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Do R&D Business Subsidies Have an Effect on Turnover: A Quantitative Study on Small Finnish IT Companies

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ABSTRACT

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The goal of this bachelor's thesis is to observe if research and development business subsidies have a positive effect on turnover for small Finnish IT companies. Data used in this study have been gathered from two sources: Amadeus database and Yle MOT's business subsidy data. Amadeus database has been used to gather the financial data needed and business subsidy data compiled by Yle's MOT has provided information about the granted regarding R&D subsidy amounts, companies and years. This data has been then compiled into a separate Excel spreadsheet to modify it and to form variables used in the quantitative models. The used quantitative models are: linear and probit regression and four different matching methods to match the observations based on their propensity scores.

The research findings form an interesting look into the effects of business subsidies on turnover. The results of linear regression indicate that research and development subsidies positively affect turnover but propensity score matching is not able to form a conclusive evidence for whether or not receiving research and development subsidies have an effect on turnover. Possible reasons for this outcome could be the rather low sample size and the possibility of these subsidies not being effective on the given time frame. Other interesting findings are that employee numbers positively affect company's chances of receiving subsidies and working capital per employee has positive effect on turnover. These results could help businesses more efficiently allocate their resources when applying for research and development subsidies.

TIIVISTELMÄ

Tekijä:	Aleksi Rautiainen
Tutkielman nimi:	Vaikuttavatko R&D yritystuet yrityksien liikevaihtoon: kvantitatiivinen tutkimus suomalaisista pienistä IT-yrityksistä
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Tutkielman tavoitteena on selvittää, onko tutkimus- ja kehitystuilla vaikutusta pienten IT-alan yrityksien liikevaihtoon. Tutkimusdata on koostettu kahdesta lähteestä: Amadeus-tietokannasta ja Ylen MOT-ohjelman kasaamasta yritystukiaineistosta. Amadeus-tietokannasta on saatu tarvittavat tiedot yrityksien tilinpäätöstiedoista ja yritystukiaineistosta tiedot tukia saaneista yrityksistä ja tukien määristä, sekä tukien saamisvuosista. Tutkimuksessa käytetty data on koostettu erilliselle Excel-laskutaulukolle, jossa sitä on käsitelty ja siitä on luotu erilaisia muuttujia. Tämä kandidaatintutkielma on toteutettu kvantitatiivisilla tutkimusmenetelmillä. Käytetyt tutkimusmenetelmät ovat lineaarinen ja probit regressioanalyysi, sekä neljä erilaista menetelmää havaintojen yhdistämiseksi propensity scorejen perusteella.

Tutkimustulokset antavat mielenkiintoisen kuvan siitä, vaikuttavatko yritystuet liikevaihtoon. Lineaarisen regressioanalyysin tulokset indikoivat tutkimus- ja kehitystuilla olevan positiivinen vaikutus liikevaihtoon, mutta propensity score matchingin tulokset eivät anna selkeää vastausta näiden tutkimus- ja kehitystukien vaikutuksista. Mahdollisia syitä sille, etteivät tulokset anna luotettavaa vastausta ovat pieni otoskoko ja se, etteivät yritystuet ole ehtineet vaikuttaa mittausajalla. Muita mielenkiintoisia tuloksia ovat, että työntekijämäärällä on positiivinen vaikutus yritystukien saamiseen ja käyttöpääomalla on työntekijää kohden positiivinen vaikutus liikevaihtoon. Tulokset voivat auttaa yrityksiä tehokkaammassa resurssien allokoinnissa tutkimus- ja kehitystukia hakiessa.

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1. Introduction

Business subsidies are a common topic of discussion whether you are reading a newspaper, listening to an expert opinion or participating in a political debate. In 2018 over 700 million euros worth of direct business subsidies were granted for Finnish companies, majority of which were handed over to small companies (Suomen virallinen tilasto 2018). Even though the yearly subsidies decreased slightly in 2018 from 2017 (Suomen virallinen tilasto 2018) even entrepreneurs have called out for the further reduction of subsidies (Yrittäjägallup, 2018). Many studies however show that business subsidies have their benefits, for example in facilitating employment growth (Koski & Pajarinen 2012, 17). The importance of researching how largely business subsidies affect businesses that receive said subsidies and other businesses in the market that do not receive subsidies is significant. Understanding the effects and the significance of said effects on the businesses, markets and competitive relationship between the businesses is crucial in deciding the terms based on which subsidies are handed out and to whom they are given to. There are many great studies made of business subsidies, but research of the effects research and development business subsidies have on turnover on Finnish IT companies has not been done.

Millions of euros are granted yearly as research and development business subsidies for Finnish companies; therefore it is important that these subsidies are effective in what they aim to do. Chapter two has more information about the effects of business subsidies and what these research and development business subsidies aim to do. One of the listed goals is increase in turnover and the aim of this research is to figure out if R&D business subsidies fulfill their goal in this regard. Business subsidies are an important topic especially now with the COVID-19 pandemic as it expected to cause a recession and The Government of Finland is planning on taking extensive economic measures to help businesses and secure jobs (Valtioneuvosto 2020).

The goal of this bachelor's thesis is to find out if research and development subsidies have significant effect in helping Finnish technology companies increase their turnover over time. The data set consists of 309 Finnish companies that are under the Standard Industrial Classification code 6311 which includes companies in data processing, hosting and related activities that have 10 or fewer employees.

1.1 Research problems and objectives

This bachelor's thesis studies the effects business subsidies have on small Finnish information technology companies under the Standard Industrial Classification code 6311 meaning companies involved in data processing, hosting and related activities. More specifically if there is a measurable increase in turnover for companies that have received R&D subsidies from Tekes. The data consists of 309 companies 28 of which have received R&D subsidies. For each company the dataset includes a dummy variable that expresses if the company has received R&D subsidies and the amounts of subsidies received from 1997 to 2016, working capital per employee, legal form dummy variable, dummy variable for whether or not they are a part of a corporate group, number of employees, dummy variable for region (1=Uusimaa, 0 elsewhere in Finland), dummy variable depicting if the company mainly does business to business sales or business to consumer sales as well as turnover last available year and turnover difference between last available year and two years prior that. The main research problem has been formed based on the lack in prior research on the effects business subsidies might have on turnover on small Finnish IT companies. The main research question of this thesis is:

"Do R&D business subsidies increase the turnover of a company?"

In addition to the main research question, following sub-questions have been formed:

1. *"Which factors may increase company's chances of receiving business subsidies?"*

While Tekes has official funding conditions available it is beneficial to study if there are other factors that influence company's chances of receiving research and development business

subsidies. Answering this sub-question improves the knowledge businesses have about the factors that effect company's chances of receiving subsidies.

2. *"Which factors may have an effect on turnover?"*

There are many other factors that may have a significant effect on turnover. With this research sub-question, we aim study what these effects are and how significant they are so they can be factored in. In addition to being able to factor in which other elements increase or decrease turnover, the answer of this sub-question could be valuable information for businesses in improving their turnover.

1.2 Structure of the thesis

This study includes five chapters. The first chapter has general information about the subject as well as the research questions and objectives. The second chapter of this study includes literature review where earlier studies of the subject are reviewed, the effects of business subsidies are examined and the funding conditions for research and development subsidies are listed. Third chapter includes explanations of the used quantitative methods in addition to general overview of the data used in this thesis. Fourth chapter goes through research findings and has detailed tables with relevant information and interpretation of the results. The fifth and final chapter includes conclusions based on the research findings, ideas for further research and shortcomings of this research.

2. Business subsidies

This chapter of the thesis first goes through what business subsidies are and how can they be defined. The second sub-chapter explains the effects business subsidies have on the companies that receive them, on the competitiveness of the market and the economy in general. The third sub-chapter includes funding conditions set by law that companies must fulfill in order to receive and keep granted subsidies.

2.1 Business subsidy definition

Defining business subsidies is not easy and there is not a perfect way to generalize the concept in just a few words. Different experts have different ways to define business subsidies, for example the ministry of employment and the economy of Finland defines business subsidies in their 2017 report as such: “Business subsidies are subsidies, interest subsidies and loans, bails, guarantees, equity financing, tax-subsidies and other types of arrangements that include financial assistance [translated from Finnish]” (Rothovius, Palko, Hämäläinen, Rainio & Romanainen 2017). On the other hand, the Oxford Dictionary defines the word subsidy as follows: “1. A sum of money granted by the state of a public body to help an industry or business keep the price of a commodity or service low. 1.1 A grant or contribution of money” (Lexico 2020). Furthermore, the ministry of employment and the economy of Finland defines the conditions that a governmental monetary assistance must fulfill to be qualified as a business subsidy as following (Rothovius 2020):

- “A clear financial or social objective. If a subsidy has a financial objective (efficacy, renewal, competitiveness, reinforcing economic growth conditions) the subsidy must also be allocated to means that correct market inefficiencies.
- Adequate and cost-effective way of reaching its goals.
- Must have minimal effects on competitiveness.
- Temporary.
- Supportive impact.
- Preconditions for profitability.
- Evaluation of effectivity.”

[translated from Finnish]

The ministry of employment and the economy of Finland has also defined the term subsidy in their Business Subsidy Report (Pietarinen 2012) based on European Union law and global WTO regulation:

1. “funding, which is granted cheaper than the market-based rate by the government or other government body e.g. municipality,
2. funding, which is granted selectively, meaning not for all companies,
3. funding, which distorts or may distort competition,
4. funding, which may affect the trade between member states.”
   [translated from Finnish]

The exact definition of a business subsidy is important for one to be able to calculate the total amount of subsidies granted and the burden it puts to the public finance (Laukkanen & Maliranta 2019).

There are multiple different business subsidies and each one is used to achieve different benefits for the recipient. Business subsidies can be divided into two categories: direct subsidies and loans. Generally direct subsidies have been more impactful in benefitting the companies in the ways they were intended to than loans, this is mainly because a direct subsidy is allocated by the government body that grants the subsidy and a loan is allocated by the company

that receives it. Loans and direct subsidies are not commensurable, so it is advisable to treat them as separate entities. (Laukkanen & Maliranta 2019)

There are plenty of different direst business subsidies and they have different goals. The desired effect of each subsidy has been set by the government body that sets it.

When business subsidies are mentioned in this thesis from this point on, the meaning of the term is based on the definition of the ministry of employment and the economy of Finland and A. Rothovius (Rothovius 2020). Furthermore, as this thesis is focused on research and development subsidies when subsidies are mentioned they refer to R&D subsidies granted by Tekes, if not specified otherwise.

2.2 Effects of business subsidies

This sub-chapter explains the effects business subsidies have based on prior studies. The sub-chapter explains the effects business subsidies have in general and the effects research and development subsidies have in more detail as R&D subsidies are the focus of this study. It is important to understand prior research to have a clear picture of what effects public subsidies have and how efficient they are in fulfilling their intended goal.

The effects business subsidies have can be approached from many different points of view. One angle to approach the topic is from the angle of competitiveness. Laukkanen and Maliranta study the effects Finnish business subsidies have on the competitiveness in global markets in their paper “Yritystuet ja kilpailukyky”. The paper analyses the problem based on prior empirical findings, economics and new empirical research. The study first makes a distinction between the competitiveness of companies and the competitiveness of national economies and further distinctions in the competitiveness of companies to short-term price and cost competitiveness and long-term growth competitiveness. Laukkanen and Maliranta claim that the effects of energy tax cuts and compensations are very limited even though they have been justified by the proposition that they prevent production from moving to other countries by increasing the cost-competitiveness of production companies. The study also claims that the

focus in public subsidies should be shifted to research and development, more specifically to large and ambitious projects. (Laukkanen & Maliranta 2019)

Laukkanen and Maliranta point out that companies might not invest enough funds into research and development projects that would lead in to harnessing new technologies if the benefits are not clear enough for the company. These projects, however, would benefit the economy as whole through positive spill-over. (Laukkanen & Maliranta 2019)

Segerstrom investigates long-run growth effects of R&D subsidies on his paper. His research takes the scale effects of long-run growth effects in consideration. The model used in the paper has general assumptions about research and development and constant returns to scale production technology. Segerstrom implies that there are two dimensions of growth: horizontal and vertical. Vertical R&D means improving existing products and horizontal R&D refers to creating new products. Because population growth is positive premium profits increase over time, although as technology advances further technological advances become more expensive. The conclusion is that research and development subsidies are never able to permanently increase horizontal and vertical innovation in economy. (Segerstrom, 2000)

In a research about the effectiveness of public subsidies in OECD countries when accounting for wage and employment effects in research and development, Wolff and Reinthaler investigate the effects on macroeconomic level using panel data from 15 OECD countries between years 1981 to 2002. The conclusion of this paper is that research and development subsidies are effective in generating additional research projects. However, the effects on employment regarding research and development are insignificant. (Wolff & Reinthaler, 2008)

Dirk Czarnitzki is a respected researcher in subsidy related studies. Czarnitzki together with Matthias Almus have investigated how public research and development subsidies affected firms' innovation activities in Eastern Germany. The goal of the study was to find out if public funding stimulates R&D activities or does public funding crowd out private investment. At least in this case, companies that received public R&D funding did achieve higher R&D intensity on average than companies that did not receive subsidies. (Almus & Czarnitzki, 2003)

In the case of Flemish firms, Czarnitzki and Lopes-Bento investigate government sponsored research and development projects. As with the previous study above, this study is able to reject the null hypothesis of total crowding out of private investment if public subsidies are introduced. Receiving multiple grants at the same time does not seem to lead into crowding out either. As a conclusion, on average one funded project was able to create five new jobs. (Czarnitzki & Lopes-Bento, 2012)

Input and Output Additionality of R&D Subsidies by Czarnitzki and Hussinger analyses how public R&D subsidies affect research and development input and output of German firms. The paper explains that public subsidies appear to accelerate research and development spending in companies. Additionally, both fully privately financed R&D projects as well as publicly funded projects increase patent outcomes as well as the quality of new patents. (Czarnitzki & Hussinger, 2017)

Research conducted about the causal effects R&D subsidies have in a pan-European program investigates specifically small and medium sized enterprises and the effects these subsidies have on firm growth and sales. The budget allocation rule Virtual Common Pot is used to avoid cross-subsidization between participating countries. The study finds no significant average treatment effects, it does however find significant treatment effect heterogeneity on project quality. Companies that receive public R&D funding and have high evaluation scores benefit from them in considerable firm growth. (Hünermund & Czarnitzki, 2019)

A differing viewpoint from the effects subsidies have is how efficient they are in achieving the wanted or expected effect. The study attempts to assess the efficiency of public R&D funding for private R&D among OECD countries over past two decades. Efficiency in the study is conducted to be the difference between R&D input and output. As one of the main conclusions the paper explains that the most efficient countries are Australia, Canada, Finland, Germany, Japan, Netherlands, New Zealand, Singapore, Switzerland and the United States. (Cincera, Czarnitzki & Thorwarth, 2009)

Generally prior research indicates that research and development subsidies are quite efficient compared to other types of public subsidies. The aim of R&D business subsidies is to benefit the whole society from the spill-over effect when projects get financed that might not have been financed through only private investment. In general, prior research suggests that public financing through subsidies does not crowd out private investment. Research and development subsidies seem to accelerate R&D spending, new patents, and the quality of new patents. The researchers have not agreed on whether R&D subsidies are efficient, do they permanently increase innovation in the long run, do they positively affect employee numbers or if they have an effect on turnover. The aim of this thesis is to answer the question if research and development business subsidies influence turnover.

2.3 Funding conditions

This study focuses on research and development business subsidies granted by Tekes. After year 2018 Tekes has been known as Business Finland (Business Finland 2018). Research and development business subsidies used in this thesis were granted between the years 1997 and 2016, therefore they were granted by Tekes and not Business Finland.

The funding conditions under which a company can be granted research and development subsidies are listed in the document “Yritysten tutkimus- ja kehitystoiminnan rahoituksen yleiset ehdot” by Tekes which translates to “General conditions for financing of research and development activities for enterprises” (Tekes, 2013). These conditions are based on three statutes: Laki valtion lainanannosta sekä valtiontakauksesta ja valtiontakuusta (20.5.1988/449), Valtioneuvoston asetus tutkimus-, kehittämis- ja innovaatiotoiminnan rahoituksesta (298/2008) and Valtionavustuslaki (27.7.2001/688). The three aforementioned laws translated to English in order are: Act on State Lending, State Guarantee and State Security (20.5.1988/449), Government Decree on the financing of research, development and innovation activities (298/2008) and Act on Discretionary Government Transfers (27.7.2001/688). Act on Discretionary Government Transfers (27.7.2001/688) is an official translation while Act

on State Lending, State Guarantee and State Security (20.5.1988/449) and Government Decree on the financing of research, development and innovation activities (298/2008) have been translated by the author.

This thesis focuses on direct research and development subsidies granted by Tekes and therefore only sections that concern these specific subsidies are included in this sub-chapter. Laki valtion lainanannosta sekä valtiontakauksesta ja valtiontakuusta (20.5.1988/449) in its entirety consists of terms for public loans and bails and is not relevant for direct subsidies. From two remaining statutes only the most important and relevant parts are included in this sub-chapter as including everything would make this chapter unnecessarily lengthy.

Valtioneuvoston asetus tutkimus-, kehittämis- ja innovaatiotoiminnan rahoituksesta (298/2008) is about the financing research, development and innovation activities. The first chapter's third section lists general conditions. The statute begins by explaining some important terms, most important being what research and development activities mean exactly: R&D activities include fundamental research, industrial research and experimental development or a combination of industrial research and experimental development. Financing can be only granted and paid for companies that are registered in Finland and only used for projects that include a detailed project plan. Funding will not be granted for companies that are struggling. This thesis does not differentiate between companies that have financial struggles and those that do not, therefore these problems are not taken into consideration in any of the quantitative models. Second chapters fourth section demonstrates that financing can be granted for projects which benefit society, the economy or environment and the funding must enhance the recipients expertise, the recipient networking capabilities either nationally or internationally, or have a positive effect on the company's employee numbers, turnover or exports. This section sheds more light to the purpose of this thesis. Although it is not required for the funding to increase all the aforementioned characteristics it is intended to have a positive effect on at least one of them.

The sixth section in the same chapter demands that the recipient must have approval from the development center for any end result that originates from the funded project for the intellectual property and other rights for selling, patenting or handing them over in any other

way for markets that exist outside of European common markets. This approval is not necessary if the licensing of the intellectual property is an essential part of the original project.

Seventh section of the second chapter defines the amount of funding out of the total expenditure used in one project. For fundamental research the subsidy intensity can be up to 100 per cent, for industrial research up to 50 per cent and for experimental development up to 25 per cent of the total cost of the project.

One very relevant section is the 15th section of the second chapter, in which are listed costs which can be allocated for funding: Personnel costs for personnel that either directly or in other ways contribute to the project. Instruments, tools, equipment, buildings and land that are used in the project for the duration of usage. Costs of research, technical knowledge or patents bought with market price or received with use permission if the transaction is executed under common trade conditions. Consulting and equivalent services if they are directly used for the project can also be allocated to the funding. Direct overheads caused by the research and development project as well as materials, necessities and similar products, travel expenses and other expenses that can be directly traced to the project.

Valtionavustuslaki (27.7.2001/688) defines the terms for public funding more generally. The most relevant chapter of this Act is chapter 4. Section 14 specifies that the recipient is obligated to disclose accurate and correct information for the authorities granting said funding. The authorities are responsible for supervising the recipient regarding this information and is authorized to make inspections if needed. If the recipient has received funding mistakenly, has received too much of it or the funding is distinctively unjustified the recipient is obligated to return the funding, or the part of it, which they have unfoundedly received.

3. Research data and methods

This chapter goes through the data as well as the research methods used in this study. First is a thorough explanation of the data used and the sources of where they have been acquired plus the explanations of each variable used in this study. The following sub-chapters include explanations of the research methods used.

The data used in this thesis have been compiled from two sources: Amadeus database and business subsidy material compiled by MOT of Yle (Ranta & Skön, 2014; Ranta & Skön, 2018). As this thesis focuses on one industry rather than all available companies the first limiting factor when choosing companies was the industry data processing, hosting and related activities under Standard Industrial Classification code 6311. Second limiting factor is that the companies must have 10 or fewer employees as this thesis focuses on small companies and this limitation helps finding companies that are similar size. If employee numbers were not available for a company, Amadeus uses an estimation for the company. Companies that have no employee numbers available are also included in the data if Amadeus data base estimates the employee number to be 10 or fewer. All the companies also had to have turnover over 1 000 € on their last available year to make sure that all the companies are at least somewhat active.

MOT's data of granted business subsidies is split into two different datasets. One includes years 1997 to 2013 and the other one includes years 2010 to 2016. The dataset has all direct subsidies as well as loans grated by TEM (työ- ja elinkeinoministeriö, Finland's Ministry of Economic Affairs), Tekes, Liikenne- ja viestintäministeriön (Finland's Ministry of Transport and Communications), Liikennevirasto (Finnish Transport Infrastructure Agency), Energiamarkkinavirasto (Finland's Energy Authority) and Maa- ja metsätalousministeriö (Ministry of Agriculture and Forestry of Finland) that are determined public information by law. The numbers represent the actual sum of money that these companies have received. Relevant information for this study from this dataset is which of the companies chosen have received business subsidies from Tekes and which have not. In addition to gathering information if a company has received subsidies from Tekes also the amount of subsidies received, and the year were added to the separate Excel spreadsheet. (Ranta et al. 2014; 2018)

Important data from these two sources have been combined in a separate Excel spreadsheet to make the data easy to understand and use in quantitative models. Using the data from MOT a subsidies variable was created. The variable is a binary variable meaning it can only be a 1 or a 0 for each company. 1 in this variable means that the company did receive subsidies from Tekes and 0 means it did not. The amounts of granted subsidies a company received were also added into another separate Excel spreadsheet for further use, these exact amounts however were not used in the quantitative tests. Subsidies variable was used in probit model, logistic regression and regression models as dependent variable and in propensity score matching as treatment variable. Other variables were also forming in this aforementioned Excel spreadsheet. A summarized view of the variables, their means, standard deviations plus minimum and maximum values can be seen below.

Table 1: Used variables

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
subsidies	301	0.0930233	0.2909487	0	1
turnoverlast	294	278.8367	513.3889	1	3135
workingcapitalp-eremployee	105	24.24762	196.5802	-81	2009
legalform	300	0.0433333	0.2039466	0	1
corporategroup	294	0.5612245	0.4970835	0	1
employees	169	2.970414	2.391518	1	10
region	301	0.5182724	0.5004981	0	1
b2bb2c	223	0.7085202	0.4554664	0	1
turnoverdiff	210	13.08571	359.8066	-4218	924

Working capital per employee variable was available in Amadeus database and is used as is. Working capital is the difference between current assets and current liabilities for a company (Knauer & Wöhrmann, 2013). Working capital has been divided by the number of employees each company has and the value is in thousands of euros. This variable is used to have an independent variable for seeing the effect that available working capital has on the company.

Having working capital per employee instead of working capital itself has the advantage of balancing the value to the company size.

Legal form variable is a binary variable and is used as a control variable. In this variable 0 expresses that the company is of limited liability, either a limited liability company (Oy, osakeyhtiö) or cooperative company (osuuskunta). (Osakeyhtiölaki: 21.7.2006/624; Osuuskuntalaki: 421/2013) 0 includes other legal forms. It is important to have this variable as a control variable because whether or not a company has limited liability might be a significant factor in receiving subsidies.
Corporategroup variable is also a binary variable 1 meaning the company belongs in a corporate group, ether as a subsidiary or a parent company and 0 meaning the company is an independent company. Whether the company is a subsidiary, or a parent company is not separated. This is an interesting variable since it shows if belonging into a corporate group makes a difference in receiving subsidies or turnover.

Employees variable is a discreet variable expressing the number of employees a company has in their last available financial year. The dataset only has companies that have 10 or fewer employees and companies that do not have employee numbers available but Amadeus database estimates to have 10 or fewer employees so the range of this variable is 1-10. If a company does not have employee numbers available the estimation is not included in the data, only actual employee numbers are included.

Region variable is a binary variable and expresses whether or not the company is located in Uusimaa region or elsewhere in Finland. Companies located in Uusimaa are defined as 1 and others as 0. Another control variable is whether a company mainly does business to business sales or business to consumer sales. A company gets value of 1 if they mainly do business to business sales and a 0 if they mainly do business to consumer sales.

The next variable used is turnover of the last available year (turnoverlast). The turnover is in thousands of euros, for example value 3135 means 3 135 000 €. This variable is used as an independent variable in all the quantitative models.

The last variable is turnoverdiff. It is calculated by subtracting the company's turnover two years prior the last available data from the last turnover value the company had reported. As turnoverlast the value is in thousands of euros.

3.1 Research methods

The research methods used in this thesis are regression model, probit regression and propensity score matching. In propensity score matching four types of matching methods are used to get more generalized results: nearest neighbor matching, radius matching, kernel matching and stratification matching. Turnover for the last available year is used as the dependent variable first and then in the second calculation turnover difference is used as the dependent variable, which is the difference between turnover last available year and turnover two years prior of the last available year. Probit regression is used in forming propensity scores and is therefore briefly explained below.

3.1.1 Probit regression

Probit regression model is a good alternative for logistic regression (Agresti, 2015). The model uses Gaussian normal distribution cumulative, whereas logistic regression uses logistic function (McNelis, 2004).

In the probit regression model the dependent variable *Y* must be a binary variable, meaning it can only reach two values: 1 or 0 (Aldrich & Nelson, 1984).

The probability of being in one category or not being in said category is calculated as follows:

$$p_i = \Phi(x_i\beta + \beta_0) = \int_{\infty}^{x_i\beta+\beta_0} \varphi(t)dt \quad (1)$$

Where:

$\Phi =$ cumulative standard distribution

$\varphi =$ standard normal density function

Partial derivates are calculated from the following function:

$$\frac{\partial p_i}{\partial x_{i,k}} = \varphi(x_i\beta + \beta_0)\beta_k \quad (2)$$

(McNelis, 2004)

3.1.2 Propensity score

Propensity score matching was introduced in 1983 by Paul R. Rosenbaum and Donald B. Rubin in their paper "The central role of the propensity score in observational studies for causal effects". This sub-chapter explains the term propensity score and how propensity scores are calculated the next sub-chapter will focus on the matching of propensity scores. Propensity score model involves treatments 1 and 0. In other words *i*th of the N units have a response r_{1i} that results if it receives treatment 1 and r_{0i} that will result if it receives treatment 0, treatment 0 can also be not receiving said treatment. Therefore, the causal effect can be discerned from $r_{1i} - r_{0i}$ or r_{1i}/r_{0i}. *N* units are a random sample from a population and the quantity that is estimated is average treatment effects (ATE) (Rosenbaum & Rubin, 1983):

$$E(r_1) - E(r_0) \quad (3)$$

E being expectation in this population. Average treatment effect shows the effect of the treatment on a randomly selected subject. Each unit *i* can only receive one treatment, therefore the comparison is not perfectly measurable. Additionally, $z_i = 1$ if the unit *i* receives treatment and $z_i = 0$ if it receives control treatment or no treatment at all. Vector of observed pretreatment measurements or covariates for unit *i* is x_i. These measurements must be done before treatment assignment. (Rosenbaum & Rubin, 1983)

In propensity score matching formula, *i* represents index of the population, when i^{th} observation receives treatment it gains value Y_{i1}, if the observation does not receive treatment it gains value Y_{i0}, otherwise known as control treatment. The effect treatment has on single observation, T_i is calculated as such: (Dehejia & Wahba, 1998)

$$T_i = Y_{i1} - Y_{i0} \tag{4}$$

The effect treatment has can be generalized to the population in question with the following formula:

$$\begin{aligned} \tau|_{T=1} &= E(\tau_i|T_i = 1) \\ &= E(Y_{i1}|T_i = 1) - E(Y_{i0}|T_i = 1) \end{aligned} \tag{5}$$

(Dehejia & Wahba, 1998)

Where $T_i = 1$ if the i^{th} unit was exposed to treatment and $T_i = 0$ if it was not. $E(Y_{i0}|T_i = 1)$ cannot be estimated where as the first term $E(Y_{i1}|T_i = 1)$ can be. This can be problematic in non-experimental studies if the treated and non-treated observations differ largely in their characteristics. This can be prevented with randomization: (Dehejia & Wahba, 1998)

$$Y_{i1}, Y_{i0} \perp T_i \boldsymbol{f} = E(Y_{i0}|T_i = 0) = E(Y_{i0}|T_i = 1) = E(Y_i|T_i = 0) \tag{6}$$

(Dehejia & Wahba, 1998)

In this formula $\perp$ is the symbol for independence and $Y_i = T_iY_{i1} + (1–T_i)Y_{i0}$ represents the observed value of outcome. If the treated and non-treated groups are not fundamentally different from each other the condition T_i is not needed, which leads to: $\tau|_{T=1} = \tau^{e2}$. (Dehejia & Wahba, 1998)

The popularity of propensity score matching has evoked a fair share of criticism. Gary King and Richard Nielsen explain the weaknesses of using propensity scores for matching in their article titled “Why Propensity Scores Should Not Be Used for Matching”, particularly using the

method for preprocessing data for causal inference. King and Nielsen insist that the method creates imbalance, inefficiency, model dependence and bias as well as pointing out that the method attempts to form a completely randomized experiment instead of fully blocked randomized experiment like most other popular methods. (King & Nielsen, 2018)

It is important to understand the actual matching methods that are used to match treated observations to no-treated ones, therefore a brief summary of each method is presented. Nearest neighbor matching is often seen as the most straight-forward matching method for propensity score matching. Essentially an observation from the treated group is matched with an observation from the non-treated group. The matching is done with an observation which is closed to the treated observation in terms of propensity score. Many different variations of nearest neighbor matching exist, for example nearest neighbor matching with replacement allows a non-treated observation to be used multiple times for pairing with multiple treated observations. (Caliendo & Kopeinig, 2005)

One large problem with nearest neighbor matching is that if the dataset simply does not have an observation with a similar propensity score it will match the treated observation with an observation that is closest to the propensity score of the treated observations, regardless of how large the difference is. Radius matching is a variant of caliper matching and therefore explaining caliper matching before radius matching is essential. In caliper matching the method sets a limit of the difference in propensity scores between a treated and a non-treated observation before matching them. This method helps avoid unsatisfactory matches from forming. This matching method however bring in another problem, if a treated observation does not have a pair within the specified range a matching pair will not be formed. In radius matching the method uses all observations within the caliper instead of only one. The outcome is more reliable when no great matches can be done. (Caliendo et al., 2005)

Stratification matching can also be referred as interval matching and its general function is to divide the common support of the propensity score to a set of intervals. These intervals are called strata. The mean difference of outcomes between the treated and non-treated individuals is then calculated to estimate the impact in each interval. (Caliendo et al., 2005)

Kernel matching differentiates itself from the other matching methods in a large way, in the previous matching methods only a selected few of the non-treated observations are used for matching and in kernel matching uses all of the available non-treated observations for the matching. This is achieved by using non-parametric estimations that take in account weighted means of all non-treated observations. Using this method generally lead to lower variance, benefitting from the larger set of observations used. (Caliendo et al., 2005)

4. Research findings

This chapter consists of research findings for all the used quantitative models. First being propensity score matching and analysis of the results using turnover for the last available year followed by differences-in-differences model using turnover difference between last available year and two years prior to the last available year.

4.1 General analysis

The first following table includes observations which have not received subsidies and the table below that one has observations that have received subsidies.

Table 2: Observations that have not received subsidies (subsidies = 0)

Variable	**Obs**	**Mean**	**Std.Dev**	**Min**	**Max**
turnoverlast	266	254.4774	502.8904	1	3135
workingcapi-talperemployee	89	27.61798	213.2604	-81	2009
legalform	272	0.0477941	0.2137236	0	1
corporategroup	266	0.5676692	0.4963336	0	1
employees	150	2.72	2.210773	1	10
region	273	0.5164835	0.500646	0	1
b2bb2c	196	0.6836735	0.4662329	0	1

Table 3: Observations that have received subsidies (subsidies = 1)

Variable	**Obs**	**Mean**	**Std.Dev**	**Min**	**Max**
turnoverlast	28	510.25	562.7317	6	2315
workingcapi-talperemployee	16	5.5	25.91782	-47	68
legalform	28	0	0	0	0
corporategroup	28	0.5	0.5091751	0	1
employees	19	4.947368	2.876605	1	10
region	28	0.5357143	0.5078745	0	1
b2bb2c	27	0.8888889	0.3202563	0	1

These first two tables has the main dependent variable turnoverlast and the independent variables used in the study sorted by whether or not the group received subsidies or not. Main takeaways from these tables are that only 28 companies received subsidies out of the whole dataset. The mean of turnover of the last available year for companies that did not receive treatment was a little over 254 thousand euros while the mean turnover of the treatment group was over 510 thousand euros. This difference is very significant but as the sample size of the treatment group is small and this does not take into consideration any factors looking at the data this way is not a very reliable way of analyzing the data. Interestingly working capital per employee was lower on average for the treatment group. All the companies that received subsidies were companies that have limited liability, which is interesting because the recipient having to be of limited liability is not explicitly mentioned in the funding conditions, although this makes sense since only a small percentage of the companies had legal form of other than limited liability. Observations in the treatment group also had around two more employees on average and more companies that received subsidies mainly did business to business sales compared to the group that did not receive subsidies.

4.2 Regression

Before forming the propensity scores using probit regression, a simple T-Test and a regression with multiple independent variables have been conducted. The following table represents the values acquired from linear regression model with turnoverlast as the dependent variable on the column labeled “Model-1” and the column labeled “Model-2” has the turnoverdiff variable as the dependent variable. Both tests on the first table have subsidies as the independent variable. The next two tables have results of another regression model in them however more independent variables are added to find out the effect those variables have on turnover and turnover difference.

Table 4: Regression with turnover as the dependent variable and subsidies as independent (Model-1) and turnoverdiff as dependent variable and subsidies as independent variable (Model-2).

	Model-1	Model-2
Coef.	255.7726	56.72617
Std. Err.	101.0722	74.25135
R^2	0.0215	0.0028
Adj R^2	0.0181	-0.0020
Prob > F	0.0119	0.4457
t	2.53	0.76
P>|t|	0.012	0.446

When using turnoverlast as the dependent variable (Model-1) the t-value is higher than 2.5 and the p-value is under 0.05, therefore a conclusion can be formed that the null hypothesis of receiving subsidies having no effect on turnover can be rejected. R-squared value is relatively low 0.0181, indicating that approximately two per cent of the variance in turnover last available year can be credited to receiving subsidies. The coefficient shows that the predicted turnover last available year would be approximately 255 thousand euros higher for those companies that receive subsidies.

The results of the regression model when using turnoverdiff as the dependent variable (Model-2) estimate that the difference between turnover last available year and turnover two years prior would be approximately 56 thousand euros higher if a company receives subsidies. On this test however, both the t-value and p-value illustrate that the null hypothesis cannot be rejected.

Table 5: Regression with turnoverlast as the dependent variable

R^2		0.5067		
Adj R^2		0.4714		
Prob > F		0.0000		
	Coeff.	**Std. Err.**	**t**	**P>|t|**
subsidies	-192.2078	155.1182	-1.24	0.219
workingcapitalperemployee	1.108328	0.2748624	4.03	0.000
legalform	0	omitted		
corporategroup	302.7029	119.2838	2.54	0.013
employees	162.0042	21.68119	7.47	0.000
region	44.32422	114.7335	0.39	0.700
b2bb2c	-23.00287	143.382	-0.16	0.873

The table seen above take into consideration more independent variables to estimate if they affect turnover last available year. Both r-squared and adjusted r-squared values indicate that the model fits the data relatively well with values of 0.5067 for r-squared and 0.4714 for adjusted r-squared. Prob > F additionally indicates that these independent variables are successful in predicting the turnoverlast variable.

A large difference is visible in the coefficient of subsidies variable compared to the earlier regression model without these additional independent variables. The value demonstrates a significant reduction in turnover if an observation receives subsidies. However, with the p-value being very high we cannot reject the null hypothesis.

Working capital per employee has t-value of 4.03 and p-value of 0.000 and this is enough to conclude that this variable does have an effect on turnover. Increasing working capital per employee of the company by one (one thousand), this model predicts that the company's turnover would increase by 1.108328. While higher working capital does not directly lead into higher turnover, higher turnover on the other hand could lead to higher profits and more working capital in future. As with some other tests legalform variable has been omitted because the entire treated group were companies of limited liability.

Corporategroup variable has coefficient of 302.7029 which shows that if a company belongs to a corporate group the model predicts the company to have a turnover over 300 thousand euros higher than a company that does not belong to a corporate group. Both t-value and p-value indicate that belonging to a corporate group does in fact have an effect on turnover.

Another clear indication of influence to turnover can be seen in employee numbers. The model predicts that one additional employee would raise a company's turnover by 162 000 € and both t-value and p-value back this claim. A clear picture of whether company's location has affects turnover cannot be formed since p-value of 0.700 and t-value of 0.39 barres one from rejecting the null hypothesis. The coefficient does indicate that companies that are located in Uusimaa the model predicts an increase in turnover compared to those located elsewhere.

B2bb2c variable has high p-value and low t-value as well, therefore the null hypothesis of this independent variable having no effect on turnoverlast stays. The coefficient value shows a predicted decrease in turnoverlast for companies that mainly do business to consumer sales.

Table 6: Regression with turnoverdiff as the dependent variable

R^2		0.0945		
Adj R^2		0.0122		
Prob > F		0.3448		
	Coeff.	**Std. Err.**	**t**	**P>|t|**
subsidies	76.55624	173.23	0.44	0.660
workingcapitalperemployee	-0.685531	0.2995442	-2.29	0.025
legalform	0	omitted		
corporategroup	-73.89485	146.3395	-0.50	0.615
employees	-11.42252	25.66819	-0.45	0.658
region	-133.3597	138.7968	-0.96	0.340
b2bb2c	-91.02821	183.0061	-0.50	0.621

Looking at the above results of the regression using turnover difference between last available year and two years prior shows much lower r-squared and adjusted r-squared values compared to the earlier table interpreting the results when using turnoverlast variable. Prob > F value in turn indicates that this model is not very good at explaining the data.

Out of all independent variables only workingcapitalperemployee has an acceptable p-value below 0.05 alongside with t-value of -2.29. This model predicts a decrease in turnover difference if company's working capital were increased by one (thousand euros), although the decrease is merely -0.685531 thousand euros.

Since other variables do not display acceptable p-values thorough interpretation of the values is not necessary. Receiving subsidies does seem to have a positive effect on turnoverdiff while the other independent variables show negative coefficient values. Region has the largest effect on turnoverdiff predicting turnover difference of -133.3597 if a company is in Uusimaa.

4.3 Probit regression

The following model has been shown as one table since the outcomes of using turnoverlast and turnoverdiff are identical. This model forms propensity scores for each observation in the dataset if the observation has enough information available for a score to be formed. The following table is probit regression results from forming propensity scores.

Table 7: Probit regression from propensity score forming

Obs		91		
LF chi2(5)		7.96		
Prob > chi2		0.1587		
Pseudo R^2		0.0940		
Variable	**Coef.**	**Std. Err.**	**z**	**P>|z|**
workingcapitalp-eremployee	-0.0043535	0.0087366	-0.50	0.618
corporategroup	-0.4483962	0.343908	-1.30	0.192
employees	0.1359817	0.0587762	2.31	0.021
region	-0.1188522	0.3335979	0.722	0.722
b2bb2c	0.3021552	0.4662933	0.517	0.517

Total of 91 observations have been reported which indicates that only 91 companies had all the information available needed to be used in the model. The Prob > chi2 value is over the accepted alpha value of 0.05 and therefore the null hypothesis for the test as whole cannot be rejected. Pseudo r-squared is not a vary good value to look at when determining the impact of the model and therefore will be largely ignored.

Starting with working capital per employee the p-value is very high (0.618) and the z-value is not significantly positive or negative, therefore the null hypothesis cannot be rejected, and no certainty can be achieved regarding this variables effect on receiving treatment. The coefficient of the variable is also rather insignificant (-0.0043535). Even though the coefficient of corporategroup is larger and negative, indicates that belonging in a corporate group has a

negative effect on whether or not a company receives subsidies, this variable has a p-value of over 0.05 and not very convincing z-value. Employees-variable on the other hand has a p-value of < 0.05 and z-value of higher than 2 and therefore can be determined to be significant. With coefficient value of 0.1359817, with this is mind, increasing the number of employees in a company by one would increase the likelihood of said company receiving subsidies by 0.1359817, ceteris paribus. For both region and b2bb2c the results indicate that the null hypothesis cannot be rejected based on p-value (with confidence level of 95 per cent) and small z-values. Based on this, the coefficients of these variables are not of particular interest.

4.4 Matching

This sub-chapter focuses on the actual matching based on the propensity scores given. The following table presents coefficients, standard errors as well as t-values for each matching method used. In addition, means for the coefficients and standard errors are shown for achieving a more generalized image of the results.

Table 8: Propensity score matching

Method	**ATT turnoverlast**	**Std. Err. turnoverlast**	**t**	**ATT turnoverdiff**	**Std. Err. turnoverdiff**	**t**
nearest neighbor	-573.500	450.662	-1.273	-250.087	295.115	-0.847
radius	46.538	201.691	0.231			
kernel	-291.161	273.623	-1.064	25.456	126.748	0.201
stratification	-324.388	253.148	-1.281	121.923	214.681	0.568
Mean	-285.628	294.781		-34.236	212.181	

The abbreviation ATT refers to *Average Treatment effect on the Treated*. Starting with the nearest neighbor matching with turnoverlast as dependent variable the difference in turnover that receiving has is very large, -573.500. This means that based on nearest neighbor matching

receiving subsidies would decrease company's turnover by this much. As has been discussed prior in the research methods chapter, one of nearest neighbor matching's shortcomings is the possibility of bad matches, which could explain the fact that the negative value is so large. On the other hand, the t-value is only -1.273 where values over two or less than negative two would be significant. When looking at nearest neighbor matching but with turnoverdiff as the dependent variable a sharp decrease in ATT can be seen. While still negative, -250.087 is almost half of the value of the same matching model using turnoverlast variable. T-value is even less significant when using turnoverdiff variable, therefore the null hypothesis that subsidies have no effect on turnover cannot be rejected confidently. Unlike nearest neighbor matching, radius matching shows positive

The next matching method, radius matching, could not be run using the turnoverdiff as the dependent variable, therefore only values for last available turnover are presented. This is the first test that shows positive ATT value so far. Average Treatment effect on the Treated value 46.538 is however paired with t-value of only 0.231 therefore null hypothesis in this case cannot be rejected either.

Kernel matching using turnoverlast variable shows ATT of -291.161 and t-value of -1.064. As with nearest neighbor matching the effect is negative and significantly at that which indicates that receiving subsidies indeed does negatively affect observed company's turnover. With turnover difference between last available year and turnover two years prior to that as the dependent variable the ATT value is positive. This indicates that when looking at the change of turnover over a short period of time shows that receiving subsidies has slightly positive effects. This must be largely ignored, however, because of the low t-values when using either of the dependent values turnoverlast and turnoverdiff.

Stratification matching shows the largest difference in the ATT values between tests ran with turnoverlast and turnoverdiff. The test shows a large negative effect when using turnover of the last available year (-324.388) and a largely positive one when using the difference in turnovers between last available years value and the value of two years prior (121.923). As with all of the former matching methods the t-values stay at very low levels indicating that the null hypothesis cannot be rejected in these cases either.

The means of ATT values using both dependent variables show that on average the effect is negative, however, the effect is significantly more negative when using only one year's data instead of the difference over time. Based on the t-values the null hypothesis that receiving subsidies have no effect on turnover must be kept.

5. Conclusions

The goal of this study was to research if receiving subsidies affects turnover. The field used in the study was chosen for two reasons:

1. In information technology field, research and development plays a major role in the success of a company and,
2. the field has large quantity of companies

As mentioned in the introduction business subsidies as a major talking point can be found in politics and regular conversations. Public funding has been both praised and heavily criticized. Research and development subsidies, as most of the subsidies have, been researched rather thoroughly throughout the years and the consensus is that they fill in the blanks where private investment and the market fails to fund beneficial projects. This is especially important in projects that would benefit the society if completed.

Subsidy-data between years 1997 and 2016 was compiled with the available financial data to form a dataset used in the quantitative studies utilized in this study. The dataset was edited to form dummy variables of whether or not a company received subsidies, legal form, does the company belong to a corporate group or not, region and if the company mainly does business to business or business to consumer sales. Turnoverdiff variable was created by the difference of turnover value of last available year and turnover of two years prior of the last available year.

This dataset was then inserted to Stata. In Stata subsidies was formed to be the treatment variable, the y-variable or dependent variable on the first run was turnoverlast and was placed in a list defined as “ylist”. In the list “xlist” all independent variables were placed: workingcapitalperemployee, legalform, corporategroup, employees, region and b2bb2c. The bootstrap replications were set to 1000. To get a generalized image of the data and variables used the data was sorted by subsidies variable.

First actual test used was regression test with turnoverlast as the dependent variable and subsidies as independent variable. After this another similar test was run, although this time with subsidies, workingcapitalperemployee, legalform, corporategroup, employees, region and b2bb2c as the independent variables to interpret the effects other variables might have on turnover. These tests were run again with turnoverdiff as the dependent variable.

Third test run was creating the propensity scores from each observation using pscore function that uses probit model. With propensity scores formed matching the treated observations to non-treated observations was done first with nearest neighbor matching, followed by radius, kernel and stratification matching. The average treatment effects on the treated were then used to analyse the effects subsidies have on turnover.

Lastly propensity scores were created again, however this time using turnoverdiff as the y-variable. This was done to analyse the effects subsidies might have on the turnover difference over time.

The research results are lacking in some regards. The largest problem stems from the improper sample size used. Although all tests were successfully run the results have rather low t-values after matching. The general trend with the results is that subsidies have a negative effect on the last available turnover and less negative effect on turnover difference over time. These results do not lead into a definitive resolution that subsidies affect turnover or turnover over time.

Interesting observations can however be gathered from the other tests. The general analysis of the data shows that the entirety of the companies that received were of limited liability.

The funding conditions stated by law do not explicitly say that only companies of limited liability can receive research and development subsidies. Without further research it is hard to say why companies that are either osakeyhtiö (limited liability company) or osuuskunta (co-operation company) are the only companies to receive research and development funding from Tekes. Companies that received funding had more employees on average but still less working capital per employee. This could indicate that the companies that received funding were more prone to use capital for research and development activities than companies that have not received subsidies and could be a decider in whether a company receives or does not receive subsidies. The treated group also had much higher turnover latest reported year but were slightly less likely to belong to a corporate group.

Regression model with latest turnover value as dependent variable and subsidies as independent variable (Model-1) predicted that receiving subsidies does increase turnover by over 250 thousand euros, although only approximately one per cent of the variance can be credited to receiving subsidies. The same test with turnover difference instead of turnover latest year as the dependent variable (Model-2) had p-value of 0.446 and therefore is not significant.

Regression model with more independent variables and turnoverlast variable as the dependent variable indicated that working capital per employee affects turnover. The model predicted that increasing working capital per employee by one thousand the company's turnover would increase by approximately 1.1 thousand. Being part of a corporate group also increases turnover which could be credited to a larger network for acquiring customers and partners, however without further research this cannot be said with certainty. As expected, having more employees positively affects turnover or more likely higher turnover lead into the ability to hire more employees.

The aforementioned regression model with multiple independent variables with turnoverdiff as the dependent variable in place of turnoverlast presents results arguing that increasing working capital per employee decreases the turnover difference over time slightly. None of the other variables presented acceptable p-values, therefore it can be concluded that these independent variables have no effect on turnover difference.

Probit model showed that only one independent variable, employees, significantly affect company's chances of receiving subsidies. Increasing the number of employees a company has by one increases the chances of receiving subsidies by approximately 13.6 per cent.

The results from completing the matching of observations based on propensity scores with four different matching methods first using turnoverlast and then using turnoverdiff as the dependent variables. The consensus of the results is that receiving subsidies has a negative effect on turnover and additionally negative effect on turnover difference, although less so. The t-values of the matching methods indicate however that the tests are not very trustworthy.

Answering the research questions, we start with the first sub-question:

"Which factors may increase company's chances of receiving business subsidies?"

The probit regression shows a clear indication that employee numbers positively affect company's chances of receiving subsidies. According to the results hiring one additional employee would increase a company's chances of receiving subsidies by approximately 0.136. Out of all the independent variables used in this research, employee numbers were the only one to have an effect on receiving business subsidies. Only companies that have limited liability were granted R&D business subsidies out of the companies used in this research. This information may be relevant for businesses when they consider improving their chances of receiving business subsidies for a specific research or development project. Having a company with legal form that has limited liability as well as having more employees may increase a company's chances of receiving R&D business subsidies.

"Which factors may have an effect on turnover?"

Based on the results of regression model we can say that working capital per employee does have an effect on turnover, as increasing the working capital per employee for a company by one thousand the model predicts an increase of approximately 1.1 thousand in turnover. How-

ever, using turnover difference as the dependent variable shows that increasing working capital per employee decreases turnover slightly. Additionally, additional employees have a positive effect on turnover. From the point of view of businesses this is relevant information, focusing on having higher working capital per employee could increase turnover. The number of employees a company has does have a positive effect on turnover, however having more employees is more likely to be an effect of having higher turnover and being a successful company, rather than vice versa. The same might be true for working capital per employee as well.

Do R&D business subsidies increase the turnover of a company?

One indication is that receiving subsidies does have a positive effect on company's turnover for the latest year. This makes sense since receiving additional funding for research and development activities could lead to larger utilization of R&D projects, which in turn could lead to better quality in products and services or the invention of new products. This could lead to higher turnover. These results are based on the simple regression model analysis and do not take in consideration other factors that could influence turnover.

Based on the main research model, propensity score matching, a definitive solution to the main research question cannot be formed as the matching represents very low t-values. The results however indicate subsidies to have a negative effect on both turnover and turnover difference. Further research with larger sample size and more available information would be needed to reach more confident conclusion. In conclusion the linear regression analysis provides results indicating that subsidies do positively affect turnover, however the propensity score matching shows, which can be seen as a more reliable method since it takes other factors into account, that no definitive answer to the main research question can be given.

When analyzing the reliability of this research the size of the dataset is one of the main concerns. The sample size is small and therefore the reliability of the research is limited. Total of 301 observations were used in this research, however information was not available for all the variables for each observation. For example, where 301 observations were available for the variable "subsidies" yet only 105 companies had their working capital per employee value in the Amadeus database. This lowered the usable observations in most quantitative models to

a much lower quantity which in turn lowers the reliability of the research further. For further research more industries should be included in the dataset to ensure that the sample size is large enough. Alternatively, only one industry could be used if more data is available for that specific field and the number of companies would be much larger.

Another reason for the unsatisfying results could be the time frame used. It is entirely possible that the research and development business subsidies granted had no observable effect on turnover or turnover difference because the time between receiving subsidies and the year of the turnover data measured was not long enough. This research only uses a dummy variable for subsidies and does not include amounts or the year in which said subsidies were received. More accurate results could be achieved if enough time between the year of receiving subsidies and the year when the turnover was recorded would have passed. In addition to this, taking subsidy amounts into consideration alongside with turnover amounts would result in more accurate results and possibly reveal how much subsidies affect turnover, if they do.

The variables turnoverlast and turnoverdiff were formed from the data available. Turnover last available year has the reported turnover of the company on the year that was the most recent one they have reported. This means that the numerical value is from year 2018 for many companies, but others have turnover of year 2019 while some have turnover of year 2017 as their most recent reported value. The variable was formed in this way because some companies did not have reported their turnover for years 2018 or 2019, while others did not have data available for year 2017 but had data for years 2018 and 2019. The problem with this method of forming the variable is that it does not take into consideration economic cycles which might have an effect on the field as a whole and this decreases the reliability of the study. Having R&D spending and export revenues as independent variables in this study would have been beneficial for the overall quality since they would bring in more information about the companies. This data was unfortunately not available from the databases available.

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