

Goerke, Björn; Albers, Sönke

Preprint

Long-term effects of subsidies on firm growth: introducing the concept of outcome additionality

Suggested Citation: Goerke, Björn; Albers, Sönke (2016) : Long-term effects of subsidies on firm growth: introducing the concept of outcome additionality, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg

This Version is available at:

<https://hdl.handle.net/10419/142164>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Long-term effects of subsidies on firm growth: introducing the concept of outcome additionality

Björn Goerke and Sönke Albers

Abstract

Public agencies provide subsidies for small and medium sized businesses (SMEs) to foster their development in terms of employment and sales. Although input and output additionality have been researched intensively little is known about the actual long-term effects of subsidies on SME growth. Relying on a unique dataset of actual SMEs we provide a means of evaluating whether subsidies lead to the expected positive long-term effects. We apply a specifically designed 3-stage-effects-model (3SEM) from the input of resources to the final outcome. The results imply that the effects of subsidies differ across types: While R&D grants unfold enduring positive effects other subsidies like corporate matchmaking might even harm companies.

1 Introduction

Since research and development (R&D) is considered the source of future business, governments strive to support private R&D (David et al., 2000; Wolff and Reinthaler, 2008). The logic is that R&D will “deliver” new products and increase the productivity that a company needs to grow and to withstand its competition (Ortega-Argiles et al., 2009; Jones, 2002; Aghion and Howitt, 1992) which eventually leads to increased welfare.

However, since investing in R&D means investing under uncertainty firms tend to spend their funds for R&D only hesitantly (Scherer and Harhoff, 2000; Ortega-Argiles et al., 2009; Segerstrom, 1991; Griliches, 1979, 1992; Caballero and Jaffe, 1993). This is due to the disproportionate effect of a possible negative outcome of the project. With regard to welfare any

project that is favorable in a risk neutral setting should be carried out as it adds to overall welfare (Arrow, 1962; Nelson, 1959; Aerts and Schmidt, 2008). Nevertheless, firms may turn down such a project due to risk-aversion. While the decision to turn down the project may be the correct decision for risk-averse firms, this causes a loss for welfare. The gap between favorability in terms of welfare and favorability for the decision making firm is especially wide for SMEs causing disproportionately high losses in welfare (for a comprehensive discussion of the reasons why SMEs are affected more, see Ortega-Argiles et al., 2009).

Governments have been trying to compensate this market failure for long. A common way is to offer grants, tax breaks or subsidies in general. Transferring part of the risk from the company to the taxpayer shall make companies change their minds about R&D investments. The objective of these subsidies is to increase the odds that a favorable R&D investment is carried out in order to add to welfare (Aerts and Schmidt, 2008).

When public funds are spent it is of utmost relevance to understand whether the return for society is positive (Ortega-Argiles et al., 2009), i.e. whether companies, e.g., create new jobs and pay higher taxes. Thus, a large body of research has evolved in the domain of the effectiveness of subsidies for SMEs (David et al., 2000; Klette et al., 2000; Brockhoff, 1983).

The effectiveness is commonly evaluated in one of the concepts of additionality as a measure of additional value created by infusing the subsidy. Numerous authors have evaluated the degree of additionality that is produced by subsidies (Wallsten, 2000; Aerts and Schmidt, 2008; Czarnitzki and Licht, 2006; Hujer and Radic, 2005; Clausen, 2009), i.e. the authors analyzed whether the subsidies led to additional funds spent on R&D (input additionality) or whether the subsidies led to a complete crowding-out of private funding of R&D which means that the subsidy completely replaces the otherwise privately provided funds for R&D. Unfortunately, the findings are ambiguous. The degree of additionality found depends on different factors like industry, scope of the subsidy or even the appropriateness of the funding (Gelabert et al., 2009; Görg and Strobl, 2007).

Yet, we only know little about the effects of the subsidies on the actual development at firm level in terms of *outcome*, e.g. growth in number of employees, sales, and - finally - profits. Though former studies show that there are *additionality* effects regarding *input* (i.e. R&D budget that is provided through subsidies does not fully replace the private funding but leads to an increase in total R&D budget) this does not necessarily lead to a positive development of the subsidized firms with respect to the above measures that reflect the *outcome* (Merito et

al., 2010; Piva, 2005). It could as well be the case that companies that received grants to foster R&D are encouraged to take inadequate risks. Then the companies could even lose money and destroy jobs instead of providing new jobs and earning additional income. So, in order to award subsidies efficiently we need to understand how the return structure of the subsidies on the *outcome* of the awardees, e.g. number of employees, sales, and profits evolves over time. Only by understanding what the long-term effects of the subsidies on these *outcome* measures are, policy makers and subsidy granting agencies can make sure that the subsidies are not spent inefficiently in a systematic manner.

The analysis of the effects of subsidies on the *outcome* contributes both to research in the field of subsidies as well as to the management of the awarding public agencies. The contribution to research is providing knowledge about the long-term effects of subsidies on firm growth. It is widely unknown what the effects of subsidies on figures like sales, profits, and the number of employees are in the long run. Do companies hire more employees after having received subsidies? And if so, do these companies maintain these jobs even after the subsidies have been discontinued?

While most studies in the field of subsidies center around *input additionality* which is defined as the additional input factor that is resulting from the subsidy and would not have been available without the subsidy (Clarysse et al., 2009) - only very little is known with regard to the actual growth of the receiving firm. Lerner (1999) and Wallsten (2000) shed some first light on the question but little has been contributed since. In this article we set forth a means of assessing the long-term effects and formalize a new concept for the effects on actual company development.

This question is highly relevant to the taxpayer because a better understanding of the long-term effects of subsidies leads to better management of this multi-billion dollar topic. Policy makers and the management of the awarding agencies benefit from the enhanced opportunities of structuring subsidy regulations and by selecting the awardees more profoundly. This will lead to better social returns of the subsidies.

We collected a unique dataset of annual report data from a set of companies that were subsidized. Due to an exemption from reporting requirements small and medium sized companies do not have to report their annual figures on a basis as detailed as it is necessary for our

study.¹ Therefore the companies in our sample had to be acquired one by one by contacting top management and convincing them of the importance of this study.

This article is organized as follows. In the following section we will present the current state of the literature. Then we move on to the methodological section where we present the data, the statistical method, and the model. Finally we present and discuss the results and their implications and present the limitations.

2 Introducing the concept of outcome additionality

For a company to grow investing in R&D is essential. Governments have been trying to support companies in their respective jurisdictions for long. The effects of those subsidies are called additionalities (Clarysse et al., 2009, David et al., 2000). Additionalities can be observed – or at least – investigated at different stages in the innovation process. There can be input-additionalities with regards to the resources that a company is willing to provide for R&D. Then there may be additionalities with regard to the output of the R&D projects and finally the companies might grow or stay the same (outcome). In the following, we categorize these different types of additionality by building on the work of Clarysse et al. (2009).

It begins with companies investing in their R&D portfolios. Companies need to provide input factors (e.g. expert staff, licenses etc.) in order to stimulate their own innovations and to come up with new products and services. The concept of *input additionality* aims to capture the effects of input factors when governments subsidize R&D projects. The main question is whether companies simply reduce their own R&D budget “Dollar by Dollar”, as Wallsten (2000) reports, which means a complete crowding-out of the private budget or whether subsidies add (at least to some degree) to the total R&D budget that companies provide for their R&D projects (Clarysse et al., 2009).

The second stage in the process is the *output* that can be achieved. Companies strive to develop new products and services. These are the obvious output figures. But there are other outputs that count as well. Companies might file new patents, enter into partnerships, and the like. These are examples of different outputs of innovation activities. Whenever subsidies add to these output figures this is called *output additionality* (Clarysse et al., 2009). This is without doubt an important concept as the companies’ growth dynamics might rely on strong out-

¹ While all companies are required to file their annual reports with the respective courts small and medium-sized companies only need to report a reduced set of numbers. E.g. companies do not need to report the number of employees and the sales figures can be reported in an aggregate way where the true sales figures cannot be derived anymore. Statistics on R&D budgets or patents and similar information are not required either.

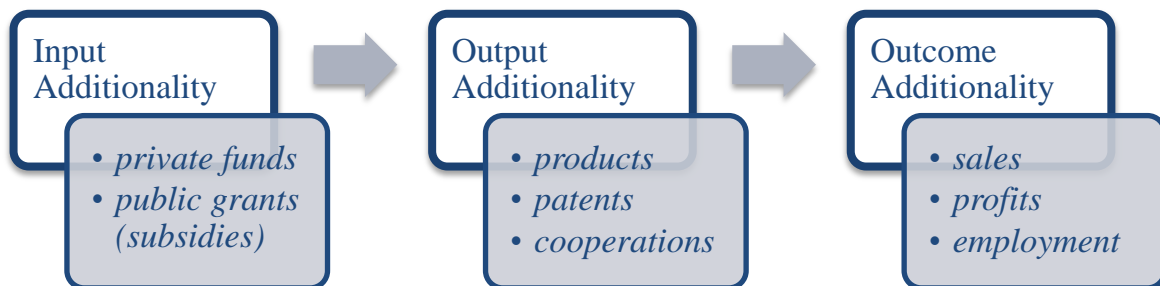
put figures. Still, output additionality does not cover the final and most relevant aspect: Does a company finally grow because it was awarded subsidies?

In the end companies as well as subsidy granting agencies and governments need to investigate the question whether subsidies actually add to the growth of a firm, i.e. do companies that receive subsidies grow in their sales and profit more than they would without the support? Public stakeholders also need to understand whether employment is positively affected as well. So, in order to create welfare-positive subsidy programs we need to understand whether and how much subsidies add to the core of these outcome figures. Accordingly we summarize this as *outcome additionality*. This is the third and final stage in the process of observing the effects of subsidies on the individual company level.

Figure 1 provides an overview of the three stages and the variables that are commonly measured. The further to the right the closer the concepts get to the effect on how the firms actually develop. The first two concepts lack the outcome of the subsidies. So, in case the subsidy creates substantial *input additionality* this does not necessarily lead to a positive development of the respective firm. It is the same with *output additionality*. In case a company invests heavily in new products because it was supported by subsidies this does not automatically lead to thriving sales figures or even employment numbers – it could well be the other way round when a company is being de-focused because of new projects and omits marketing the existing products.

Nevertheless, the concepts build on each another. *Outcome additionality* cannot be evaluated alone. We need to understand the whole process. Hence, we will set forth the current state of research in all three fields of additionality. Figure 1 shows the relationship of the different concepts of additionality. We call this the 3-stage-effects-model (3SEM).

Figure 1: Relationship of the different concepts of additionality



3 Literature Review

For a better understanding of the context that *outcome additionality* resides in we will first give a brief overview over the two concepts of input *and* output additionality. Both concepts will be reviewed regarding the findings in research. We will present the influences of the subsidies that were found and make use of those findings for a brief synthesis.

3.1 Input Additionality

Input additionality centers on the question whether the award of public grants leads to a crowding-out or even to a crowding-in of private R&D funds (Clarysse et al., 2009). A complete crowding-out of private funds by public support would mean that the firms simply replace their own funds by public funding and thus shift the risk from inside the company to the taxpayers. Crowding-in on the contrary means that companies invest even more in R&D than they would have without the support of public grants. As a measure of success of a subsidy program Georghiou (2002) suggested considering a project being a success in terms of public funding if the company invests at least the same amount of money that it is awarded as a subsidy.

The body of research in this field is so large that David et al. (2000) meta-analyzed the findings of the studies. The authors come to the conclusion that the studies deliver ambiguous results. In their sample of studies R&D subsidies could either add to R&D activity or they could just crowd-out private R&D funding. Blanes and Busom (2004) in their study of Spanish R&D subsidies review the literature with the same results.

Both research teams state that the results depend on different factors such as firm size and industry (David et al. 2000). Blanes and Busom (2004) discuss differing participation patterns in the different subsidy programs and differing goals of the agencies controlling the subsidies as a cause for the divergent findings.

In the following, we will give an overview over a sample of relevant studies in this field indicating whether the studies find crowding-out or crowding-in and the influencing factors they found if any (table 1). It seems as if there was no simple answer to the question whether public R&D financing adds to R&D activity or not.

Table 1: Literature in the field of input additionality

Author	Year	Journal	Crowding-out vs. crowding in
Wallsten	2000	RAND Journal of Economics	Complete crowding-out
Bönte	2004	Research Policy	Crowding-out in lower technology industries, positive effects in high-tech industries
Feldman and Kelley	2006	Research Policy	Partial crowding-out
Görg and Strobl	2007	Economica	Crowding-in for small subsidies
Aerts and Schmidt	2008	Research Policy	No crowding-out
Gonzales and Pazo	2008	Research Policy	No crowding-out
Özcelik and Taymaz	2008	Research Policy	Crowding-in and partial crowding-out in one sample, depending on company size

Therefore, the investigation of a possible crowding-out of private funds is highly relevant. The objectives of subsidy programs mainly center on providing new jobs and increasing sales, profits, productivity, or the like. If the R&D projects were largely carried out anyhow, i.e. with or without public support, this goal could not be met. Nevertheless, it is only a necessary condition for firm growth. It could still be that companies extend their R&D activities and do not develop better than they would have without (Merito et al., 2010; Piva, 2005). There can be different reasons, e.g. companies could be encouraged to take inadequate risks or companies might not be able to take advantage of the newly developed products since the subsidies only support R&D but not the similarly important sales resources.

3.2 Output Additionality

Output additionality takes research a step closer to the actual growth of the awardees. The goal of research in this domain is to analyze the effects of the awarded subsidies on more direct and immediate output figures. These are figures like new patents, new products and services, productivity, and so forth (Clarysse et al., 2009). Some studies go into more detail with regard to these output figures. E.g., Bérubé and Mohnen (2009) take a closer look at the degree of innovativeness that companies achieve in their new product development.

Research on output additionality draws less attention than input additionality. Nevertheless, there is research that establishes an understanding of the relevant processes in output additionality. Klette et al. (2000) worked out an overview in their meta-analysis of five studies that were in part focused on output additionality. The findings are predominantly positive. Table 2 gives an overview over the studies in the field of output additionality.

Table 2: Literature in the field of output additionality

Author	Year	Journal	Findings
Griliches and Regev	1995	Journal of Econometrics	Positive effect on productivity
Branstetter and Sakakibara	1998	Journal of Industrial Economics	Positive effect on patents filed
Klette and Møen	1999	Nordic Journal of Political Economy	Negative influence on productivity (assumed to be due to negative selection bias)
Hujer and Radic	2005	Scottish Journal of Political Economy	Positive effect on the number of new products
Czarnitzky and Licht	2006	Economics of Transition	Positive effect on patents filed
Berubé and Mohnen	2009	Canadian Journal of Economics	Positive effect on new products

These findings are plausible. Since there is evidence that subsidies do not crowd out private funds completely there must be additional R&D resources in the game. And as long as there are companies that spend the money on their R&D we should find additional output. Although these findings are desirable from the public point of view there is still no evidence that these positive conclusions result in better company growth (Hujer and Radic, 2005; Falk, 2007). Companies could well be able to develop a whole set of new products but if they are not able to market them efficiently these companies might even take financial harm from the R&D that they were encouraged to undertake. Therefore, we move on to studying the actual growth of the outcome of the companies that received public funding (Czarnitzky and Licht, 2006).

3.3 Outcome Additionality

The final step in evaluating the effects of R&D subsidies is to analyze the actual development of the companies after having been awarded. The core outcomes for assessing firm development are the number of employees and sales. Further on we will address the additionality associated with these metrics as *outcome additionality*.

Astonishingly, the presence of outcome additionality in research is still in its infancy. To the best of our knowledge there is no meta-analysis yet covering this topic but only two articles discussed below. Please note that we will emphasize the long-term effects achieved over time that the subsidies have on outcome. In contrast to *input additionality*, where there is a *point in time* when the decision on the external funding is made, outcome additionality *evolves over time* so that the long-run effects are of importance. With respect to *outcome* there is no “natural” ending to the investigation of the effects on, e.g. sales (Falk, 2007). As long as it is statistically meaningful we will investigate how the subsidies and the subsequent inputs and outputs carry-over to the final outcome.

There are two articles that deal with the well-known Small Business Innovation Research program (SBIR). The SBIR was tailored for small businesses in the USA. In the course of this program high-tech SMEs in the USA were provided with more than US-\$ 7 billion in grants for R&D between 1983 and 1997.

Lerner (1999) researched the effects of the SBIR. He analyzed the effects of the funds granted on sales and on the number of employees of the awardees over a ten year period starting 1985. The author constructed a sample of awarded and matching non-awarded firms. Lerner (1999) had the 1985 and the 1995 sales and employment figures of the companies to compare. He tested these data for significant growth of the awarded firms over the non-awardees. The awarded firms grew significantly better. On average the awardees reported an increase in sales of US-\$ 4.0 Mill. compared to an increase of US \$ 1.1 Mill. of the non-awardees. With regard to employment the figures were positive as well. The mean increase in employment was 26 employees compared to the increase of the non-awardees of 6 additional jobs.

Lerner (1999) reports a highly skewed distribution with the top awardees contributing disproportionately high to these positive findings. Lerner (1999) also reports variations in the findings due to different influences like region, industry, the number of SBIR awards received, or venture capitalist activity in the area. This more detailed analysis suggests that the average increase of the outcome mainly stems from companies in certain areas with a lot of activity by venture capital firms.

Wallsten (2000) researched the SBIR as well and came to very different conclusions. He criticized the endogeneity bias in Lerner's study. According to Wallsten (2000) it may well be that companies do not grow because of the grants they received but that they – the other way round – only received the grants because these companies were the faster growing ones. Therefore, endogeneity needed to be controlled for explicitly.

The way Wallsten (2000) constructed the sample for his study allowed for addressing the endogeneity bias. The author makes use of a system of equations that is being simultaneously estimated making use of 3SLS. One equation is designed to capture the influence of firm-size on the probability of receiving an award. The influence is positive and significant. But the estimates of the remaining equations (Wallsten covers two different phases of the SBIR program) do not indicate a significant influence of the awards on employment.

Due to specific requirements for this procedure Wallsten (2000) could only make use of data supplied by NASA and the US Department of Defense (DoD). Since there was a wide range

of agencies awarding the SBIR grants this is a substantial restriction as NASA and DoD act as awarding agencies and as potential customers for the newly developed product at the same time which was also acknowledged by Wallsten (2000) in the same article. Though, other agencies may act in these two roles as well, NASA and DoD are acting in very special markets. Wallsten explains why he thinks that the sample is representative, anyhow. Nevertheless, this severe restriction in the sampling process remains.

The findings of Wallsten (2000) are contrary to those of Lerner (1999). According to Wallsten (2000) the impact of the grants on the KPI development of the awardees is insignificant. Additionally, Wallsten (2000) finds that larger and more patent-intensive firms are more likely to win the awards. Altogether, Wallsten concludes that the grants awarded under the regulations of the SBIR programs were crowded-out “Dollar by Dollar”.

In another case, Merito et al. (2010) investigate the effects of R&D grants on several firm-level indicators of manufacturing firms in Italy. The authors point out that even if the private funds are not crowded out a rise in sales or employment does not have to be the result. Therefore, they compare groups of awarded companies to groups of non-awarded companies with regard to the development of the outcome. They construct a sample for short-term effects (2000 - 2002) and a sample for medium-term effects (2000 - 2004). While there are no overall significant effects on the development of the awardees, for the subset of SMEs the authors find a positive effect on employment in the medium term.

The inconclusive results point out the need to learn about subsidy effects in the long run (Falk 2007) but also stress the challenges that come with a long-term study of R&D grants on firm-level indicators. Lerner (1999) and Wallsten (2000) have started this important stream in research. Both scholars demonstrated that it is a feasible task to tackle the long-term effects but that it is also necessary to control for effects that merely stem from company characteristics that may have an influence on the probability of receiving awards. The ambiguity of their findings suggests that there is a wide range of challenges that need to be researched in order to come to a generalized long-term evaluation in terms of outcome additionality. Merito et al. (2010) add to understanding the effects but still their findings are ambiguous. By analyzing different time frames they allow for the first time to distinguish between different intervals of company development.

In the following we will present an approach that deals with the different challenges of analyzing the long-term effects of the subsidy. We start by elaborating the theoretical framework for the study.

4 Hypotheses

We make use of the resource-based view of the firm introduced by Wernerfelt (1984) and Barney (1991). According to the resource-based view a firm consists of a bundle of manifold resources. They usually comprise funds, machinery and knowledge (e.g. patents or exceptionally skilled staff) but they could also consist of brand value, distribution channels, or the like. Altogether the resources enable the firm to deliver its products and services, to grow, and to withstand its competition. In a situation of a lack of resources a company will not be able to grow and might even be forced to exit the market.

According to the resource-based view a company that acquires additional resources permanently lifts itself to a higher level of company development and possibly to an improved market position. This means, e.g., that a company that has acquired an improved market position by hiring an excellent salesperson will continue to benefit from this shift as long as the salesperson stays within the company – or until it is otherwise eliminated from the list of competitive advantages. This could occur, e.g., by direct competitors improving their own sales competences as well. Subsidies add to the bundle of resources as well. When a company receives a grant in order to carry out an R&D project this is an infusion of a new resource that the company can make use of.

Another aspect evolves along the question whether it is merely the resources that hinder companies from developing (Merito et al. 2010). Especially for non-SMEs the assumption is that companies can rather easily access capital markets that will provide companies with new funds in case the company can prove the upcoming projects to be favorable. SMEs may not have staff dedicated to managing the interactions with capital markets. Rather these companies rely on senior managers that handle finance as only one aspect of their management tasks. Following these arguments the resource-based view is especially relevant for SMEs.

As was shown by Merito et al. (2010) SMEs will develop better with regard to firm growth in case that they receive additional resources from the outside. Since the resource-based view does not distinguish between the different types of resources we can form one single hypothesis that can be applied to any subsidy awarded to SMEs:

Hypothesis 1a. *The growth of an SME with regard to the outcome is positively associated with subsidies awarded to the SME.*

According to the resource-based view the effects of the resources that were added to the bundle of resources will not diminish over time. This even accounts for hiring a highly skilled R&D manager who has knowledge the value of which could decay over time. On the other hand shifting a company to a new level of productivity could also lead to disproportionate growth due to overcoming barriers of growth. In order to test whether the assumption of an enduring and constant effect of the additional resources holds we state the following second hypothesis.

Hypothesis 1b. *The change in outcome is enduring and constant.*

5 Model

For testing the hypotheses we designed a sequential equation approach where *input additionality* is explained by subsidies, *output additionality* is explained by *input additionality* and subsidies and finally *outcome additionality* by *input and output additionality* together with subsidies. Thus, we cover the influences the complex structure of effects has on *outcome additionality*. The framework is displayed in figure 2.

In the first stage, input additionality, we employ a model that reflects the influences of the subsidies on the R&D budget that is being provided by the companies. We introduce firm size measured as number of employees to control for endogeneity that might result from the pure size of the company as Wallsten (2000) found in his study of the SBIR.

The second stage, output additionality, is structured in a similar way. We make use of the number of patents filed as output measure.² The independent variables consist of the subsidies and controls again but they are extended by the R&D budget provided by the companies which was the dependent variable in the first stage. This way we connect the two intertwined stages.

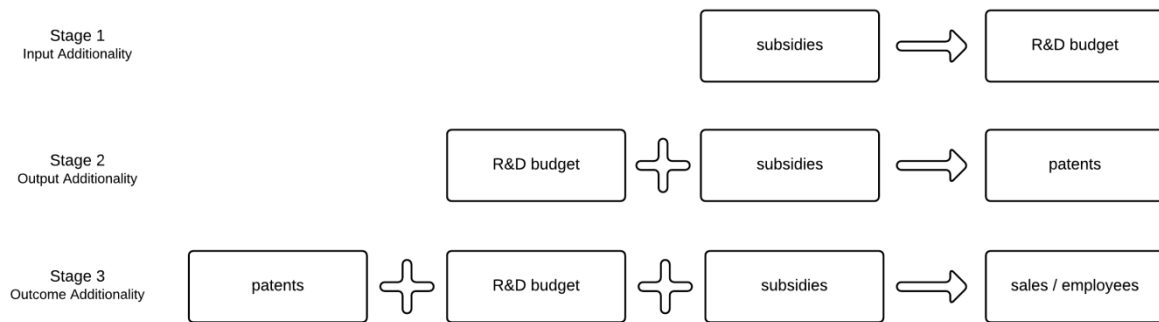
Finally, the third stage, the stage of outcome additionality, is developed in the same way. The independent variables consist of the subsidies and controls but also of the dependent variables of the two preceding stages. Three key measures to assess whether the aim of growing was

² There is a wide array of different measures for output additionality with new patents being in line with former research. We opted for patents, first, as filing a new patent is clearly defined and unambiguously measurable whereas new products, e.g., will always be less precise to measure as some respondents might interpret a new feature of an existing product a new product while others may not. Thus, patents reduce noise in the data. Second, patents are often filed substantially earlier than the release of the products that are based on the respective patents. This reduces noise in the data as well.

accomplished are sales, number of employees, and profits.³ While profits can easily be manipulated by the management (e.g. profits can be deferred to later periods or to other entities), the sales figures and the number of employees are rigorously defined and reported.

This set of models allows for a comprehensive investigation of the effects of subsidies in all the stages. Furthermore, this also allows assessing the impact of preceding stages on the following stages.

Figure 2: Stylized overview of the 3SEM frameworks



6 Data

The agency providing the data for this study, WTSH, is a so-called “One-Stop-Agency”.⁴ It is the largest public agency covering the region with a wide portfolio of subsidy instruments. Within this portfolio 4 of these instruments are commonly used. These 4 instruments are described in more detail below and will serve as independent variables in this study. The hypotheses stated before will be tested on all of these instruments.

6.1 The subsidy instruments

6.1.1 R&D grants

SMEs receive a substantial amount of funds for single R&D projects. The grants do not have to be repaid. The awardees only need to document that they spent the grants according to the project proposal. The purpose is to come up with new products and services.

6.1.2 Patent consultancy

Companies are offered a large array of patent-related support. As patenting is a difficult and lengthy process many SMEs do not take advantage of the chance to safeguard their intellectual property rights. WTSH offers extensive support to the SMEs in the area with regards to

³ These measures are common targets of subsidy programs. Programs specialized in single industries or technologies may have other target measures.

⁴ The Wirtschaftsförderung und Technologietransfer Schleswig-Holstein GmbH (short: WTSH) is located in Kiel, Schleswig-Holstein, Germany. It is the general subsidy awarding agency in the federal state of Schleswig-Holstein. Please refer to <http://www.wtsh.de> for further information.

patenting. Companies can take part in information workshops, receive personal assistance in developing an IP strategy, have patent databases researched, and make use of support filing a new patent. Beware that a strategy for intellectual property protection may be not to patent the knowledge but to exploit it as fast as possible (time-to-market).

6.1.3 Corporate matchmaking

WTSH also offers a service of matching two or more companies that seek to find partners in developing new products. This matchmaking is not aimed at one company developing and producing the products and the other one selling them. WTSH engages in finding technological partners that, e.g., enable a company to develop a new technological approach by making use of the competencies of a partner.

6.1.4 Trade fairs

WTSH offers taking part in international trade fairs at a price considerably below market level. Additional to that companies receive further support on location, e.g. they are invited to networking activities. Besides offering a discount for trade fairs this instrument is especially designed to increase a firm's probability to engage in export business.

6.2 The Dependent Variables

In each of the three stages we observe a specific dependent variable that could be affected by the subsidies. In the third stage we estimate the effects of the two dependent variables of the earlier stages on the last stage.

Stage 1 – input additionality

Alongside the large body of research in the field of input additionality (e.g. David et al., 2000) we investigate the R&D budget that a company invests in new product development in a given year. The variable is operationalized as numeric in thousands of Euro. Companies were asked to state the budgets they actually used for new product development. As these figures are not reported in the annual Profit & Loss accounts the respective managers were required to estimate the figures.

Stage 2 – output additionality

Output additionality is commonly measured as direct results of R&D. This could be, e.g., licenses, patents, new product, or the like. As new patents filed are unambiguously measurable this is a favorable output measure to research on. Accordingly, in our study we use new patents filed in the respective year as the figure we build the model upon.

Stage 3 – outcome additionality

Following Lerner (1999) we focus on the outcome of the number of employees and the sales to assess the companies' growth. These outcome figures also have certain advantages: These figures will be reliable since they can be extracted from the companies' financial reports. With profits this is different. While this figure is part of the financial reports as well, companies can easily manipulate their profit and loss calculations for tax or other reasons, e.g. defer income to other periods. This would add noise to the data. Additionally, the companies under investigation do not have to report any of the figures we asked them for. The test of asking for the profits was vastly negative. Only very few companies provided this piece of information. Therefore the two outcome figures that we investigate are sales and employment. In the following data section we will discuss how these variables were coded.

In stages 1 and 2 that data on the number of employees also serves as a control variable for capturing possible influences that stem from firm size.

6.3 Dataset

The data in this study were collected by WTSH. WTSH strives for being in contact with every single SME in the region that invests in R&D. Thus, they cover the whole region in a way only a state-funded agency can operate.

Each company in our sample is regarded as an SME according to the subsidies rules of the European Union, i.e. fewer than 250 employees and annual sales below 50 million Euros or total assets below 43 million Euros.⁵ Since these companies have relaxed reporting regulations it is not possible to obtain appropriate data of companies of this size from databases. In an unprecedented effort WTSH collected this unique dataset by asking the companies' general managers to take part in this study and share their otherwise undisclosed financial information for this study.

The data comprises the years from 1996 until 2005. We have annual data on the 2 outcome figures of sales and number of employees for 33 companies. The sales data and the information on the R&D budget were deflated to 1996 prices, so that inflation effects are being controlled for. Inflation data was obtained from Destatis (German statistical office).

⁵ The term small and medium sized business is used differently throughout the literature in this field of research. We are using the official European definition. Many scholars in this field investigated reasonably larger companies – albeit, they are called SMEs as well. As the size of the company was often found to be an influence factor on the probability of receiving subsidies this is different in our sample as there are strictly no larger companies involved.

While the data on the dependent variables was provided by the companies themselves the data on the subsidy instruments were extracted from the customer database of WTSH. While the instruments of Trade fairs, Corporate matchmaking, and Patent consultancy were coded as a dummy variable (1 if subsidy awarded, 0 otherwise), R&D grants were coded in Euros and deflated to 1996 prices as well.

Since we obtained annual data covering a time span of 10 years we set up a panel dataset. Not all companies in our sample existed throughout the entire period, so our panel is unbalanced. The information on the subsidies received was assigned to the first year the subsidy was granted to allow for an accurate assessment of the long-term effects of the instruments.

The average annual sales figure of the companies in our dataset during the 10 year period is 5.08 million Euros. This sales volume was generated by an average number of employees of 37.4 per company. None of the companies in the study belongs to the services sector. The subsidies were granted for the development and promotion of products. Table 3 shows the descriptive statistics of the dataset.

Table 3: Descriptive statistics and correlations

	Dependent variables				Subsidy instruments			
	R&D budget	patents	sales	Employees	Patent consultancy	Corporate matchmaking	Trade fairs	R&D grants
Mean	245.118	4.030	5,081.595	37.415	.181	.242	.140	37.022
Std. Dev.	326.893	12.686	6,769.454	46.621	.386	.428	.369	123.283
Correlations								
	R&D budget	patents	sales	Employees	Patent consultancy	Corporate matchmaking	Trade fairs	R&D grants
R&D budget	1.000							
Patents	.218	1.000						
Sales	.299	.670	1.000					
Employees	.488	.746	.849	1.000				
Patent consultancy	.265	-.055	.148	.048	1.000			
Corporate matchmaking	.390	.260	.052	.203	.143	1.000		
Trade fairs	.119	-.028	-.046	-.043	.212	.237	1.000	
R&D grants	.238	.036	.107	.157	.178	.051	.101	1.000

7 Methodology

Building on previous research we constructed a framework that allows for a more precise and richer analysis. Testing for differences between two points in time limit the results to the specific time span of the respective study. The comparison of, e.g., sales figures at the time the subsidy was granted and a certain number of years later, does not allow for understanding whether this was the maximum of the effect. The annual observations of our panel dataset allow for a different, more information rich analysis. Specifically, employing the stock model approach we can test whether the effects of the subsidies are enduring or if there is a decay after the subsidy might have had an effect right after it was awarded. Following we describe the methodological approaches we employed in our study.

Panel Regression

First of all as we observe the companies repeatedly on an annual basis the dataset is structured in the form of a panel. Either Random Effects or Fixed Effects panel regressions can be employed to compute the effects inherent in the data. We carried out the Hausman specification test in order to decide for the method. The Hausman specification test indicated using the Random Effects panel regression ($\text{Prob} > \text{Chi}^2 = 0.0000$).

Grid Search

The second hypothesis states an enduring and constant effect of the subsidies. This means that the effects of the subsidies are not only observed in the period when they are granted but in the subsequent periods as well. In order to capture whether the effects are actually enduring and constant, diminish, or only last for the period when they are granted we employ the carry-over concept. Specifically we make use of the stock model by Nerlove and Arrow (1962).

Equation (1) reflects the Random Effects model. *model* depicts whether it is the equation for input, output or outcome additionality (either sales or employees), *i* depicts the subsidy instrument with *t* indicating the period. Instead of the common independent variables of the subsidy instruments the equation contains stock variables $s_t^{i,model}$. On the one hand the stock variables contain the information of the current period *t* but – on the other hand – they also contain the information on how much of the effect of previous periods has been carried over.

$$y_t^{model} = \alpha^{model} + \beta^{i,model} s_t^{i,model} + \varepsilon_t^{model} \quad (1)$$

Equation (2) depicts the stock model that is built by introducing the carry-over coefficient. The carry-over coefficient $d^{i,model}$ for every subsidy instrument *i* carries the information

which proportion of the effect of the previous periods is carried over. i denotes the respective subsidy instrument while t denotes the successive year of the subsidy starting at 0 in the first year. In case the carry-over coefficient $d^{i,model}$ is 0 no stock of the previous periods is build and the stock variable $s_t^{i,model}$ equals the original independent variable x_t^{model} . In case $d^{i,model}$ is 1 the whole value of the previous periods is added to the current stage. For any value between 0 and 1 the carry-over effect will lead to adding fractions of the values of the previous stages. The equation is as follows:

$$s_t^{i,model} = x_t^{model} + d^{i,model} s_{t-1}^{i,model} + \dots + d^{i,model} s_{t-n}^{i,model}, \quad (2)$$

where $s_t^{i,model}$ is the stock of instrument i in period t with n being the maximum amount of periods taken into account from previous years.

The empirical coefficients are derived in an iterative process known as Grid Search (Greene 2003, p. 566). We work with idiosyncratic carryovers per subsidy instrument and additionality measure. The boundaries of the variation of the coefficients are 0 (no carry-over of the effect at all with the effects taking place in the respective period only) and 1 (enduring and constant effect). In every iteration the model is estimated anew. Finally, the model with the best fit in terms of R^2 is chosen. This process determines the carry-over coefficients for the subsidies and the coefficients of the subsidies models jointly.

Control Function Approach

Our primary aim is to estimate the effects of the subsidies on growth in sales and employment. It is straightforward to include the subsidies as independent variables. In addition, we assume that the results of the two preceding stages of additionality will have influence as well. Thus, the additionality variables are endogenous. In order to control for endogeneity, we make use of the Control Function Approach (Petrin and Train, 2009). The Control Function Approach demands that the residuals of the regression explaining the endogenous variable are inserted in addition to the endogenous variable into the equation under investigation.

8 Results

The 3SEM framework of the additionalities results in a multi-step presentation. First we will focus on the degree that the subsidies affect input and output additionality. Afterwards we will show the estimates of the effects on sales and the number of employees.

The influence of the subsidies on the R&D budget that is being invested by the companies is being estimated. The results are presented in table 4.

Table 4: Estimates of stage 1 and 2 (input and out additionality)

Variable	Stage 1 R&D budget		Stage 2 Patents	
	Beta (Standard Error)	z-value (p-value)	Beta (Standard Error)	z-value (p-value)
R&D grants [in 1.000 €]	0.183 (0.074)	2.48 (0.013)	- 0.011 (0.004)	- 2.82 (0.005)
Patent consultancy [dummy 0/1]	123.496 (20.033)	6.16 (0.000)	- 3.932 (1.518)	- 2.59 (0.010)
Corporate matchmaking [dummy 0/1]	24.931 (10.803)	2.31 (0.021)	6.746 (1.512)	4.46 (0.000)
Trade fairs [dummy 0/1]	-47.819 (23.483)	- 2.04 (0.042)	- 1.444 (1.606)	- 0.90 (0.368)
Number of employees [nominal value]	3.960 (0.617)	6.42 (0.000)	0.148 (0.030)	4.99 (0.000)
R&D budget	-	-	- 0.003 (0.003)	- 0.97 (0.331)
Residuals of the Control Function Approach	-	-	-0.012 (0.007)	-1.74 0.082
constant	-4.494 (53.151)	-0.08 (0.933)	- 1.372 (1.742)	- 0.79 (0.431)
R ² overall	0.39		0.61	
R ² within	0.54		0.33	
R ² between	0.38		0.59	
Wald Chi ² (Prob > Chi ²)	199.43 (0.000)		113.13 (0.000)	

The model itself is significant (Wald = 190.43, $P > \text{Chi}^2 = 0.0000$) and it shows adequate quality with an overall R^2 of 0.39 and R^2 within and R^2 between in similar ranges. All coefficients of the model have significant estimates. While the effect of the subsidy of Trade fairs is negative the other variables show positive estimates. The variable Number of employees which was introduced to control for size of the companies is significant and positive indicating that the budget that is provided for R&D projects is positively correlated with the size of the company itself.

The second model shows a different picture (table 4). The aim of this model is to capture the influence of the subsidies on the number of patents that the companies file. In order to increase the explanatory power the R&D budget of the companies is introduced into this equation. As this variable is the dependent variable of the preceding stage we need to assume that

the error terms are not independent of each other. The expected endogeneity is then controlled for by adding the residuals of the first stage to this second stage equation (Petrin and Train, 2009).

The model itself is significant (Wald = 113.13, $P > \chi^2 = 0.0000$). R^2 of 0.61 is higher than in the first stage. Three of the four subsidy coefficients have significant estimates. While Trade fairs do not seem to affect the number of patents filed, R&D grants, Patent consultancy, and Corporate matchmaking are significant. However, the negative signs of R&D grants and Patent consultancy are not in line with expectations. Again the control variable Number of employees is positive and significant indicating that the number of patents filed is correlated with the size of the company as well. The residuals of the first stage are also significant. This implies that the R&D budget is endogenous while the residuals correct for this endogeneity so that the coefficient of R&D represents the corrected influence. The dependent variable of stage 1 itself, R&D budget, has no significant influence.

The third stage is the one we focus on. The results of both equations are presented in table 5. There are two models capturing the effects on the two outcome variables under investigation. On the one hand there is the model of the number of employees and on the other hand we have the model of the sales figures. For both models we also report the carry-over coefficients as described in the methodology section. The aim is to estimate the long-term effects of the subsidies.

The employees model of stage 3 has high explanatory power with an R^2 of 0.77 (Wald = 579.23, $P > \chi^2 = 0.000$). The model was enriched by the dependent variables of the preceding stages. Both variables – R&D budget and patents filed – carry a significant coefficient. So do the variables of R&D grants and Corporate matchmaking. Patent consultancy as well as Trade fairs are insignificant. Both carry-over coefficients of R&D grants and Corporate matchmaking are 1.00, indicating an enduring effect that, once it was installed, carries on to the following periods without decay. While R&D grants shows the expected positive sign Corporate matchmaking has a negative effect in growth on the number of employees. The residuals that were introduced according to the Control Function Approach are positive and significant. Again, this shows that the two equations are endogenous and that controlling for this endogeneity is necessary.

Table 5: Estimates of the third stage – employees and sales model (outcome additionality)

	Stage 3: employees			Stage 3: sales		
Variable	Carry-over coefficient d	Beta (Standard Error)	z-value (p-value)	Carry- over coeffi- cient d	Beta (Standard Error)	z-value (p-value)
R&D grants [in 1.000 €]	1.00	0.027 (0.009)	2.95 (0.003)	1.00	- 1.291 (1.357)	- 0.95 (0.342)
Patent consultancy [dummy 0/1]	0.76	1.406 (3.026)	0.46 (0.642)	0.94	1,459.005 (319.301)	4.57 (0.000)
Corporate matchmak- ing [dummy 0/1]	1.00	-27.969 (5.531)	- 5.06 (0.000)	0.79	- 696.082 (396.611)	- 2.42 (0.015)
Trade fairs [dummy 0/1]	0.39	- 0.233 (4.375)	- 0.05 (0.957)	0.75	- 653.855 (396.611)	- 1.65 (0.099)
R&D budget [nominal value]		0.048 (0.007)	6.43 (0.000)		5.451 (1.140)	4.78 (0.000)
Patents [nominal value]		3.476 (0.227)	15.30 (0.000)		96.039 (25.753)	3.73 (0.000)
Residuals of the Con- trol Function Ap- proach		- 3.280 (0.431)	- 7.61 0.000		141.917 (129.742)	1.09 0.274
constant		16.466 (2.643)	6.23 (0.000)		3,799.028 (887.617)	4.28 (0.000)
R ² overall	0.77			0.34		
R ² within	0.22			0.40		
R ² between	0.95			0.34		
Wald Chi ² (Prob > Chi ²)	579.23 (0.000)			107.03 (0.000)		

Finally, the sales model of stage 3 shows adequate explanatory power as well. R^2 is 0.34 (Wald = 107.03, $P > \text{Chi}^2 = 0.000$). Again, two of the four subsidies carry significant coefficient estimates, namely Patent consultancy and Corporate matchmaking. While Patent consultancy shows the expected positive effect, Corporate matchmaking has a negative effect like in the employees' model of stage 3. The carry-over coefficient of Patent consultancy of 0.94 is close to one. This indicates a slowly diminishing effect over time. The carry-over coefficient of 0.79 for Corporate matchmaking indicates a faster diminishing process than Patent consultancy but, e.g., there still remain about 30% of the effect after 5 years. Like in the employees model both dependent variables of the preceding stages show significant and positive effects. Other than in the employees' model and the second stage model the residuals of the Control Function Approach are not significant. These two equations do not seem to be endogenous.

The hypotheses are partially supported. Table 6 presents the results regarding the hypotheses. Hypothesis 1a states a positive relationship between the subsidy and the outcome. In the employees model this is true for R&D grants while the findings of the remaining three subsidies are not in line with this hypothesis. Hypothesis 1b states that the effect shall be enduring. This means that the carry-over coefficient needs to be 1.00. With regards to the R&D grants of the employees' model this is the case. So, R&D grants support both hypotheses concerning the growth in employment.

Table 6: Overview of results for hypotheses

Overview of results for hypotheses					
		R&D grants	Patent consultancy	Corporate matchmaking	Trade fairs
employees	Hypothesis 1a Positive influence of the subsidies	yes	not significant	no, negative	not significant
	Hypothesis 1b Positive influence is enduring and constant	yes	-	-	-
sales	Hypothesis 1a Positive influence of the subsidies	not significant	yes	no, negative	not significant
	Hypothesis 1b Positive influence is enduring and constant	-	no, to some extent	-	-

In the sales model we find one variable supporting Hypothesis 1a of the positive effects on the outcome. This is the subsidy of Patent consultancy. Hypothesis 1b of endurance is not met perfectly but the high carry-over coefficient of 0.94 indicates a long-lasting effect of the subsidy. The three remaining subsidies are either insignificant or they even show a significant negative sign contradicting the first hypothesis.

All in all the results in table 6 show some support for the hypotheses. These results will be discussed in the following section.

9 Discussion

The finding of the positive influence of the R&D grants in stage 1 implies that these R&D grants do not result in a complete crowding-out. In fact, since the value is positive this means that the overall budget grows. A coefficient of 0.183 means that for a 1,000 € that a company is awarded the overall budget grows by 183 €. So, a substantial amount of the award replaces

the private funding by the company. What we observe is a partial crowding-out of the funds which is in line with the majority of the studies carried out in the field of input additionality.

The positive influence of Patent consultancy and Corporate matchmaking are plausible as both subsidies reduce the risk of an R&D project. This in return increases the expected returns and improves the favorability of the projects. The negative influence of Trade fairs seems counter-intuitive at first. But since taking part in a trade fair means investing cash-flow in this marketing instrument this results in a reduced free budget to be allocated. While we find a negative sign this does not automatically translate into a negative decision.

The second equation on output additionality captures the effects of the subsidies granted on the patents filed by the companies. Interestingly, the coefficient of Patent consultancy is negative which seems counter-intuitive. Patent consultancy of course comprises the consulting on how to file a patent for a new product. But a major task of Patent consultancy is working on an appropriate strategy on how to protect the intellectual property of a company. Especially for SMEs patenting technology can jeopardize the whole investment in R&D. In order to file a patent companies have to describe their technology in detail. This description is free to be investigated by any other company. So, first, other companies could just copy the patent. Though the technology is then protected by a patent it is within the responsibility of the patent holding company to defend its rights. This can be time-consuming and can cause large expenses. Second, other companies can learn how to solve a technological problem and build their own solution using this knowledge making sure that the technological gap to the patent is just big enough not to violate the existing rights. Thus, many SMEs refrain from patenting their intellectual property especially after they have learned about other strategies of protection of intellectual property. This often comprises a very high level of confidentiality and aggressive time-to-market.

The findings of a negative influence of R&D grants on the number of patents filed follow the same reasoning. When a company applies for an R&D grant it must explain in great detail how it is going to protect the intellectual property that is being created in the course of the R&D project. Because of this companies need to consider the threats explicitly which they do not have to do carrying out an R&D project by themselves. Going into detail the companies might learn about the threats associated for the first time. The positive influence of Corporate matchmaking on patents filed is interesting. Carrying out R&D projects in a joint venture with another company or even other companies increases economic power which in turn increases the probability of a successful defense of a patent violation. Developing new products with

another organization also means that confidentiality as a strategy might not work as it might not be possible to control the dissemination of information as is it needed.

The results of the third stage are the ones in our focus. Hypothesis H1a states that there is a positive effect of the subsidies on the growth of the outcome figures of the companies. The second hypothesis H1b states that this effect be enduring and constant which means that once the company has received this support the positive effect will not only occur in the year the subsidy was received but that this effect will be observed in the following years as well.

The results of the subsidy of R&D grants support the employment hypothesis H1a as well as hypothesis H1b. The positive effect of R&D grants carries over with a factor of $d = 1.00$. This means that the effect does not diminish over time. A new job that gets created because of the subsidy will be sustained. It is a different situation in the sales model of stage 3. The effect of the subsidy on sales is insignificant. This may be an indicator that companies mostly invest the subsidies in R&D staff as an investment in the sales team which should increase the sales capacity and should lead to an increase in sales which we do not observe. Since both dependent variables of the stages 1 and 2 - the R&D budget and the number of patents filed - have a significant and positive influence on the growth in employment as well as in sales these findings further support the results of the employment model while for the sales model this can be interpreted as a hint that there is a positive compound effect of the R&D grants received on sales. Since the carry-over coefficient d of the instruments are individually estimated for every equation this effect cannot just simply be computed by inserting the values of the preceding equations in the respective equations of stage 3.

Patent consultancy supports hypothesis H1a in the sales equation while it is insignificant in the employees' model. The carry-over coefficient d of 0.94 in the sales model is high and close to 1.00. While this finding does not support hypothesis H1b completely this is a partial acceptance of the hypothesis. Even after, e.g., 3 years 83.1% of the effect still remains. The high coefficient of 1,459,005 € of additional sales is in line with the results that Patent consultancy often has to offer for SMEs. While it might not be favorable to actually file a patent there are two common strategies that can be combined. One is confidentiality and the other one is aggressive time-to-market. The latter option aims at monetizing the intellectual property as fast as possible. In order to do so many companies may make use of distributions channels outside their own organization as growing the own sales team is time consuming and comes with an increased risk.

The direct effect of Corporate matchmaking on employment as well as sales is negative. Both coefficient estimators are significant and the values of the coefficient are relatively high implying that Corporate matchmaking will harm a company on its growth track. Hypothesis H1a is not being supported for both equations. Hypothesis H1b is supported with regards to the employment equation which - taking into account that the effect is negative - would be a warning signal for any company seeking support in Corporate matchmaking. With regards to employment the negative effect is enduring. Findings for H1b in the sales equation suggest a long-lasting albeit not an enduring effect with a carry-over coefficient of $d = 0.79$. This result partially supports hypothesis H1b. It says that after, e.g., 3 three years the negative effect of taking part in Corporate matchmaking still is at a level of 49.3%. Taking into account the effects of Corporate matchmaking on the preceding stages changes the conclusion on this subsidy. As Corporate matchmaking has significant and positive effects on both preceding stages the compound effect is positive as well. It is not only that the effects in the preceding stages are positive they are also considerably high in numerical terms. So, carefully compounded the effects of Corporate matchmaking indicate a slightly negative effect on employment and a slightly positive effect of sales.

The subsidy of Trade fairs is insignificant in both equations. Hence, the hypotheses are not supported with respect to this subsidy. While this seems counter-intuitive at first glance this result gets plausible when put into context with the findings of the two preceding stages with respect to Trade fairs. The effects of Trade fairs on R&D budget were negative. The investment in a trade fair does not only consume free funds, it also focuses the organization towards this event lowering the output in other parts of the company. Nevertheless, the compound effect of the negative influence on R&D budget in first stage implies a negative effect on both employment and sales. Anecdotal evidence from managers of SMEs in the region shed a light on this counter-intuitive finding. Most managers only expect positive returns from a specific trade fair after taking part a few times. The first two or three fairs will result in negative returns. Since WTSH focuses on supporting the first time of taking part in a specific trade fair the negative effects become plausible.

10 Implications

The implications are mainly driven by the findings on the different degrees of endurance of the subsidy instruments that we analyzed in this study. The results have implications on different levels. To start we take a closer look at what the results imply for research.

Research implications. As raised in the literature review of this paper the main body of research in the field of additionality focuses on input additionality. In this paper we apply a broader approach and investigate the three stages of input, output, and outcome additionality simultaneously. The findings clearly show that this broader approach is necessary in order to understand how the effects on input additionality actually proceed through the subsequent stages. The theoretical approach that input additionality will finally translate into company growth may fall short due to processes that are not factored in common theory.

The second implication is that of the long-term effects of subsidies. While input additionality focuses on a single decision made by the companies' management all other processes take time and the effects need to build up or the effects diminish. Here the resource based view falls short stating that the effects of newly added resources be enduring. The results of our study clearly show that this needs to be considered in more detail. While R&D grants have an enduring effect on the number of employees this does not show for the other subsidies. Research will need to investigate how subsidies that were once granted wear off and how this wear off can be slowed down in order to help policy makers improve the subsidy granting programs.

Finally, the findings of the negative effects of Trade fairs can be plausibly explained to some degree. Anyway, being able to explain the effect does not improve the result with regards to decision making. Talking to SMEs in the region we came to the conclusion that the decision to start using the marketing instrument of Trade fairs is something that will only pay off in the long run. Anecdotal evidence is that it takes a few repetitions of taking part in the Trade fairs before the contacts made on the fairs do actually turn into business as most business people conservatively want observe the progress a new player makes. WTSH especially supports the first time a company takes part in a trade fair. In order to investigate the effects of the Trade fairs on company growth one needs to design a study that is especially capable of capturing effects that may only occur 3, 4 or even more years later than the subsidy was granted.

Policy implications. The implications for policy makers and the management of the subsidy granting agencies are manifold. The positive effects of R&D grants and Patent consultancy are straightforward. The companies receiving this kind of support grow better than they would do without. This is in line with the aim of adding to welfare through subsidies. While the granting agencies could just carry on giving away the subsidies policy makers need to assess whether the outcome that follows the subsidies actually justifies the investment as there is not

only the subsidy itself that needs to be earned in terms of welfare but also process cost that are incurred just by granting subsidies.

With regards to the more complex results for the subsidies of Trade fairs and Corporate matchmaking this is not so straightforward. While the plain results of stage 3 suggest being very careful with awarding these subsidies further investigation of the effects seems reasonable. Trade fairs may pay off considerably later than the other subsidy instruments. While investing in Trade fairs may still be favorable the awarding agencies could increase the value of the subsidies by accelerating the process of repayment with regards to welfare. The agencies could provide a more comprehensive framework of marketing activities so that taking part in a trade fair is just one means in a set of options. Another option would result in giving away these subsidies more carefully. The agencies could check whether the applying companies are all set for the long run. If this is not the case agencies could simply turn down applications in order to save their own resources and also to protect the companies from engaging into activities they have trouble overseeing the consequences. This same change in mindset could be appropriate for Corporate matchmaking as well.

11 Limitations

As this study is an early one in the field of the research of outcome additionality we had to deal with a number of limitations. The differences in the results of the different instruments show that the results are not uniform across subsidy instruments. It is important to distinguish between the instruments in the market of subsidies and to understand the processes that are associated with the different instruments. So, in order to understand the whole field of subsidies further research is to be directed at additional subsidy instruments.

WTSH is the agency for one of the federal states in Germany. Though regulation in the EU provides some level of comparability across regions further research needs to collect data from other regions as well. Lerner (1999) found different effects across the zip code areas in the US. Further studies should investigate the influences the different regions and their unique patterns of the economy, capital resources, and education have.

Finally, matching methods are common in this field of research in order to cope with the (self)-selection bias that is to be expected in the awarding process. While the matching algorithms can provide some accuracy in case that there are matching observations we do not come to the conclusion that this is true for researching a set of broadly awarded, general subsidy instruments. There are numerous agencies in the field providing similar instruments to

the same companies. In order to arrive at reliable results in a matching process one would have to get the data of all agencies that provide the same sort of instruments. The publicly available database of subsidy instruments “Förderdatenbank” (www.foerderdatenbank.de) returns 117 results for companies seeking R&D grants in the federal state of Schleswig-Holstein.⁶ This is simply not a feasible number of programs to collect data from.

Self-selection bias

According to WTSH, the agency aims at contacting between 1.000 and 2.000 companies per year intensively. The agency actively approaches technology-oriented firms in its region. This usually leads to some sort of public support. Over a timeframe of 10 years which is what we cover in this study only a very small number of companies has not been supported by WTSH or other subsidy granting agencies. Due to the confounding effects that are to be expected by other subsidies and that cannot be controlled for it is merely not feasible to carry-out a reliable, non-biased matching approach which is widely used in subsidy research for which we would have had to form a sample of non-treated firms. Therefore we decided to use a panel-based approach which allows isolating the effects of every single subsidy that can be controlled for.

The advantage of the panel is that every company in the sample is treated with at least one of the subsidy instruments. Simultaneously, this company is not being treated with the other instruments. So, for these instruments we implicitly have a non-treated subsample. This allows assessing the difference between companies that were treated and those that were not treated. As described above it is not a realistic venture to try and construct a sample that was not treated by any instrument at all.

References

- Aerts, K. & Schmidt, T. (2008).** Two for the price of one? Additionality effects of R&D subsidies: A comparison between Flanders and Germany. *Research Policy*, 37, 806-822.
- Aghion, P. & Howitt, P. (1992).** A Model of Growth through Creative Destruction. *Econometrica*, 60 (2), 323-351.
- Arrow, K.J. (1962).** Economic welfare and the allocation of resources of invention. In: Nelson, R.R. (Ed.), *The Rate and Direction of Inventive Activity: Economic and Social Factors*. Princeton, 361-392.
- Barney, J. (1991).** Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17 (1), 99-120.

⁶ The result was retrieved on Jan 24, 2016.

- Bérubé, C. & Mohnen, P. (2009).** Are firms that receive R&D subsidies more innovative? *Canadian Journal of Economics*, 42 (1), 206-225.
- Blanes, J.V. & Busom, I. (2004).** Who participates in R&D subsidy programs? The case of Spanish manufacturing firms. *Research Policy*, 33, 1459-1476.
- Bönte, W. (2004).** Spillovers from publicly financed business R&D: some empirical evidence from Germany. *Research Policy*, 1635-1655.
- Branstetter, L. & Sakakibara, M. (1998).** Japanese Research Consortia: A Microeconomic Analysis of Industrial Policy. *Journal of Industrial Economics*, 46 (2), 207-233.
- Brockhoff, K. (1983).** The measurement of goal attainment of governmental R&D support. *Research Policy*, 12, 171-182.
- Caballero, R.J. & Jaffe, A.B. (1993).** How High are the Giants' Shoulders: An Empirical Assessment of Knowledge Spillovers and Creative Destruction in a Model of Economic Growth. In: Blanchard, O., Fischer, S. (Ed.), *NBER Macroeconomics Annual 1993*, Volume 8. MIT Press, 15-86.
- Clarysse, B., Wright, M. & Mustar, P. (2009).** Behavioural additionality of R&D subsidies: A learning perspective. *Research policy*, 38, 1517-1533.
- Clausen, T.H. (2009).** Do subsidies have positive impacts on R&D and innovation activities at the firm level? *Structural Change and Economic Dynamics*, 20, 239-253.
- Czarnitzki, D. & Licht, G. (2006).** Additionality of public R&D grants in a transition economy. *Economics of Transition*, 14 (1), 101-131.
- David, P.A., Hall, B.H. & Toole, A.A. (2000).** Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. *Research Policy*, 29, 497-529.
- Falk, R. (2007).** Measuring the effects of public support schemes on firms' innovation activities – Survey evidence from Austria. *Research Policy*, 36, 665-679.
- Feldman, M.P. & Kelley, M.R. (2006).** The ex ante assessment of knowledge spillovers: Government R&D policy, economic incentives and private firm behavior. *Research Policy*, 35, 1509-1521.
- Gelabert, L., Fosfuri, A. & Tribó, J.A. (2009).** Does the Effect of Public Support for R&D Depend on the Degree of Appropriability? *Journal of Industrial Economics*, 57 (4), 736-767.
- Georghiou, L. (2002).** Impact and additionality of innovation policy. Innovation policy and sustainable development: can innovation incentives make a difference. 57-65.
- González, X. & Pazó, C. (2008).** Do public subsidies stimulate private R&D spending? *Research Policy*, 37, 371-389.
- Görg, H. & Strobl, E. (2007).** The Effect of R&D Subsidies on Private R&D. *Economica*, 74, 215-234.
- Greene, W.H. (2003).** *Econometric Analysis*. 566.
- Griliches, Z. (1979).** Issues in assessing the contribution of research and development to productivity growth. *Bell Journal of Economics*, 10, 92-116.
- Griliches, Z. (1992).** The search for R&D spillovers. *Scandinavian Journal of Economics*, 94, 29-47.
- Griliches, Z. & Regev, H. (1995).** Firm productivity in Israeli industry 1979-1988. *Journal of Econometrics*, 65 (1), 175-203.
- Hujer, R. & Radic, D. (2005).** Evaluating the Impacts of Subsidies on Innovation Activities in Germany. *Scottish Journal of Political Economy*, 52 (4), 565-586.

- Jones, C.I. (2002).** Sources of U.S. Economic Growth in a World of Ideas. *American Economic Review*, 92 (1), 220-239.
- Klette, T.J. & Møen, J. (1999).** From Growth Theory to Technology Policy – Coordination Problems in Theory and Practice. *Nordic Journal of Political Economy*, 53-74.
- Klette, T.J., Møen, J. & Griliches, Z. (2000).** Do subsidies to commercial R&D reduce market failures? Microeconomic evaluation studies. *Research Policy*, 29, 471-495.
- Lerner, J. (1999).** The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program. *Journal of Business*, 72 (3), 285-318.
- Merito, M., Giannangeli, S. & Bonaccorsi, A. (2010).** Do incentives to industrial R&D enhance research productivity and firm growth? Evidence from the Italian case. *International Journal of Technology Management*, 49 (1), 25-48.
- Nelson, R.R. (1959).** The Simple Economics of Basic Scientific Research. *Journal of Political Economy*, 67 (3), 297-306.
- Nerlove, M. & Arrow, K.J. (1962).** Optimal Advertising Policy under Dynamic Conditions. *Economica*, 29, 129-142.
- Ortega-Argilés, R., Vivarelli, M. & Voigt, P. (2009).** R&D in SMEs: a paradox? *Small Business Economics*, 33 (3), 3-11.
- Özçelik, E. & Taymaz, E. (2008).** R&D support programs in developing countries: The Turkish experience. *Research Policy*, 37, 258-275.
- Piva, M. & Vivarelli, M. (2005).** Innovation and Employment: Evidence from Italian Microdata. *Journal of Economics*, 86 (1), 65-83.
- Petrin, A. & Train, K. (2009).** A Control Function Approach to Endogeneity in Consumer Choice Models. *Journal of Marketing Research*, 47 (1), 3-13.
- Scherer, F.M. & Harhoff, D. (2000).** Technology policy for a world of skew-distributed outcomes. *Research Policy*, 29, 559-566.
- Segerstrom, P.S. (1991).** Innovation, Imitation, and Economic Growth. *Journal of Political Economy*, 99 (4), 807-827.
- Wallsten, S.J. (2000).** The effects of government-industry R&D programs on private R&D: the case of the Small Business Innovation Research program. *RAND Journal of Economics*, 31 (1), 82-100.
- Wernerfelt, B. (1984).** A Resource-Based View of the Firm. *Strategic Management Journal*, 5, 171-180.
- Wolff, G.B. & Reinthaler, V. (2008).** The effectiveness of subsidies revisited: Accounting for wage and employment effects in business R&D. *Research Policy*, 37, 1403-1412.