categories.

Almost 60% of the respondents reported in the project follow-up reports that the project had no impact on the number of firm's employees, while more than one third evaluated that the project resulted in a slight positive increase in the employment. Decrease or notable increase in the firm's number of employees was reported less often. The firms' subjective reports concerning the growth in the number of employees seem quite consistent with the actual changes: there was an average 6% decline in the number of employees among those 17 firms that reported that the Tekes funded project decreased their number of employees, while the mean changes grow consistently when we more higher up with the subjective evaluation categories.

Table 4. The influence of Tekes funded project on the growth in the number of employees: reported vs. actual changes

The reported influence of the project on the number of employees	Actual change in the number of firm's employees, the end year of the project		
	Mean change (%)	Number of observations	Percentage of observations
Decrease	-5.78	17	2.00
No impact	5.30	499	58.78
Some increase	12.90	297	34.98
Notable increase	40.18	36	4.24
Total	9.22	849	100.00

We do the t-test that suggests that that the actual employment growth has been statistically significantly greater among those firms that have reported “notable increase” due to Tekes finance. The problem, however, is that that the t-test does not control for the other factors influencing the employment growth. We therefore re-estimate the models for the employment growth to test the hypothesis whether those firms that have reported that Tekes finance has caused a notable increase in their employment growth differ significantly from the other companies in regard to their actual growth performance. We replace the variables PUBLIC_RD and TEKES_PROJ by the variables PUBLIC_RD*EMPL_EFFECT and TEKES_PROJ*EMPL_EFFECT, where EMPL_EFFECT gets value 1 if the firm reported that Tekes finance resulted in a notable increase in the number of firm’s employees and 0 otherwise. The coefficient of this variable should be positive and statistically significant if Tekes funding has facilitated employment growth among the group of firms that reported that their employment grew notably as a result of the Tekes financed project.

Only the estimated coefficient of the variable TEKES_PROJ*EMPL_EFFECT is positive and statistically after controlling for the other factors that may influence firm’s employment growth. This empirical finding hints that those firms that have reported notable employment effects have indeed grown more than other firms though the order of magnitude of public R&D finance has not significantly affected their employment growth. This subjective evaluation measure of the impacts of Tekes R&D funding suggests that the project managers are able to evaluate and willing to report rather accurately at least some of the impacts of the public R&D funding.

5. Conclusions

This study using data from the Finnish companies finds some empirical support for the positive relationship between the public R&D support – at least for the certain types of entrepreneurial research and development projects - and employment growth. It seems that the firms that have received public R&D funding have not generally witnessed any greater employment growth than other companies though. However, employment in those firms that have received public funding for the R&D projects targeted to the new business areas has clearly grown relatively more than in other companies. Entry, as well as the preceding R&D activities, to the new markets involves typically more risk for a firm than staying in its existing markets in which the firm has accumulated knowledge, intellectual capital, and routines and practices. Public support for the R&D lowers this risk, and seems to successfully encourage activities that not only create more innovations (see Koski 2008 for empirical evidence) but also promote employment. Public funding for R&D in the new business areas seems thus to create new product innovations and also notably boost the firm's demand further resulting in employment growth in the subsidized firms.

Our data further shows that the top receivers of public R&D finance – i.e. 1% of the sampled companies having 10 to 59 publicly funded R&D projects and receiving about 13% of allocated public R&D funding – had lower employment growth than on average among the sampled firms, and actually cut down their number of employees. Whatever is the underlying explanation for this – e.g. process innovations the firms have created within the multiple publicly funded R&D projects improving their efficiency and leading firms to diminish employees - our empirical findings suggest that if the employment effects are considered important while allocating money for entrepreneurial R&D, resources should be rather

targeted to the firms that are doing R&D in the new business areas than concentrating a disproportionate share of the funds for a small number of firms.

One should bear in mind that the findings of this empirical study of the impacts of the public R&D support shed light on and apply only for one technology policy goal, employment growth. Based on this, it is not possible to conclude whether the observed allocation of public R&D funding is socially optimal – for instance due to the presence of substantial R&D spillovers (see, e.g., Griliches, 1992) – or whether the firms had under-invested in R&D without the public R&D subsidies. The investigation of this important question is out of the scope of this paper – hopefully, the future empirical work will shed more light on this issue as well as provides more guidance on how the allocation of public resources to private R&D purposes serves different technology policy objectives.

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Annex 1: Number of firms with project beginning and ending years

Beginning year Ending year	1999 or before	2000	2001	2002	2003	Total
1999	241	0	0	0	0	241
2000	248	2	0	0	0	250
2001	238	52	3	0	0	293
2002	149	83	43	3	0	278
2003	98	47	63	32	2	242
Total	974	184	109	35	2	1304

Annex 2: Tekes evaluation criteria

The text below extracted from:
http://www.tekes.fi/eng/Tekes/rd/evaluation_criteria.htm (August 2008)

Evaluation criteria

High-quality, advanced technology and effective networking are essential criteria in Tekes' R&D funding decisions. Additionally, the project's long-term effects, such as employment and potential turnover and exports are considered at the evaluation process.

The enterprise projects to be funded are selected by evaluating

- the business to be generated
- the technology, innovation and competence to be developed
- the resources available
- the cooperation to be developed and used
- the social and environmental well-being factors to be promoted
- the impact of Tekes funding and expert services

The public research projects to be funded are selected by evaluating

- the technology and competence to be developed
- the cooperation to be developed and used
- the utilisation of results
- the resources available
- the social and environmental well-being factors to be promoted
- the impact of Tekes funding and expert services

Annex 3: Description of the variables

Description of variable	**Variable name**	**Mean**	**Standard deviation**
Dependent variables:			
The percent change in the number of firm's employees between year t and t-1.	EMP_GROWTH	7.24	40.62
Explanatory variables:			
R&D intensity = log firm's annual R&D expenditures divided by firm turnover	RD	-4.99	2.06
Log number of patent applications a firm has filed in Finland.	PATENTS	-5.93	-2.54
Log firm's annual total finance obtained from Tekes relative to its turnover	PUBLIC_RD	-6.78	1.63
Dummy variable that gets value 1 if firm is undertaking Tekes financed project at year t, 0 otherwise.	TEKES_PROJ	0.44	0.50
Dummy variable that gets value 1 in case of the R&D projects, and 0 in case of development projects.	RD_PROJECT	0.33	0.47
Number of valid patents firm has in Finland at the year of Tekes' project funding decision	PATENT_VALID	4.59	45.61
Dummy variable that gets value 1 if firm's project is part of Tekes technology program, 0 otherwise	TECH_PROGRAM	0.23	0.42
Dummy variable that gets value 1 if part of the firm's Tekes project funding is allocated to university or research institute, 0 otherwise.	RES_ORG_COLLAB	0.31	0.46
Dummy variable that gets value 1 part of the large firm's Tekes project funding is allocated to SMS firm(s), 0 otherwise.	SMS_COLLAB_LARGE	0.10	0.30
Dummy variable that gets value 1 if business to be generated within the firm's project is new, 0 if it is existing.	NEW_BUSINESS_DMY	0.46	0.50
Dummy variable that gets value 1 if firm exports products or services, 0 otherwise.	EXPORT	0.45	0.50
Dummy variable that gets value 1 if firm is among those 10 companies that have largest number of Tekes financed projects ending 1999-2003, 0 otherwise.	TOP10_FIRM	0.11	0.31
Asiakastieto debt rating class: Excellent: AAA = 6 good+ AA+ = 5 good AA = 4 satisfactory+ A+ = 3 satisfactory A = 2 välttävä B = 1 poor C = 0	RATING_CLASS	4.15	1.48

Firm's return on its total equity (%).	RETURN_EQUITY	4.71	63.76
Log firm's age	AGE	2.42	0.80
Dummy variable that gets value 1 if firm has 10-50 employees and its turnover is max 50 million euros, and 0 otherwise.	MEDIUM	0.12	0.33
Dummy variable that gets value 1 if firm has more than 250 employees and its turnover is over 50 million euros, and 0 otherwise.	LARGE	0.26	0.44
Percent change in the firm's turnover between year t and t-1.	TURNOVER_GROWTH	25.02	107.36

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THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
LÖNNROTINKATU 4 B, FIN-00120 HELSINKI

Puh./Tel. (09) 609 900 Telefax (09) 601753
Int. 358-9-609 900 Int. 358-9-601 753
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