Evaluating Additionality of an Innovation Subsidy Program Targeted at SMEs: An Exploratory Study

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CroEconSur
Vol. 15
No. 1
April 2013
pp. 61-88

Received: October 1, 2012
Accepted: March 11, 2013
Research Article

Abstract

This paper explores the effectiveness of a recently introduced innovation subsidy program targeted at SMEs in Croatia. Three aspects of program additionality were evaluated: input, output and behavioral aspects. Both qualitative and survey research was employed, and four case studies with selected recipient companies were conducted. This study is a response to the policy-makers' need for early program assessment. It attempts to show that even with early evaluation and small population of recipients it is possible to gain insight into program effectiveness. The analysis suggests that the effects of programs targeted at innovative SMEs might need to be evaluated differently than general subsidies. This is especially evident in the evaluation of input additionality. The analysis indicates that SMEs which started with a higher R&D capability tend to increase R&D intensity while participating in the program. The program raised R&D and innovation

capability of the participating SMEs, but commercialization of project results remains a concern.

Keywords: additionality, innovation, R&D subsidy, SMEs, developing country, commercialization

JEL classification: O31, O32, O38

1 Introduction[1]

The comparative advantage of companies has become increasingly based on new knowledge. For this reason, policies directed at small and medium-sized enterprises (SMEs) aim to support the involvement of SMEs in the commercialization of knowledge and innovation (Audretsch, 2003). One of the public instruments for encouraging innovation in SMEs is a direct subsidy program. The main rationale for the existence of such a program is to correct market failure, which prevents private firms from adequately investing in R&D (Arrow, 1962). Compared to large firms SMEs in particular are less able to appropriate rents associated with innovation.[2] Supporting innovation in SMEs is particularly important for developing countries in their attempt to make a transition from traditional to knowledge-based economy.

Because public programs are expensive, it is necessary to show their effectiveness. Evaluation is considered one of the key mechanisms for program improvement (Niosi, 2010), and it is of particular importance in countries where competition for public resources is severe and governments are under pressure to discontinue programs that do not show results. For this reason evaluations are sometimes performed early (i.e. only a few years after the introduction of the program).

1 This paper is based on data collected through the project "Consulting Services for Evaluation of the Innovation Programs Financed by World Bank in Croatia (Impact Assessment)" financed by Croatian Ministry of Science, Education and Sports and the World Bank.

2 The market failure argument says that firms will not invest enough in R&D because they are not able to fully appropriate the benefits of innovative activities due to knowledge spillovers between firms, competitive actions, etc. Since SMEs are in a worse position when it comes to intellectual property protection and competitive power, it is to be expected that fully appropriating the benefits of innovation will be even more difficult for them.

Ideally, subsidies are supposed to produce R&D activities that would not have occurred without government support, and this additional effect is measured using the concept of additionality (Hsu, Horng and Hsueh, 2009).

The purpose of this paper is to explore effectiveness of an innovation subsidy program targeted at SMEs in Croatia. It presents an early evaluation of the program, which is a response to the policy-makers' need for early program assessment. The program, whose acronym is RAZUM (Development of Knowledge-Based Companies), aims at supporting the development of innovations with higher value added in SMEs by means of conditional loans. Based on company survey (n=20), this exploratory study empirically examines the additionality of RAZUM program, considering three aspects of additionality: input, output and behavioral aspects (Hsu, Horng and Hsueh, 2009).[3] The selected case studies illustrate how RAZUM affected each of the recipients depending on the characteristics of companies, industry and project.

This paper attempts to make the following contributions to the existing literature. First, it seeks to generate deeper insights into firm behavior in innovation subsidy programs targeted at SMEs. Considering a recent trend of introducing SME targeted innovation programs in EU and developing countries, it is important to have good insight into effectiveness of such programs.

Second, the paper contributes to the level of knowledge on the effects of R&D policies in Croatia and consequently in developing countries where there are very few studies on that topic. Almost everything we know about the impacts of R&D subsidies in general on companies and economy originates from studies performed on developed countries. Similar studies for the developing countries are extremely hard to find. In particular, there is scarcity of information about evaluations of

3 With the help of the World Bank, in 2007 RAZUM program was created as an instrument to foster private sector investments and R&D expenditure (this program is often reffered to as "new" RAZUM as opposed to "old" RAZUM which was a program that preceded the current one). Its goal is funding research and development of innovation in existing SMEs, and establishing new knowledge-based companies founded on innovation. RAZUM gives subsidies in the form of conditional loans which cover up to 70 percent of new product development costs, with maximum support of 1.5 million euros per project and duration of up to three years. BICRO agency closely monitores how the recipient companies spend their grants. RAZUM program is designed to finance product/service development to the prototype phase, and no commercialization activity is supported through this program.

targeted innovation subsidy programs for SMEs. To the authors' knowledge the only research paper on this topic discusses the PIPE program in Brazil (Salles-Filho et al., 2011). Considering the importance of SMEs and innovation, this leaves policy-makers in developing countries with a lack of relevant information. However, evaluation is especially important for developing countries (Niosi, 2010). Developing countries lack innovations and dynamic sectors based on advanced technologies to accelerate their growth and development. Market forces alone will not produce medium- and high-technology sectors in those countries. In developing countries, business expenditures on R&D are low in absolute terms and as a percentage of GDP (Niosi, 2010), and thus public investment is needed to stimulate R&D and innovations. Policies that are introduced in order to stimulate R&D often yield poor results because of the lack of government commitment, ineffienct implementation of programs and system resistance. Due to a lack of financial resources there is often pressure to reduce expenditures on R&D and to discard programs. Accordingly, evaluation of R&D programs is very important to convince policy-makers about advantages of R&D programs and correct possible problems as soon as possible. Governments learn through evaluation (Niosi, 2010).

Section 2 discusses additionality-related literature. Section 3 introduces RAZUM program in Croatia. Section 4 describes methodology used in this research. Section 5 presents the findings and Section 6 concludes the paper.

2 Additionality: Literature Review

Traditional approach for assessing additionality used to be focused on estimating firm's own R&D investment in the presence of subsidies. Since it requires less effort to obtain government subsidies compared to attracting private investors, firms could use public subsidies to substitute some (partial crowding out) or

all (full crowding out) of their own R&D expenditure.[4] "Crowding out" of private investment would preclude the intention that subsidy becomes "a stimulating force to do more R&D" (Lach, 2002). Some recent studies tend to reject full crowding out effect (Aerts and Czarnitzki, 2004; 2006; Almus and Czarnitzki, 2003; Czarnitzki and Fier, 2002; Fier, 2002; Hussinger, 2008; Loof and Heshmati, 2005), while some studies find the support for partial crowding out effect (Busom, 2000; Heijs and Herrera, 2004; Kaiser, 2004; Lach, 2002; Suetens, 2002; Wallsten, 2000). Partial crowding out effect implies that the firm may have reduced its private effort relative to what it would have done without the subsidy.

Although traditional approach focused on estimating crowding out of R&D investment in the presence of subsidies, other dimensions of additionality were recognized as important. Researchers soon recognized that input and output additionality need to be complemented by taking in account other changes that the recipients can experience when participating in one of the subsidy programs. This recognition led to the broadening of the concept to include behavioral additionality (Georghiou et al., 2004).

Input additionality is the most widely used concept for measuring the effectiveness of R&D programs (Clarysse, Wright and Mustar, 2009), and it is closely related to the "crowding out" issue. It has primarily been applied to inputs such as R&D expenditures, but it can include the scale of the R&D.

Output additionality deals with the extent to which the firm's output has changed as a result of having received a subsidy. Standard output indicators are patents, papers, prototypes, introduction of new products, new processes or services.

As the most recently recognized aspect of additionality, behavioral additionality addresses the changes in firm behavior resulting from receiving the subsidy. In particular, Buisseret, Cameron and Georghiou (1995) specify that behavioral

4 Crowding out occurs when public funding drives private funding out partially or completely (Busom, 2000). Full or complete crowding out takes place when a recipient firm lowers its intended R&D spending by the amount provided by the subsidy. Partial crowding out occurs when total effort increases, but the private contribution is smaller than if the firm had not received a subsidy.

additionality includes the changes in the breadth of innovation activities and changes in both technological and business strategies of the firm. Very few studies such as Clarysse, Wright and Mustar (2009) and Hsu, Horng and Hsueh (2009) provided empirical analysis of behavioral additionality; their approach was adopted in this paper.

In this paper we examine all three aspects. In the past, most evaluations of subsidy programs targeted at SMEs focused on input additionality through examination of crowding out effects (Wallstein, 2000) and social effects (Audrestch, Link and Scott, 2002). Broadening this perspective by including all three aspects of additionality may bring new insights into the effectiveness of SME programs.

3 Methodology

In this study we employ both survey research and qualitative research (in particular case studies with selected recipients), following the methodology from the evaluation of Small Business Innovation Research (SBIR) program (Audretsch, Link and Scott, 2002). The additionality concept in this study was adopted from Georghiou (1994), while the treatment of particular aspects of additionality was adopted from Clarysse, Wright and Mustar (2009) and Hsu, Horng and Hsueh (2009). Following the long history of subjective measures of the effects of R&D and innovation grants, the data on additionality was collected through self-assessment: such measures are widely used and accepted in the field of evaluation research (Clarysse, Wright and Mustar, 2009).

3.1 Data Collection and Sample Profile

Survey instrument designed for this project is a highly structured questionnaire which was web-based and addressed to directors/owners of the companies. Telephone follow-ups were used. In spring of 2011 RAZUM had 21 projects under implementation (out of which 6 graduated by summer 2011). Out of this

population of 21 applicant firms, 20 firms responded to the survey. Table 1 presents basic demographic data on recipient companies.

Table 1: *Recipient Company Demographic, n=20*

Size	11 micro companies (less than 10 employees), 6 small companies (less than 50 employees), 3 medium companies (less than 250 employees).
Age	At the time of the survey ranged between 20 and 1, with the average of 10.2 years. There are 4 startups whose forming was assisted by RAZUM.
Sector	9 companies operating in sector Computer Programming, Consultancy and Related Activities, 5 companies in Research and Development, 6 companies from various manufacturing sectors.

All of the recipients had been conducting in-house innovation and R&D activities in a continuous manner prior to the application. The four startups created with the help of RAZUM grant were founded on ideas for innovative products/services.

In the exploratory research qualitative methodology was employed. Semi-structured interviews were conducted in order to explore the interviewees' experience regarding the RAZUM program. Based on these interviews, case studies of four program graduates were developed. Basic information on these companies is presented in Table 2.

Table 2: *Companies Taken as Case Studies, n=4*

	Sector	**Age at application for RAZUM**	**Project innovation level**
Company A	Aeronautics	Startup	Radical innovation
Company B	Software	2 years	High level of novelty
Company C	Electronics	13 years	High level of novelty
Company D	Metal construction and parts	17 years	High level of novelty

3.2 Measurement

Following extensive literature survey in Hsu, Horng and Hsueh (2009) and taking into account specificities of the RAZUM program we measure the three dimensions of additionality (see Table 3). As in Hsu, Horng and Hsueh (2009), assessment of additionality was carried out through questions involving a "counterfactual scenario", i.e. a hypothetical situation where recipients had to imagine they had been denied the grant.

Table 3: *Items Used to Assess Input, Output and Behavioral Additionality*

Input additionality	Scale of the project R&D intensity before and after the grant
Output additionality	Number of new products/services introduced to the market Number of new products/services under development
Behavioral additionality	Innovation development process New employment Collaboration

Input Additionality

This aspect of additionality is examined following two approaches. First approach addresses this issue in the manner of Hsu, Horng and Hsueh (2009), where input additionality was evaluated by asking recipient firms what they would have done had they not received the subsidy (adjusted scale of the project, development time, etc.).

The second approach follows the "crowding out" literature. In order to examine if firms substituted any of the public money for their own investment, the values of own and total R&D intensity were compared before and after the beginning of the RAZUM grant. The explanation of the items used in the assessment of input additionality follows:

Scale of the project – recipient companies were asked to answer the following yes/no questions: (1) would the company abandon the project, and if no they were asked (2) would the project be performed on a smaller budget, (3) would the

project be performed on a smaller scale and (4) would the project be performed over longer time period.

R&D intensity before and after the grant – R&D intensity was measured as R&D investment divided by firm's turnover.

To get a deeper understanding of the use of R&D budget, we examined if the recipients diverted own R&D funds to some other purpose. We inquired if RAZUM enabled the recipients to invest a part of their funds in some other activities such as current business activities, improvement of the R&D capacity, improvement of business functions inside the company, or something else. We also asked recipients about when they expect this investiment to produce some outputs (within one year, from one to five years, and after more than five years).

Output Additionality

In general, output additionality of a subsidy is difficult to measure because a direct link between specific innovation project and innovation output is hard to identify due to inter- and intra-firm spillovers (Clarysse, Wright and Mustar, 2009). In this paper spillovers from RAZUM are also considered as the benefit of the program, and output was assessed by a number of new products introductions and a number of new products in development, regardless of whether these products were developed within RAZUM or not.

Behavioral Additionality

The new product development process (NPD process) is one of the key factors for new product success (Cooper and Kleinschmidt, 1991; Lynn et al., 1999). The degree of structure of NPD process reflects the ability of the firm to innovate in a sustainable way. In this paper changes in NPD were addressed as follows:

Innovation development process – recipient companies were asked to agree/disagree with each of the following statements: (1) prior to the RAZUM grant, we had no formal process of new product development but now we do, and (2) prior to the RAZUM grant, we had a formal process of new product development and have improved this process as the result of the program.

Next, we examine changes in employment and collaboration that are also considered to reflect behavioral additionality (Hsu, Horng and Hsueh, 2009).

New employment – (1) number of new people hired because of the RAZUM grant and (2) number of new people hired in R&D. Also, recipient companies were asked to agree/disagree with the statement: "In case our company had not received the RAZUM grant, it would have proceeded with the project without employing new people".

Collaboration – recipients were asked to agree/disagree with two following statements: (1) "In case our company had not received the RAZUM grant, it would have proceeded with the project but without collaborating with universities or research institutions", and (2) "In case our company had not received the RAZUM grant, it would have proceeded with the project without collaborating with other companies". Recipients were also asked to assess if networking and development of collaboration with new partners would have been one of the benefits of the RAZUM program on the scale from 1 (no benefit) to 5 (high benefit).

4 Findings

RAZUM projects were "major" projects that were rated as important for future business strategies of recipient firms (all but one firm agree that the project is very important/important for their business and that it is linked to long-term strategy of the firm).

4.1 Input Additionality

First adjustment of project scale was explored[5], followed by the analysis of possible substitution of funds, and finally by the analysis of fund use/diversion. It is important to emphasize that due to a very small sample size, we need to be careful when generalizing the results of the analysis of input additionality.

Project Scale

The usual argument in the literature is that the additionality of the subsidy is doubtful if a firm would have engaged in the project anyway: from an agency's point of view subsidy is successful only if the project would not have been performed otherwise (Lach, 2002). The question what would have really happened in the absence of a subsidy is unresolved. While Bond, Harhoff and Van Reenen (1999) suggest that financial restrictions may affect the firm's decision to enter the R&D project rather than the decision to modify the level of R&D, Hsu, Horng and Hsueh (2009) found the later to be true. Specifically, their study showed that in the case of financial constraints most companies were likely to continue with the project but on an adjusted scale. This finding was attributed to the fact that large firms in that study had enough resources to allow them to continue without the subsidy, which biased the results (Hsu, Horng and Hsueh, 2009). This argument would suggest that large firms could be expected to go on with the project while small firms could be expected to balk.

The results from this study do not confirm the above hypothesis. SMEs in this study were also much more likely to adjust the scale of the project in order to keep it alive than to abandon it (see Table 4). Companies reported that the project would have received a lower budget, it would have been conducted on a smaller scale, and it would have been slowed down. Only two companies reported they would not have started the project.

5 For example, scaling down the project if the subsidy was not received.

This propensity to continue on a smaller scale does not mean that the subsidy is ineffective. If the SME could embark on the project by itself and finish it at the same time and on the same scale without affecting the other projects in the pipeline, then the effectiveness of the subsidy would be doubtful (see Table 4). However, if the firm proceeds on a smaller budget, on a smaller scale and at a slower speed, it would very likely miss the market opportunity. It is most likely that this commitment to the project is a reflection of its strategic importance for the SME ("major" projects), and not the firm's ability to finance the project without the subsidy.

Table 4: *The Project Scale without RAZUM, Directors/Owners Perceptions, n=20*

	Yes	
	No. of companies	**In %**
Our company would not have gone ahead with this or any other project	2	10
Our company would have proceeded with the project on a small budget	14	70
Our company would have proceeded with the project but over a longer time	13	65
Our company would have proceeded with the project but on a reduced scale	12	60

Substitution Effect

RAZUM recipients were asked to report their R&D expenditures from 2006 until 2010 (firms founded after 2006 took the founding year as the first year). For five out of twenty respondents this data is missing (it is either irrelevant due to recent entrance into RAZUM or it is not provided by companies). By comparing the firm's R&D intensity before and after the start of the RAZUM grant, we observed an increase in own R&D intensity in nine companies after the beginning of the grant (on average from 41 percent in the year before the RAZUM grant to 44 percent in the year after the beginning of the RAZUM grant). In the remaining six companies, a slight decrease in R&D intensity was observed (on average from 0.34 in the year before the RAZUM grant to 0.28 in the year after the beginning of the RAZUM grant). These results would suggest the existence of a partial substitution effect.

To obtain better insight we examined the characteristics of the firms in two groups. The group in which a decrease in own R&D intensity was observed consisted of older (15.5 years vs. 10.2 years), and slightly larger companies (37.3 employees vs. 22.7 employees). Almost none of these companies (5 out of 6) collaborated with public research institutions, neither during the RAZUM grant nor before, which may indicate their lower level of absorptive capacity. These companies also had weaker share of R&D employment computed as number of R&D employees divided by the total number of employees (0.43 vs. 0.78). Taking in account these characteristics, one possible explanation for the observed decrease in own R&D expenditure is crowding out of other non-funded projects. The companies in question are comparatively larger and have a weaker share of R&D employment. The receipt of a grant which is targeted to one strategically important project may indeed divert the staff from the less important projects. These projects that are slowed down would not require the same amount of resources, which will be visible in decreased own R&D expenditures.

Although these findings should be taken with care due to a small population of recipients, they suggest that more advanced firms may be more likely to respond to direct grants by increasing own R&D spending.

Fungible Funds

Although RAZUM money is used strictly according to program requirements, financing from RAZUM frees up certain own resources that can then be channelled to some other activities. Seven firms in the population used that opportunity: they invested in improvement of R&D capacity, current business activities and improvement of other business functions inside the company. All these are not short-term investments, as the companies expect to see the results of these investments in the period from 1 to 5 years (as opposed to within 1 year). All of these seven firms belong to the group that increased own R&D

intensity during the RAZUM grant, so this diversion of own funds cannot be called substitution.

Nevertheless, literature would treat such a situation as breach of additionality because firms divert some of the funds that would have been used for R&D into other activities. It may be warranted to view this issue differently in SMEs. Due to limited capacity in non-R&D areas, it may be beneficial for the subsidized project if the firm would invest in improvement of other business functions. For example, unsatisfactory marketing function could jeopardize commercialization of current products, but also of the subsidized new product. So the subsidized product also stands to benefit from new non-R&D skills.

4.2 Output Additionality

Most RAZUM projects were geared to development of new products or new product prototypes, with new processes not so prevalent. It is important to emphasize that due to a very small sample size, we need to be careful when generalizing the results of the analysis below.

Higher level of novelty was reflected in the fact that half of the recipients expected to develop a patent during the grant, and one third expected to create industrial design. Table 5 shows that the average number of new products/services did not change significantly before and after the beginning of the grant, which is understandable considering that it takes time to develop an innovation and introduce it to the market. Instead, the effect of RAZUM can be seen in firms' stock of innovations under development. The observed increase shows positive effect of the grant on firms' innovation pipeline.[6]

6 Although the number of new products/services is a standard measure for output additionality, we have to recognize that to get deeper insight into the effect of the RAZUM one would have to go beyond the numbers to examine these innovations along other dimensions like quality, market potential, novelty etc. A share of sales from introduced innovations is another indicator that is often used in this context, but that we are not able to employ due to the fact that this was an early evaluation and none of the subsidized innovations were commercially available. Partially, we tried to provide the additional insight on output additionality using the four case studies.

Table 5: *New Products/Services before and after RAZUM, n=9*

	Two years before the beginning of the grant – average	Two years after the beginning of the grant – average	t-test of significance
Number of new products/services introduced to the market	1	1.2	p=0.62
Number of new products/services in the development	0.9	1.6	p=0.04

Note: Startups and companies that signed the grant contract after the beginning of 2009 were excluded due to insufficient time in the program.

It would be interesting to know whether this increase results from spillover of ideas from RAZUM project to other projects. Majority of firms (17 out of 20 firms) reported that they indeed generated ideas for new product/services during the RAZUM grant, although they mostly did not have the capacity to work on them (11 out of 17 firms). Regarding the nine firms from Table 5, seven of them reported obtaining new ideas, but only two were able to pursue them. This indicates that the increase in the innovation pipeline reported in Table 5 was not caused by spillover ideas from RAZUM. Considering the magnitude of the increase, it is most likely caused by the RAZUM product itself.

4.3 Behavioral Additionality

Majority of recipients (17 out of 20) reported positive changes in the new product development process. Out of those 17 companies, 10 firms have had a formal NPD before and have improved it due to participation in RAZUM, while the remaining 7 have introduced formal NPD for the first time. This change in behavior can be expected to yield improvement in future innovation capability.

Data shows that RAZUM generated new employment, most of which has been in R&D (see Table 6).[7] The SMEs expressed their intention to keep the new staff after the project is over, which suggests that firms anticipate permanent increase in cash flow as a result of RAZUM (Wallstein, 2000).

Table 6: *Change in Employment due to RAZUM*

	One year after receiving the RAZUM grant (n=11)		***Two years after receiving the RAZUM grant (n=11)***	
	Number of people employed because of the RAZUM grant	**Number of people employed in R&D because of the RAZUM grant**	**Number of people employed because of the RAZUM grant**	**Number of people employed in R&D because of the RAZUM grant**
Sum total	46	39	54	48
Average per company	4.42	3.83	5.1	5.8

Note: In this table we use 11 firms that allowed us three data points (one year before the grant and two years after the grant).

Without the grant SMEs would not have been able to sufficiently invest in the project, neither financially nor in terms of time and effort (see Table 7). More than half of the companies would have been unable to hire new staff for the project. No new collaboration would have been established. Since collaboration and employment of skilled staff raise R&D capacity of the firm, without RAZUM the companies would have been unable to increase their R&D capabilities. The influx of knowledge coming through collaborative networks would have decreased as well. As expected, collaboration with firms would have been affected less than collaboration with research institutions.

7 Companies have reported the number of new staff who were employed because of the grant, both in total and specifically in R&D. Theoretically it is possible that some of these new employees have substituted previous employees, but we do not have that information. However, when we look at the number of employees in the year preceding RAZUM, we find that in the first year companies have increased the number of their employees either for exactly the number of people hired because of RAZUM, or in some cases they have even hired a few extra people. These numbers do not raise suspicion that companies would deliberately use RAZUM to substitute existing employees by new ones.

Table 7: *The Consequences for Employment and Collaboration, n=20*

	Yes	
	No. of companies	**%**
Our company would have proceeded with the project without employing new people	11	55
Our company would have proceeded with the project but without collaborating with universities/research institutes	7	35
Our company would have proceeded with the project without collaborating with other companies	4	20

4.4 Financial Aspects and Commercialization of Projects Developed in RAZUM

Prior to applying to RAZUM program, recipient SMEs have investigated private sources of financing their projects. Although it is hard to find an investor for R&D activities due to asymmetric information between the firm and the investor, this situation is exacerbated in developing countries. The reasons for this are scarcity of capital and underdeveloped markets for know-how, which force SMEs to rely on their own funds. Asked how they would have financed the project had they not received the RAZUM grant, most recipients (12 out of 20) responded quoting own resources.

Almost half of the recipients (9 out of 20) claimed that the RAZUM grant would not suffice for the completition of the project. Those firms anticipated having to put in on average additional 70 percent of the amount received by RAZUM. Asked where they would turn to get additional financing, small and medium firms planned to rely on their own resources while micro firms would have resorted to venture capital funds or strategic partnerships. Only medium firms with a larger collateral considered bank loans as a possible source of finance. In reality, outside financing option for project completion does not seem realistic because uncompleted project means that there is no prototype to alleviate investors' risk

adversity. Consequently, firms would have to resort to their own resources, and that could mean a long delay for the project or in the worst case abandonment.

Financial problems do not cease with successful completion of a prototype. Once the firm finishes the product, it has to find resources for commercialization (RAZUM does not cover any such activity). Half of the companies expect the commercialization to be difficult. Majority of the firms (85 percent) will need additional financial resources for commercialization. Firms are divided in their perception of how difficult it is to raise additional resources: 53 percent think this would be somewhat or very difficult. More than half of the firms count on their own resources, and the other half plans to find a strategic partner. Smaller percentage of firms will also try banks or venture capital funds. Considering the fact that more than half of the firms believe it would be difficult to find additional money for product commercialization, there is credible danger that these SMEs may be stranded with prototypes that they would not be able to commercialize.

4.5 Case Studies

The goal of the presented case studies is to show the specific effect of RAZUM on companies. The four chosen firms represent different sectors and technologies and different levels of project novelty and associated development risk. One company is a startup, one is very young, and the remaining two firms were founded in the 1990s. The cases illustrate specific issues that companies faced in making use of the RAZUM grant during the project development. In all four cases the RAZUM project was satisfactorily completed (i.e. prototype was developed). All four products are of a high-novelty level and one of these projects can even be considered a truly radical innovation.

Although all four companies graduated from RAZUM successfully, the real impact of the subsidy will be determined by the market success of the product. The cases illustrate how RAZUM affected each of the recipients depending

on the characteristics of companies, industry and project. Further, the cases show how these characteristics are likely to shape the commercialization of the product. The cases illustrate a variety of product commercialization scenarios: from inability to find financiers to fitting in with the existing market partners.

Company A: A Story of Radical Innovation

Company A is an example of a high-tech startup with a radical innovation. Company A was founded a year before submitting application for the RAZUM grant. It applied with the project of an autonomous stratospheric airship, which presents a true radical innovation. Without the RAZUM grant the company probably would have never started the project.

At the moment the company has a working prototype: a small (3.6 meters long) ship. One million euros was invested in the project up to now, and the management's estimation is that additional 15 million euros and 3.5 years are needed from the working prototype to the commercialization. The company employed 25 people, but as it was not able to raise additional funding after the expiration of the RAZUM grant, it has been put on hold. The two founders are trying to find financing globally, but due to the radical nature of the innovation this has proved a very difficult task. To quote one of the founders: "In the last 7 months we had 250 contacts regarding financing. Potential investors are very skeptical of the fact that this company originated in a country which is not renowned for its technological prowess. The usual question we get from the business community is how come nobody in a technologically developed country ever thought of an innovation like ours."

The targeted market for the intended product is large and growing, meaning that Company A's project could be extremely profitable. However, the radical nature of the innovation and the associated risk (and cost) present a big hurdle for investors. This case draws attention to a situation where public money is used in the development of truly radical innovations with a potentially large payoff.

Private investors may lack sophisticated technological knowledge to evaluate the product, or may just perceive it as too risky. In the case when the project is technologically sound but represents a large risk for individual investors, the mechanisms to find financing become a priority, otherwise a promising radical innovation may be abandoned.

Company B: Realizing the Entrepreneur's Dream

The case of Company B represents the ideal scenario. Company B is a young (founded in 2007) software company with a high-novelty product. The project financed under the RAZUM grant is a tool for developing social networks, which enables businesses and individuals to start their own mobile social networks. At first Company B tried to find private investors to finance the product development, but that proved to be an impossible task. According to one of the founders: "Investors did not want to fund an innovation which was backed up only by a concept explained on paper." Without the RAZUM grant the company probably would have never started the project.

Once the company developed the prototype of the RAZUM product it started searching for investors; this time the search ended successfully with a favorable response from one foreign venture capital fund. At the request of the investors a new spin-off was created centered around the RAZUM product. The purpose of the spin-off was to take the RAZUM product out of the firm and set it up as a separate business so it can be given proper focus and care including further development. The investor also required that the company sets up an office in the U.S.A., since that seems to be the most promising market for the product.

Company C: Established Company with a Strong Partner

Company C was founded in 1995 and is specialized in the development of FPGA designs (Field-programmable Gate Array). Although small, this is a global

company with headquarters located in Zagreb (Croatia), and offices in Germany (opened in 2004) and Japan (opened in 2009). Since 2001 Company C has enjoyed a long-lasting strategic partnership with a strong international industry player. Regardless of this partnership, without the RAZUM grant the company would have had to scale down the project and take more time for development. Other projects would have been damaged due to sharing of R&D capacity.

The aim of the RAZUM project was to develop the unique solution for the control of 3D graphic applications based on the technology FPGA. By the end of the grant period Company C has produced a working prototype of a 3D graphic accelerator. The fact that Company C has a strategic partner has proved crucial for the relative ease of product commercialization, because this activity will be performed in cooperation with the partner.

Company D: Transition from Low-knowledge to High-knowledge Enterprise

This case illustrates a possibility of a RAZUM grant to act as a catalyst for changes in the internal orientation of the company in the direction of R&D and innovation. The Company D was founded in 1991. Initially, the company was operating as a retailer and wholesaler and later expanded into manufacturing of mechanical and spare parts for metal processing. Before applying for the RAZUM grant Company D has experimented with new product development, but on a very small scale. In 2003 the company first started playing with the idea of improved pneumatic grinder. It tested and developed the idea, but did not get much further than the concept stage. With the participation in the RAZUM grant, Company D developed this idea into an entire line of new types of pneumatic grinders and is now focused on R&D instead of wholesale.

Since the completion of the RAZUM project, the company has embarked on the production and commercialization activities. These will be financed by bank loans. Its success with banks could be explained by the fact that Company D

is an older company with established reputation and assets. Although the new grinder is considered a novel product within its industry, it is likely that investors perceived it as less risky than the high-tech products described in the previous three cases.

Company D is new in R&D, but it has been selling to the same market for two decades. Due to that presence it has gained considerable market knowledge and has developed contacts with business partners and customers which can be used in the new endeavor. The company plans to commercialize the product through its existing network of partners and customers.

5 Discussion and Conclusion

SMEs in the RAZUM program exhibited very high levels of project involvement and commitment. The fact that companies were set on continuing with their innovation projects regardless of the grant is not a sign that the program allocated funds to firms that had enough resources (as literature would suggest), but more likely signalled firms' belief about significant potential of the project. This effect may be specific for input additionality of SME innovation programs such as RAZUM, and may be missing from other types of subsidies.

RAZUM data shows that some recipients decreased the amount of own R&D intensity, which literature would interpret as partial substitution effect. Since RAZUM is a special program geared toward innovating SMEs, the comparison with other studies that show partial substitution may not be appropriate. The only crowding out study focusing on SMEs is by Wallsten (2000), who found a strong substitution effect for SBIR. This was not confirmed in the analysis of RAZUM, where about half of the firms increased their R&D intensity.

It is not easy to interpret crowding out effect in SMEs (Lerner, 1999), and little is known about company characteristics that may be related to crowding out among SMEs. This study suggests that SMEs with better R&D capability,

better innovation capability and larger absorptive capacity may be more likely to respond to grants by expanding their R&D investments, while the others could be more prone to decrease them. For programs like RAZUM, this may speak in favor of stringent applicant evaluation by a grant-giving agency.

Another finding that would indicate partial input additionality according to the literature is the diversion of intended R&D funds after the grant was received. Interestingly, the RAZUM recipients that diverted funds showed no evidence of substitution effect: they even increased their own R&D intensity (and also R&D expenditure) after the receipt of the grant. Regardless, part of the intended R&D budget was diverted into other business functions, which the literature would consider as breach of additionality. This requirement may be too stringent for innovation programs aimed at SMEs, because unlike large firms SMEs struggle with tight resources in all business functions. If other business functions are not developed satisfactorily, they may not be able to support the business aspects of the subsidized product, and that could jeopardize the end result of the project. It may be even postulated that in order to fully realize additionality, SMEs should also invest in developing "enablers of additionality" who will ensure stronger output and behavioral additionality down the road.

All of the above discussed points indicate that certain widening of perspective may be needed in assessment of input additionality for programs oriented toward innovative SMEs. Due to the fact that RAZUM began in 2007, the output effects of the program were visible only in the innovation pipeline (i.e. new products in development), and were not noticeable in the number of new introductions. Although ideas for new projects were generated during the participation in RAZUM, most companies lacked resources to start working on them. Indeed, the size of the pipeline suggests that the increase was due mainly to the RAZUM project. Unlike large firms SMEs have a limited R&D capacity which prevents them from harnessing the intra-firm spillover from the subsidy program.

RAZUM has shown behavioral additionality effects in improving new product development process, which should raise the firm's future capability to innovate. RAZUM has also made new employment in R&D possible, which raises R&D capability. Exploratory research suggests that the goal of the new employment was to add sufficient capacity to carry out RAZUM project without harming existing projects, but this increase seems to be permanent. RAZUM grant also enabled collaboration with other organizations during the project.

Although the RAZUM program by itself does well, the effect of a subsidy can be lost if the product does not reach the market. This can happen either because the grant is not large enough to finish the project, or because the SME cannot commercialize the product on its own (RAZUM does not fund commercialization activities). More than half of the recipients expect commercialization to be difficult. In financial sense they count mostly on their own resources, although small companies would like to form strategic partnerships. The fact that RAZUM does not cover commercialization may be a problem. In a country where capital markets and markets for know-how are developed, a good prototype should attract a private investor. Outside investors' support is expected not only to provide capital funding, but also to provide useful business and management guidance that will help to bring about the commercialization of the project (Lerner, 1999). However, in a developing country such as Croatia, such investors are almost non-existent. This damages an SME in two ways: first, it cannot get financial resources, and second, the transfer of knowledge and skills does not happen. As a consequence companies can end up with promising prototypes and no capacity to commercialize them. This indicates a need for another public program to bridge the stage from the prototype to market introduction. Otherwise, the effect of the subsidy may be lost.

One particular aspect of public innovation programs that this paper would like to point out is the treatment of radical innovation in developing countries. As one of the case studies shows, commercialization of radical innovation that is potentially very profitable is often out of the reach of an SME. In case of a truly

radical innovation, investors may be deterred by a very large risk and technical sophistication of the product. Our case studies indicate that the country of origin of the innovation may be an additional obstacle, namely that a high-tech radical innovation coming from a developing (as opposed to a developed) country raises suspicion as to its quality. Whether this is a real effect or just an artefact of our study remains to be investigated in the future.

A limitation of this study is that it is performed just after the program introduction (after only 4 years), which does not allow for observation and the analysis of long-term effects. A related problem is a small population of program recipients. Because of the latter issue, care has to be exercised in the interpretation of the findings. Small data set also did not allow us to perform matching procedure and conduct more complex analyses. However, an early evaluation of the program might be very useful for policy-makers. Due to the lack of finance and pressures from various stakeholders competition for public money is intense in developing countries, and by conducting an early evaluation, policy-makers can make a case for the continuation of program funding, and/or correct inefficiencies. Repeating the evaluation in the future might allow for replicating the analysis on a larger population.

Another limitation is subjective methodology which is appropriate for early evaluation of the exploratory type, but has its shortcomings (for example respondents may have an interest in overstating the effects of subsidies since they expect further help from the government). In the future, a larger number of companies and longer time from the inception of the program will allow for one of the traditional matching procedures.

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