Aalto University
School of Economics

Public R&D and Business Support in Finland
Objectives and Impact

Economics

Master's thesis

Jenni Laakso

2011

Department of Economics
Aalto University
School of Economics

AALTO UNIVERSITY SCHOOL OF ECONOMICS
Economics, Master's Thesis
Jenni Laakso

EXECUTIVE SUMMARY
03.02.2011

PUBLIC R&D AND BUSINESS SUPPORT IN FINLAND: OBJECTIVES AND IMPACT

OBJECTIVES

This research addresses the lack of comprehensive answers on the impact of public R&D and business support on company performance. The research has a two-fold research objective: 1) to gather up the scattered information concerning the objectives of public support instruments in Finland; 2) to empirically examine what can we say about the firm-level impact of public R&D and business support on company performance.

DATA AND METHODOLOGY

As the public business support allocation process is not random and the allocation decisions are rather based on the company characteristics, the support decisions done by public support organizations are found to be endogenous. To tackle this problem this study uses the instrumental variable approach in evaluating the impact of public business support on company performance.

The data includes the following firm-level measures: turnover growth, export growth and private R&D expenditure growth. Based on the data, the turnover growth figures for the years 2004-2008 can be calculated for 261 703 companies of the sample. The export growth figures are calculated only for the companies that have reported a positive export figure at least once during the years 2004-2008. Respectively, the private R&D expenditure growth figures are calculated only for the companies that have reported positive private R&D expenditure at least once during the years 2004-2008. As a result, the export growth figures for the years 2004-2008 can be calculated for 1 649 companies of the sample and the private R&D expenditure growth figures for 1 424 companies of the sample.

RESEARCH RESULTS

The results indicate that the turnover growth of publicly supported companies is faster than the turnover growth of unsupported companies, but that the impact of public business support on growth is small.

The estimated model measuring the impact of public business support on private R&D expenditure growth doesn't explain the fluctuations in growth rates very well. However, according to the statistically significant results Tekes fails to support the private R&D expenditure growth. Thereby, the results indicate that there is crowding out related to the public support allocated by Tekes.

Finnvera supports the private R&D expenditure growth of large companies and TEM the private R&D expenditure growth of all companies.

It is not possible to provide conclusive answers about the impact of public business support on export growth. According to the results, the support allocated by TEM has a positive impact on export growth and the support allocated by MMM has a positive impact on SMEs' export growth.

Key words: public subsidies, R&D subsidies, Finland.

Table of Contents

List of Tables

Table of Figures

1. Introduction

1.1. Background for the research and research gap

Finland has succeeded well in the international comparisons of education, research and technology, being one of the leading countries in the world in terms of innovation. The latest decades have been characterized by a rapid development of new technology, driven by advances in information technology.

In 2006 the innovation rates for Finnish companies were 3rd highest among the EU countries, when 51 per cent of the Finnish companies were innovation active (Government of Ireland, 2010: Community Innovation Survey 2006-2008). Two years later, in 2008, Finland ranked 3rd among the OECD countries in the total R&D expenditure share of GDP, and among the EU countries Finland's total R&D expenditure share of GDP has been long time the second highest after Sweden. In the beginning of this millennium the indicators such as the number of researchers in total labor force, the number of scientific publications per capita and the number of patents per capita have also put Finland in the first or second place among the EU countries (Georghiu *et al.*, 2003).

The proposal for Finnish innovation strategy (Aho *et al.*, 2008) argued that Finland's success in the past has largely been based on its high-quality educational system, networked institutions, and long-term investments in research and development (R&D) both by the private companies and the Finnish public sector. Like Aho *et al.* (2008) noted Finland's future challenges of growth and competitiveness cannot be tackled only by means of sector-based, technology-oriented innovation strategy. In order to compete in the innovation-driven world economy and obtain the front position in science and technology Finland should create more appropriate environment for innovation creation and company growth.

One of the critical signs concerning the prevailing situation in the Finnish innovation and business support system occurred in 2009 when the evaluation of the Finnish innovation system was published. The evaluation stated that the current innovation support system is complex and disintegrated.

This thesis participates in the analysis of Finnish innovation and business support system by introducing the research results concerning the objectives and impact of public R&D and business support instruments in Finland. The research is of importance because there is a lack of evidence concerning the impact of public support instruments, despite the fact that government innovation and business support programs are common across the industrialized economies and that there has already been extensive interest in the area.

Until now, the analysis has been made mainly regarding to the impact of technology support instruments allocated by the Finnish Funding Agency for Technology and Innovation (Tekes) (see Tanayama, 2007; Ali-Yrkkö, 2008, and Einiö, 2010). This thesis takes wider perspective. Besides the support allocated by Tekes, we will focus on the public support finance allocated by Finnvera, the Ministry of Employment and the Economy, and the Ministry of Agriculture and Forestry.

Furthermore, a majority of the econometric evaluation studies have focused primarily on the issue of whether the public R&D support complement or crowd out the private R&D investments. However, in this research we focus not only on the private R&D expenditure growth but also on the impact of public business support on turnover growth and export growth of Finnish companies.

1.2. Research question and objectives

The first objective of this thesis is to build a solid base for understanding the motives and objectives of public R&D and business support instruments towards the Finnish companies and the economy at large. The second objective is to empirically examine the firm-level impact of public business support in Finland.

In focus at this thesis is the public business support that is allocated by the Ministry of Employment and the Economy (TEM), the Ministry of Agriculture and Forestry (MMM), the Finnish Funding Agency for Technology and Innovation (Tekes), and Finnvera.

The research question derived from these objectives can be stated as follows:

How can the objectives of public R&D and business support instruments be specified, and what can we say about the firm-level impact of public R&D and business support allocated by Tekes, Finnvera, MMM and TEM?

The first part of the question is more theoretical and the literature review part of this thesis will focus on it more specifically. In order to build a comprehensive understanding of the target-setting and impact-measurement of public business support we will present 1) motives for public support policies promoting the private R&D expenditure and company growth, 2) a review of Finnish business support organizations, their objectives and instruments, and 3) different methodologies for analyzing the impact of public support on company performance. The first part of this thesis is awaited to add value to the research topic in general by collecting up the scattered information related to the objectives of Finnish public support instruments.

The second part of the research question is answered in the empirical part of this thesis. The second part is awaited to add value to the quantitative analysis of Finnish innovation and business support system. The research question will be answered using the measures and methodologies presented

briefly in the sub-chapter 1.4. Concerning this second part of the research it is highly important to try to tackle the possible biases and the general endogeneity problem faced in the impact research.

1.3. Scope and limitations

Due to the data limitations the impact research is limited to the public R&D and business support, which is allocated by Tekes, Finnvera, TEM and MMM.

The study is also limited by the quality of data. Despite the good overall coverage some challenges are faced concerning the possible time scale of the research and the possible variables included in the regression model specifications.

The data include only limited number of observations related to the companies that applied for public support and were rejected, containing only information about the companies rejected by Tekes. Therefore, it is impossible to separate out and examine the applied but rejected companies and their performance development without public funding. Also the data related to the various project-specific factors (such as the riskiness of the project) is limited to Tekes financed projects. Consequently, it is impossible to add these characteristics in our regression model specifications. Furthermore, due to the data limitations it is possible to examine the impact of public business support only by support organization, instead of by single support instrument.

The availability of the data related to the actual public support amounts and the use of lagged variables in the estimation equations limit our examination period to the years 2004-2008.

1.4. Research design and methods

This research is conducted as a firm-level analysis on the impact of public R&D and business support. The approach is to analyze the firm-level impact of public support based on three performance indicators, which are most commonly mentioned in the objectives of public support instruments. The firm-level indicators include turnover growth, export growth and private R&D expenditure growth. The objective of enhance at least one of these performance indicators is incorporated in approximately 80 per cent of all Finnish public business support funding. Therefore these indicators create an excellent foundation for impact evaluation.

The methodology part of this thesis is divided into two parts. The first part is the descriptive analysis of the data. The second part includes the regression analyses that are seeking to identify the actual association between the public business support and the development of firm-level performance measures.

The study uses "Statistics on business subsidies" database of Statistics Finland, which includes the direct subsidies, loans, subordinated loans and guarantees allocated by Tekes, Finnvera, TEM, and MMM during the years 2000-2008. The support allocated by TEM consists of the total support amounts allocated by the Ministry of Employment and the Ministry of Trade and Industry before the year 2008.

This thesis follows the recent research methods (Wallsten, 2000; Ali-Yrkkö, 2008), which have been used in the impact studies focusing on the effectiveness of public business support. The most severe challenge in conducting a reliable and valid impact research is overcoming the endogeneity problem that arises from the somewhat non-random nature of public support allocation process. To tackle this problem we use panel data and random effects instrumental variable regression in evaluating the impact of public business support on company performance. The total annual support amounts of public support organizations are treated as instrument variables.

1.5. The most relevant findings

The results indicate that the turnover growth of publicly supported companies is faster than the turnover growth of unsupported companies, but that the impact of public business support on growth is small.

The estimated model measuring the impact of public business support on private R&D expenditure growth doesn't explain the fluctuations in growth rates very well. However, according to the statistically significant results Tekes fails to support the private R&D expenditure growth. Thereby, the results indicate that there is crowding out related to the public support allocated by Tekes.

Finnvera supports the private R&D expenditure growth of large companies and TEM the private R&D expenditure growth of all companies.

It is not possible to provide conclusive answers about the impact of public business support on export growth. According to the results, the support allocated by TEM has a positive impact on export growth and the support allocated by MMM has a positive impact on SMEs' export growth.

1.6. Key terms and definitions

Innovation

The latest (3rd) edition of the Oslo Manual (OECD, 2005) defines innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.

Innovation policy

Innovation policy is a policy that facilitates innovations. It consists of the public development measures that are targeted at the prerequisites and incentives of innovation activity and the functionality of the innovation environment (Aho *et al.*, 2008).

Research & Development (R&D)

Creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications (OECD, 2008)

Public business support

In this study the public business support refers to all support instruments included in the "Statistics on business subsidies" -database of Statistics Finland. Therefore, the public business support instruments contain all instruments from loans and guarantees to direct employment and R&D subsidies.

Public R&D support

Public R&D support refers to the public business support instruments, which are aimed to influence on private R&D activity. However, the difference between the public R&D support and more general business support has become thinner, so the division between them is not unambiguous.

1.7. Structure of the thesis

The second chapter of this thesis will present the motivation and justifications for public R&D and business support policies. Because of the importance and the vast general interest related to the private R&D activity, we will discuss about the public R&D support policies more detailed throughout the thesis. The second chapter concludes with the discussion concerning the need for this kind of public intervention.

The third chapter presents the public support organizations and instruments in Finland, which are in focus at this research. We will gather up the scattered information related to the objectives of public support instruments and discuss about the objectives that collect the largest share of public R&D and business support funding in Finland.

The fourth chapter focuses on the impact measurement of public R&D and business support. We will present results of some previous studies, which have focused on the performance indicators that we are interested in during this study. In addition, we will discuss about the common challenges in the impact literature and present the methodological choices that have been made concerning our empirical research.

The chapters five, six and seven will cover the empirical part of the research. First, we will present the testable hypotheses and after that describe the used data and methodology. The chapter number seven presents the actual analysis and the results of this research.

The chapter number eight presents the conclusions and gives some suggestions for further research.

2. Motivation for public R&D and business support

This chapter presents the most commonly used rationale for public R&D and business support. Because of the importance and the vast general interest related to the private R&D activity, we will focus our analysis more on the motivation for public R&D support policies.

First we are going to discuss about the market inefficiencies and then present some other motives for public support policies.

2.1. Market inefficiencies and public support

The interest in public business support policies arises from the inefficiencies in innovation activity in a competitive market environment, when markets fail to achieve the most efficient allocation of recourses. The economic theory has identified two main sources that are leading to underinvestment of private R&D and therefore are forming a condition for public innovation policies. These sources are financial market imperfections and externalities.

2.1.1. Financial market imperfections

At the markets for R&D and business finance the companies and financiers face the phenomena like *adverse selection* and *moral hazard*. These financial market inefficiencies refer to the unsuccessful selecting of supported projects or companies, and the changed behavior of supported companies caused by the insulation of business risk due to the received public support. Both of the inefficiencies are stemming from the asymmetric information between the companies and financiers.

Adverse selection tend to arise in situations where the companies have better information about the expected project returns than financiers, and moral hazard in situations where actions taken by the companies cannot be verified to third parties (Takalo, 2009).

According to De Meza and Webb (1987), adverse selection may lead to overlending to the business projects because the financiers cannot separate the good and bad projects from each other and consequently end up with financing both. Stiglitz and Weiss (1981) suggest that adverse selection cause also credit rationing and insufficient lending to entrepreneurs in general.

The case concerning moral hazard is somewhat different. Leland and Pyle (1977) have argued that the company's willingness to invest in its own project signal the quality of a particular project. With a requirement of including company's own capital share in the business project the outsider investor may believe the company's motivation and participate in the project more probably. This diminishes the moral hazard problem in general, but creates a funding gap if the company does not have enough liquid assets (Holmström and Tirole, 1997; Ali-Yrkkö, 2008). Takalo (2009) notes that the monitoring

activities carried on by public support organizations help to reduce the moral hazard problem, but may not necessarily be capable to eliminate it.

Sometimes companies are just unable to transfer the needed information to investors (Tanayama, 2007) and occasionally even reluctant to do that because there is a risk that the information will leak to the rivals (Kamien and Schwartz, 1978). This is the case especially with the R&D related activity. The nature of R&D activities is non-transparent and human capital intensive, so it is difficult and sometimes even impossible for outside financiers to estimate the creditworthiness and return expectation of R&D projects. Consequently, by preventing the external financiers from correctly estimating the risk and rate of return of a business project these two problems of asymmetric information prevent the efficient allocation of private R&D finance. This leads to a higher cost of external than internal capital and, hence, obstructions to companies to undertake economically viable R&D projects (Tanayama, 2007).

It has been argued that public business support might offer a justified solution to this inefficient allocation caused by asymmetric information. Niinimäki and Takalo (2007) suggest that the public business support organizations are in a better position to gather up information concerning the R&D projects because they are more centralized and used to screening activities. The public sector might also be capable of encourage private sector financiers to invest in some of the companies that would otherwise remain unfunded. Thus, the screening activities executed by the public sector organizations may have a certification role when signaling the situation of a particular company to the private financiers (Lerner 2002; Asplund and Kiander, 2003; Takalo and Tanayama, 2009; Toivanen, 2009; Einiö, 2010).

However, it is not apparent that public funding solves these kinds of problems. Takalo (2009) has duly noted that in the case where private sector has created organizations and instruments to overcome these problems, and if such mechanisms are unsuccessful, it is difficult to see why public funding agencies would be capable of perform better. Hyytinen *et al.* (2003) have furthermore argued that especially in Finland it is increasingly harder to justify the government intervention purely on the basis of the existence of market failures because of the improved overall availability of capital.

In conclusion, it can be stated that the economic theory and limited empirical evidence do not seem to offer unambiguous support for public R&D finance policies that are motivated by financial market imperfections.

2.1.2. Externalities

Externalities arise when a company investing in R&D does not or cannot take fully into account the effects of its R&D investment beyond the company profits. Already Nelson (1959) and Arrow (1962)

have stated that the companies might invest in less R&D than is socially optimal because of the positive externalities, which arise from incomplete appropriability of the results of R&D projects, and the consequent uncertainty about the success of projects. In the presence of externalities the inventor will not be capable of extract the sought benefits for his invention and therefore there will be no incentives to engage in innovative activities (Arrow, 1962). Especially in the case where the advantage of R&D project slips easily to the competitors the companies' willingness to invest decreases. This is because of the growing risks (Asplund and Kiander, 2003).

There are various forms of externalities: *knowledge spillovers*[1] result for example from the departure of personnel; original innovations may enable another actor to build on the original innovation to make further innovations ("*cumulative innovations*"); vendors cannot fully capture the value of their innovations to all users, for example by charging a higher price from the customers who value its innovation more ("*consumer surplus*"). In addition, there are *agglomeration externalities*[2], which refer to the benefits related to the creation of industrial clusters, and naturally also *negative externalities* that refer for example to the duplication of R&D costs or so large environmental damage that the aggregate social value of the new technology is negative.

The R&D activities generate large externalities because new knowledge and new technologies have the properties of a public good. This complicates the functioning of market mechanism creating a difference between the social and private value of innovations, making the private R&D spending lower than the social optimum and, as a result, creating a justification for a public innovation support policy aiming at improve the market outcome. Because these kind of positive externalities are important from the society's point of view, the government tries to motivate the companies to invest more in R&D than the private optimum would be. Thereby, with the public R&D support system the society compensates the possible externalities to the companies (Lach, 2002; Asplund and Kiander, 2003).

The main problem with the externality rationale is that it is a broad meaning and cannot easily provide straightforward policy advice. In theory, the amount of public support given to a R&D project should be tied to the amount of externalities generated by it. This sounds logical, but is not only difficult but usually impossible to execute in practice.

In conclusion, there is a wide agreement in the literature that the higher social return to private R&D activities justifies the government involvement with public R&D finance policies. There is also

[1] Research joint ventures are an example of active policy designed to alleviate the problems related to the knowledge spillovers. This kind of R&D knowledge spillovers and cumulative innovation play a crucial role in the modern growth theory, see e.g. Aghion and Howitt, 2009. There is also a huge economic literature that analyzes the presence of positive spillovers suggesting that their social rates of return are likely to be considerably higher than the private ones. See e.g. Tanayama (2007) and the references therein.

[2] See Sheehan and Wyckoff (2003) and Veugelers *et al.* (2009).

empirical evidence[3] supporting the observation that the social rate of return to R&D spending exceeds the private rate of returns, though evidence from Finland is quite limited (see Klette *et al.*, 2000, and Hyytinen *et al*., 2003, and the references therein). Still, only a few years ago Takalo, Tanayama and Toivanen (2008) argued that our understanding of the social returns to innovation is limited, and that there is not that much evidence on the joint distribution of private and social returns to R&D.

2.2. Economic growth and regional disparities

Besides the rationales related to the market inefficiencies there has been proposed other motives for public business support policies. These proposals are based on the phenomena such as the system failures, social and regional disparities, and the economic growth.

The system failure rationale emphasizes the national innovation systems and the potential for system failures to occur inside them (Technopolis, 2001; Asplund and Kiander, 2003; Woolthuis et al., 2005; Chaminade and Edquist, 2006). According to this viewpoint, one of the main tasks of public R&D and business support system is to correct the inefficiencies related to the innovation system as a whole. Usually in the case of system failure the market mechanism has not lead to the fulfillment of the objectives established by the government, and therefore the market mechanism has been complemented by public intervention (Chaminade and Edquist, 2006). Various researchers have paid attention to these systemic imperfections, which have led to the list of eight main system imperfections, e.g. infrastructural failures, transition failures, network failures, and institutional failures (for deeper discussion see e.g. Woolthuis *et al.*, 2005 and the references therein).

Especially in Finland a traditional rationale for public business support has been the regional policy (Asplund and Kiander, 2003). In every country there are regions, which degenerate with relation to the average economic development of the country, and the government aims to support the economic growth of these regions with the public investments and public R&D and business support system. The use of such policy instruments is aimed at influence on the regional allocation of investments and employment, in order to increase the competitiveness, self-sustaining growth, and new employment in low income regions (Pellegrini and Centra, 2006). In general the profitability of entrepreneurship or (R&D) investment projects is poor at the regions of low economic development. Therefore, with the public support it is possible to make private (R&D) projects and plans feasible from the entrepreneur's or company's point of view (Lach, 2002; Asplund and Kiander, 2003).

Furthermore, according to Einiö (2010) one argument has also been that the private innovative activities should be subsidized in order to increase the total R&D effort, which in turn will result in a

[3] Calculations concerning the relation of private R&D investments' profit channeling to the society and private sector fluctuate quite a bit. However, usually it has been argued that advantage to the society is at least double as much as is the advantage to the private sector. See e.g. Griliches, 1992, and Hall, 1996, Griffith, Redding and Van Reenen, 2003.

higher growth rate of the whole national economy. Interest in the innovation policy from the macroeconomic viewpoint arises indeed from this fundamental role of innovation in increasing social welfare. Since the contribution of Solow (1956, 1957) and Arrow (1962) it has been generally recognized that the innovation and technological change are the principal engines of economic growth. The unsatisfactory feature of their traditional framework, however, was the lack of technological change arising from the intentional investment decisions made by the individual agents.

The leading idea of the endogenous growth theory is that investment in knowledge and learning is affecting the long run growth rates. According to the new growth theory, the economic growth is generated by endogenous investments in R&D (Jones, 1995). Both theoretical and empirical work related to the endogenous growth theory went on with enormous professional interest during the 1990s. The modern endogenous product-variety model of Romer (developed over several papers, but mainly in Romer, 1990) emphasized the technological spillovers and innovation causing productivity growth by creating new varieties of goods. The Schumpeterian model due to Aghion and Howitt (1992 and 1998; Aghion, 2002) added the cumulative innovation on the top of the spillovers focusing on the quality improving innovations which destroy the rents generated by the previous innovations. Hence, they presented a model of growth through the creative destruction.

Among others, Romer (1990), Segerstöm *et al*. (1990), Grossman and Helpman, (1991) and Aghion and Howitt (1992) all find that the public R&D support encourages firms to devote more resource to R&D activities, and as a result increase the long-run rate of economic growth[4]. Nevertheless, it can be argued that endogenous growth theories do not give so undoubted justification for public R&D support than was previously thought. For example Jones (1995) has presented some doubt concerning the efficiency of R&D support raising the economic growth levels. Jones emphasized that at the same time as the OECD countries have experienced substantial increases in the R&D levels during the past fifty years there has been no apparent payoff in terms of faster economic growth. These findings appear to be at odds with the R&D based models of growth that predict that the economic growth rate should significantly increase.

Davidson and Segerström (1998) have argued that the general R&D support can even lower long-run growth rates despite the increasing growth in the short-run. They state that only vertical R&D support lead to faster economic growth. In countries where R&D is excessively horizontal in nature, R&D support generally harms rather than enhance the economic growth. Both Jones' (1995) as well as Davidson and Segerström's (1998) key assumption driving these critical conclusions are decreasing returns to scale, to which R&D activities are subject.

[4] In the presence of increasing returns to scale and horizontal R&D support.

Although it would be possible to show a positive relation between the higher R&D levels and higher economic growth it is not certain that public support policies will automatically increase private R&D effort. Even in the absence of government support, a substantial amount of private R&D is conducted in those innovative projects that are profitable without the government support. It is obviously important that the public support is a complement to the market and does not cause overlapping or competing: there must be an additionality associated with the public intervention. Risks in these cases are that the government support may induce only a little additional R&D – if any at all.

2.4. Conclusions

The literature concerning the economic growth and R&D activity derives mainly results that support the view that public R&D support is an effective policy tool in raising the long-run economic growth levels. Nonetheless, it can be argued that the growth theories give a somewhat weaker justification for the public R&D and business support than was previously thought. Accordingly, it is not certain that the public policies will increase private R&D activity – after all, the companies are essentially profit-seeking units which will undertake the amount of R&D that maximizes their profits. Like Einiö (2010) remarks, the main problem concerning the impacts of this kind of government support is that the privately profitable R&D will be undertaken irrespective of public support. The conclusion of countless studies is that the companies have invested in new technologies when they have seen an opportunity to earn profits (Grossman and Helpman, 1994).

Nonetheless, there is a common agreement in the literature that the market economy cannot provide adequate incentives for companies to invest in R&D.

The economic theory and limited empirical evidence do not offer unambiguous support for public R&D and business support policies that are motivated by the financial market imperfections. Especially in Finland it is increasingly harder to justify the government intervention purely on the basis of the existence of market failures. But the wedge between the social and private returns that arises due to the positive spillover effects of R&D activity can be accepted as a proper rationale for the government to provide funding to the companies. The goal of public policies is to channel funding to its most productive use, hence, where the gap between the social and private returns is widest. Like Martin and Scott (2000) highlight, the forces leading to the underinvestment in R&D differ from sector to sector across the economy, for example in the degree of appropriability of technology and in the extent to which commercially applicable knowledge is tacit. In order to be efficient, the public policy design should take these differences into account.

Furthermore, the potential failure of government innovation policies should be recognized as one of the fundamental challenges. The term *government failure* seeks to capture the fact that even if one

were able to design theoretically perfect policies, a real-world government may be unable to implement them for a variety of reasons[5].

For example, many Finnish opinion leaders (Talouselämä, 16.8.2010; HS 26.11.2010) have recently presented views against public business support finance, arguing that it is impossible for government to identify the new growth industries, and that it is less justified to support companies in the economy that is closely engaged with the global economy. They argued that picking the winners belongs to the markets, not to the public business support organizations.

One of the main targets of this thesis is to gather up the information concerning the objectives of public support instruments, and analyze what kind of rationale Finnish public support organizations may use in order to justify their public business support funding. It is worth of noticing that Finnish companies are very small on average, and that the main rationales for public R&D support, mainly spillovers and financial constraints, do not apply equally to SMEs and large companies, but instead much more viciously in SMEs.

The next chapter will present an overview to the Finnish innovation and business support system.

[5] For more information see Martin and Scott, 2000; Hyytinen et al., 2003; Chaminade and Edquist, 2006; Tanayama, 2009.

3. Innovation and business support system in Finland

Better understanding of knowledge expanded the scope of innovation policies in the 1990s together with concepts such as the national innovation system (Ormala, 1998), which refers to the totality of private and public actors producing and applying knowledge influencing on interactive innovation process[6]. At the beginning of this millennium understanding of innovation moved away from the linear approach, which assumed that efforts in R&D would lead directly to new innovation and commercialization, and subsequently to better economic performance (Technopolis, 2001). The distinctive feature of recent innovation research is its stress on innovation as an interconnected and mutual process, which is based on solid empirical evidence.

As Roos *et al.* (2005) emphasize the nation that fosters an infrastructure of linkages among the companies, universities and public sector may gain competitive advantage through quicker information diffusion and product deployment. The complex operational environments differ in important ways across national economies – even when there is considerable economic integration between the countries (Georghiou *et al.*, 2003; Chaminade and Edquist, 2006), and therefore may often determine the success of a country's innovation activity (Woolthuis *et al.*, 2005).

Finland was among the first countries to adopt the concept of national innovation system as a basis for its technology and innovation policy. It was selected as a starting point for national policy planning in the beginning of 1990s (Ormala, 1998) and it was an outcome of adopting policy organizations and models from various countries and adjusting them to the Finnish framework (Lemola, 2001). The structural change in the Finnish production, export and R&D was very strong in international comparison during the 1990s while only some newly industrialized countries have shown similar patterns of rapid structural transformation as Finland (Georghiou *et al.*, 2003).

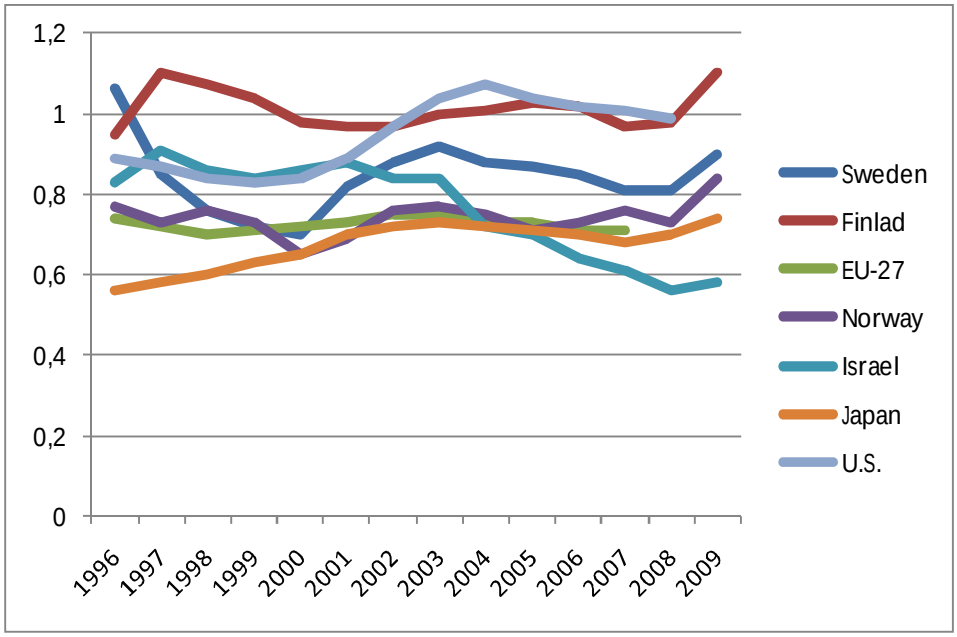
Aho *et al.* (2008) and Nikulainen and Tahvanainen (2009) have argued that because of the EU-level[7] efforts to push the union towards a more competitive and knowledge-based economy, also the policymakers in Finland started to seek new stresses between the science- and technology-based innovation policy and the demand-based innovation policy. Venetoklis (2000) notes that the research related to the business subsidies boosted in the beginning of this millennium due to the legal obligations stated in the EU directives. Anyhow, in a few decades Finland went from being one of the least R&D-intensive OECD countries to being the third most R&D-intensive OECD country today.

There has been some variation in the public R&D financing share of Finnish GDP, although during the last three years the trend has again been modestly upwards. As we can see from *Figure 1*, the level of

[6] See Technopolis (2001) for further analysis concerning the National Innovation Systems.
[7] The legal provisions of the EU create also the foundation of government support programs. See e.g. Article 107 of the Treaty on the Functioning of the European Union.

public financing share is rather high in Finland in international context. At present, the Finnish Government seeks 1,2 per cent public financing share of GDP, which in terms of money indicates almost 2,1 billion euro. At that point the public finance would cover 30 per cent of aggregate R&D expenditure in Finland, and the total R&D expenditure share[8] would be approximately 4 per cent of GDP.

Figure 1 Public R&D financing share of GDP in 1996-2009



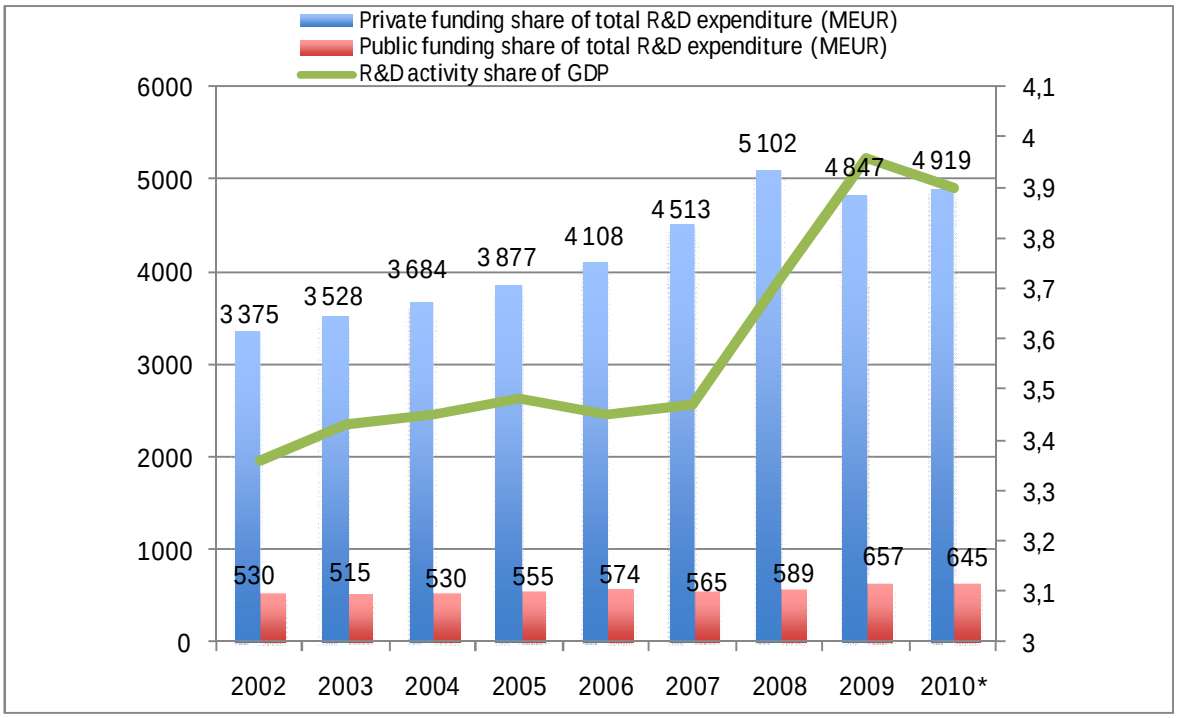
Source: Statistics Finland

While the public R&D financing share of GDP has remained quite constant during the last decade, the total R&D expenditure share of GDP has increased noticeably. In other words, the public R&D financing share of aggregate R&D expenditure has diminished while private funding has become more common way to finance R&D activities.

When examining the Finnish situation more closely, we can observe the trends clearly. The total R&D expenditure share of GDP has been growing significantly during the years 2007-2009, amounting almost to 6,9 billion euro in 2008 (see the green line in *Figure 2*). In 2002 the public R&D financing share was approximately 13,6 per cent of the total R&D financing and by the year 2009 it had decreased to 10,6 per cent of the total R&D funding in Finland (see the red columns in *Figure 2*). In 2009, first time in decades, the private R&D funding share declined and remained over 250 million euro lower level compared to the previous year (see the blue columns in *Figure 2*). On the contrary, in 2009 the public funding share increased almost in 660 million euro level.

[8] Besides the public and private financing shares the total R&D expenditure share of GDP includes also the R&D expenditure of the higher education sector.

Figure 2 R&D activity and funding in Finland



Source: Statistics Finland

* Estimated values

Because innovative activity is one of the key factors driving the growth of economy, several governments have developed policies to foster the domestic innovation and business activities. In numerous countries, there has also been an increasing political pressure to deepen the government intervention in the R&D and business support sector. In Finland, the wide-ranging discussion and growing concern of whether our country will succeed in terms of innovation have brought the public R&D and business support policies under more comprehensive evaluation.

Considering the notable role of Finnish public sector in R&D funding and the aggregate amount of public funds allocated to the private business sector by public business support instruments, the question of optimal support instrument design is crucial. Because market inefficiencies occur mainly in two different ways, by market failures and externalities, there should be instruments to tackle both of these problems. The large number of different policy instruments available to promote private innovation activity and private business in general doesn't make the challenge of optimal support design any easier.

By defining the roles of different public business support organizations, classifying the different instruments and support objectives most commonly used by these organizations, and examining the impact of support finance on company performance, this thesis seeks to create valuable information concerning the impact of Finnish public business support finance.

The sub-chapter 3.1. will present briefly the public business support objectives and instruments in general, while the sub-chapter 3.2. focuses on the support instruments allocated by four Finnish public support organizations. The sub-chapters 3.3. and 3.4. will present the detailed analysis concerning the support organizations' relative financing shares and the objectives for their support instruments. The last sub-chapter will also set down the first starting point for the empirical part of this study.

3.1. Business support objectives and instruments in general

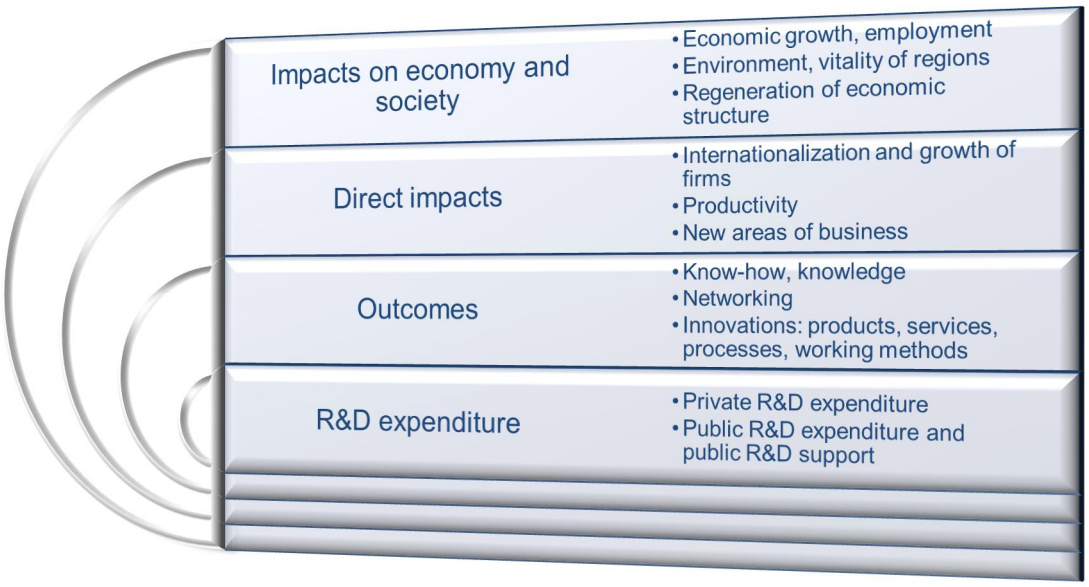
The typical ultimate objectives of public R&D and business support instruments are to promote the economic growth, productivity growth, or technological development, to increase employment or competitiveness, or to equalize regional differences related to these economic indicators. To achieve these objectives governments try to improve the long-term operational investment and development prerequisites and incentives for private R&D activity by allocating public business support finance. As Asplund and Kiander (2003) emphasize, the public support objectives, like increasing the amount of private R&D investments, are only an intermediate phase on the way to the final objective of fostering economic growth. Therefore, achieving the intermediate objective itself is seldom enough for the policymakers. For example, the increase in private R&D investments should lead to new products to be commercialized and succeeded in market, which in turn can lead to the growth of production, productivity and employment.

Different impacts of public business support in different levels of the society can be described like we present them in *Figure 3*. Firstly, the public business support instruments encourage companies to invest more or in a different manner in private R&D activity than they would do otherwise. The changed behavior of companies induces outcomes like new innovations or new knowledge. These outcomes may improve the company performance. More productive companies further support the ultimate objectives, like increasing the employment, prosperity or vitality of regions.

At the moment more often than not the objectives of public business support instruments are only economic ones. But like Chaminade and Edquist (2006) note, they may also be a non-economic kind such as cultural, social, environmental, or military. The Finnish support instrument palette includes currently a few instruments that have other than pure economic objectives. These instruments[9] focus on environmental objectives like environmental investments, energy saving and diminishing environmental hazards.

[9] The instruments include at least the energy support subsidy allocated by TEM, the launching aid in rural areas allocated by MMM and the environmental loan allocated by Finnvera.

Figure 3 Impact of private innovation activity



Source: the figure modified from Tekes (2008)

Usually the business support finance is distributed in two forms: either as a direct transfer of money (e.g. grants or subsidized loans) or as non-financial aid (e.g. advisory services). Using a broad classification, the main tools of innovation policy are intellectual property rights, subsidies and other direct public funding, tax incentives, prizes and contests, and public procurement and production including innovation services (Tanayama, 2007; Takalo, 2009). The Finnish innovation policy system is currently based on a subset of three main tools: intellectual property, subsidies, and public production. However, all major forms of innovation policy have been employed in Finland through the history[10].

The intellectual property attempts to solve the externality problem by legal means, allowing exclusive use of the protected knowledge and in that way increase the incentives for private R&D. The term intellectual property is used generically, covering patents and other industrial rights such as utility models and protection of typographies of semiconductor products, as well as copyrights and related rights such as database rights. (Takalo, 2009)

The public production, on the other hand, provides services typically to complement the private sector innovation, directly produce innovations themselves, or buy innovation from private contractors. Such public production of innovations and complementary services have been widely used thorough the economic history (see e.g. Scotchmer, 2004).

The R&D and business subsidies are typically given as direct grants or subsidized loans, whose economic effects are qualitatively similar (Takalo, 2009). Several countries have used this central

[10] Lemola (2001) describes the formation of Finnish innovation policy and Georghiou *et al*. (2003) provide details of the more recent innovation policy environment.

policy tool of subsidizing private business and innovative activity for decades in order to foster the development of new products and production processes. As Tanayama (2007) remarks, the public R&D subsidies constitute one of the largest forms of industrial subsidies in OECD countries at the moment, and the relative importance of private R&D activity as a purpose for industrial subsidies has increased. At the moment, direct subsidies constitute also a key ingredient of the Finnish innovation policy[11]. Because subsidies are the most important policy tool for the public R&D and business support and have a theoretical justification from the endogenous growth literature (Howitt, 1999; Segerström, 2000) we are going to analyze them here more specifically. However, it is noteworthy that same kind of problems relate to the impact-measurement of direct subsidies as relate to the measurement of other support instruments (Tanayama, 2007).

According to Martin and Scott (2000) the direct subsidies are the most effective form of public support for private innovation when the main mode of innovation is the development of complex systems, related with high costs, increased risk and limited appropriability. The essence of R&D subsidies is that they are tailored application by application, which is their greatest asset in comparison to R&D tax credits. Because one is able to target the public business support to certain types of companies, one is consequently able to increase their likelihood of applying a subsidy (Toivanen, 2009).

Another well-known benefit of R&D subsidies is that the government may use them to generate externalities. The Finnish government does this by requiring that large firms have to cooperate with SMEs in order to be eligible for certain government support funding.

Additionally, the public subsidy may act as a signal to private financiers if the government agency is good at finding out the potential and prosperous applicants.

There are also fundamental weaknesses related to the direct support instruments (see Asplund and Kiander, 2003; Takalo, 2009, Einiö, 2010). Firstly, subsidies are exposed to misuse by the recipients and public executors both because they are discretionary and monetary. The effectiveness of subsidies depends heavily on public executors' honesty and ability to pick up the right projects. A major concern is that projects with the best technical merits and the highest potential for commercial success are supported (Wallsten, 2000; Asplund and Kiander, 2003; Tanayama, 2009; Einiö, 2010), although these projects are most probably undertaken even in the absence of public business support.

Additionally, the government interventions may in general cause distortions to the private business sector if the public support is assigned more inefficiently to the companies compared to the situation

[11] Tanayama and Ylä-Anttila (2009) provide a review of the literature on subsidies to business sector R&D and gives some recommendations on the desirable properties of such a subsidy scheme.

in which the market-power leads the funding. Competition distortions may also occur if the public business support situates companies into unequal positions. (Asplund and Kiander, 2003)

Last but not least, all relevant R&D projects will never be subsidized because the subsidies are not applied for in the first place or because applications are with one thing or another rejected (Takalo, Tanayama and Toivanen 2008).

3.2. Public R&D and business support in Finland

The framework of public policy has many dimensions that affect whether and how companies can innovate (Grossman and Helpman, 1994; Ormala, 1998; Georghiou *et al.*, 2003). Georghiou *et al.* (2003) rationalize the *unique task* of Finnish public sector in national innovation system by arguing that it covers areas that cannot be covered through the private sector alone in a way that is optimal for the national economy.

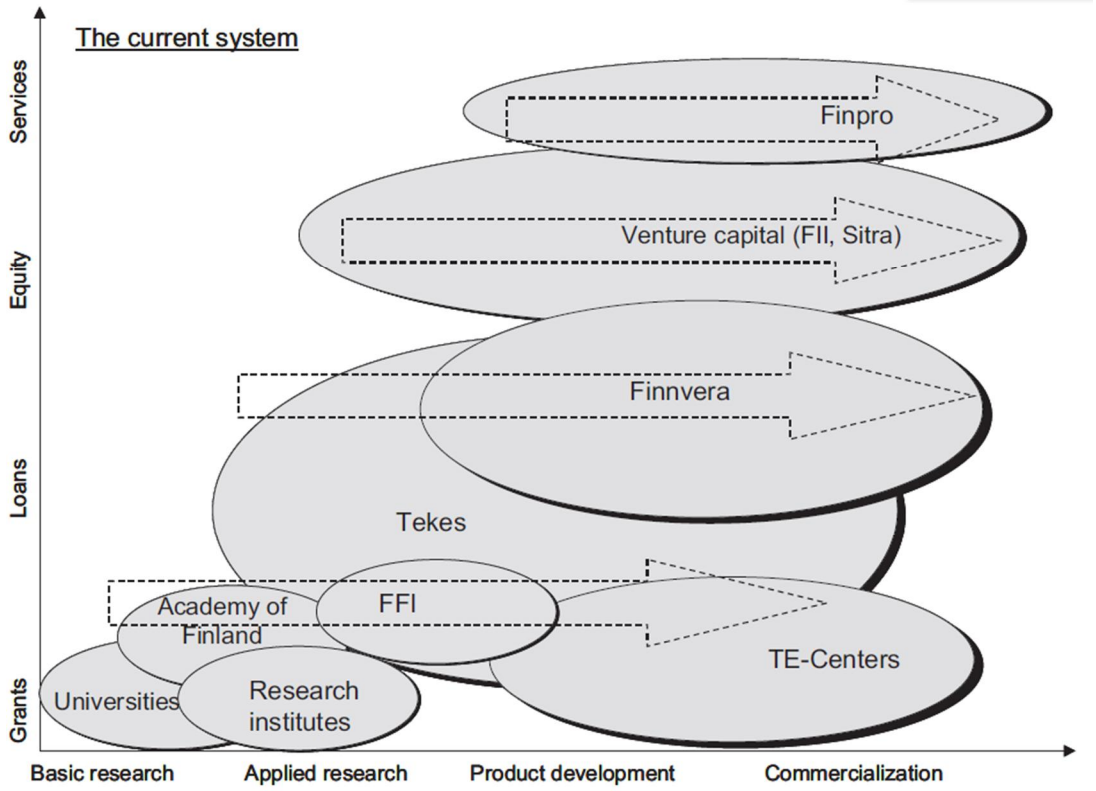
The support instruments allocated by the Ministry of Employment and the Economy (TEM), the Ministry of Agriculture and Forestry (MMM), the Finnish Funding Agency for Technology and Innovation (Tekes), and Finnvera are in focus at this research. Some of the support organizations have innovation at the center of their mission and others have more general tasks of promoting the private businesses, SMEs, internationalization or regional policy, while at the same time also serving the needs of innovative firms to some extent. The organizations differ also a great deal in the amount of resources they have in use to fulfill their tasks. While some organizations are asked to be self-sufficient in their financing activities, other relies on large budgets funded by the Finnish government.

In the evaluation of Finnish innovation support system Georghiou *et al.* (2003) attempted to capture the different roles of Finnish innovation and business support organizations in one figure. This figure (*Figure 4*) describes the roles of support organizations in two dimensions. On the x-axis the division is made by a linear representation of innovation starting from the basic research and leading to the commercialization. On the y-axis the division is made by the type of support instrument used. The distinction between the basic research, applied research, and product development is usually made according to how close the research is to commercial applications. According to Hall *et al.* (2010), the closer the research is to commercial applications, the larger public support is usually devoted to it.

Already based on this figure we can conclude that Tekes has the widest operational environment in terms of innovation and it allocates mainly direct grants or loans. Finnvera is focusing mainly on pure financing operations with loan and guarantee instruments, and it supports primarily product development and commercialization functions. The TE-Centers mentioned in the figure reflect the role

of current Centers for Economic Development, Transport and the Environment[12] (ELY-Centers) and TEM. Their location in the figure mirrors the role of ELY-Centers and TEM as a source of direct subsidies with product development and commercialization focus. More detailed analysis related to the organizations' roles will follow in the next sub-chapters.

Figure 4 Public R&D and business support organizations in Finland



Source: Georghiou *et al*. (2003)

The four support organizations that are in focus at this thesis have total of five different support instrument categories[13]. The support instrument palette has been gathered up in *Table 1*.

Table 1 Support instrument palette in focus at this research

	Direct subsidy	Subordinated loan	Loan	Guarantee	Launching aid
Tekes	4	1	1		
Finnvera			8	6	
TEM	5				1
MMM	2				1
Total	11	1	9	6	2

[12] The tasks of ELY-Centers comprise those of the former Employment and Economic Centers (TE-Centers), Road Districts, Regional Environmental Centers and State Provincial Offices. Finnish regional administration underwent a transformation in the beginning of 2010.

[13] The information is collected from the organizations' websites and annual reports, and is based on the situation in 2009. Additionally, one source of information has been the report concerning the Finnish innovation subsidies made by Net Effect Oy (2010).

The next four sub-chapters will present the detailed analysis of the support instrument objectives. After the review we will derive some conclusions related to the relative importance of support instruments. Based on the analysis we will also choose the performance indicators that will be in focus at the empirical part of this thesis.

3.2.1. Ministry of Employment and the Economy

The Ministry of Employment and the Economy (TEM) is responsible for the overall innovation and technology policy formulation in Finland and it also allocates public R&D and business support in co-ordination with the Centers for Economic Development, Transport and the Environment (ELY-Centers). Besides the public R&D and business support finance directed to SMEs, ELY-Centers provide business support services, consultation and advice. The public business support allocated by TEM includes funds from the national and the EU-level, of which the EU-level support is directed through the European Regional Development Fund (ERDF)[14] and the European Social Fund (ESF). For example, in 2009 TEM allocated 94,4 million euro of energy support, of which TEM covered 76,0 million euro, the ELY-Centers 18,4 million euro and the ERDF 1,3 million euro.

Because TEM was established in the beginning of 2008 by merging two ministries, the Ministry of Trade and Industry and the Ministry of Employment, there are some inconsistencies in the data from the years 2007 and 2008. The support amounts allocated by the former Ministry of Employment include the support allocated through the EU-wide fund ESF. On the other hand, the support amounts allocated by the former Ministry of Trade and Industry include the support allocated through the EU-wide fund ERDF but the support amounts don't include the support allocated through the ESF. Furthermore, the support amounts allocated by TEM during the year 2008 include the support allocated through the EU-wide funds. Consequently, before presenting the information concerning the individual support instruments allocated by TEM, we will briefly present the support mechanism and support objectives of the two EU-wide funds.

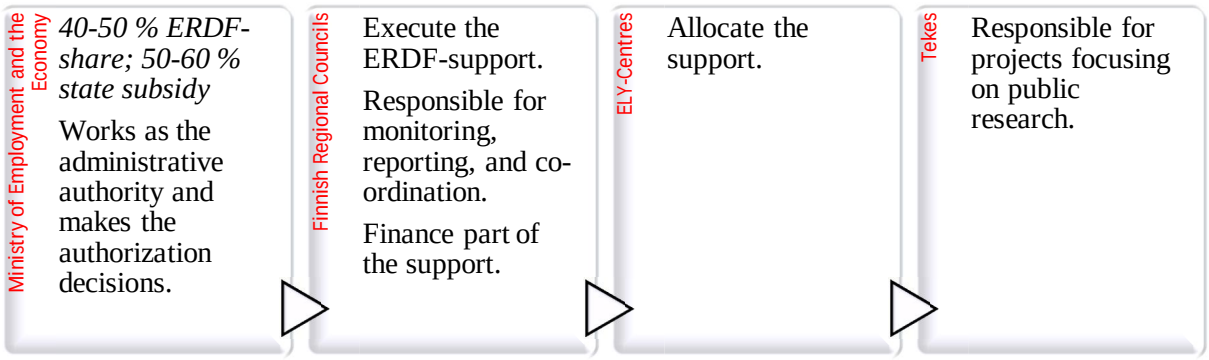
3.2.1.1. ERDF and ESF

The ERDF supports the structural development of regions. The support funds allocated through the ERDF seek the improvement of employment, development of regional competitiveness, and enhancement of regional vitality. The objectives consist of more specific intentions like to encourage the entrepreneurship in the region, create new innovations and networks, develop learning and innovation environments, and improve the accessibility of regions.

[14] See also Einiö (2010) concerning the impact of government support on private R&D based on the regional differences in the eligibility for the ERDF.

The division of labor between the ERDF, TEM and the ELY-Centers is shown in *Figure 5*. The support is allocated through four different lines. The support allocated through *Line 1* and *Line 2* has parallel objectives with the public R&D and business support in Finland. The objectives of *Line 1* are to support the creation of innovative, viable and growing companies, to foster the competitiveness of companies and to enhance the innovation activity of companies. The main support instrument is the investment subsidy directed to SMEs to create permanent jobs.

Figure **5** R&D and business support allocated through the ERDF



Source: Net Effect, 2010.

The objective of *Line 2* is to develop the competitiveness of the region by strengthening the regional innovation structures and applied research. *Line 2* funds the promotion of innovation activity and networking and the strengthening of regional competence structure.

The ESF, on the other hand, supports the creation of new employment opportunities as well as the social and regional cohesion within the country. In Finland the funds allocated through the ESF have four goals. The first target is to develop the working environments and to boost the entrepreneurship. The second objective is to support employment opportunities and the third objective to develop innovation activity and service systems that improve the labor market functioning. The fourth objective is to support the administrative actions between the government and regions inside the ESR-program. The division of labor between the ESF, TEM and the ELY-Centers is shown in *Figure 6*.

Figure **6** R&D and business support allocated through the ESF

3.2.1.2. Support instruments and objectives

The support allocated by TEM and the ELY-Centers is primarily focused on the promotion and support of regional and rural development. The main reason for this kind of target-setting is the existing situation in which the Finnish regions are enjoying different amounts of economic development. This shows up not only in the amount of companies situated in the region but naturally also in the amount of business activity and general wellbeing that is generated.

Some of the Finnish regions come off really well in their R&D activities compared to other regions with the same economic activity, but some regions are obvious underachievers. According to Georghiou *et al.* (2003), the regional disparities have grown in Finland during the last decade and the knowledge-intensive activities have concentrated in few areas – not surprisingly mainly in Southern Finland. At the moment, 41 per cent of all R&D activities in Finland are carried out in the Helsinki region, and as much as 82,5 per cent only in the four largest regions (Uusimaa, Pirkanmaa, Pohjois-Pohjanmaa and Varsinais-Suomi).

Piekkola (2006) argues that the agglomeration of human capital explains the top ranking of all the big cities. He reports that the Greater Helsinki region is 12-13,5 per cent more competitive than other areas[15]. Yet Piekkola highlights that in general the public R&D expenditure is distributed over the country more equally than the private R&D expenditure. Of all public R&D expenditure over 80 per cent takes place in Uusimaa, Varsinais-Suomi, Pohjois-Pohjanmaa (Oulu) or Kanta-Häme, although 50 per cent of public support still takes place in the Greater Helsinki region.

The basic challenge of regional support policies is that the knowledge-based activities always tend to agglomerate heavily in certain regions due to the potential agglomeration externalities. Georghiou *et al.* (2003) also remark that it is evident that in a small country there can be only a few regional centers that are able to link directly to the global economy. However, they argue that through networking and specialization it is possible for any region to develop successfully within the country.

Supporting the creation and growth of local businesses is one of the potential ways by which the government can assist the regional economies. The idea behind this kind of support objective is that by supporting entrepreneurs and investors, and thus enhancing the productive capacity of region, it may be possible to improve the economic performance of the region.

Table 2 sums up TEM's total annual support amounts and the average support amounts of every support instrument category. *Table 3* presents the specific objectives of support instruments allocated by TEM and the allocated support amounts in 2009. Based on the presented information we can define

[15] Piekkola (2006) uses competitiveness indexes, which include human capital indices constructed from linked employer-employee data and regional information on innovativeness, agglomeration and accessibility. In the competitiveness indices the human capital and innovativeness play a major role.

more specific objectives for the public business support allocated by TEM. This information is gathered up in *Table 4* together with the possible rationale for TEM's support.

Table 2 Support finance allocation of TEM

Annual support allocated by TEM (MEUR)		Average support amounts allocated by TEM (1000 EUR)		
			TYM employment aid	KTM direct subsidies
2004	172,66	Mean	4.91	54.7
2005	194,39	St. Dev.	8.23	151.58
2006	203,93	Min (10 %)	0.02	0.17
2007	236,15	Max (90 %)	459.11	4800
2008	241,86	Observations	70814	21939

Table 3 Support instruments allocated by TEM

SUPPORT INSTRUMENT	OBJECTIVE	MEUR / 2009
Energy support	To support the voluntary investments directed to the renewable energy usage, energy saving, intensified power production, and reduction of environmental hazards caused by power production and usage.	94,4
Launching aid	To promote the creation of new entrepreneurship and new employment opportunities. (Not included in the empirical analysis of this thesis)	-
Preparation financing	To support SMEs' challenging R&D projects, new innovative businesses, and internationalization of a firm by financing the preparation phases of these projects.	8,7
Development aid	To support the creation of permanent jobs in SMEs.	88,3
Operational environment development aid	To improve the conditions for the development of SMEs' operational environment.	7,0
Employment subsidy	To support the creation of new employment opportunities. (Allocated only up to the end of the year 2007 by the Ministry of Employment)	-

Table 4 Support objectives of TEM

Objectives of the EU-wide support programs	TEM: Support objectives	Rationale for the public support allocated by TEM
To support the creation of firms, foster the competitiveness of firms and enhance the innovation activity of firms. To develop competitiveness of the regions by strengthening the regional innovation structures and applied research. Main support instrument is targeted at SMEs.	To support the regional development, including the local entrepreneurship, creation of new employment opportunities, and development of operational environment. To support challenging R&D projects and internationalization. A half of the annual support is allocated to SMEs and entrepreneurs. A half of the annual support is allocated as energy support with environmental objectives and no restrictions related to the company size.	The degenerating regions need public support in order to create agglomeration externalities and favorable operational environment for private businesses. Due to the market failures especially the young companies need public R&D and business support.

3.2.2. Administrative branch of the Ministry of Agriculture and Forestry

The public R&D and business support of the administrative branch of the Ministry of Agriculture and Forestry (MMM) is based on the Rural Development Program for Mainland Finland, which provides tools that can be used by all kinds of stakeholders to promote the rural development.

The reasoning behind the support objectives of MMM is similar to the objectives of TEM. The rural areas are enjoying different amount of economic development. Consequently, Finland, as one of the most rural areas in the Europe, has policy instruments that support the economic performance of the rural regions that are lagging behind in terms of competitiveness and quality of life.

The business support funds allocated through the program during the current program period (2007-2013) will be in total of 7,8 billion euro, of which 2,1 billion euro comes from the EU-level, 1,1 billion euro is private funding, and 4,6 billion euro a state subsidy. The EU-level support is directed through the European Agricultural Fund for Rural Development (EAFRD) –program. The division of labor between the EAFRD-program, MMM, and the ELY-Centers is presented in *Figure 7*.

Figure 7 R&D and business support allocated through EAFRD -program

The general objectives of the Rural Development Program for Mainland Finland are to maintain the rural area, improve the condition of environment, and secure the sustainable usage of renewable natural resources. The practical measures are grouped under the program's four main themes: 1) to improve the competitiveness of the agricultural and forestry sector; 2) to improve the quality of environment and countryside; 3) to improve the quality of life in rural areas and diversification of the rural economy; 4) to support the collaboration between the regions.

Table 5 sums up MMM's total annual support amounts and the average support amounts of allocated grants. *Table 6* presents the specific objectives of support instruments and the allocated support amounts in 2009.

Based on the presented information we can define more specific objectives for the public business support allocated by MMM. This information is gathered up in *Table 7* together with the possible rationale for MMM's support.

Table 5 Support finance allocation of MMM

Annual support allocated by MMM (MEUR)		Average support amount allocated by MMM (1000 EUR)	
2004	6,85	Mean	41.38
2005	21,39	St. Dev.	423.52
2006	44,23	Min (10 %)	0.39
2007	48,33	Max (90 %)	15664.95
2008	59,56	Observations	6863

Table 6 Support instruments allocated by MMM

SUPPORT INSTRUMENT	OBJECTIVE	MEUR / 2009
Launching aid in rural areas	To support the voluntary investments directed to the renewable energy usage, energy saving, intensified power production, and reduction of environmental hazards caused by power production and usage.	*Support in total 54,6 MEUR*
Investment support in rural areas	To promote the creation of new entrepreneurship and new employment opportunities. To secure the subsistence of an entrepreneur during the time that is takes to start and establish the business (max. 18 months).	
Development aid in rural areas	To support SMEs' challenging R&D projects, new innovative businesses, or internationalization of a firm by financing the preparation phases of these projects.	

Table 7 Support objectives of MMM

Objectives of the EU-wide support programs	MMM: Support objectives	Rationale for the public support allocated by MMM
To maintain the rural area, improve the condition of environment, and secure the sustainable usage of renewable natural resources.	To support the rural development, including the local entrepreneurship, creation of new employment opportunities, and development of operational environment. To support challenging R&D projects and internationalization. Two of the three instruments are targeted at SMEs and entrepreneurs. The launching aid instrument is allocated with environmental objectives and no restrictions related to the company size.	The degenerating regions need public support in order to create agglomeration externalities and favorable operational environment for private businesses. To support the R&D projects that would have been unrealized otherwise. Due to the market failures especially young companies need public R&D and business support.

3.2.3. The National Technology Agency of Finland

Tekes, the National Technology Agency of Finland, is the principal organization for implementing the Finnish innovation and technology policy. In addition, it is the main financing organization for R&D activities administering 30 per cent of Finnish public R&D funding.

Tekes funds the innovation activities of companies and research organizations that are registered in Finland, and promotes the cooperation with SMEs and research organizations by imposing more strict requirements on large companies. Sharing the risk involved in R&D projects and promoting the innovative risk-intensive projects are central elements of Tekes funding. For example, in 2008 Tekes allocated third of the total support to the companies which had high innovation-intensity and whose R&D expenditure was over 10 per cent (Koski and Pajarinen, 2010a). Tekes directs grants also to the basic research oriented R&D. The support is used mainly at the early phases of companies' growth cycle or innovation process, and is usually justified based on the infant industry argument: the public support finance is needed in order to get the emerging industrial activities to take off and reach a critical mass.

Tekes also launches, coordinates and funds programs which are implemented together with companies, research institutes and universities. Around a half of Tekes' funding is usually allocated through these programs. The programs can be seen as one of the main tools for boosting the private R&D activity, because they provide opportunities for carrying out R&D projects, sharing information, and developing business expertise and international cooperation. Roos *et al.* (2005) argue that the programs have proven to be an effective form of co-operation and networking for companies and the research sector. Toivanen (2009) furthermore suggests that the government use Tekes' programs to generate externalities by requiring that large firms have to cooperate with SMEs in order to be eligible for the support. This may allow small firms and entrepreneurs to access information that would not be available to them otherwise.

Table 8 sums up Tekes' total annual support amounts and the average support amounts of every support instrument category. *Table 9* presents the specific objectives of support instruments and the allocated support amounts in 2009.

Figure 8 presents the business support allocation of Tekes based on the size of a company. We can conclude that in 2009 Tekes allocated over 60 per cent of its support to SMEs and almost 40 per cent to the companies at least with 250 employees. Of the total private business project funding 87 per cent was targeted at the companies with less than 500 employees.

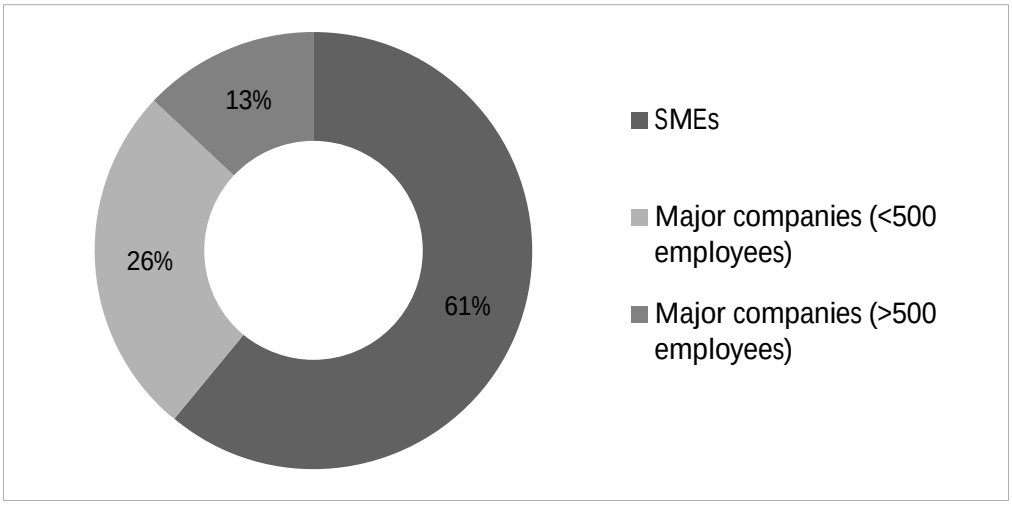
Table 8 Support finance allocation of Tekes

Annual support allocated by Tekes (MEUR)		Average support amounts allocated by Tekes (1000 EUR)			
			Direct subsidies	Loans	Subordinated loans
2004	238,48	Mean	168.6	219.76	232.69
2005	251,80	St. Dev.	546.73	365.72	444.8
2006	268,45	Min (10 %)	2.1	13.4	15.14
2007	283,62	Max (90 %)	13468.3	4760	4400
2008	293,25	Observations	9271	2264	884

Table 9 Support instruments allocated by Tekes

SUPPORT INSTRUMENT	OBJECTIVE	MEUR / 2009
Funding for development projects (grant / loan)	To support the challenging R&D projects that are laying a foundation for the development of products, services and organizations. Allocated as a direct grant and / or loan.	204,5
Procurement of innovation services (grant)	To support SMEs to seek more external expert services related to their innovative activity in order to boost SMEs' own R&D&I activities.	2,37
Funding for young innovative companies (grant)	To boost the growth and internationalization of the most promising small businesses.	17,5
De minimis -support for innovative activity (grant)	To support the innovative activities of young companies and small-scale development and commercialization projects of SMEs.	6,3
Subordinated loan for a technology start-up	To share the financial risk of an entrepreneur while setting up a technology company that seeks an internationally competitive business.	124,0[16]

Figure 8 Tekes support financing by a company size in 2009



[16] The difference between the balance sheet values in 2008 and 2009.

During the last decade the funds allocated to Tekes by the Finnish government has grown by 36 per cent, being almost 611 million euro in 2010. This possibly indicates that the government believes in the effectiveness of direct R&D subsidies, taking also into account that during this decade Tekes has allocated almost 9 300 direct grants and only 3 000 loans.

Based on the presented information we can define more specific objectives for the public business support allocated by Tekes. This information is gathered up in *Table 10* together with the possible rationale for Tekes' support.

Table 10 Support objectives of Tekes

Tekes: Support objectives	**Rationale for the public support allocated by Tekes**
To boost the company growth and internationalization, as well as the innovative activities of SMEs. To create externalities by co-operation requirements. Almost 90 per cent of the support is targeted to high-risk R&D projects without restrictions related to the company size, so supporting innovation is a center of Tekes's mission. Over 60 per cent of the total support allocated by Tekes is assigned to SMEs.	Support the R&D projects that would have been unrealized otherwise. Firms at the beginning of the life cycle are especially more in need of R&D subsidies. (Tanayama, 2007) Due to the market failures especially young companies need public R&D and business support. Because the literature suggests that large firms can better internalize the spillover effects compared to SMEs, subsidization of large firms should rely to a large extent on the spillover justification (Tanayama, 2009). Infant industry argument: the public support finance is needed in order to get the emerging industrial activities to take off and reach a critical mass.

3.2.4. Finnvera

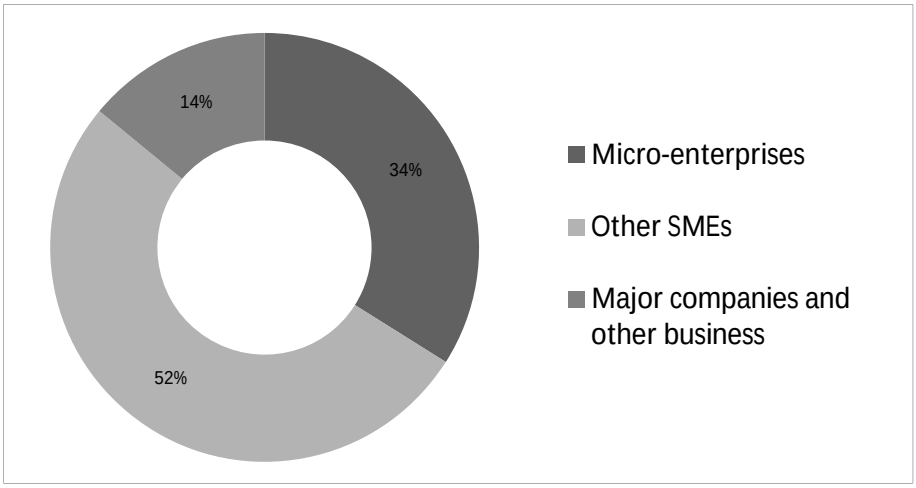
Finnvera plc is a state-owned financing company administered by the Ministry of Employment and the Economy that sets the goals for Finnvera's operations each year. Finnvera is also Finland's official Export Credit Agency and thus acts as an intermediary between the European Union's financing programs and Finnish SMEs. Although Finnvera is expected to achieve economic self-sustainability in its operations, it can take higher risks than commercial financial institutions because the government covers part of Finnvera's credit and guarantee losses.

Finnvera offers risk financing particularly for SMEs and promotes internationalization and export operations of all Finnish companies. It promotes also government's regional policy measures by aiming at correct the deficiencies that exist in the provision of financial services (Georghiou *et al.*, 2003).

Only a comparatively small part of Finnvera's activities fall under innovation policy. Instead, it seeks to foster the entrepreneurship in Finland.

From *Figure 9* we can see the business support allocation of Finnvera's support based on the size of a company. We can conclude that Finnvera allocates almost 90 per cent of its support to micro-enterprises or SMEs, and only 14 per cent to the companies with at least 250 employees.

Figure 9 Finnvera support financing by a company size in 2009



The loans and guarantees differ fundamentally from the direct grants as support instruments. The supported companies have an obligation to pay the loan capital back to Finnvera in aggregate. In addition, the companies pay an additional price for the risk that Finnvera is taking when financing the companies. This price is the interest for the loan or the commission for the guarantee.

Table 11 sums up Finnvera's total annual support amounts and the average support amounts of every support instrument category. *Table 12* presents the specific objectives of Finnvera's support instruments and the allocated support amounts in 2009.

Because there are a lot of different instruments in the Finnvera's support instrument palette, we grouped the instruments in seven different clusters based on their support objectives. *Figure 10* presents the allocation between the different objectives, taking into account the amounts of support assigned to the objectives during the year 2009. The three main objectives are to promote the company growth, to support the creation of private R&D expenditure and to boost the internationalization of Finnish firms.

Table 11 Support finance allocation of Finnvera

Annual support allocated by Finnvera (MEUR)		Average support amount allocated by Finnvera (EUR)		
			Loans	Guarantees
2004	905,17	Mean	87.13	18803.3
2005	932,06	St. Dev.	404.88	1.15
2006	962,09	Min (10 %)	1	715.06
2007	999,26	Max (90 %)	16670	224.2
2008	1135,80	Observations	38220	20291

Table 12 Support instruments allocated by Finnvera

SUPPORT INSTRUMENT	OBJECTIVE	MEUR / 2009
Counter-cyclical loan	To save profitable businesses and maintain jobs. Loan is intended for companies whose profitability or liquidity has declined because of economic trends.	140,6
Development loan	To improve the operating conditions of SMEs. The financing may be used e.g. for research and product development or marketing promotion.	12,9
Entrepreneur loan	To support the control or growth of equity capital and flexible purchases of shares of partnership interests.	25,5
Environmental loan	To support SMEs' voluntary environmental investments with significant positive environmental impact.	14,5
Internationalization loan	To support business operations (investment, development or growth) of a Finnish SME abroad.	4,1
Investment and working capital loan	To support growth of SMEs.	335,1
Loans for women entrepreneurs	To support women entrepreneurship.	24,4
Microloan	To support activities of small companies. Loan is used e.g. for investments, development, start-up or expansion projects.	36,4
Counter-cyclical guarantee	To save profitable businesses and maintain jobs. Guarantee is intended for companies whose profitability or liquidity has declined because of economic trends.	47,3
Finnvera guarantee	To boost internationalization of companies, especially of SMEs.	231,2
Internationalization guarantee	To support business operations (investment, development or growth) of a Finnish SME abroad.	4,2
Micro-enterprise guarantee	To support the activities and growth of small companies.	21,2
Export guarantee	To support the export of Finnish companies by covering needs for collateral.	127,4
Investment guarantee	To support Finnish companies by insuring foreign investments against political risks.	1,0

Based on the presented information we can define more specific objectives for the public business support allocated by Finnvera. This information is gathered up in *Table 13* together with the possible rationale for Finnvera's support.

Figure 10 Support objectives of Finnvera 1

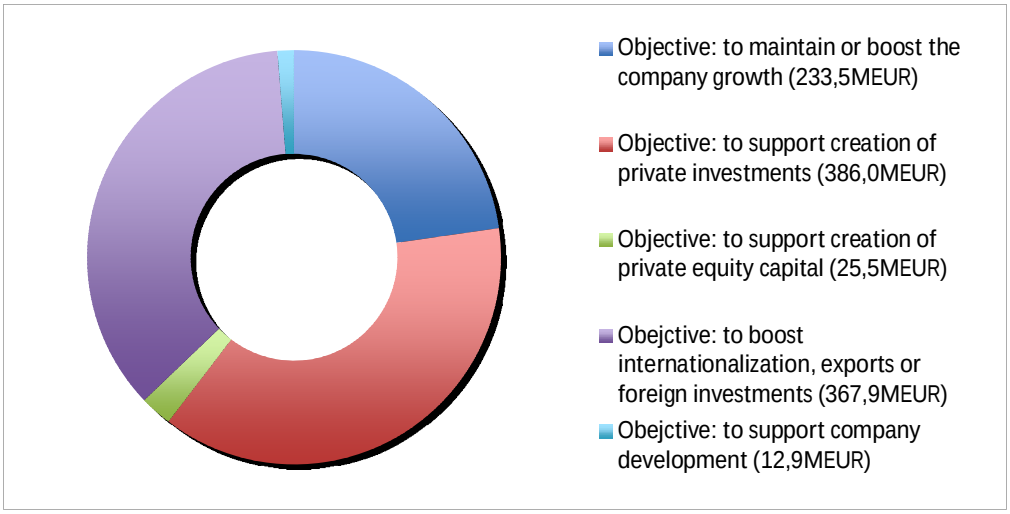


Table 13 Support objectives of Finnvera 2

Finnvera: Support objectives	**Rationale for the public support allocated by Finnvera**
Makes the allocation decisions despite the R&D perspective. To support the company growth, private investments and internationalization. To offer finance especially to micro-enterprises and SMEs. Separate instruments for entrepreneurs.	Due to the market failures especially young innovative companies need public R&D and business support. Because firms are fundamentally risk-averse they won't allocate risk optimally and consequently there will be discrimination against risky and highly uncertain projects.

Although the development of the Finnish financial markets has somewhat reduced the attractiveness of the financial constraints argument, there is evidence that innovation projects of especially young and small innovative firms may still face financing constraints (see Tanayama, 2009, and references therein). In this respect, Finnvera has credible rationale to justify its public business support allocations.

3.3. Relative financing shares of the organizations and instruments

The summary of the organizations' total annual support amounts can be found in *Table 14*. During the year 2008, which is the last year in our research timeframe, the public support organizations allocated total of 1,7 billion euro R&D and business support, which was about 0,96 per cent of Finnish GDP.

Table 14 Annual support amounts allocated by the public organizations

Annual public R&D and business support allocated by the public support organizations (MEUR)				
Year	TEM	MMM	Tekes	Finnvera
2004	172,66	6,85	238,48	905,17
2005	194,39	21,39	251,80	932,06
2006	203,93	44,23	268,45	962,09
2007	236,15	48,33	283,62	999,26
2008	241,86	59,56	293,25	1135,80

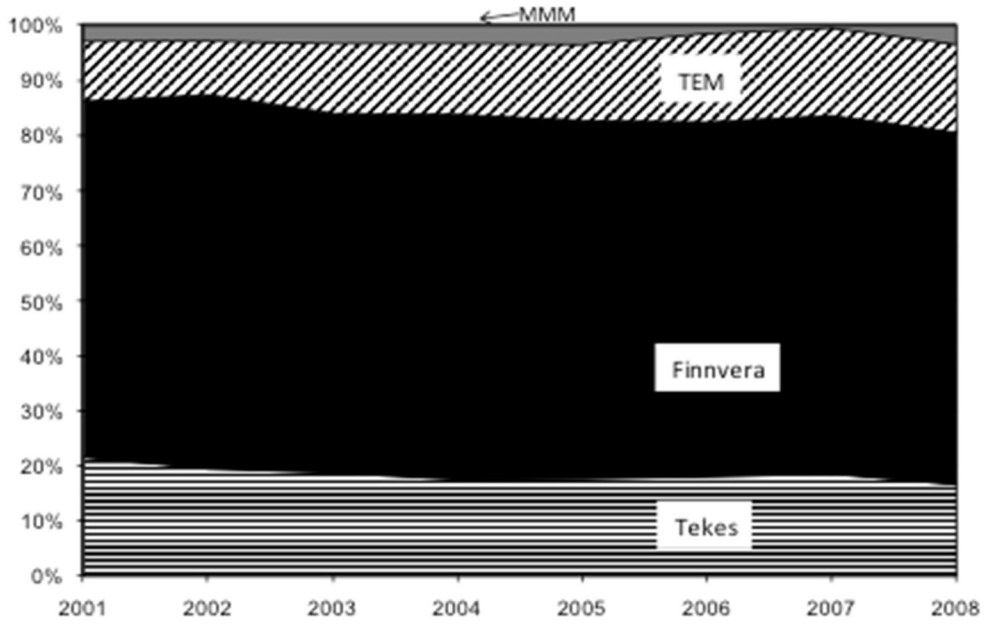
Based on the figures we can conclude that Finnvera is the largest support organization, followed by Tekes and TEM. The relative share of business support allocated by MMM has jumped in 2005 but is still small compared to other organizations.

Koski and Pajarinen (2010a) have examined more specifically the trend of relative financing shares of these support organizations. They use the same database as we are using during this research. Based on their research they report that Finnvera has been the largest public support organization awhile covering clearly over 50 per cent of public business support allocated to the private sector. Tekes and TEM cover slightly fewer than 20 per cent each, the shares being in 2008 around 17 per cent and 14 per cent. MMM is the smallest support organization, allocating only less than 4 per cent of all annual public business support.

It is also worth of noticing that Tekes and Finnvera together cover approximately 80 per cent of the total annual business support. As we can see from *Figure 11*, there haven't been notable changes in the relative financing shares during the last decade. This is the situation despite the fact that there has been a growing trend of public business support both in terms of money and in number of companies supported.

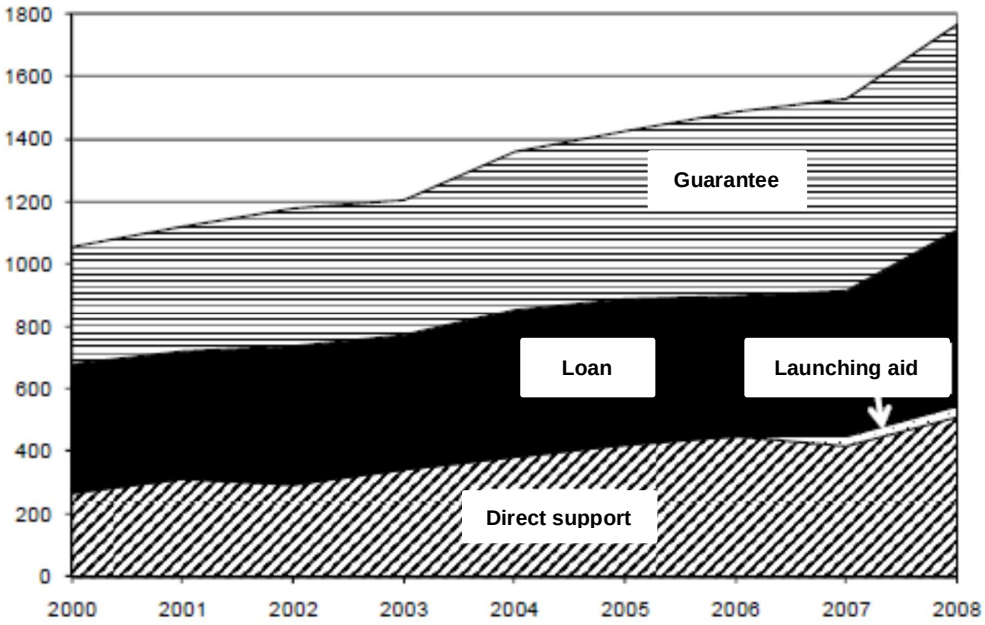
Furthermore, Koski and Pajarinen (2010a) have calculated the financing shares of different support instrument categories. In 2008 the public support organizations allocated 1,7 billion euro public business support funding, of which 29 per cent was direct support, 2 per cent launching aid, 32 per cent loans and 37 per cent guarantees. In the beginning of this millennium the relative financing shares of direct support, loans and guarantees were somewhat equal, but during the recent years the number of guarantees and loans have increased steeper than the volume of direct support (*Figure 12*). The relative financing share of launching aid is marginal compared to the other instrument categories.

Figure 11 Relative financing shares of the support organizations during the years 2001-2008



Source: Koski and Pajarinen (2010a)

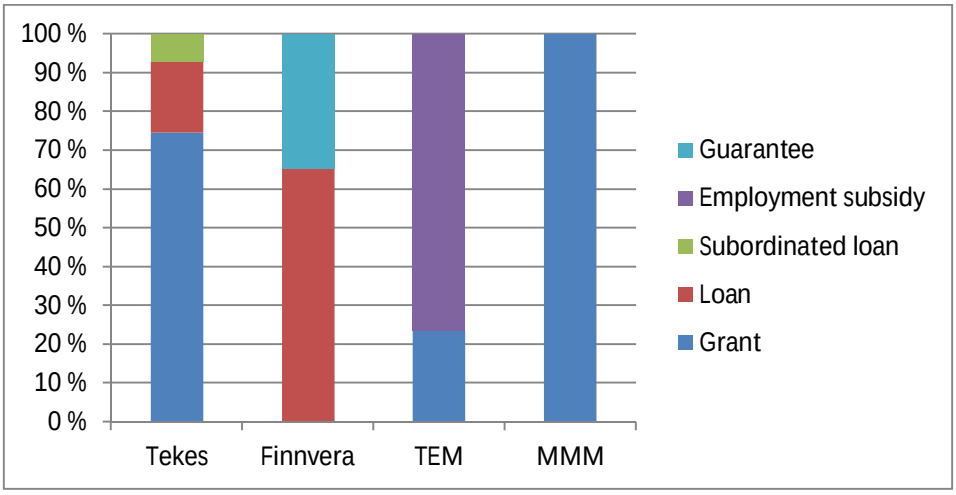
Figure 12 Allocated R&D and business support by instrument (MEUR) during the years 2000-2008



Source: Koski and Pajarinen (2010a)

Because in the empirical part of our research we can assort the allocated public business support only by organization, it is important to know what kind on instruments the organizations mainly allocate. During the sub-chapters 3.2.1-3.2.4 we presented the actual numbers of observations that we have for every support instrument category in our data. *Figure 13* sums up this information so that we can observe the primary support instruments of every organization.

Figure 13 Main support instruments by organization during the years 2004-2008



Tekes has primarily allocated direct grants, which have been used in almost 75 per cent of the allocation decisions. All support allocated by MMM has been assigned as direct grants. On the contrary, Finnvera has allocated mainly loans and not direct grants at all. Because the Ministry of Employment have allocated mainly employment subsidies during the years 2004-2007 the column reflecting the support allocated by TEM has an emphasis on employment subsidies.

This viewpoint is essential from the government's point of view because it reflects also the differences in the expenses of public business support funding. The loans and guarantees are subsidized for example with a lower interest rate or with releases from payback obligations in case of a project failure. But direct grants are always plain money that is fully paid after the support allocation decision has been made. Therefore, the total cost of direct grants is multifold compared to the costs of loans or guarantees.

3.4. The main objectives for public business support

Table 15 presents the summary of the previous observations related to the objectives of public support organizations and their support instruments. In conclusion it can be stated that there are some logical reasons behind the organizations' target-setting.

Table 15 Main observations concerning the support objectives of public support organizations

Main observations concerning the objectives of public support organizations			
TEM	**MMM**	**Tekes**	**Finnvera**
To support the regional development, including the entrepreneurship and creation of new employment opportunities. To support the development of operational environment, challenging R&D projects and internationalization. A half of the annual support is targeted at SMEs or entrepreneurs. A half of the annual support is allocated as energy support with environmental objectives and no restrictions related to the company size.	To maintain rural areas and their development by supporting the entrepreneurship and creation of new employment opportunities. To support the challenging R&D projects and internationalization. Two of the three support instruments are targeted to SMEs and entrepreneurs. Launching aid instrument is allocated with environmental objectives and no restrictions related to the company size.	To boost the company growth and internationalization, as well as innovative activities of SMEs. To create externalities by co-operation requirements. Almost 90 per cent of the support is targeted to high-risk R&D projects without restrictions related to the company size. Supporting innovation is in a center of Tekes' mission. Over 60 per cent of the total support allocated by Tekes is assigned to SMEs.	Finnvera makes the allocation decisions ignoring the R&D perspective. To support the company growth, private investments and internationalization. To offer finance especially to micro-enterprises and SMEs. Separate instruments for entrepreneurs.

By interpreting the table it can be argued that one of the cross-sectional characteristics in the Finnish R&D and business support system is the objective to support the development, growth and internationalization of SMEs and start-up firms. As Veugelers *et al.* (2009) note, the Finnish firms are generally very small on average, the median new firm having only 0,5 employees and the arithmetic mean being 1,2 employees. All public organizations are allocating at least half of their annual support to micro-enterprises or SMEs, and the holy trinity of company development, company growth and stronger internationalization is in every organization's support agenda. For example, according to Koski and Pajarinen (2010a), over 95 per cent of the ministries support in 2008 was directed to SMEs.

Furthermore, based on the analysis made in sub-chapter 3.2.1.2 it is understandable that TEM and MMM have a strong focus of regional and rural development in their support instruments.

With relation to Tekes there seems to be three main themes defining the support objectives: high-risk R&D, co-operation and company growth among SMEs. These themes support the conclusion that sharing the high risk involved in a R&D project and promoting innovative, risk-intensive projects are

the central elements of Tekes funding. In respect of micro-enterprises, Tekes' support is not directly aimed at promoting entrepreneurship, although it has some policies directly aimed at start-ups. Indeed, the main instrument of Tekes' support policy, R&D subsidies, is not the most effective way of supporting entrepreneurship having a slow decision-making process and ex post support allocations. Therefore, with the support instruments like guarantees and loans Finnvera is capable of foster the entrepreneurship better.

Hyytinen and Väänänen (2002) have made an interesting study concerning the company characteristics that increase and decrease the likelihood of obtain public business support from Tekes or Finnvera. Their results (*Table 16*) strengthen some of the observations of this review. On the other hand, the results offer also some contradictory information concerning the company characteristics. Based on their examination Finnvera focuses more on companies, which have high growth potential or high internationalization prospects. There again, Tekes focuses on patenting and high R&D intensive companies, which have usually received public business support funding also before. Whereas Hyytinen and Väänänen found Finnvera to be more likely to allocate finance to companies from the Western and Eastern provinces, no such regional effect was found for Tekes.

Table 16 Company characteristics related to the support decisions

Finnvera	**Tekes**
Increase the likelihood of obtaining finance	
High growth expectations	High R&D intensity
High export share of sales	Existence of patents
Private sector has previously denied a loan	Have made losses earlier
Earlier innovation activity	Received public funding during the previous year
Being a small R&D intensive firm	Little realized growth in turnover
	Large size (measured by employment)
Decrease the likelihood of obtaining finance	
Small size	
High R&D expenditures	
Old CEO	

However, according to their study the earlier innovation activity increase the likelihood of obtaining finance from Finnvera. Furthermore, the likelihood of obtaining finance from Finnvera decreases if the applicant is a small company. On the contrary, the likelihood of obtaining finance from Tekes increases if the applicant is a large company. These observations are somewhat out of the tune with the cross-sectional characteristics of Finnish R&D and business support system, which we derived from the written support objectives of support organizations and their support instruments.

Tanayama (2007) has examined the decision-making process and allocation rule, which Tekes use to allocate the support funding. According to Tanayama, being SME, having higher technological challenge, higher risk, and larger extent of collaboration in the application have positive effect on the

acceptance decision. Risks related to the implementation of the project and economic stance of the company will, on the other hand, have a negative effect on the acceptance decision.

As a final point, several recent studies have argued that there are strong continuities in participation within and between the different public support programs, that public business support programs and public support organizations' roles overlap with each other, and that several public organizations work broadly in the same area (see *Table 36* in the chapter 8). This study doesn't commit on these issues. However, the impact of public business support on company performance and the role differentiation between the public support organizations are interconnected. In order to control the desired impacts of public business support one must have a well-defined and efficient support system.

In order to reach a clear and informative outcome for our impact evaluation we will group[17] the support instruments on six different sets on the grounds of their objectives. Thereby, we are able to identify the most common support objectives in the Finnish support system. The groups will be set as follows: 1) the instruments with counter-cyclical objectives; 2) the instruments aimed at support internationalization, export and / or foreign investments; 3) the instruments aimed at support the increase in private R&D expenditure; 4) the instruments with environmental objectives (e.g. environmental investments, energy saving, renewable energy use); 5) the instruments aimed at support the company growth (measured by turnover or employment).

Figure 14 is based on the support amounts that were allocated during the year 2009. From the figure we can see which support objectives collect most of the public support finance in Finland.

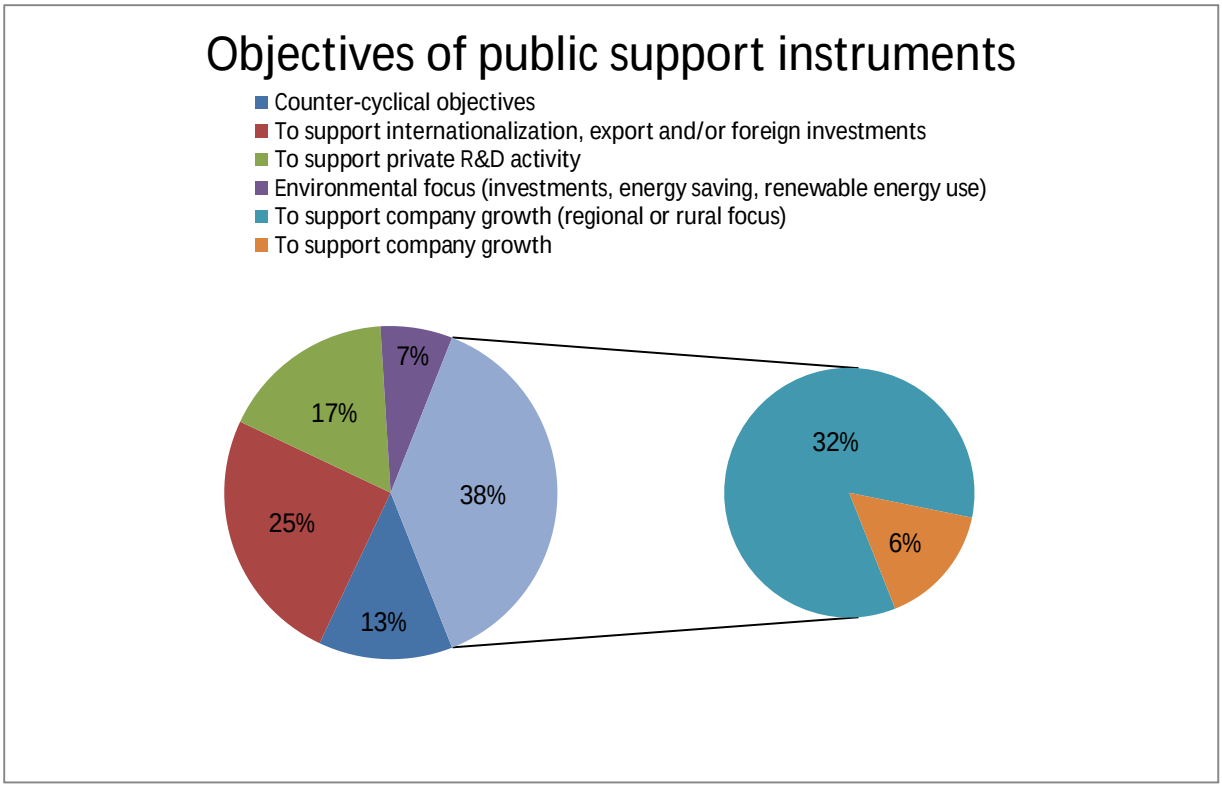
The largest share of public business support is focusing on company growth. In total 38 per cent of all public business support finance is allocated to promote the company growth, of which 16 per cent have some kind of regional limitation. Additionally, a majority of this support has limitations regarding the company size, since most of the support is targeted specifically at SMEs. The second largest share (25 per cent) of public business support is targeted at internationalization, export or foreign investments of the Finnish companies. The third largest share (17 per cent) of public support is focusing on the private R&D expenditure.

Several support instrument objectives include a goal concerning the employment growth and creation of new employment opportunities. Because there has been recently published a working paper[18] with a focus on the employment growth, we have decided to leave this performance indicator out of our empirical research.

[17] The detailed grouping of instruments will be found in *Annex 1*.
[18] See Koski and Pajarinen (2010c).

The public support objectives of boosting internationallization, company growth and private R&D expenditure growth cover approximately 80 per cent of Finnish public business support funding, and consequently create an excellent foundation for impact evaluation. We will therefore approach the empirical question of *what we can say about the firm-level impact of public R&D and business support allocated by Tekes, Finnvera, MMM and TEM* based on these three company performance indicators.

Figure 14 Objectives of public support instruments



From now on the thesis will be structured as follows. The fourth chapter focuses on the impact measurement of public R&D and business support. We will present results of some previous studies which have focused on the same performance indicators that we are interested in during this study. In addition, we will discuss about the common challenges in the impact literature and present the methodological choices that have been made in our empirical research.

The chapters five, six and seven will cover the empirical part of the research. We will first present the testable hypotheses and after that describe the used data and methodology. The chapter number seven presents the actual analysis and results of the research. The chapter number eight will conclude.

4. Measuring the impact of public support instruments

The aim of this review is to build a solid empirical foundation for the analysis concerning the impact of public R&D and business support in Finland. The transformation from traditional technology policy towards more challenging and comprehensive innovation policy has created new challenges for the estimation of the impacts of public support policies. At present, the Finnish support system is a useful case for evaluating the impact of public support, because the implementation of public support policy is concentrated mainly in a few organizations and there are no other direct support instruments than subsidies to complicate the analysis.

The empirical researches focusing on the impacts of public R&D and business support can be divided into two main groups: quantitative and qualitative research. Usually the qualitative evaluations, in which the researcher asks an estimation of the impact of public support from the beneficiary himself, give results according to which the support is effective and influential. Due to the obvious credibility gap related to the results, which is stemming from the beneficiary's interest to emphasize the usefulness of support (Klette *et al.*, 2000; Asplund and Kiander, 2003), we will execute our analysis based on a quantitative research.

Quantitative researches explore with the econometric methods the sign and magnitude of the impact of public support, and have variation in several relevant elements – like in the observation unit, estimation methods, scope and quality of data, and period of time. Therefore, we will first present results of some previous studies, which have focused on the same performance indicators that we are interested in during this study. After this review we will discuss about the common empirical challenges indentified in the impact literature.

4.1. Results of previous empirical studies

In general the empirical analyses have added reliability to the view that public policies promoting private R&D activities may have a large impact on private R&D expenditure. Nevertheless, it is difficult and premature to end up with conclusive answers about the effects of public R&D and business support.

Asplund and Kiander (2003) argue that the inconsistency of research results and the lack of evidence can be explained by the fact that the performance of national innovation policies is actually really hard thing to measure. They indicate that because the public finance has both direct and indirect outcomes, the impact of public support seems to differ depending on which support instrument is in question. Consequently, it would be necessary to measure the impact for each instrument separately. David and Hall (2000) and Lach and Sauer (2001) have also highlighted the need for structural models in explaining the different channels of impact and the underlying decision-making problems.

A clear majority of the econometric evaluation studies have focused on the issue of additionality, hence, whether the public R&D support complement or crowd out private R&D investments[19]. There are also some econometric studies analyzing the impact of public business support on some performance indicator. For example, the relationship between public business support and productivity growth has gathered a great amount of interest.

The next two sub-chapters present some examples of the impact studies focusing on the private R&D expenditure growth and company growth.

4.1.1. Private R&D expenditure growth

According to Ali-Yrkkö (2008), it is still an open empirical question whether the public R&D support really complements private R&D and thus increases the total R&D expenditure. The majority of the studies have reported complementary effects but the substitute effects have also been found. Some of the papers (Klette *et al.*, 2000; David *et al.*, 2000; Wallsten, 2000) have also strongly questioned the results of previous studies. These critics argue that there has been an insufficient control for the potential endogeneity of receiving public support, which arises from a false assumption of randomly assigned public support.

David *et al.* (2000) have gathered up information concerning 33 different studies related to the impact of public R&D support on private R&D expenditure. In their review they have 19 researches in firm- or division-level and 14 in industry- or nation-level. As much as 50 per cent of the studies found substitute effects on firm- and division-level. On the other hand, only 2 researches of 14 industry- or nation-level researches discovered substitute effects. Also Klette and Moen (1998) conclude that there is little tendency for crowding out in their sample of high-technology Norwegian firms.

Wallsten (2000) has documented that companies reduced their R&D spending in the years following the grant. Busom (1999) has showed that in 30 per cent of her Spanish sample firms the public support funding fully crowds out privately financed R&D. Furthermore, David and Hall (2000) note that a weak response of private R&D spending to public R&D support is more likely when the public share of total R&D spending is large, or when the public R&D support does not enhance private productivity very much.

Conversely, the Finnish impact studies focusing on the issue of additionality have mainly attained reversed research results. The results of previous Finnish studies focusing on R&D complementary and substitute effects are presented in *Table 17*:

[19] David *et al.* (2000) survey the literature, and studies concerning additionality include e.g. Lach (2002) and Ali-Yrkkö (2004).

Table 17 Results of previous studies: private R&D expenditure growth

Writer(s)	Year	Article	Main findings
Niininen, P.	1999	High Technology Investment, Growth and Productivity, Empirical Studies of Finnish Data, *HSE A-158, Helsinki*.	The public funding increases the private R&D investments of firms that have high research intensity.
Lehto, E.	2000	Regional impacts of R&D and public R&D funding, *Palkansaajien tutkimuslaitos, tutkimuksia 79, Helsinki.*	The public funding increases the private R&D investments. The results indicate that Finnish firms face difficulties in receiving funding for their projects. There is no crowding out related to the public funding. One unit increase in public funding increases the private R&D investments with one unit.
Toivanen, O. and Niininen, P.	2000	Investment, R&D, subsidies and credit constraints, *HSE Working papers W-264, Helsinki.*	The public R&D funding increase the private R&D activity in the firms which have moderate cash flow but which don't have enough inter-company funding to cover the R&D costs.
Czarnitzki, D., Ebersberger, B., and Fier, A.	2007	The relationship between R&D collaboration, subsidies and R&D performance: Empirical evidence from Finland and Germany, *Journal of Applied Econometrics, 22, 1347-66.*	The subsidies in the Finnish R&D support program induced additional R&D.
Ali-Yrkkö, J.	2008	Essays on the impacts of technology development and R&D subsidies, *Acta Universitatis Oeconomicae Helsingiensis. HSE, Helsinki.*	Ali-Yrkkö applied Wallsten's (2000) approach and found evidence of positive effects of public R&D support on private R&D in Finland.
Einiö, E.	2010	Essays on Innovation Policy, Technology and Skills, *Research Reports, Kansantaloustieteen tutkimuksia, No.121:2010.*	Based on the research it is possible to induce additional private R&D given correctly designed public R&D support policies. The impact of public R&D support may be substantial: a conservative estimate is that one subsidy euro induces 1,25 euro of additional private R&D.

4.1.2. Company growth

The econometric studies focusing on the impact of public business support on company growth have obtained less and varied results. The main distinctive element between the different studies is the performance indicator with which the researchers have measured the impact of public support. The studies have naturally different starting point if the company growth is measured by the turnover growth, employment growth, or by some other growth indicator. Furthermore, drawing the general conclusions is not easy because of the differences in used samples and methodologies.

Results of some previous Finnish studies focusing on the company growth indicators are presented in *Table 18.*

Table 18 Results of previous studies: company growth

Writer	Year	Article	Main findings
Ebersberger, B.	2004	Labor Demand Effect of Public R&D Funding, *VTT Working Papers No 9, Technical Research Centre of Finland*	Ebersberger utilizes differences-in-differences techniques to analyze the innovation and labor demand effects of public R&D funding in Finland. The results suggest that subsidies have a positive impact on **innovation output**, and in the long run on **employment**.
Piekkola, H.	2005	Public funding of R&D and growth: firm-level evidence from Finland, *ETLA Discussion Papers No. 996*	The results suggest that public R&D subsidies complement private R&D expenditure. Furthermore, the subsidies increase **the share of workers engaged in R&D work**, but the firms use subsidies to raise R&D employment at a decreasing rate. The writer finds little evidence that subsidies improve general **employment**. Public subsidies overall fail to augment growth in large firms.
Koski, H.	2008	Public R&D subsidies and employment growth – microeconomic evidence from Finnish firms, *ETLA, Discussion Papers, No 114*	This study empirically explores whether the public financial support for entrepreneurial R&D affects **employment growth** at the firm level. The data from the Finnish companies suggests that the firms that have received public R&D funding have not generally witnessed any greater employment growth than other companies. According to the findings, the public R&D support targeted to the certain types of R&D activities notably contribute to the creation of new jobs: employment in those firms that have received public funding for the R&D projects targeted to the new business areas has clearly grown relatively more than in other companies.

4.2. Common challenges in the impact literature

Several arguments have been proposed to explain the difficulty to draw definitive conclusions from the impact studies. The main problems and possible biasedness, however, arises largely from two issues that are interconnected: the methodology and the choice of sampling. The more advanced methods have been identified and the methodologies develop further all the time. Still, these methods cannot often be fully employed because the required data is not available.

This part of the thesis presents the common challenges and sources of bias and the methodological choices that are made in order to tackle these challenges in this research.

4.2.1. Selection bias and endogeneity

The term selection bias most often refers to the distortion of a statistical analysis, resulting from the method or process of sample collection. In impact research it refers to the dynamics of public business support system. With enough randomness in the public support allocation process, the data consisting of the publicly supported and unsupported firms provide us a basis for causal, econometric analysis. According to Klette *et al.* (2000), a random allocation may not be too misleading assumption in some cases, but assuming that governments' deliberate selection process is largely random is questionable and thus significant bias might be involved in the estimated impact parameters. If neglecting these problems, the biased results are rather explained by the fact that public business support is allocated

more probably based on the company characteristics (Asplund and Kiander, 2003; Einiö, 2010), for example to the companies that are already engaged to R&D activity because their innovation potential is discovered to be high quality.

Kauko (1996), Lehto (2000) and Technopolis (2001) are arguing that this bias occurs especially in the researches based on Finnish data, because in Finland is absorbed an innovation policy that promotes intentional choosing of already successful companies to receive public R&D support. Jaffe (2002) highlights that the researcher very seldom observes these characteristics affecting the actual selection, causing biased estimates of the causal effect if randomly assigned public support is assumed. As the selection process is not random and the allocated public support is based on the company characteristics the support decisions done by public support organizations are found to be endogenous.

The endogeneity problem has been addressed recently in the work of Heckman *et* al. (1998a), Busom (2000) and Wallsten (2000). Especially Wallsten has strongly questioned the results of previous impact studies due to the inadequate treatment of endogeneity problem. The methodology for defining the control group against which the supported companies are compared is highly relevant for the problem with endogeneity. When evaluating the effects of publicly financed projects, one has to face the question of what would have taken place without the subsidies: neither the companies receiving support, nor those not applying can be considered as random units. As a result, constructing a valid control group in this setting is crucial and challenging. The main challenge arises from the fact that typically the groups of supported and unsupported firms are not directly comparable, which naturally influence on the reliability of estimation results (Klette *et al.*, 2000; Tanayama, 2007; Einiö, 2010).

Klette *et al.* (2000) discuss an additional complication related to the control group selection created by the spillover effects. By these effects the companies that are not participating in the support program may be affected by the support program invalidating further the use of control group in the study. Using the unsupported companies to evaluate what would have happened to the supported companies if they had not been supported, assumes that there are no spillover effects of the public support scheme to the unsupported companies. This is clearly a strong assumption. According to Tanayama (2007) this issue is especially important in analyzing the effects of R&D subsidy programs as spillovers are precisely one of the main justifications for the existence of these programs.

In this research we are going to use as a basis the business register of all companies operating in Finland. Consequently, we don't have to face the challenges related to the control group selection.

4.2.2. Unobservable attributes

The observable characteristics that affect the public support allocation are a major source of bias that is stemming from the heterogeneity. Naturally, also the unobservable characteristics of the companies

may affect the support decision. These attributes tend to increase the likelihood that a company is accepted in a public support program, thus in order to receive reliable results we should seek to control for both observable and unobservable characteristics in the regression equations.

We can divide the unobservable attributes into two different categories, time-invariant characteristics and time-variant characteristics, which refer to whether the characteristics change in time. In the case of time-variant company characteristics, the positive support decision may be associated with the unexpected development in unobservable attributes (Einiö, 2010), such as the company's research productivity. On the other hand, the time-invariant characteristics obviously do not change in time so the public support is associated with unobservable continuous attributes.

There are proper methodological solutions to overcome, or at least to reduce, the bias stemming from the unobservable attributes. When the supported and unsupported companies are observed over time, hence before and after the positive grant decision, it is possible to use models based on a panel data in order to deal with the problem related to the time-invariant unobservable attributes. For example Lack (2002) and Görg and Strobl (2007) have utilized panel data in their impact studies.

If one has data for both supported companies and unsupported companies before and after the involvement, it is also possible to apply the difference in differences method or appropriate econometric techniques such as Heckman's two stage estimation. In the Heckman two-step estimation the omitted variable should be estimated first. This is followed by the second step where the estimated omitted variable is included as an explanatory variable in the OLS regression equation, which then yields consistent estimates (Heckman, 1979).

However, Heckman *et al.* (1998b) suggests that 'difference-in-differences' method is preferable to the alternatives, such as the widely-used parametric selection-correction method introduced by Heckman (1979) and the matching methods discussed in Heckman *et al.* (1998a). With observations for more than two years, a preferable estimator might be the 'within'-estimator that is widely used in the panel data literature. The 'within'-estimator is closely related to the 'difference-in-difference'-estimator. With 'within' -estimator it is possible to estimate the time profile of the impact by considering a number of 'difference-in-differences' estimates (see Heckman *et al.*, 1998b).

On the other hand, in order to deal with the problem related to the time-variant unobservable characteristics for example Wallsten (2000) used an instrumental variables (IV) approach based on the idea that differences in government R&D support funding across industries induce variation in the likelihood of receiving the support.

In this research we follow the methodological choices of Wallsten (2000) by using an instrumental variable approach. In addition, we will use panel data in our empirical analysis in order to deal with the problem related to the time-invariant unobservable attributes.

5. Hypotheses

This part of the research is awaited to add value to the quantitative analysis of Finnish R&D and business support system. Our empirical research question was stated as follows:

What can we say about the firm-level impact of public R&D and business support allocated by Tekes, Finnvera, MMM and TEM?

The question will be now answered using the measures and methodologies presented in the previous chapter. It seems reasonable to argue that in order to be justified public business support instruments should create value-added to private companies' performance. As presented previously, most of the instruments focus on three performance indicators: turnover growth, export growth and private R&D expenditure growth.

Therefore, we will set our testable hypotheses as follows:

H1. There is a positive relationship between the public business support received and the growth of turnover, and the positive impact is statistically significant.

H2. There is a positive relationship between the public business support received and the growth of export, and the positive impact is statistically significant.

H3. There is a positive relationship between the public business support received and the growth of private R&D expenditure, and the positive impact is statistically significant.

Through the impact analysis we will see how well the public support organizations succeed in reaching their support objectives.

6. DATA AND METHODOLOGY

6.1. Research approach

This study analyzes firm-level impact of public R&D and business support on company performance. We will seek to analyze the impact of public support based on three growth measures: turnover growth, export growth and private R&D expenditure growth.

6.2. Data

The study uses data from "Statistics on business subsidies" -database[20], which includes the public support allocation decisions of Tekes, Finnvera, TEM, and MMM from the years 2001-2008. This database is merged with the business register of all companies operating in Finland and databases about companies' financial information, and R&D activities and patents, all provided by Statistics Finland. The resulting database – as the use of lagged variables further limit the estimated equations to the years 2004-2008 – comprises a total of about 260 000 companies and information about their characteristics and participation in support programs. Some of the most severe outliers of the data are excluded in order to be conservative in the analysis.

Because TEM was established in the beginning of 2008 by merging two ministries, the Ministry of Trade and Industry and the Ministry of Employment, there are some inconsistencies in the data from the years 2007 and 2008. The support amounts allocated by the former Ministry of Employment include the support allocated through the EU-wide fund ESF. On the other hand, the support amounts allocated by the former Ministry of Trade and Industry include the support allocated through the EU-wide fund ERDF but the support amounts doesn't include the support allocated through the ESF. Furthermore, the support amounts allocated by TEM during the year 2008 include the support allocated through the EU-wide funds.

6.3. Methodology

The methodology part of this thesis is divided into two parts. The first part is the descriptive analysis of the data. The second part includes the regression analyses that are seeking to identify the actual association between the public business support and the development of firm-level performance measures.

[20] The creation process and the specific content of the database are described in the final report of the working group that was establishing the database (see Ministry of Trade and Industry, 2006).

6.3.1. Descriptive Analysis

The aim of the descriptive analysis is to provide a good overall picture on the data. This is necessary for both conducting the actual analysis and the interpretation of the final results, as both of these depend highly on the used data. This part of analysis does not take the endogeneity problem into account and thus does not reliably provide insight on if the public business support funding has actually been the cause of the observed differences.

Lastly, we will present the statistic related to the company performance indicators that are in focus at this study. *Table 19* below describes and defines the econometric measures that are included in the analysis.

Table 19 Firm-level performance indicators

This table presents the different firm-level economic measures that are included in the analysis and the aspects of firm-level impact they are derived from. The table further presents a detailed description of each measure and its mathematical formula.

Aspect of firm-level impact	**Measure**	**Mathematical formula**
Company size	Turnover growth, three-year average	$\frac{Y_{it}^{Turnover} + Y_{i,t-1}^{Turnover} + Y_{i,t-2}^{Turnover}}{3}$
Internationalization	Export growth, three-year average	$\frac{Y_{it}^{Export} + Y_{i,t-1}^{Export} + Y_{i,t-2}^{Export}}{3}$
Innovation	Private R&D expenditure growth, three-year average	$\frac{Y_{it}^{R\&Dexpenditures} + Y_{i,t-1}^{R\&Dexpenditures} + Y_{i,t-2}^{R\&Dexpenditures}}{3}$

6.3.2. Regression Analysis

The regression analysis seeks to analyze the actual association between the public R&D and business funding and the company performance indicators.

6.3.2.1. Instrumental variables regression

In order to tackle the endogeneity problem we employ, instead of a normal OLS regression, a two-stage least squares regression (TSLS) with instrumental variables. The method of instrumental variables (IV) is used to estimate causal relationships when controlled experiments are not feasible. The explanatory variable correlated with the error term may be due to the endogeneity or lack of explanatory variables. It is also very likely that OLS estimates suffer from problems associated with reverse causality.

We run the TSLS regression with instrumental variables for panel-data models for all three company performance indicators. The formulation of the standard model is as follows.

The first-stage regression specification is:

$$X_{it} = \pi_0 + \pi_1 Z_t + +\beta_1 W_{1it} + \ldots + \beta_2 W_{2it} + v_{it}$$

where

X_{it} is the mean amount of public support received by a company
Z_t is the instrumental variable included in the analysis
$W_{1it}, \ldots, W_{2it}$ are the exogenous variables included in the analysis
v_i is a component of the error term u_{it} with which X_{it} is correlated

and the second-stage regression specification is:

$$Y_{it} = \beta_0 + \beta_1 \widehat{X_{it}} + \beta_2 W_{1it} + \ldots + \beta_3 W_{2it} + u_{it},$$

where

Y_{it} is the firm-level performance indicator
$W_{1it}, \ldots, W_{2it}$ are the exogenous variables included in the analysis
u_{it} is the error term with which X_{it} is uncorrelated

We are going to test the reliability of the regression results with Hausman specification test and report the results of linear generalized least squares (GLS) regressions for a comparison. The Hausman specification test helps us to evaluate if our model corresponds to the data.

6.3.2.2. Variables used in the regression models

We will now present the variables that are used in the regression models.

Firstly, we can choose whether we want to use the amount of support granted or the amount of support actually paid as an indicator of allocated public support. Like Meeusen and Janssens (2001) note, it is rather the amount of support granted that will influence on company behavior. We will follow their view in this research and use the amount of support granted as an indicator of allocated support.

Secondly, in order to avoid biased results it is important to define the used instrument variable carefully. An appropriate instrument variable is correlated with the endogenous public support variable, but uncorrelated with unobservable factors that affect the dependent variables. In our case the dependent variables are turnover growth rate (three-year average), export growth rate (three-year average) and private R&D expenditure growth rate (three-year average). According to the previous studies (Lichtenberg, 1988; Wallsten, 2000) an endorsed instrumental variable would be the aggregate amount of public funds that is annually *potentially receivable* for every company. Therefore, we will

follow the same technique as Ali-Yrkkö (2008) and use the support organizations' aggregate annual support budgets as instrumental variables.

Table 20 gathers up the specific information concerning the variables used in the regression models.

We will control the company size by including a logged variable (number of employees) in the regression specifications. We will also run the regressions for samples consisting of SMEs and large companies only. According to Tanayama (2007), larger firms are likelier not only to conduct such innovative activities that are eligible for R&D subsidies but also to be better informed about the subsidy programs. It is also possible that some companies have more advantageous position in the public funding application procedure due to their greater resources for filing and lobbying the application for public finance.

We will also introduce a variable reflecting the efficiency of a company (sales per employee) to the regression specifications. According to Tanayama (2007), innovative companies generate higher sales on average compared to non-innovative companies, and as a result the companies with higher sales per employee -ratio are likelier to launch projects that are eligible to public support.

Following the practice of some previous studies (e.g. Klette and Moen, 1998; David *et al.*, 2000) we will introduce the industry dummies and regional dummies to the regression specifications. This helps us against the biased estimates that are otherwise potentially stemming from the inter-industry differences in product characteristics or other such factors that affect the support allocation decisions.

The importance of public support is hard to judge, since the supported companies may already have the best technology or knowledge. A part of the positive impact of public business support on company performance may therefore reflect just the ability of public support organizations to pick up the winners among the applicants. We try to correct this bias by controlling the R&D intensity of the companies. Unfortunately, due to the data limitations it is impossible to introduce project-specific factors to the regression specifications. Our data of project-specific factors is limited only to the support allocated by Tekes. Consequently, we cannot introduce variables that would measure the expected success of a supported project.

Lastly, it is impossible to take into consideration the dynamics of applying for support because the observations related to this information is inadequate. The data include only limited number of observations concerning the companies that have applied for public funding but were rejected.

Table 20 Variables used in the regression analysis

This table presents the variables that are used in the regression analysis.	
$meanGROWTH_{it}^{Turnover}$	Dependent variable. Mean turnover growth of a company during the three most recent years (t, t-1, t-2).
$meanGROWTH_{it}^{Exports}$	Dependent variable. Mean export growth of a company during the three most recent years (t, t-1, t-2).
$meanGROWTH_{it}^{R\&D\_expenditures}$	Dependent variable. Mean private R&D expenditure growth of a company during the three most recent years (t, t-1, t-2).
$\log(meanTEK)_{it}$	Dependent variable. Log of the mean support received by a company from Tekes during the three most recent years (t, t-1, t-2).
$\log(meanFIV)_{it}$	Dependent variable. Log of the mean support received by a company from Finnvera during the three most recent years (t, t-1, t-2).
$\log(meanTEM)_{it}$	Dependent variable. Log of the mean support received by a company from TEM during the three most recent years (t, t-1, t-2).
$\log(meanMMM)_{it}$	Dependent variable. Log of the mean support received by a company from MMM during the three most recent years (t, t-1, t-2).
$allTEK_t$	Instrument variable. Total annual support allocated by Tekes.
$allFIV_t$	Instrument variable. Total annual support allocated by Finnvera.
$allTEM_t$	Instrument variable. Total annual support allocated by TEM.
$allMMM_t$	Instrument variable. Total annual support allocated by MMM.
$\log(ika)_{it}$	Log of age
$\log(hk)_{it}$	Log of employment (number of employees)
$\log(lv\_hk)_{it}$	Log of sales per employee
$\log(suht\_tkmenot)_{it}$	R&D intensity (private R&D expenditure divided by turnover)
U	Vector of geography dummy variables, indicating the region.
T	Vector of industry dummy variables, indicating the industrial classification.
$lagsumTEK_{it}$	Lagging continuous sum variable of Tekes' subsidies. Sums the total support received by a company in years t-1 and t-2.
$lagsumFIV_{it}$	Lagging continuous sum variable of Finnvera's subsidies. Sums the total support received by a company in years t-1 and t-2.
$lagsumTEM_{it}$	Lagging continuous sum variable of TEM's subsidies. Sums the total support received by a company in years t-1 and t-2.
$lagsumMMM_{it}$	Lagging continuous sum variable of MMM's subsidies. Sums the total support received by a company in years t-1 and t-2.

7. ANALYSIS AND RESULTS

7.1. Descriptive analysis

The aim of this descriptive analysis is to summarize the key properties of the used data. The descriptive analysis is divided into three different parts. First we are going to present the descriptive statistics related to the distribution of data. Then we will present a few key figures of the observed companies, and finally the statistics related to the company performance indicators.

If not stated otherwise the statistics are based on the data that has been gathered up from the years 2004-2008.

7.1.1. Distribution of the data

Based on *Table 21* we can say that the data is annually well distributed. We have enough observations for every year in order to execute the regressions properly.

Table 21 Distribution of the data: year, company size and age

This table presents the distribution of the data based on annual observations, the size of companies measured by the amount of employees and the age of a company.

Annual distribution		Company size (employees)		Age (years)	
2004	16,92 %	Below 10	92,36 %	Under 2	9,91 %
2005	17,22 %	10 – 49	5,05 %	2 – 5	18,19 %
2006	20,35 %	50 – 250	0,92 %	6 – 10	18,43 %
2007	22,34 %	Over 250	0,23 %	Over 10	53,46 %
2008	23,19 %	Not known	14,44 %		

Most of the Finnish companies are small sized and it naturally shows in our data because the data is consisting of all Finnish firms. 92,36 per cent of the observed companies have less than ten employees. Only 0,23 per cent of the observed companies have over 250 employees.

Furthermore, 53,46 per cent of the companies are over 10 years old, and only one tenth of the observed companies has been established during the last two years.

Table 22 presents the distribution of observed companies based on their R&D intensity. As we have noted earlier, only some of the business support instruments focus on private R&D activity. Therefore the companies may have received public business support although the company doesn't have private R&D expenditures. R&D intensity describes the relation between the private R&D expenditure and total turnover, so it doesn't include the public R&D support amounts that are possibly received by the company. Only under 0,8 per cent of the observed companies have private R&D expenditure, hence,

the R&D intensity larger than zero. The relation is about the same among SMEs, but when observing the large companies almost 40 per cent have a positive R&D intensity.

Table 22 Distribution of the data: R&D intensity

This table presents the distribution of the data based on the R&D intensity of all observed companies. The R&D intensity is the relation between the private R&D expenditure and turnover.

R&D intensity	All companies	SMEs	Large companies
0 %	99,24 %	99,36 %	61,70 %
1 – 5 %	0,38 %	0,28 %	33,13 %
5 – 10 %	0,09 %	0,08 %	2,33 %
Over 10 %	0,29 %	0,28 %	2,83 %

Table 23 presents the industrial distribution of the data. We report the distribution among all companies and R&D intensive companies separately. Of all R&D intensive companies in the data, 66,23 per cent operate in extractive industry, 20,06 per cent in unspecified service sector, 3,85 per cent in real estate services and 2,28 per cent in finance and insurance industry.

Table 23 Industrial distribution of the data

This table presents the industrial distribution of the data. Second column presents the distribution when observing the whole sample, hence, all Finnish firms registered in the business register. The second column presents the distribution among R&D intensive companies. The R&D intensity is the relation between the private R&D expenditure and turnover.

Industry	All companies	R&D intensive companies
Basic metal production	1,71 %	0,32 %
Business services, R&D	11,83 %	1,57 %
Chemistry	0,36 %	0,38 %
Commerce and trading	16,65 %	1,15 %
Computer services	17,64 %	0,97 %
Construction	12,79 %	0,65 %
Electricity and electronics	0,60 %	0,56 %
Engines and machines	1,53 %	0,66 %
Extractive industry	12,56 %	66,23 %
Finance and insurance	1,39 %	2,28 %
Food industry	0,64 %	0,22 %
Forest	0,97 %	0,22 %
Other industry	2,55 %	0,45 %
Other services	20,14 %	20,06 %
Real estate services	5,39 %	3,85 %
Tevanake	0,82 %	0,10 %
Traffic	8,32 %	0,33 %

Table 24 presents the regional distribution of the data. We report the distribution among all companies, R&D intensive companies and supported companies separately.

44,25 per cent of all R&D intensive companies is situated in the Western Finland while the Southern Finland region holds 29,83 per cent and the Eastern Finland region 14,11 per cent of all R&D intensive companies.

Respectively, 37,58 per cent of all supported companies is situated in the Western Finland while the Southern Finland region holds 32,81 per cent and the Eastern Finland region 14,87 per cent of all supported companies.

Table 24 Regional distribution of the data

This table presents the regional distribution of the data. Second column presents the distribution when observing the whole sample. The columns in the middle present the distribution among the R&D intensive companies. The R&D intensity is the relation between the private R&D expenditure and turnover. The last columns present the distribution among the supported companies. 'Supported companies' refers to those companies which have received public business support at least once from one of the public support organizations.

	All	**R&D intensive companies**			**Supported companies**		
Region	**All**	**All**	**SMEs**	**Large**	**All**	**SMEs**	**Large**
Southern Finland	40,96 %	29,83 %	29,51 %	65,16 %	32,81 %	32,10 %	67,38 %
Western Finland*	37,28 %	44,25 %	44,42 %	25,25 %	37,58 %	37,91 %	21,28 %
Eastern Finland	9,88 %	14,11 %	14,20 %	4,57 %	14,87 %	15,04 %	6,60 %
Oulu region	7,15 %	9,22 %	9,27 %	3,61 %	9,53 %	9,65 %	3,60 %
Lappi	3,23	2,60 %	2,61 %	1,41 %	5,20 %	5,28 %	1,15 %
Not known	1,50 %						

*Western Finland region includes Åland

In conclusion, the data is annually well distributed and consists mainly of small and not R&D active companies. The R&D intensive companies and supported companies tend to cluster in the Southern and Western Finland.

7.1.2. Key figures of observed companies

At this moment on we turn our focus on the differences between the supported and unsupported companies. *Figure 15* below reports the relative shares of SMEs and large companies in the whole sample, and among the supported and unsupported companies. The share of large companies in different samples varies a lot. When observing all companies, the share of large companies is 0,31 per cent. Among the supported companies the share of large companies is, however, 9,75 per cent.

Figure 15 Relative shares of SMEs and large companies in different samples

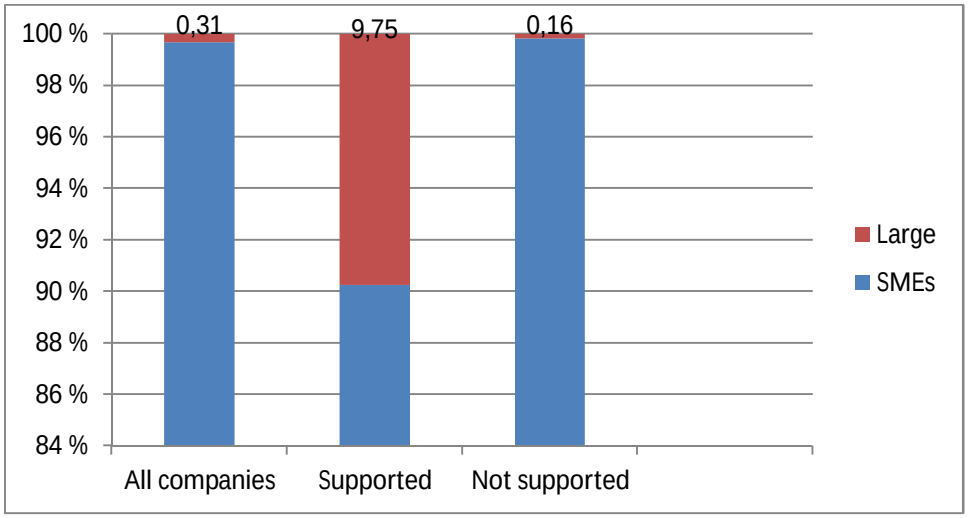


Table 25 presents a few key figures of observed companies. The statistics include the turnover, net profit, total personnel and age of the companies.

On average, the supported SMEs are somewhat older and the supported large companies somewhat younger than the companies, which have not received public business support. Furthermore, the supported companies, both SMEs and large ones, employ a greater number of people compared to the unsupported companies. When the average size of an unsupported SMEs is 4,05 employees, the average size of a supported SMEs is almost ten times larger (34,10 employees). In addition, when the average size of an unsupported large company is 642,15 employees, the same figure for a supported large company is 867,53.

The average turnover of a supported company is higher than the average turnover of an unsupported company. Especially the differences between the supported and unsupported SMEs are clear. When the average turnover for a supported SME is 6,26 million euro, the same figure for an unsupported SME is only 0,51 million euro. For a large supported company the average turnover is almost double as large as the average turnover of an unsupported large company.

In relation to the average net profit there is more variation. The average annual net profit of a supported large company (18,52 MEUR) is almost four times larger compared to the average net profit of an unsupported large company (5,80 MEUR). While the average annual net profit for an unsupported SMEs is 0,02 million euro, the same figure for a supported SMEs is not even positive (-0,02 MEUR).

> *In conclusion, the key figures of the supported companies differ from the figures of unsupported companies. On average, a supported SME is older and larger, and a supported large company younger and larger than a company, which have not received*

public business support. The supported companies have also higher turnover. However, although on average the supported large companies have higher net profit than unsupported large companies, the situation is reverse with SMEs.

Table 25 Statistics related to company information

This table presents the statistics related to the age, total personnel, total turnover and net profit of observed companies. It reports the figures from the whole examination period (2004-2008). The first columns presents the information related to the while sample. The columns in the middle present the figures among the R&D intensive companies. Here the R&D intensity is the relation between the private R&D expenditure and total turnover. The last columns present the distribution among the supported companies. 'Supported companies' refers to those companies which have received public business support at least once and at least from one of the public support organizations.

	Whole sample			**Supported companies**			**Not supported companies**		
	All	**SMEs**	**Large**	**All**	**SMEs**	**Large**	**All**	**SMEs**	**Large**
Age (years)									
Mean	11,41	11,38	20,50	13,85	13,29	19,02	11,37	11,35	21,97
St. Dev.	9,28	9,21	20,64	13,06	11,84	20,53	9,20	9,16	20,65
Min (10 %)	0	0	0	0	0	0	0	0	0
Max (90 %)	109	109	108	108	108	108	109	109	108
Total personnel									
Mean	5,83	3,49	754,64	115,39	34,10	867,53	4,05	3,04	642,15
St. Dev.	94,45	11,81	1499,66	604,57	47,72	1760,75	54,12	9,69	1172,98
Min (10 %)	0	0	0	0	0	0	0	0	0
Max (90 %)	23905	249,8	23905	23884	249	23884	13618	250	13618
Turnover (MEUR)									
Mean	1,37	0,61	251,46	35,54	6,26	306,79	0,76	0,51	180,63
St. Dev.	57,39	6,40	1003,86	413,36	13,72	1292,58	16,91	6,17	387,74
Min (10 %)	0	0	0	0	0	0	0	0	0
Max (90 %)	26900	3586,23	26900	26900	334,13	26900	5381,96	3586,23	5381,96
Net profit (MEUR)									
Mean	0,06	0,02	12,96	1,78	-0,02	18,52	0,03	0,02	5,80
St. Dev.	8,38	1,11	150,32	59,81	6,34	189,83	2,77	0,78	72,28
Min (10 %)	-799,66	-330,90	-799,66	-799,66	-321,32	-799,66	-452,65	-266,26	-402,54
Max (90 %)	2966,54	235,02	2966,54	2827,56	186,56	2827,56	1030,36	220,89	1030,36

7.1.3. Business expansion indicators

This part of the descriptive analysis presents the statistics concerning the development of firm-level measures. In focus are the absolute annual growth rates of sales, private R&D expenditure and exports.

First, we are going to present the levels of annual sales, private R&D expenditure and export for the supported and unsupported companies.

Table 26 shows the levels of annual sales for different samples. On average the level of sales in 2004, which is the first year of our research frame, is already higher for the supported companies compared to the unsupported companies. The supported SMEs have on average a three times larger turnover (1,64 MEUR) than their unsupported counterparts (0,55 MEUR). The supported large companies have double as large turnover in 2004 as the unsupported large companies. Furthermore, while the average level of sales for unsupported SMEs and large companies is at the same level four years later, the average level of sales for supported companies have increased. On average, the level of sales of supported SMEs is 12,8 per cent higher in 2008 (1,85 MEUR) than in 2004, and of supported large companies it is 19,2 per cent higher than in 2004.

Table 27 shows the levels of annual private R&D expenditure for different samples. Here the whole sample, as well as the supported and unsupported companies, includes only those companies that have had positive private R&D expenditure at least once during the years 2004-2008.

On average, the level of private R&D expenditure in 2004 is higher for the supported companies compared to the unsupported companies. The supported SMEs (0,011 MEUR) and large companies (8,157 MEUR) have on average ten times larger private R&D expenditure than their unsupported counterparts. While there is no increase in the level of private R&D expenditure for unsupported SMEs during the four examination years, the supported SMEs increase their private R&D expenditure for 18,2 per cent on average. Whereas the level of private R&D expenditure of supported large companies increase on average 10,3 per cent (9,001 MEUR), the level of private R&D expenditure of unsupported counterparts decrease with 12,3 per cent (0,743 MEUR).

Table 28 presents the levels of annual export for different samples. Here the whole sample, as well as the supported and unsupported companies, includes only those companies that have had positive export figures at least once during the years 2004-2008.

On average the level of export is higher for supported companies. The supported SMEs have double as large and the supported large companies six times as large export in 2004 as their unsupported counterparts. By the year 2008 the level of export of the supported SMEs grew 3,8 per cent (1,37 MEUR) and the level of export of the supported large companies 16,6 per cent (140,65 MEUR). At the same time, the level of export of unsupported SMEs decreased and the level of export of large companies increased only 6,5 per cent.

Table 26 Levels of annual sales in 2004 and 2008

This table presents the levels of annual sales (MEUR) in 2004 and 2008. We present the figures for the whole sample and in addition for the supported and not supported companies separately.

	Mean		St. Dev.		Min (10 %)		Max (90 %)	
	2004	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**
Whole sample								
All	1,37	1,53	54,27	66,04	0	0	4416,97	8143,56
SME	0,62	0,64	4,71	5,50	0	0	413,30	971,32
Large	251,05	286,43	959,58	1144,90	2,37	0	4416,97	8143,56
Supported companies								
All	8,43	10,09	201,95	236,38	0	0	4416,97	8143,56
SME	1,64	1,85	5,52	10,71	0	0	137,88	164,53
Large	357,03	425,71	1420,76	1642,83	10,40	0,09	4416,97	8143,56
Not supported companies								
All	0,85	0,85	13,80	15,82	0	0	1357,02	2863,76
SME	0,55	0,55	4,63	4,85	0	0	413,30	387,41
Large	169,63	167,44	255,42	312,24	9,97	0	1357,92	2863,76

Table 27 Levels of annual private R&D expenditure in 2004 and 2008

This table presents the levels of annual private R&D expenditure (MEUR) in 2004 and 2008. We present the figures for the whole sample and in addition for the supported and not supported companies separately.

	Mean		St. Dev.		Min (10 %)		Max (90 %)	
	2004	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**
Whole sample								
All	0,014	14,060	3,423	3,171	-1,874	-2,681	66,152	122,364
SME	0,002	2,060	0,069	0,163	-1,830	-1,853	8,458	28,381
Large	3,866	4,457	61,514	60,885	-0,620	-1,011	66,152	122,364
Supported companies								
All	0,171	0,185	13,383	12,586	-1,874	-2,681	66,152	122,364
SME	0,011	0,013	0,209	0,376	-1,830	-1,853	8,458	11,261
Large	8,157	9,001	95,532	90,599	-0,620	-1,011	66,152	122,364
Not supported companies								
All	0,003	0,003	0,186	0,176	0	0	28,762	27,921
SME	0,001	0,001	0,045	0,137	0	0	5,480	12,140
Large	0,847	0,743	4,012	2,660	0	0	28,762	22,685

Table 28 Levels of annual export in 2004 and 2007

This table presents the levels of annual export (MEUR) in 2004 and 2007. We present the figures for the whole sample and in addition for the supported and not supported companies separately.

	Mean		St. Dev.		Min (10 %)		Max (90 %)	
	2004	**2007**	**2004**	**2007**	**2004**	**2007**	**2004**	**2007**
Whole sample								
All	2,52	7,74	75,58	226,42	0	0	9,23	3301,30
SME	0,75	0,75	3,61	3,67	0	0	62,32	49,86
Large	62,92	79,29	466,59	755,78	0	0	2080,44	3301,30
Supported companies								
All	16,97	21,67	260,39	415,72	0	0	2080,44	3301,30
SME	1,32	1,37	4,77	5,05	0	0	49,01	49,04
Large	120,67	140,65	711,33	1082,20	0	0	2080,44	3301,30
Not supported companies								
All	1,86	1,93	16,70	22,30	0	0	301,00	608,22
SME	0,57	0,52	3,11	2,95	0	0	47,94	43,97
Large	20,79	22,14	62,00	84,08	0	0	3001,00	608,22

In conclusion, in the beginning of our research frame the sales, private R&D expenditure and export are already at the higher level among the supported companies compared to the companies that have not received public business support. In the means of these simple indicators the supported companies also grow faster during the four years.

Next tables present the actual average growth rates for sales, private R&D expenditure and export.

Table 29 presents the absolute annual growth rates of sales during the years 2004 and 2008. The average growth rate of a supported SME (22,35 %) is double as high as the average growth rate of an unsupported SME (10,71 %). The average growth rate of a supported large company (12,47 %) is also somewhat higher than the average growth rate of an unsupported large company (11,20 %).

Table 30 shows the absolute annual growth rates of private R&D expenditure during the years 2004 and 2008. Only the growth rates for supported and unsupported large companies are positive. While the private R&D expenditure has on average grown 0,72 per cent among the unsupported large companies, the average growth rate for supported large companies is seven times as large (5,44 %). The growth rate of private R&D expenditure is negative for both supported (-23,45 %) and unsupported SMEs (-19,38 %). Furthermore, the decrease in private R&D expenditure growth rate has not been as strong for unsupported SMEs as it has been for the supported SMEs.

Table 31 shows the absolute annual growth rates of export during the years 2004-2007. The export growth rate for supported SMEs (19,65 %) and large companies (17,13 %) are lower compared to the unsupported companies. The growth rate of export for unsupported SME was 26,06 per cent on average, and for unsupported large company 22,27 per cent on average.

In conclusion, the annual growth rate of sales is on average higher for a supported company than for an unsupported company. The annual growth rate of private R&D expenditure is on average higher for a supported large company, but is the lowest and negative for a supported SME. The growth rates of export are lower for supported companies.

Table 29 Absolute annual growth of sales 2004-2008

This table presents the absolute annual growth of sales for the observed companies during the time period of 2004-2008. We present the figures for the whole sample and in addition for the supported and unsupported companies separately.

	Observations	Mean	St. Dev.	Min (10 %)	Max (90 %)
Whole sample					
All	859063	11,54 %	0,50	-100 %	400 %
Supported companies					
All	61917	22,12 %	0,54	-100 %	399,29 %
SMEs	60504	22,35 %	0,55	-100 %	399,29 %
Large	1413	12,47 %	0,29	-96,60 %	268,66 %
Not supported companies					
All	797146	10,72 %	0,49	-100 %	400 %
SMEs	795592	10,71 %	0,49	-100 %	400 %
Large	1554	11,20 %	0,34	-100 %	291,70 %

Table 30 Absolute annual growth of private R&D expenditure 2004-2008

This table presents the absolute annual growth of private R&D expenditure for the observed companies during the time period of 2004-2008. We present the figures for the whole sample and in addition for the supported and unsupported companies separately. Here the whole sample, as well as supported and unsupported companies, includes only those companies which have had positive private R&D expenditure at least once during the years 2004-2008.

	Observations	Mean	St. Dev.	Min (10 %)	Max (90 %)
Whole sample					
All	6425	-16,93 %	0,85	-100 %	395,72 %
Supported companies					
All	2976	-17,58 %	0,86	-100 %	393,95 %
SMEs	2371	-23,45 %	0,88	-100 %	389,40 %
Large	605	5,44 %	0,72	-100 %	375,26 %
Not supported companies					
All	3449	-16,38 %	0,84	-100 %	395,72 %
SMEs	2934	-19,38 %	0,87	-100 %	395,72 %
Large	515	0,72 %	0,66	-100 %	316,08 %

Table 31 Absolute annual growth of export 2004-2007

This table presents the absolute annual growth of export for the observed companies during the time period of 2004-2007. We present the figures for the whole sample and in addition for the supported and unsupported companies separately. Here the whole sample, as well as the supported and unsupported companies, includes only those companies which have had positive private R&D expenditure at least once during the years 2004-2007.

	Observations	Mean	St. Dev.	Min (10 %)	Max (90 %)
Whole sample					
All	6590	22,42 %	0,7742	-100 %	392,06 %
Supported companies					
All	3200	19,18 %	0,7799	-100 %	376,48 %
SMEs	2599	19,65 %	0,808	-100 %	376,32 %
Large	601	17,13 %	0,6444	-100 %	218,44 %
Not supported companies					
All	3390	25,48 %	0,7676	-100 %	391,84 %
SMEs	2864	26,06 %	0,7864	-100 %	373,97 %
Large	526	22,27 %	0,6556	-100 %	282,32 %

7.3. Regression analysis

7.3.1. Regression model specifications

The IV regression model specifications are presented in *Table 32*.

We have tested the multicollinearity that potentially arises from the regression equations with multiple variables by calculating the correlations between the explanatory variables[21]. We didn't find significant correlation between any of the variables, so we conclude that the regressions should not suffer from multicollinearity.

7.3.2. Regression results

The instrumental variable regressions seek to validate the impact of public business support on the company performance. The first-stage regression equations are used to run regressions for the endogenous covariates with all the exogenous variables in the model, containing also the instrumental variable. In the second stage, each endogenous covariate is replaced with the predicted values from the first stage model. In other respects the model is estimated in the second stage as usual.

To control the potential bias caused by the outliers, the companies with performance indicator's growth rate higher than 400 per cent are excluded from the samples. Otherwise, the samples are defined as follows.

The sample for the regression model estimating the turnover growth consists of the companies that in general have observations in the database during the years 2004-2008.

The sample for the regression model estimating the private R&D expenditure growth consists only of the companies that have had at least once a positive private R&D expenditure entry in the database during the years 2004-2008.

The sample for the regression model estimating the export growth consists only of the companies that have had at least once a positive export entry in the database during the years 2004-2007. Altogether, the database includes the export information only for companies operating in specific industries and employing over 20 people.

All regressions will be also run for samples consisting of SMEs and large companies only.

[21] See *Annex 2.*

Table 32 IV regression model specifications

This table presents the regression model specifications for each model group and firm/level economic impact that is explained through regression model. The variables are defined in sub-chapter 7.3.2.2.

Dependent variable	Instrument variable	Model specification: first-stage regression specifications
Support amount received from Tekes	Total amount of support allocated (Tekes)	$\log(meanTEK)_{it} = \pi_0 + \pi_1 allTEK_t + \beta_1 \log(ika)_{it} + \beta_2 \log(hk)_{it} + \beta_3 \log(lv\_hk)_{it} + \beta_4 \log(suht\_tkmenot)_{it} + \beta_5 U + \beta_6 T + \beta_7 lagsumTEK_{it} + \beta_8 lagsumFIV_{it} + \beta_9 lagsumTEM_{it} + \beta_{10} lagsumMMM_{it} + u_{it}$
Support amount received from Finnvera	Total amount of support allocated (Finnvera)	$\log(meanFIV)_{it} = \pi_0 + \pi_1 allFIV_t + \beta_1 \log(ika)_{it} + \beta_2 \log(hk)_{it} + \beta_3 \log(lv\_hk)_{it} + \beta_4 \log(suht\_tkmenot)_{it} + \beta_5 U + \beta_6 T + \beta_7 lagsumTEK_{it} + \beta_8 lagsumFIV_{it} + \beta_9 lagsumTEM_{it} + \beta_{10} lagsumMMM_{it} + u_{it}$
Support amount received from TEM	Total amount of support allocated (TEM)	$\log(meanTEM)_{it} = \pi_0 + \pi_1 allTEM_t + \beta_1 \log(ika)_{it} + \beta_2 \log(hk)_{it} + \beta_3 \log(lv\_hk)_{it} + \beta_4 \log(suht\_tkmenot)_{it} + \beta_5 U + \beta_6 T + \beta_7 lagsumTEK_{it} + \beta_8 lagsumFIV_{it} + \beta_9 lagsumTEM_{it} + \beta_{10} lagsumMMM_{it} + u_{it}$
Support amount received from MMM	Total amount of support allocated (MMM)	$\log(meanMMM)_{it} = \pi_0 + \pi_1 allMMM_t + \beta_1 \log(ika)_{it} + \beta_2 \log(hk)_{it} + \beta_3 \log(lv\_hk)_{it} + \beta_4 \log(suht\_tkmenot)_{it} + \beta_5 U + \beta_6 T + \beta_7 lagsumTEK_{it} + \beta_8 lagsumFIV_{it} + \beta_9 lagsumTEM_{it} + \beta_{10} lagsumMMM_{it} + u_{it}$
Form of impact	**Firm-level measure**	**Model specification: second-stage regression specifications**
Company size	Turnover growth, three year average	$\frac{Y_{it}^{Turnover} + Y_{i,t-1}^{Turnover} + Y_{i,t-2}^{Turnover}}{3} = \overline{\beta_0} + \overline{\beta_1 \log(meanTEK)_{it}} + \overline{\beta_2 \log(meanFIV)_{it}} + \overline{\beta_3 \log(meanTEM)_{it}} + \overline{\beta_4 \log(meanMMM)_{it}} + \overline{\beta_5 log(ika)_{it}} + \overline{\beta_6 log(hk)_{it}} + \overline{\beta_7 log(lv\_hk)_{it}} + \overline{\beta_8 log(suht\_tkmenot)_{it}} + \overline{\beta_9 U_i} + \overline{\beta_{10} T_i} + \overline{\beta_{11} lagsumTEK_{it}} + \overline{\beta_{12} lagsumFIV_{it}} + \overline{\beta_{13} lagsumTEM_{it}} + \overline{\beta_{14} lagsumMMM_{it}} + \overline{u_{it}}$
Company size	Export growth, three year average	$\frac{Y_{it}^{Export} + Y_{i,t-1}^{Export} + Y_{i,t-2}^{Export}}{3} = \overline{\beta_0} + \overline{\beta_1 \log(meanTEK)_{it}} + \overline{\beta_2 \log(meanFIV)_{it}} + \overline{\beta_3 \log(meanTEM)_{it}} + \overline{\beta_4 \log(meanMMM)_{it}} + \overline{\beta_5 log(ika)_{it}} + \overline{\beta_6 log(hk)_{it}} + \overline{\beta_7 log(lv\_hk)_{it}} + \overline{\beta_8 log(suht\_tkmenot)_{it}} + \overline{\beta_9 U_i} + \overline{\beta_{10} T_i} + \overline{\beta_{11} lagsumTEK_{it}} + \overline{\beta_{12} lagsumFIV_{it}} + \overline{\beta_{13} lagsumTEM_{it}} + \overline{\beta_{14} lagsumMMM_{it}} + \overline{u_{it}}$
Innovation	Private R&D expenditure growth, three year average	$\frac{Y_{it}^{R\&Dexpenditures} + Y_{i,t-1}^{R\&Dexpenditures} + Y_{i,t-2}^{R\&Dexpenditures}}{3} = \overline{\beta_0} + \overline{\beta_1 \log(meanTEK)_{it}} + \overline{\beta_2 \log(meanFIV)_{it}} + \overline{\beta_3 \log(meanTEM)_{it}} + \overline{\beta_4 \log(meanMMM)_{it}} + \overline{\beta_5 log(ika)_{it}} + \overline{\beta_6 log(hk)_{it}} + \overline{\beta_7 log(lv\_hk)_{it}} + \overline{\beta_8 log(suht\_tkmenot)_{it}} + \overline{\beta_9 U_i} + \overline{\beta_{10} T_i} + \overline{\beta_{11} lagsumTEK_{it}} + \overline{\beta_{12} lagsumFIV_{it}} + \overline{\beta_{13} lagsumTEM_{it}} + \overline{\beta_{14} lagsumMMM_{it}} + \overline{u_{it}}$

Next we will present the estimated results. First we will present the results for the turnover growth, secondly for the export growth, and thirdly for the private R&D expenditure growth.

The general conclusions are that we obtain statistically significant results when we are examining the impact on turnover growth. However, we face more challenges when estimating the impact on export growth and private R&D expenditure growth. These estimation results are based on a substantially smaller amount of observations than the results concerning the turnover growth. The models estimating the impact on export growth and private R&D expenditure growth generate less statistically significant results and lower coefficients of determination. Consequently, we created specification equations[22] for export growth and private R&D expenditure growth to estimate also the impact on annual growth rates in addition to the three-year average growth rates. These estimation results will be used to support the analysis related to the impact of public business support on export growth and private R&D expenditure growth.

We will start with the results related to the turnover growth. *Table 33* presents the results of IV regression with random effects in the whole sample and among the SMEs and large companies separately. The results of linear GLS model were generated in order to execute the Hausman test[23] between the IV regression model and the linear GLS model.

The most important observations concerning the model estimating turnover growth are that the coefficients for public support variables are positive and statistically significant at 99,9% confidence level. The variable describing the support allocated by MMM receives the highest coefficient (0,005) indicating the highest positive effect on turnover growth. The coefficients for Finnvera's (0,004), Tekes' (0,004) and TEM's (0,003) support are just a bit lower.

Older companies as well as more R&D intensive companies attain lower turnover growth. There again, the size and efficiency of a company are positively related to turnover growth. The coefficient for R&D intensity variable is the weakest of these four coefficients (-0,004), indicating that the other factors than R&D intensity have a larger impact on company growth.

Of the regional dummies only the Western Finland (0,012) and Oulu region (0,010) get statistically significant positive coefficients implying that the companies from these regions obtain a higher turnover growth. The Southern Finland region is serving as a reference group and is therefore omitted from the results.

[22] The equations can be found in *Annex 3*.
[23] The Hausman test results can be found in *Annex 4.*

Table 33 Turnover growth, three year average

This table presents the results of IV regression model with random effects and linear GLS regression model. The first column presents the different variables employed in the models. The second column presents the estimated coefficients and T-values of IV model within the whole data sample. The third column presents the estimated coefficients of linear GLS model within the whole data sample. The final two columns present the estimated coefficients and T-values of IV model within SMEs and large companies separately.

Turnover growth, three-year average

	IV (random effects)		**Linear GLS model**	**IV (re) SMEs**		**IV (re) Large**	
	Coefficient	T-value	Coefficient	Coefficient	T-value	Coefficient	T-value
	R^2=0,257, n=261703		R^2=0,254, n=261703	R^2=0,256, n=261041		R^2=0,332, n=1052	
Tekes support	0,004	4,66***	0,000	0,005	5,71***	0,002	0,53
Finnvera support	0,004	8,84***	0,021***	0,004	8,21***	0,000	0,02
TEM support	0,003	9,61***	0,002***	0,003	9,88***	0,002	0,58
MMM support	0,005	4,98***	0,011***	0,005	4,97***	-0,004	-0,33
Age	-0,468	-440,58***	-0,491***	-0,470	-440,60***	-0,256	-25,49***
Size (employees)	0,074	105,24***	0,096***	0,077	105,68***	0,006	0,41
Sales / employee	0,081	108,06***	0,102***	0,085	108,65***	-0,011	-0,77
R&D intensity	-0,004	-8,16***	-0,004***	-0,003	-5,84***	-0,001	-0,56
Southern Finland	(omitted)		(omitted)	(omitted)		(omitted)	
Western Finland	0,012	5,84***	0,012***	0,011	5,53***	0,002	0,05
Eastern Finland	0,001	0,44	-0,001	0,000	0,13	0,054	0,72
Oulu region	0,010	2,66***	0,004	0,008	2,29**	0,022	0,03
Lapland	0,002	0,39	-0,003	0,001	0,24	-0,041	-0,28
Received support earlier (Tekes)	0,000	-3,34***	0,000***	0,000	-2,12**	0,000	-0,23
Received support earlier (Finnvera)	0,000	6,36***	0,000***	0,000	5,30***	0,000	-0,24
Received support earlier (TEM)	0,000	2,64***	0,000	0,000	4,85***	0,000	-2,82***
Received support earlier (MMM)	0,002	12,15***	0,001***	0,002	12,00***	0,000	0,04
Constant	1,372	83,63***	1,525***	1,389	83,77***	0,857	3,03***
+ industry dummies							

Statistically significant at *95%, **99% and ***99,9% confidence level.

Concerning the results of the sample consisting of SMEs only we can observe that the coefficients for public support variables are still positive and statistically significant at 99,9% confidence level. The coefficients stay at approximately same level. R&D intensity has still negative but small impact on turnover growth (-0,003). The regional dummies for Western Finland and Oulu region have statistically significant positive coefficients.

As regards to the sample consisting of the large companies only we receive only few statistically significant results. The coefficients for Tekes' (0,002), Finnvera's (0,000) and TEM's (0,002) support variables are positive and the coefficient for MMM's support variable (-0,004) negative, but none of them are statistically significant.

> *To sum up, the results indicate that the turnover growth of publicly supported companies is faster than the turnover growth of unsupported companies, but the impact of support on growth is small. Older and more R&D intensive companies attain lower turnover growth. The size and efficiency of a company are positively related to turnover growth. The coefficients remain at the same level when we are observing the sample consisting of SMEs only. With the sample consisting of the large companies only we receive few statistically significant results.*

Next, *Table 34* presents the results for the regression specification of export growth [24].

The most important observations concerning the model estimating the three-year average export growth are that there are only a few coefficients that are statistically significant and that the coefficient of determination is lower than in the previous estimation.

Regarding the variables describing the public support allocated by support organizations, only TEM receives a positive coefficient (0,005) that is statistically significant. Tekes (0,001), Finnvera (0,003) and MMM (0,02) receive positive coefficients as well, but none of them is statistically significant.

Based on the estimation results, larger and more efficient companies attain higher export growth.

The dummy variable for Oulu region receives a positive coefficient (0,082) that is statistically significant at 99% confidence level, implying that companies from this region obtain higher export growth. This coefficient is even larger (0,243) when estimating the impact among the large companies only.

[24] We have estimated the IV regression also for annual export growth. The results will be used in the analysis and they can be found in *Annex 3*.

Table 34 Export growth, three year average

This table presents the results of IV regression model with random effects and linear GLS regression model. The first column presents the different variables employed in the models. The second column presents the estimated coefficients and T-values of IV model within the whole sample. The third column presents the estimated coefficients of linear GLS model within the whole sample. The final two columns present the estimated coefficients and T-values of IV model within SMEs and large companies separately.

Export growth, three-year average							
	IV (random effects)		**Linear GLS model**	**IV (re) SMEs**		**IV (re) Large**	
	Coefficient	T-value	Coefficient	Coefficient	T-value	Coefficient	T-value
	R^2=0,0422, n=1649		R^2=0,0410, n=1649	R^2=0,045, n=1403		R^2=0,107, n=313	
Tekes support	0,001	0,54	0,000	0,002	0,93	0,001	-0,20
Finnvera support	0,003	1,56	0,002	0,003	1,18	0,006	0,65
TEM support	0,005	2,62**	0,003**	0,006	1,83*	0,002	0,60
MMM support	0,02	0,61	(omitted)	0,048	2,62**	0,007	0,32
Age	-0,007	-0,65	-0,007	-0,005	-0,41	-0,019	-1,11
Size (employees)	0,032	4,34***	0,035***	0,065	6,29***	0,033	1,66
Sales / employee	0,050	6,24***	0,052***	0,077	7,09***	0,048	2,59**
R&D intensity	-0,001	-1,44	-0,001	-0,001	-1,04	0,001	0,34
Southern Finland	(omitted)		(omitted)	(omitted)		(omitted)	
Western Finland	-0,004	-0,22	0,001	-0,013	-0,67	0,000	0,00
Eastern Finland	0,033	1,05	0,049	0,0164	0,48	0,037	0,53
Oulu region	0,082	2,23**	0,092*	0,05	1,20	0,243	3,44***
Lapland	0,027	0,43	0,039	-0,006	-0,09	0,088	0,77
Received support earlier (Tekes)	0,000	-2,17**	0,000	0,000	-1,89*	0,000	-0,66
Received support earlier (Finnvera)	0,000	0,67	0,000	0,000	0,26	0,000	-0,09
Received support earlier (TEM)	0,000	-2,25**	0,000*	0,000	-1,88*	0,000	-1,94*
Received support earlier (MMM)	(omitted)		(omitted)	(omitted)		(omitted)	
Constant	(omitted)		-0,284*	(omitted)		(omitted)	
+ industry dummies							

Statistically significant at *95%, **99% and ***99,9% confidence level.

Concerning the results that are based on the sample consisting of SMEs only, we can observe that the support variables for TEM (0,006) and MMM (0,048) receive statistically significant coefficients.

As regards to the sample consisting of large companies only, we receive only a few statistically significant results. The coefficients for all support variables are positive but not statistically significant.

The model estimating annual export growth obtains only a few statistically significant results and consequently doesn't bring noteworthy support on the analysis.

> *To sum up, it is not possible to provide conclusive answers about the impact of public business support on export growth. The results indicate that the support allocated by TEM has a positive impact on export growth. Furthermore, the support allocated by MMM has a positive impact on SMEs' export growth. With the sample consisting of the large companies only we receive few statistically significant results.*

Next, *Table 35* presents the results for the regression specification of private R&D expenditure growth[25].

The most important observations concerning the model estimating the private R&D expenditure growth is that the coefficients for the public support variables of Tekes and TEM are statistically significant at 99,9% (Tekes) and 99% (TEM) confidence level.

The variable describing the support allocated by Tekes gets negative coefficient (-0,012) and therefore indicates that the support allocated by Tekes has a negative impact on the growth of private R&D expenditure.

Because the coefficient of determination was rather low in this estimation we estimated also a model that measured the impact based on the annual growth of private R&D expenditure. This estimation obtained higher coefficient of determination and almost equal amount of statistically significant variables. The variable describing the support allocated by Tekes gets still negative coefficient (-0,023) that is significant at the 99,9% confidence level. Correspondingly, the variable describing the support allocated by TEM gets positive coefficient (0,009) that is significant at the 99% confidence level.

[25] We have estimated the IV regression equation also for annual private R&D expenditure growth. The results will be used in the analysis and they can be found in *Annex 3*.

Table 35 Private R&D expenditure growth, three year average

This table presents the results of IV regression model with random effects and linear GLS regression model. The first column presents the different variables employed in the models. The second column presents the estimated coefficients and T-values of IV model within the whole data sample. The third column presents the estimated coefficients of linear GLS model within the whole data sample. The final two columns present the estimated coefficients and T-values of IV model within SMEs and large companies separately.

Private R&D expenditures growth, three-year average

	IV (random effects)		**Linear GLS model**	**IV (re) SMEs**		**IV (re) Large**	
	Coefficient	T-value	Coefficient	Coefficient	T-value	Coefficient	T-value
	R^2=0,003, n=1424		R^2=0,029, n=1424	R^2=0,011, n=1161		R^2=0,069, n=325	
Tekes support	-0,012	-6,09***	0,001	-0,011	-4,81***	-0,009	-3,40***
Finnvera support	0,001	0,30	0,004**	-0,001	-0,20	0,03	2,64**
TEM support	0,008	3,44***	0,004**	0,008	2,75**	0,006	2,11**
MMM support	-0,028	-1,04	0,012	-0,027	-0,97	-0,028	-1,41
Age	-0,043	-3,47***	-0,033**	-0,074	-4,49***	0,023	1,65
Size (employees)	0,026	4,36***	0,019**	0,032	3,90***	0,013	0,86
Sales / employee	-0,010	-1,23	-0,006	-0,008	-0,70	-0,003	-0,20
Southern Finland	(omitted)		(omitted)	(omitted)		(omitted)	
Western Finland	0,035	1,69	0,024	0,037	1,46	-0,015	-0,50
Eastern Finland	0,012	0,31	0,018	-0,028	-0,60	0,114	1,89*
Oulu region	0,034	0,86	0,033	0,038	0,84	-0,069	-0,86
Lapland	0,10	1,25	0,084	0,146	1,40	-0,037	-0,38
Received support earlier (Tekes)	0,000	3,44***	0,000	0,000	3,45***	0,000	1,49
Received support earlier (Finnvera)	0,000	-0,55	0,000	0,000	-0,81	0,000	-1,65
Received support earlier (TEM)	0,000	-0,45	0,000	0,000	0,68	0,000	-1,83*
Received support earlier (MMM)	0,002	0,45	-0,004	0,002	0,35	(omitted)	
Constant	-0,259	-0,79	0,311	-0,249	-0,69	(omitted)	
+ industry dummies							

Statistically significant at *95%, **99% and ***99,9% confidence level.

When observing the whole sample and the sample consisting of SMEs only, the support variables for Finnvera and MMM don't obtain statistically significant results. However, the results based on the sample consisting of large companies indicate that the support allocated by Finnvera has a positive impact on private R&D expenditure growth. The coefficient (0,03) is statistically significant at 99% confidence level. Nevertheless, this result is out of tune with the outcomes of the model specification that measured the impact on annual growth.

Older companies attain lower private R&D expenditure growth while larger companies attain higher private R&D expenditure growth.

> *To sum up, the results indicate that Tekes fails to support the private R&D expenditure growth while the support allocated by TEM has a positive impact on private R&D expenditure growth. The support allocated by Finnvera has a positive impact on the private R&D expenditure growth of large companies. Older companies attain lower and larger companies attain higher private R&D expenditure growth.*

As a final point, because of the coefficient of determination is very low in the models, which are estimating the impact on export growth and private R&D expenditure growth, we can't judge the results as being too reliable. Possibly there are some central explanatory variables missing from the model specifications. Therefore, we should take with a grain especially the results regarding the impact of public support on private R&D expenditure growth and export growth.

8. Conclusions and suggestions for further research

It's been long recognized that innovation is crucial to social welfare. Numerous different public business support policies all over the world have been developed to promote innovative activities. Finland has succeeded in increasing its total R&D expenditure to a level seen only in a few other countries. However, as the competition in the global market economy intensifies Finland has to ensure a favorable foundation for the future success of Finnish companies and national economy. From this perspective it can be argued that the innovation and technology policy as a tool for achieving better productivity and economic growth has moved into a center stage.

Several recent studies (see *Table 36*) focusing on the Finnish innovation and business support system have highlighted the essential shortcomings of the current system. This thesis participates in the discussion by introducing the research results related to the impact of public R&D and business support on company performance.

The use of public business support instruments is a long-time phenomenon in Finland, which consumes annually a notable amount of public funds. Yet, there are no clear research-based views about the effectiveness of such support policies.

This thesis follows the recent research methods (Wallsten, 2000; Ali-Yrkkö, 2008), which have been used in the impact studies focusing on the effectiveness of public business support. The most severe challenge in conducting a reliable and valid impact research is overcoming the endogeneity problem that arises from the somewhat non-random nature of public support allocation process. There has been presented criticism (Klette *et al.*, 2000; Davis *et al.*, 2000; Wallsten, 2000) according to which the majority of the previous statistical analyses have created biased results due to the inadequate treatment of endogeneity.

To tackle this problem we use panel data and random effects instrumental variable regression in evaluating the impact of public business support on company performance. The total annual support amounts of public support organizations are treated as instrumental variables. The company performance indicators include turnover growth, export growth and private R&D expenditure growth. These performance indicators were chosen based on the analysis made in sub-chapter 3.4. We concluded that the objectives of boosting these three performance indicators cover approximately 80 per cent of all Finnish public business support funding. Therefore, these indicators create an excellent foundation for impact evaluation.

The data includes the R&D and business support amounts allocated by the Finnish Funding Agency for Technology and Innovation (Tekes), Finnvera, the Ministry of Employment and the Economy (TEM), and the Ministry of Agriculture and Forestry (MMM). This "Statistics on business subsidies" -

database is merged with the business register of all companies operating in Finland and the databases of companies' financial information and R&D activities, all provided by Statistics Finland. The availability of the data related to the actual public support amounts and the use of lagged variables in the estimation equations limit our examination period to the years 2004-2008.

Table 36 Results of recent studies focusing on the Finnish R&D and business support system

Writers	Year	Article	Main findings
Pajarinen *et al.*	2009	Which Companies Receive Public Support in Finland, *ETLA Discussion Papers No. 1179*	The results indicate that public support allocated to firms is quite common, larger firms have higher probability of receiving public support than smaller ones, and that receiving public support once increases the probability to apply for and to receive it in the following years.
Kotiranta *et al.*	2009	Evaluating National Innovation Systems – Key Insights from the Finnish Innoeval Survey, *ETLA Discussion Papers No. 1196*	The writers document signs of overlap in support organizations' roles and operational environments. According to their research there seems to be common characteristics in the provision of different services among different public organizations.
Veuglers *et al.*	2009	Evaluation of the Finnish National Innovation System – Full Report, *Taloustieto Oy on behalf of the Ministry of Education and the Ministry of Employment and the Economy*, Helsinki.	According to the evaluation the public support programs seem to overlap with other programs and multiple public agencies appear to work broadly in the same area and with the same firms. The evaluation panel thinks that the Finnish innovation strategy is too vague and not as much of international. The panel also argues that there are signs that the Finnish system is falling behind the global development.
Koski and Pajarinen	2010	Supply, complementarities and repetitiousness of public support in Finland, *ETLA Discussion Papers No. 1217*	The results indicate that there are complementarities between certain support forms and organizations that are allocating public R&D and business support. In addition, the writers document that various firms tend to receive support from the Finnish government repeatedly over time.
Koski and Tuuli	2010	Business subsidies in Finland: the dynamics of application and acceptance stages, *ETLA Discussion Papers No. 1225*	According to the results, there are strong continuities in participation both within and between different public support programs. The writers also document that the firms that have once entered the Finnish subsidy system not only actively seek further support from the same organization but also from the other agencies allocating business subsidies. The results also indicate that the public support agencies favor larger companies in their support allocation decisions.
Koski and Pajarinen	2010	Access to business subsidies: what explains complementarities and persistency?, *ETLA Discussion Papers No. 1226*	The writers find that large firms are less likely to exit the business support system and more likely to continue receiving both support from one organization only and simultaneous support from multiple organizations. The writers find also evidence of agency-specific loyal customers and companies that tend to obtain support simultaneously from at least two different organizations over several years.
Koski and Pajarinen	2010	Do business subsidies facilitate employment growth?, *ETLA Discussion Papers No. 1235*	The results indicate a positive relationship between business subsidies and employment growth. The findings suggest that R&D subsidies contribute to the firms' employment for one year after and employment and other subsidies for three years after the reception of subsidies. Then, the differences between the supported and unsupported firms disappear.

The most relevant conclusions of this research are the following.

The turnover growth of publicly supported companies is faster than the turnover growth of unsupported companies, but the impact of support on growth is rather small.

Every support organization has a positive impact on the turnover growth of private companies. However, the impact of support is small. For example, our results indicate that the public business support allocated by TEM has the strongest impact on private R&D expenditure growth, the second largest impact on export growth and the weakest impact on turnover growth.

Tekes fails to support the private R&D expenditure growth.

The results indicate a larger impact of Tekes' support on private R&D expenditure growth compared to the impact on turnover growth. The essential difference, however, is that the impact of Tekes' support on private R&D expenditure growth is negative and on turnover growth the impact is positive. This indicates that there is crowding out related to the public support allocated by Tekes. The public R&D and business support thus displaces private R&D expenditure and consequently doesn't induce any additional R&D activity.

Finnvera supports the private R&D expenditure growth of large companies. TEM supports the private R&D expenditure growth of all companies.

The results indicate that the impact of Finnvera's support is stronger on larger companies' private R&D expenditure growth than on their turnover growth. TEM has a larger impact on companies' private R&D expenditure growth than on their turnover growth.

It is not possible to provide conclusive answers about the impact of public business support on export growth.

Only the support allocated by TEM obtains statistically significant results. The results indicate that the support has a positive impact on export growth. Finnvera doesn't obtain statistically significant results in any sample group.

The most important findings are summarized around the hypotheses in *Table 37*.

Table 37 Summary of the key findings

This table summarizes the key findings of the thesis.

Hypothesis	Findings
H1. There is a positive relationship between the public business support received and the growth of turnover, and the positive impact is statistically significant.	Based on the regression analysis we can conclude that the turnover growth of supported companies is **faster** than the turnover growth of unsupported companies. All coefficients for the variables describing the allocated public support are statistically significant at 99,9% confidence level. The coefficients remain **small** (0,003-0,005). The coefficients stay statistically significant at 99,9% confidence level when observing the sample consisting of SMEs only.
H2. There is a positive relationship between the public business support received and the growth of export, and the positive impact is statistically significant.	It is not possible to provide conclusive answers about the impact of public business support on export growth. The support allocated by Finnvera doesn't attain statistically significant results. The support allocated by TEM has a statistically significant **positive** impact on export growth when observing the whole sample (0,005) and the sample consisting of SMEs (0,006). The support allocated by MMM has a **positive** impact on the SMEs' export growth (0,048).
H3. There is a positive relationship between the public business support received and the growth of private R&D expenditure, and the positive impact is statistically significant.	Based on the regression analysis we can conclude that several variables describing the allocated public support are statistically significant at least at 95% confidence level. The support allocated by Tekes has a **negative** impact on the private R&D expenditure growth (-0,012). The support allocated by TEM has a **positive** impact on the private R&D expenditure growth (0,008). Finnvera has a **positive** impact on the large companies' private R&D expenditure growth (0,03). The regression model specification of annual growth obtains a larger coefficient of determination (0,028) than the model of average growth (0,003). The results based on this model specification indicate larger **negative** impact of Tekes' support on growth (-0,023) and somewhat larger **positive** impact of TEM's support on growth (0,009). The support allocated by Finnvera doesn't obtain statistically significant results.

Observations	Findings
*There is a **positive** relationship between the size of a company and the development of the performance indicators.*	Positive coefficient for company size variable indicates that larger companies attain a higher turnover growth (0,074), a higher export growth (0,032), and a higher private R&D expenditure growth (0,026).
*There is a **negative** relationship between the R&D intensity level and the turnover growth of a company.*	Negative coefficient for R&D intensity variable indicates that more R&D intensive companies attain a lower turnover growth (-0,004).
*There is a **positive** relationship between the efficiency of a company (sales per employee) and the development of performance indicators.*	Positive coefficient for efficiency variable indicates that more efficient companies attain a higher turnover growth (0,081), and a higher export growth (0,050).
*There is a **negative** relationship between the age of a company and the development of the performance indicators.*	Negative coefficient for age variable indicates that older companies attain lower turnover growth (-0,468), and lower private R&D expenditure growth (-0,043).

However, we have to bear in mind that the results are associated with a wide range of uncertainties. The analysis is relatively narrow in order to make reliable conclusions concerning the impact of public R&D and business support on company performance. For example, this research doesn't commit itself on the issues such as what is the impact of public support on innovations, spillover effects or company productivity. In focus at this research is only the impact of support on turnover growth, export growth and private R&D expenditure growth. Our research results are also out of tune with some previous impact studies that have been made in Finland.

Taking into account the uncertainty that relates to our research results, we would like to emphasize two interesting issues that rise from our findings.

Firstly, the results indicate that the support allocated by TEM has a stronger positive impact on company performance compared to support allocated by Tekes. It would be interesting to study, what causes these differences between the two organizations. Both of the organizations allocate mainly direct grants and administer approximately equal amounts of public business support annually. From this viewpoint we have a clear shortcoming in this research, because due to the data limitations it wasn't possible for us to introduce any project-specific factors, such as the riskiness or commercialization potential of a project, in our estimation equations. Based on our results we can, therefore, only document that there is a difference between the impact of public support allocated by TEM and Tekes, and that the difference is noteworthy.

Secondly, as to the positive impact of public support allocated by Finnvera it would be interesting to study whether the affirmative results are obtained due to the nature of Finnvera's support instruments or its financial autonomy. In 2009, over 60 per cent of the support allocated by Finnvera was assigned as loans and the rest of the support as guarantees. These two support categories are most similar to the market-based financing instruments. Therefore, it is possible to speculate whether these instruments 1) reduce effectively the possible financial market inefficiencies that are stemming from the asymmetric information between the companies and financiers, 2) require a more liable attitude from the beneficiaries, and consequently 3) succeed in ensuring that unprofitable business projects are discarded. Furthermore, because Finnvera is expected to achieve an economic self-sustainability in its operations, the business support allocations require deliberate attitude also from the financier itself. In favor of the loans and guarantees have to be recognized also the cost-efficient nature of these instruments. The direct grants cause multifold costs to the government, while the beneficiaries pay the loans and guarantees back to the support organization in aggregate.

Based on the results of this research and a few above mentioned studies we can conclude that there are essential shortcomings related to the Finnish R&D and business support system. One costly outcome from this kind of situation is that the companies, which are incurring high opportunity costs for their

time and effort, are not able to locate and access appropriate sources of public support efficiently or at an acceptable cost. From the government's point of view it is irrational to maintain a support system that consumes a significant amount of public funds but is inefficient in its actions and unable to achieve its objectives. In compliance with the mainstream economic theory the public business support instruments should be fixed-term and of a one-time nature, which clearly is not the current practice in the Finnish support system either.

Recently there has been some discussion about the tax incentives and whether the government should introduce them in the Finnish innovation support system. The results of recent studies (*Table* 36) indicate that we have deficiencies occurring in our system at the moment. Therefore, the chances are that the introduction of tax incentives would only raise additional issues of complexity both for the administrators of the support and for the companies. After all, it makes no use to invest public funds on R&D and business support if the system that is allocating the support is inefficient. Furthermore, there is only little research related to the efficiency and impact of simultaneous public R&D support instruments (Asplund and Kiander, 2003).

These quite traditional remedies presented above may be in any case less purposeful now that markets have become entirely global. Dreaming up new products and services as well as better ways of producing old ones increasingly involves collaboration across borders and companies. A few months ago the Economist article (Economist, 7.10.2010) argued that *a smart innovation agenda, in short, would be quite different from the one that most rich governments seem to favor. It would be more about freeing markets and less about picking winners; more about creating the right conditions for bright ideas to emerge and less about promises of things like green jobs. But pursuing that kind of policy requires courage and vision — and most of the rich economies are not displaying enough of either*. The article suggested prizes for breakthrough innovations and bigger efforts to remove barriers on high-skilled immigration as more imaginative solutions.

It may well be that also in Finland we are searching the medicines for better innovation agenda from the wrong tool box.

More creative solutions could be found, for example, from Israeli experience. During the last couple of decades the Israeli high-tech sector has boomed, and according to Trajtenberg (2000), the public R&D and innovation policies of Israeli government have to be recognized as crucial elements of this success story. In compliance with the Israeli practices the companies commit to match, dollar-by-dollar, the subsidies received by the public support organization. If the publicly supported (R&D) project is commercially successful, the company pays the subsidy back to the support organization in the form of graduated royalties. As a result, the initial grant becomes a loan conditional on the success of the project.

It does not seem far-fetched that this kind of public venture capital investments could be one potential solution when creating the future successful public business support palette in Finland. It is crucial for the success that the government interventions don't cause distortions to the private business sector or situate companies into unequal positions.

However, it cannot be overstated that the rationalization of current innovation and business support system is a priority. Based on the results of this research it is easy to support the recommendation (Koski *et al.*, 2010) of reduce the annual public support amounts in order to enhance the effectiveness of public R&D and business support system. After the rationalization of current support system we can think how to include imaginative support instruments in it.

ANNEX 1

This annex presents the detailed grouping of the support instruments based on their different kind of objectives.

Objective: to support the internationalization, exports and / or foreign investments
Internationalization Loan (Finnvera)
Finnvera Guarantee (Finnvera)
Export Guarantee (Finnvera)
Internationalization Guarantee (Finnvera)
Investment Guarantee (Finnvera)

Objective: to support the company growth
Micro-Enterprise Guarantee (Finnvera)
Funding for young innovative companies (Tekes)
Loans for Women Entrepreneurs (Finnvera)
Entrepreneur Loan (Finnvera)
Investment and Working Capital Loan (Finnvera)
Microloan (Finnvera)
Development Aid (TEM)
Employment subsidy (TEM)
Investment support in rural areas (MMM)
Launching Aid (TEM)
Launching Aid in rural areas (MMM)

Objective: environmental focus (environmental investments, energy saving, renewable energy use)
Energy support (TEM)
Environmental Loan (Finnvera)

Objective: to boost the private R&D expenditure or private R&D activity in general
Preparation financing (TEM)
Development Loan (Finnvera)
Procurement of innovation services (Tekes)
De minimis -support for innovative activity (Tekes)
Operational environment development aid (TEM)
Development Aid in rural areas (MMM)
Funding for development projects (Tekes)

ANNEX 2

This annex presents the correlations between the explanatory variables in different model specifications.

This table presents the correlations between the independent variables employed in the regression model specification of annual growth of sales.

	Tekes support (mean)	Finnvera support (mean)	TEM support (mean)	MMM support (mean)	Age (log)	Employees (log)	Efficiency (log)	R&D intencity (log)	Sum var. Tekes support (lag)	Sum var. Finnvera support (lag)	Sum var. TEM support (lag)	Sum var. MMM support (lag)
Tekes support (mean)	1,00											
Finnvera support (mean)	0,16	1,00										
TEM support (mean)	0,16	0,21	1,00									
MMM support (mean)	0,00	0,05	0,04	1,00								
Age (log)	-0,01	-0,12	-0,02	-0,04	1,00							
Employees (log)	0,13	0,11	0,22	0,00	0,07	1,00						
Efficiency (log)	0,00	-0,01	-0,02	0,00	0,02	-0,72	1,00					
R&D intencity (log)	0,23	-0,05	-0,14	0,00	-0,09	-0,36	-0,11	1,00				
Sum variable Tekes support (lagging)	0,28	0,03	0,04	0,00	0,00	0,05	0,00	0,13	1,00			
Sum variable Finnvera support (lagging)	0,13	0,29	0,09	0,00	0,00	0,06	0,01	0,00	0,05	1,00		
Sum variable TEM support (lagging)	0,14	0,14	0,25	0,00	0,01	0,01	0,01	-0,02	0,05	0,16	1,00	
Sum variable MMM support (lagging)	0,01	0,04	0,03	0,52	-0,02	0,01	0,00	-0,01	0,00	0,01	0,00	1,00

This table presents the correlations between the independent variables employed in the regression model specification of annual growth of export.

	Tekes support (mean)	Finnvera support (mean)	TEM support (mean)	MMM support (mean)	Age (log)	Employees (log)	Efficiency (log)	R&D intencity (log)	Sum var. Tekes support (lag)	Sum var. Finnvera support (lag)	Sum var. TEM support (lag)	Sum var. MMM support (lag)
Tekes support (mean)	1,00											
Finnvera support (mean)	0,05	1,00										
TEM support (mean)	0,11	0,25	1,00									
MMM support (mean)				1,00								
Age (log)	-0,05	0,03	0,02	-0,02	1,00							
Employees (log)					-0,01	1,00						
Efficiency (log)	0,03	-0,08	-0,09	-0,01	-0,12	-0,32	1,00					
R&D intencity (log)	0,34	-0,09	0,01	-0,01	-0,07	0,28	0,06	1,00				
Sum variable Tekes support (lagging)	0,28	-0,05	-0,01	0,00	0,02	0,27	0,09	0,16	1,00			
Sum variable Finnvera support (lagging)	0,06	0,42	0,07	0,00	-0,03	0,01	0,00	0,02	-0,01	1,00		
Sum variable TEM support (lagging)	0,08	0,18	0,35	0,00	0,04	0,07	-0,01	-0,01	0,02	0,09	1,00	
Sum variable MMM support (lagging)	-	-	-	-	-	-	-	-	-	-	-	-

This table presents the correlations between the independent variables employed in the regression model specification of annual growth of private R&D expenditure.

	Tekes support (mean)	Finnvera support (mean)	TEM support (mean)	MMM support (mean)	Age (log)	Employees (log)	Efficiency (log)	Sum var. Tekes support (lag)	Sum var. Finnvera support (lag)	Sum var. TEM support (lag)	Sum var. MMM support (lag)
Tekes support (mean)	1,00										
Finnvera support (mean)	0,05	1,00									
TEM support (mean)	0,11	0,19	1,00								
MMM support (mean)	0,00	0,00	0,01	1,00							
Age (log)	-0,09	-0,04	0,03	-0,03	1,00						
Employees (log)	0,20	-0,16	0,22	-0,05	0,20	1,00					
Efficiency (log)	-0,08	-0,09	0,02	-0,02	0,09	0,25	1,00				
Sum variable Tekes support (lagging)	0,28	-0,05	0,01	-0,01	0,06	0,26	0,08	1,00			
Sum variable Finnvera support (lagging)	0,03	0,40	0,06	-0,01	-0,03	0,03	0,02	-0,01	1,00		
Sum variable TEM support (lagging)	0,06	0,08	0,29	-0,01	0,04	0,11	0,02	0,04	0,05	1,00	
Sum variable MMM support (lagging)	0,02	-0,01	0,01	0,64	-0,03	-0,04	-0,02	0,00	0,00	0,00	1,00

ANNEX 3

This annex presents the model specifications and regression results for annual growth of exports and private R&D expenditure.

This table presents the regression model specifications. The variables are defined in sub-chapter 6.3.2.2.

Form of impact	Firm-level measure	Model specification: second-stage regression specifications
Company size	Export growth	$\frac{Y_{i,t-1}^{Export} - Y_{it}^{Export}}{Y_{i,t-1}^{Export}} = \overline{\beta_0} + \overline{\beta_1 \log(meanTEK)_{it}} + \overline{\beta_2 \log(meanFIV)_{it}} + \overline{\beta_3 \log(meanTEM)_{it}} + \overline{\beta_4 \log(meanMMM)_{it}} + \overline{\beta_5 log(ika)_{it}} + \overline{\beta_6 log(hk)_{it}} + \overline{\beta_7 log(lv\_hk)_{it}} + \overline{\beta_8 log(suht\_tkmenot)_{it}} + \overline{\beta_9 U_i} + \overline{\beta_{10} T_i} + \overline{\beta_{11} lagsumTEK_{it}} + \overline{\beta_{12} lagsumFIV_{it}} + \overline{\beta_{13} lagsumTEM_{it}} + \overline{\beta_{14} lagsumMMM_{it}} + \overline{u_{it}}$
Innovation	Private R&D expenditure growth	$\frac{Y_{i,t-1}^{R\&Dexpenditures} - Y_{it}^{R\&Dexpenditures}}{Y_{i,t-1}^{R\&Dexpenditures}} = \overline{\beta_0} + \overline{\beta_1 \log(meanTEK)_{it}} + \overline{\beta_2 \log(meanFIV)_{it}} + \overline{\beta_3 \log(meanTEM)_{it}} + \overline{\beta_4 \log(meanMMM)_{it}} + \overline{\beta_5 log(ika)_{it}} + \overline{\beta_6 log(hk)_{it}} + \overline{\beta_7 log(lv\_hk)_{it}} + \overline{\beta_8 log(suht\_tkmenot)_{it}} + \overline{\beta_9 U_i} + \overline{\beta_{10} T_i} + \overline{\beta_{11} lagsumTEK_{it}} + \overline{\beta_{12} lagsumFIV_{it}} + \overline{\beta_{13} lagsumTEM_{it}} + \overline{\beta_{14} lagsumMMM_{it}} + \overline{u_{it}}$

This table presents the results of IV regression model with random effects and linear GLS regression model. The first column presents the different variables employed in the models. The second column presents the estimated coefficients of IV model within the whole sample. The third column presents the estimated coefficients of linear GLS model within the whole sample. The final two columns present the estimated coefficients of IV model within SMEs and large companies separately.

Private R&D expenditures growth

	IV (random effects)	**Linear GLS model**	**IV (re) SMEs**	**IV (re) Large**
	Coefficient	Coefficient	Coefficient	Coefficient
	R^2=0,028, n=3178	R^2=0,078, n=3178	R^2=0,022, n=2832	R^2=0,007, n=451
Tekes support	-0,023***	0,003*	-0,029***	-0,016***
Finnvera support	0,002	-0,002	0,002	0,02
TEM support	0,01**	0,001	0,011**	0,005
MMM support	0,032	0,009	0,036	0,019
Age	-0,021	0,013	-0,029	0,039
Size (employees)	0,064***	0,058***	0,048***	0,047
Sales / employee	0,015	0,025**	0,018	0,024
Southern Finland	(omitted)	(omitted)	(omitted)	(omitted)
Western Finland	-0,013	-0,007	-0,014	-0,074
Eastern Finland	-0,057	-0,033	-0,083	0,065
Oulu region	-0,011	0,009	-0,008	-0,123
Lapland	0,075	0,058	0,097	-0,066
Received support earlier (Tekes)	0,000***	0,000	0,000***	0,000*
Received support earlier (Finnvera)	0,000	0,000	0,000	0,000
Received support earlier (TEM)	0,000	0,000	0,000	0,000
Received support earlier (MMM)	-0,005	-0,004	-0,005	(omitted)
Constant	-0,217	-0,459	-0,280	(omitted)
+ industry dummies				

Statistically significant at *95%, **99% and ***99,9% confidence level.

This table presents the results of IV regression model with random effects and linear GLS regression model. The first column presents the different variables employed in the models. The second column presents the estimated coefficients of IV model within the whole sample. The third column presents the estimated coefficients of linear GLS model within the whole sample. The final two columns present the estimated coefficients and of IV model within SMEs and large companies separately.

Export growth

	IV (random effects)	**Linear GLS model**	**IV (re) SMEs**	**IV (re) Large**
	Coefficient	Coefficient	Coefficient	Coefficient
	R^2=0,050, n=2301	R^2=0,054, n=2301	R^2=0,053, n=2017	R^2=0,056, n=370
Tekes support	-0,002	0,001	-0,001	-0,003
Finnvera support	0,003	0,001	0,002	0,016
TEM support	0,004	0,004*	0,004	0,007
MMM support	-0,109	-0,108	-0,106	0,002
Age	0,002	0,001	0,001	0,000
Size (employees)	0,042***	0,04***	0,069***	0,023
Sales / employee	0,085***	0,085***	0,111***	0,062*
R&D intensity	0,002	0,002	0,002	0,003
Southern Finland	(omitted)	(omitted)	(omitted)	(omitted)
Western Finland	0,012	0,015	0,003	0,035
Eastern Finland	0,0184	0,022	0,001	0,019
Oulu region	0,065	0,069	0,068	0,032
Lapland	0,03	0,033	0,016	0,089
Received support earlier (Tekes)	0,000	0,000	0,000	0,000
Received support earlier (Finnvera)	0,000	0,000	0,000	0,000
Received support earlier (TEM)	0,000	0,000	0,000	0,000
Received support earlier (MMM)	0,03	0,03	0,029	(omitted)
Constant	-1,782	-1,77	-2,038	(omitted)
+ industry dummies				

Statistically significant at *95%, **99% and ***99,9% confidence level.

ANNEX 4

This annex presents the Hausman test results. The test is used in order to check the endogeneity that is related to the regression models.

The models estimating the turnover growth and export growth failed to meet the asymptotic assumptions of Hausman test. Consequently, we don't have test results to support our intention to treat the endogeneity problem adequately.

However, the model estimating the private R&D expenditure growth manages to generate Hausman test results. The test result (Pr > Chi Sq: 0,0136) indicates that the instrumental variable regression is preferred over the GLS in order to tackle the endogeneity problem.

References

Aghion, P. (2002): "Schumpeterian Growth Theory and the Dynamics of Income Inequality", *Econometrica* 70, 855–882

Aghion, P. and Howitt, P. (1992): "A model of growth through creative destruction", *Econometrica*, 60, 323-351

Aghion, P. and Howitt, P. (1998): "Endogenous Growth Theory", *Cambridge, MIT Press*

Aghion, P. and Howitt, P. (2009): "The Economics of Growth", *The MIT Press*

Aho, E. *et al.* (2008): "Proposal for Finland's National Innovation Strategy"

Ali-Yrkkö, J. (2005): "Impact of R&D financing on employment?", *ETLA Discussion Papers No. 980*

Ali-Yrkkö, J. (2008): "Essays on the Impacts of Technology Development and R&D Subsidies", *ETLA A43, Taloustieto Ltd,* Helsinki

Arrow, K. (1962): "Economic Welfare and the Allocation of Resources for Invention" in *Richard Nelson (Ed.) "The Rate and Direction of Inventive Activity", Princeton University Press*

Asplund, R. and Kiander, J. (2003): "Yritystukimuotojen arviointi ja vertailu – kirjallisuuskatsaus", *Ministry of Trade and Industry Studies and Reports 5/2003*

Busom, I. (1999): "An Empirical Evaluation of the Effects of R&D Subsidies", *Working Paper No. B99-05I,* Universitat Autonoma de Barcelona

Chaminade, C. and Edquist, C. (2006): "Rationales for public policy intervention from a systems of innovation approach: the case of VINNOVA", *CIRCLE, Lund University*

Czarnitzki, D., Ebersberger, B., and Fier, A. (2007): "The relationship between R&D collaboration, subsidies and R&D performance: Empirical evidence from Finland and Germany", *Journal of Applied Econometrics, 22, 1347-66*

David, P. and Hall, B. (2000): "Heart of darkness: modeling public-private funding interactions inside the R&D black box", *Research Policy,* 29, 1165-1183

David, P., Hall, B. and Toole, 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

Davidson, C. and Segerström, P. (1998): "R&D Subsidies and Economic Growth", *The RAND Journal of Economics*, Vol.29, No.3, pp.548-577

De Meza, D. and Webb, D. C. (1987): "Too much investment: A problem of asymmetric information", *Quarterly Journal of Economics*, 102, p. 281-292

Ebersberger, B. (2004):"Labor Demand Effect of Public R&D Funding", *VTT Working Papers No 9, Technical Research Centre of Finland*

Economist (7.10.2010): "A special report on the world economy: Smart work – Faster productivity growth will be an important part of rich economies' revival", *The Economist*

Einiö, E. (2010): "Essays on Innovation Policy, Technology, and Skills" *Research Reports, No. 121:2010, Dissertationes Oeconomicae*

Georghiou, L., Smith, K. Toivanen, O. and Ylä-Anttila, P. (2003): "Evaluation of the Finnish Innovation Support System", *Ministry of Trade and Industry Finland Publications 5/2003*

Griffith, R., S. Redding and J. Van Reenen (2003): "R&D and Absorptive Capacity: Theory and Empirical Evidence", *Scandinavian Journal of Economics*, 105, 99-118.

Griliches, Z. (1992): "The search for R&D spillovers", *Scandinavian Journal of Economics*, 94, 29-47.

Grossman, G. M. and Helpman, E. (1991): "Quality Ladders in the Theory of Growth", *Review of Economic Studies*, 58, 43-61

Grossman, G. M. and Helpman, E. (1994): "Endogenous Innovation in the Theory of Growth", *Journal of Economic Perspectives*, Vol.8, Issue 1, 23-44

Government of Ireland (2010): "Community Innovation Survey 2006-2008", *The Stationery Office, Dublin, Ireland*

Görg, H. and Strobl, E. (2007): "The Effect of R&D Subsidies on Private R&D," *Economica, London School of Economics and Political Science, vol. 74(294), pages 215-234, 05*

Hall, B. (1996): "The Private and Social Returns to Research and Development" in *Technology, R & D, and the Economy, Bruce Smith and Claude Barfield, eds. Brookings and American Enterprise Institute,* Washington

Hall, B., Mairesse, J., and Mohnen, P. (2010): "Measuring the Returns to R&D", *CIRANO Scientific Series*, Montreal

Heckman, J. (1979): "Sample selection bias as a specification error", *Econometrica*, 46, 931-961.

Heckman, J., H. Ichimura, J. Smith and P. Todd (1998a): "Characterizing selection bias using experimental data", *Econometrica*, 66, 1017-1098

Heckman, J., H. Ichimura and P. Todd (1998b): "Matching As An Econometric Evaluation Estimator" *Review of Economic Studies*, 65, 261-294

Holmström, B. and Tirole, J. (1997): "Financial intermediation, loanable funds, and the real sector", *Quarterly Journal of Economics*, 112, p. 663-691

Howitt, P. (1999): "Steady Endogenous Growth with Population and R. & D. Inputs Growing", *Journal of Political Economy*

Hyytinen, A., Rouvinen, P., Toivanen, O, and Ylä-Anttila, P. (2003): "Does financial development matter for innovation and economic growth? Implications for public policy" in *Hyytinen, A., and Pajarinen, M., (eds.), Financial Systems and Firm Performance: Theoretical and Empirical Perspectives, ETLA B:200*

Hyytinen, A., and Väänänen, L. (2002): "Government funding of small and medium-sized enterprises in Finland" in *Hyytinen, A., and Pajarinen, M., (eds.) (2003) "Financial Systems and Firm Performance: Theoretical and Empirical Perspectives", ETLA B:200*

HS (26.11.2010): “Jorma Ollila Panisi suorat yritystuet leikkuriin”, *Helsingin sanomat*

Jaffe, A.B. (2002): “Building programme evaluation into the design of public research support programmes”, *Oxford Review of Economic Policy* 18 (1), 22-34

Jones, Charles I. (1995): “R&D-based Models of Economic Growth”, *Journal of Political Economy*, 103, 1995, pp. 759-784

Kamien, M. and Schwartz, N. (1978): “Self-Financing of an R and D Project” *American Economic Review*, 68, 252-261

Kauko, K. (1996): “Effectiveness of R&D subsidies — a skeptical note on the empirical literature”, *Research Policy 25, 321 – 323*

Koski, H. (2008): “Public R&D subsidies and employment growth – microeconomic evidence from Finnish firms”, *ETLA, Discussion Papers, No 114*

Koski, H., Maliranta, M., Rouvinen, P. and Ylä-Anttila, P. (2010): ”Yritystukia tulisi karsia” in *Muistioita seuraavalle hallitukselle – Talouspolitiikan painopisteitä 2011–2015, Elinkeinoelämän Tutkimuslaitos, Taloustieto Oy*

Koski, H. and Pajarinen, M. (2010a): “Supply, Complementarities, and Repetitiousness of Public Support in Finland”, *ETLA Discussion Papers No. 1217*

Koski, H. and Pajarinen, M. (2010b): “Access to business subsidies: what explains complementarities and persistency?”, *ETLA Discussion Papers No. 1226*

Koski, H. and Pajarinen, M. (2010c): “Do business subsidies facilitate employment growth?”, *ETLA Discussion Papers No. 1235*

Koski H. and Tuuli, J. (2010): “Business subsidies in Finland: the dynamics of application and acceptance stages”, *ETLA Discussion Papers No. 1225*

Kotiranta, A., Nikulainen, T., Tahvanainen, A.-J., Deschryvere, M. and Pajarinen, M. (2009): “Evaluating National Innovation Systems – Key Insights from the Finnish Innoeval Survey”, *ETLA Discussion Papers No. 1196*

Klette, T. J. and Moen, J. (1998): “R&D investment responses to R&D subsidies: a theoretical analysis and a microeconometric study”, *Mimeo, Presented at NBER Summer Institute*

Klette, T. J., Moen, J. and Griliches, Z. (2000): “Do subsidies to commercial R&D reduce market failures? Microeconomic evaluation studies”, *Research Policy*, 29, p. 471-495

Lach, S. (2002): “Do R&D Subsidies Stimulate or Displace Private R&D? Evidence from Israel”, *Journal of Industrial Economics*, 50, 369-90

Lach, S. and Sauer, R. M. (2001): “R&D, Subsidies and Productivity”, *Mimeo*

Lehto, E. (2000): “Regional impacts of R&D and public R&D funding”, *Palkansaajien tutkimuslaitos, tutkimuksia 79, Helsinki*

Leland, H. and Pyle, D. (1977): “Informational Asymmetries, Financial Structure, and Financial Intermediation”, *Journal of Finance*, 32, 371-387

Lemola, T. (2001): "Tiedettä, teknologiaa ja innovaatiota kansakunnan parhaaksi – Katsaus Suomen tiede- ja teknologiapolitiikan lähihistoriaan.", *VTT Teknologian tutkimuksen ryhmän työpapereita nro 57/01*

Lerner, J. (2002): "When bureaucrats meet entrepreneurs: The design of effective public venture capital programmes", *Economic Journal*, 112, 73-84

Lichtenberg, F. R. (1988): "The Private R&D Investment Response to Federal Design and Technical Competitions", *The American Economic Review*, 78(3), 550 – 59

Martin, S. and Scott, J. T. (2000): "The nature of innovation market failure and the design of public support for private innovation", *Research Policy* 29, 437-447

Meeusen, W. and Janssens, W. (2001): "Substitution versus additionality: econometric evaluation by means of micro-economic data of the efficacy of R&D subsidies to firms in the Flemish region", *CESIT Discussion paper 2001/01, University of Antwerp*

Ministry of Trade and Industry (2006): "Yritystukitietokannan perustaminen. Työryhmän loppuraportti", *KTM julkaisuja 22/2006, Edita Publishing Oy*

Nelson, R. (1959): "The simple economics of basic scientific research", *Journal of Political Economy*, Vol.67, pp.297-306

Net Effect Oy (2010): "Innovaatiotukiselvitys – Loppuraportti", *Työ- ja elinkeinoministeriön tilaama selvitys*

Niinimäki, J.-P. and Takalo, T. (2007): "Benchmarking and comparing entrepreneurs with incomplete information", *Finnish Economic Papers*, 20, 91-103.

Niininen, P. (1999): "High Technology Investment, Growth and Productivity, Empirical Studies of Finnish Data", *HSE A-158, Helsinki*

Nikulainen, T. and Tahvanainen, A-J. (2009): "Towards demand based innovation policy? – The introduction of SHOKs as an innovation policy instrument", *ETLA Discussion papers No.1182*, Helsinki

OECD (2005): "Europe in figures - Eurostat yearbook 2005", *Paris*

OECD (2008): "Fact book 2008: Economic, Environmental and Social Statistics", *Paris*

Ormala, E. (1998): "New approaches in technology policy – the Finnish example", *STI Review No.22, Special Issue on "New Rationale and Approaches in Technology and Innovation Policy" OECD*, Paris

Pajarinen, M., Rouvinen, P. and Ylä-Anttila, P. (2009): "Which companies receive public support in Finland?", *ETLA Discussion Papers No.1179*

Pellegrini, G. and Centra M. (2006): "Growth and efficiency in subsidized firms" *Paper prepared for the Workshop "The Evaluation of Labour Market, Welfare and Firms Incentives Programmes", May 11th – 13th 2006, Istituto Veneto di Scienze, Lettere ed Arti*, Venezia

Piekkola, H. (2005): "Public funding of R&D and growth: firm-level evidence from Finland", *ETLA Discussion Papers No. 996*

Piekkola, H. (2006): “Knowledge and Innovation subsidies as engines for growth – The Competitiveness of Finnish Regions”, *ETLA Discussion Papers No. 216*

Romer, P. M. (1990): “Endogenous Technological Change”, *Journal of Political Economy*, 98, 1990, pp. S71-S102

Roos, G., Fernström, L. and Gupta, O. (2005): “National Innovation Systems: Finland, Sweden and Australia Compared”, *The Australian Business Foundation*, London

Scotchmer, S. (2004): “Innovation and Incentives”, *Cambridge, MIT Press*

Segerström, P. S. (2000): “The Long-Run Growth Effects of R&D Subsidies”, *Journal of Economic Growth*, Vol.5, pp.277-305

Segerström, P., Anant, T. and Dinopoulos, E. (1990): “Schumpeterian Model of the Product Life Cycle”, *American Economic Review*, 80, 1077-1092

Sheehan, J. and Wyckoff, A. (2003): “Targeting R&D: Economic and Policy Implications of Increasing R&D Spending”, *OECD Science, Technology and Industry Working Papers*, 2003/8, OECD Publishing

Solow, R. (1956): “A Contribution to the Theory of Economic Growth”, *Quarterly Journal of Economics*, 70:1, 65-94

Solow, R, (1957): "Technical Change and the Aggregate Production Function." *Review of Economics and Statistics*, 39:312-320

Stiglitz, J. E. and Weiss, A. (1981): “Credit rationing in markets with imperfect information”, *American Economic Review*, 71, p. 393-410

Takalo, T. (2009): “Rationales and instruments for public innovation policies” *ETLA Discussion papers No. 1185*

Takalo, T. and Tanayama, T. (2009): “Adverse selection and financing of innovation: Is there need for R&D subsidies?”, *Journal of Technology Transfer*

Takalo, T., Tanayama, T. and Toivanen, O. (2008): “Evaluating innovation policy: A structural treatment effect model of R&D subsidies”, *Bank of Finland Discussion Papers No. 7/2008*

Talouselämä (16.8.2010): “Innovaatiot tukehtuvat löysään rahaan”, *Talouselämä*

Tanayama, T. (2007): “Allocation and Effects of R&D Subsidies: Selection, Screening and Strategic Behavior” *Acta oeconomicae*, Helsingiensis A-309, Helsinki School of Economics

Tanayama, T. (2009): “Rationales and reality of R&D subsidies: Are SMEs and large firms treated differently?”, *HECER Discussion Papers No.280*

Technopolis Ltd (2001): “An international review of methods to measure relative effectiveness of technology policy instruments”, *Final report, UK*

Tekes (2008): “Tilastoanalyysin Tekesin vaikuttavuudesta”, *Tekesin katsaus 229/2008*

Toivanen, O. (2009): “Innovation Policy, Entrepreneurship, and Development: A Finnish View”, *United Nations University Research Paper No. 2009/48*

Toivanen, O. and Niininen, P. (2000):"Investment, R&D, subsidies and credit constraints", *HSE Working papers W-264, Helsinki*

Trajtenberg, M. (2000): "R&D Policy in Israel: An Overview and Reassessment", *The Foeder Institute for Economic Research*, DP 7-2000

Venetoklis, T. (2000): "Methods applied in evaluating business subsidy programs: A survey", *Government Institute for Economic Research, VATT*, Helsinki

Veugelers, R. *et al*. (2009): "Evaluation of the Finnish National Innovation System – Full Report", *Taloustieto Oy on behalf of the Ministry of Education and the Ministry of Employment and the Economy*, Helsinki

Wallsten, S. (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, p. 82-100

Woolthuis, R. K., Lankhuizen, M. and Gilsing, V. (2005): "A System Failure Framework for Innovation Policy Design.", *Technovation*, 25: 609-619

Other background material

European Commission (2001): “Innovation policy in Europe 2001. European Trend Chart on Innovation” *Innovation Papers, No. 17, Brussels*

European Commission (2002): “Science, Technology and Innovation – Kay Figures 2002”, *Brussels*

Finnvera (2010): “Annual Review 2009”

Ministry of Agriculture and Forestry (MMM) (2010), “Manner-Suomen maaseudun kehittämisohjelman 2007–2013 vuoden 2009 vuosikertomus”, *Maa- ja metsätalousministeriö 22.6.2010*

Ministry of Finance (2002) “Raportti Suomen kilpailukyvystä ja sen kehittämistarpeesta”

OECD (2009a) “OECD Science, Technology and Industry Scoreboard 2009”, *Paris*

OECD (2009b): “Innovation in Firms – A Microeconomic Perspective”, *Paris*

Statistics Finland (2010a): “Tutkimus- ja kehittämisrahoitus valtion talousarviossa 2010”

Statistics Finland (2010b): “Innovaatiotoiminta 2008 – Innovaatiotutkimuksen loppuraportti”

Tanskanen *et al.* (2010) “Suomi 2010 – Tuumasta toimeen. Kasvutyöryhmän loppuraportti” *Valtioneuvoston kanslian julkaisuja 11/2010*

Tekes (2002) “Ylihuomisen kilpailukyky ratkaistaan tänään. Teknologiarahoituksen tulokset ja vaikutukset.”, *Helsinki*

http://www.ely-keskus.fi, visited 2.7.2010

http://cordis.europa.eu/erawatch/index.cfm, visited 2.7.2010

http://www.tekes.fi, visited 8.7.2010

http://www.finnvera.fi, visited 8.7.2010

http://www.rakennerahastot.fi, visited 23.7.2010

http://www.maaseutu.fi, visited 23.7.2010

http://www.te-keskus.fi, visited 27.8.2010