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Public Procurement and firm performance

The effects of Public Procurement on firm performance in Norway

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1. Abstract

This master thesis sheds light on whether there is positive relationship between public procurement and firm performance in Norway. Two hypotheses are proposed. Hypothesis 1 is that there exists a positive relationship between public procurement and firm performance in Norway. Hypothesis 2 is that there exists a positive relationship between firms' higher share of sales to public procurement and firm performance in Norway. The public procurement is at the Norwegian municipality level. Two large datasets have been used on firm performance and municipality procurement.

The first dataset is firm level dataset which contains company and consolidated accounts for all Norwegian enterprises and groups for the years from 1992 to 2016. The second dataset is municipality data which comes from Kommunal Rapport's Leverandørdatabasen.

This thesis uses two methodologies to test the relationship. The problem is framed as a quasi-experiment. Firstly, Propensity Score Matching method is used in order to create a control group with identical age, industry, and region compared to treated group. Secondly, two regressions will be run on the matched sample to test for effects of public procurement on firm performance in Norway. And an additional regression analysis is conducted to test for the effects of public procurement on firm innovation performance.

The findings show that public procurement is positive related to firm performance regarding EBITDA Margin and Return of Assets. The relationship between share of sales to municipalities and firm performance are non-linear, which suggests the lacking of alternative markets as an obstacle to firm performance. In addition, the findings demonstrate that companies selling to municipalities where they are located in have better performance than other companies. Weak competition and close connections between suppliers and public procurers might cause corruption issues. The findings represent that small-sized and tech companies have better firm performance and firm innovation performance by being suppliers to municipalities. However, the additional findings suggest that companies which are suppliers to municipalities have lower firm innovation performance. This may indicate a lack of innovation support through public procurement in Norway.

Key words: Firm performance; Public Procurement; Propensity Score Matching; Norway

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2. Introduction

Public procurement accounts for a significant share of GDP and aggregate demand. Every year, over 250,000 public authorities in the EU spend around 14% of GDP on the purchase of services, works, and supplies. In many sectors such as energy, transport, waste management, social protection and the provision of health or education services, public authorities are the principal buyers (European Commission, 2018). In Norway, public purchases goods and services amounted to about NOK 500 billion in 2016, which increased by around 5% comparing to year 2015. This is about 16% of the GDP and the highest in the last five years (SSB, 2017).

Public procurement, as one of major economic activities of government in the marketplace (Thai 2001), impacts and in some cases shapes the market itself. Government purchase may influence market competition by supporting firms' finance. In order to achieve best value for tax payers' money, and best quality at the lowest price, public procurement needs to be ensured by creating a competitive public procure process (Steen Bruun-Nielsen, 2015). Regarding cost efficiency for public procurement procedures and techniques. Open procedure is the preferred public procurement method to be open for bids from all qualified and interested bidders, which has lower cost with regard to people and time invested than other procedures. Frameworks agreements aggregate in one initial stage a large part of the administrative burden of a procurement process, which lead to significant cost savings, particularly if the number of subsequent contracts within the framework is high (European Commission, 2011).

Most of the research on the effects of public procurement focused on government demand for innovation (Aschhoff and Sofka 2009), green public procurement, procurement procedures such as qualification of bidders, and measures to prevent collusion and corruption (Hoekman and Sanfilippo 2018). In the author's knowledge, there are very few researches regarding relationship between public procurement and firm performance. Less attention has been given to the prevalence and effectiveness of public procurement as a tool to enhance the performance of domestic firms (Hoekman and Sanfilippo 2018). This creates an opportunity to conduct an empirical investigation of the correlation between the public procurement and firm performance in Norway.

This research sheds lights on whether there is positive relationship between public procurement and firm performance in Norway. The thesis applies empirical methodology to test the relationship between Norwegian municipality procurement and firm performance by using two types of dataset. The first dataset is firm level dataset which contains company and consolidated accounts for all Norwegian enterprises and groups for the years from 1992 to 2016. The dataset includes both the accounting figures and the company variables with organization number, name, address, year of formation, number of employees, industry code(s) and form of incorporation. The second dataset is municipality data which comes from Kommunal Rapport's Leverandørdatabasen[1]. The dataset includes all the Norwegian counties' and municipalities' purchasing amount and purchasing suppliers from year 2012 to 2016. In addition, detailed information of suppliers, such as established year, industry, region, etc. is included.

This thesis uses two methodologies to investigate the relationship. The problem is framed as a quasi-experiment. Firstly, Propensity Score Matching method is used in order to create a control group with identical age, industry, and region compared to treated group which are suppliers to municipalities. After matching, the average treatment effect on the treated (ATT) can be analyzed for differences of outcomes. Secondly, two regressions will be run on the matched sample after matching, to test for effects of public procurement on firm performance in Norway. And an additional regression analysis is conducted to test for the effects of public procurement on firm innovation performance.

The thesis is structured as follows. Chapter 3 introduces the relevant literature on public procurement and firm performance. Chapter 4 proposes research hypothesis. Chapter 5 describes the data and descriptive statistics of the sample. Chapter 6 introduces methodology of Propensity Score Matching and regression analysis. Chapter 7 presents and discusses the results. Chapter 8 concludes.

[1] https://www.leverandordatabasen.no/

3. Literature Review

Public procurement is the process of purchasing goods, services or works by the public sector from the private sector. Examples include the building of a state school, purchasing furniture for a public prosecutor's office and contracting cleaning services for a public university (European Commission, 2018).

Public procurement accounts for a significant share of GDP and thus aggregate demand. Every year, over 250,000 public authorities in the EU spend around 14% of GDP on the purchase of services, works, and supplies. In many sectors such as energy, transport, waste management, social protection and the provision of health or education services, public authorities are the principal buyers (European commission, 2018). In Norway, public purchases goods and services amounted to about NOK 500 billion in 2016, which increased by around 5% comparing to year 2015. This is about 16% of the GDP and the highest in the last five years (SSB, 2017).

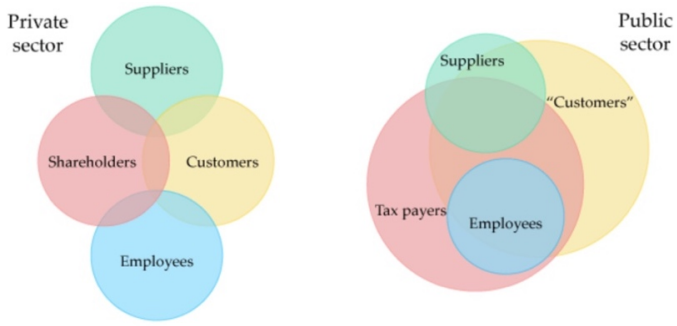

Figure 1: Characteristics differences between private and public sector.
Source: Maltaverne (2018)

According to Maltaverne (2018), public procurement and private procurement are different in some specific characteristic. Figure 1 shows that public procurement is dependent on taxpayers' money, which is expected to be in good use, and therefore public procurement is more risk averse. According to (Uyarra, Edler et al. 2014), the inherent risk aversion of the public sector is one of the barriers to innovation through public procurement. Thus, risk management is significant to make sure that public procurement to be willing for innovation procurement (Uyarra, Edler et al. 2014). In addition, it also explains that public sector is more advanced than the private sector in areas like digital procurement, in order to be more transparent,

fairness and less fraud. (Maltaverne, 2018) Decision making in the public sector is affected by strong expectations regarding transparency and accountability (Uyarra, Edler et al. 2014).

In order to achieve best value for tax payers' money, and best quality at the lowest price, public procurement needs to be ensured by creating a competitive public procure process (Steen Bruun-Nielsen, 2015). According to OECD (2011), the risks for competition in public procurement can be reduced by careful consideration of the various auction features and their impact on the likelihood of collusion. Effective public procurement avoids mismanagement and waste of public funds (OECD, 2011). In Norway, the State Procurement Center was established in 2016 in order to promote more professional, efficient and simple procurement processes, lower prices, reduced transaction costs, increased use of electronic commerce, and better regulatory compliance (Oslo Economics og Inventura 2019). Total cost benefits for society are estimated at approximately NOK 860 million over a four-year trial with the State Procurement Center in Norway (Oslo Economics og Inventura 2019).

According to European Commission (2011), public procurement procedures can be classified as, open procedure, restricted procedure, negotiated procedure, and competitive dialogue. Open procedure is the preferred method which is open for bids from all qualified and interested bidders. While restricted and negotiated procedure are only for invited suppliers to submit a tender or having a negotiation. Competitive dialogue is usually used in large infrastructure projects where technical specifications are difficult to define at the start. In EU, open procedures account for 73% of all tender announcements in the Official Journal, and more for smaller contract values. Restricted and Negotiated procedures constitute about 9 percent of total procurements each (European Commission, 2011).

There are also four procurement techniques, which are Framework agreements, Use of Joint purchasing, Dynamic Purchasing systems, and E-auctions (European Commission, 2011). Framework agreements is an agreement with terms governing contracts. Use of Joint purchasing is two or more contracting authorities that procure jointly. Dynamic Purchasing systems is an electronic system for government to buy commonly goods from suppliers which can join at any time (European Commission, 2011). And E-auctions is an e-business between auctioneers and bidders an electronic marketplace. In Norway, frameworks are used for about 40 % of all contract awards notices (European Commission, 2011).

Regarding cost efficiency for public procurement procedures and techniques. Open procedure has lower cost regarding people and time invested than other procedures. Frameworks agreements aggregate in one initial stage a large part of the administrative burden of a procurement process, which lead to significant cost savings, particularly if the number of subsequent contracts within the framework is high (European Commission, 2011).

Public procurement, as one of major economic activities of government in the marketplace (Thai 2001), impacts and in some cases shapes the market itself. Government purchase may influence market competition by supporting firms' finance. According to Cestone (1999), financial policy affects financing costs, and firm's profits by modifying the product market game. For instance, according to Telser (1966), long purse story means that firms with better access to liquid funds can survive longer in predatory product market competition. This argues that an entrant typically comes into the market with a more vulnerable financial structure than an incumbent (Telser 1966). This explains an entrant such as SME firms may issue more debt in order to do R&D and be more vulnerable to predation (Cestone 1999). On the other hands, according to Cestone (1999), the funded firm may have agency problem, such as moral hazard, which means that after the investment is made and before returns are realized, the firm's manager can either work or shirk. Therefore, government as a stable and relatively long-term customer can be a good financial support to firms. But public procurement can also try to avoid moral hazard by selecting firms with better performance.

Recent researches on public procurement are mostly in the area on how public procurement can develop an industrial strategy to promote innovation technology, develop SME companies, stimulate domestic production and consumption (Dawar and Oh 2017), develop green public procurement, and procurement procedures such as qualification of bidders, and measures to prevent collusion and corruption (Hoekman and Sanfilippo 2018).

According to Aschhoff and Sofka (2009), policy instruments support firms' innovation activities in four ways, which are regulation, universities and public research institutions, public R&D subsidies, and public procurement. Public procurement is viewed as demand policy instrument, and support innovation in two ways. One is public procurement for innovation, which involves facilitating and not hindering innovation in all types of procurement. This has the characteristic of low threshold, not very advanced, and recreational. The other is procurement of innovation, which procurement of advanced solutions that often require research and development. This has the characteristic of higher threshold, relevant to

a small proportion of public procurement (Skogli & Nellemann, 2016). Then public procurement might be a suitable tool for stimulating the generation and diffusion of technological innovation (Geroski 1990). A major advantage of public procurement in innovation policy is that the government specifies a desired output and leaves it to the creativity of private businesses to achieve this result with the most effective and efficient technologies (Aschhoff and Sofka 2009).

The latest research on relationship between public procurement and SMEs are mainly on the topic of how to promote innovation in SME (Saastamoinen, Reijonen et al. 2018) and whether SME should engage supplying government based on institutional environment, the market, and firm resource contexts (Woldesenbet and Worthington 2018). Public Procurement policy is typically viewed as a legitimate tool to stimulate domestic production and consumption (Dawar and Oh 2017).

In addition, Green public procurement (GPP) is becoming a cornerstone of environmental policies both at European Union and Member State level (Tukker, Emmert et al. 2008). Existing research mainly focused on the benefits of GPP and state of environmental procurement criteria, obstacles, and drawbacks and how to implement GPP in public policy (Testa, Iraldo et al. 2012). Furthermore, governments may use procurement as a macroeconomic tool, through stimulus packages to boost aggregate demand in the aftermath of the global financial crisis (Evenett and Anirudh 2016).

However, there are very few researches regarding relationship between public procurement and firm performance. Less attention has been given to the prevalence and effectiveness of public procurement as a tool to enhance the performance of domestic firms (Hoekman and Sanfilippo 2018). One most relevant latest research investigate whether participation in public procurement is associated with realization of the types of goals that underlie industrial policy- an improvement in measures of firm performance, and find that firms that sell a larger share of their output to government entities have better productivity performance (Hoekman and Sanfilippo 2018). This is a case for domestically-owned firms, especially small companies, firms engaged in manufacturing activities and those located in the capital city. The research uses firm-level data from 6,700 companies based in 19 Sub-Saharan African countries (Hoekman and Sanfilippo 2018).

4. Research Hypothesis

According to the previous research, public procurement as a demand may positively affect firm performance in different ways. Firstly, to some degree public procurement as additional demand to firms' output which may help to solve firms' some problems such as access to finance, mobilizing resources to invest and enhance their performance (Lee 2017). Secondly, firms may benefit from winning procurement bids by increasing firm size, winning more contracts in the future, and to be more importantly enter more valuable auctions, penetrate more markets, and also increase the variety of product lines (Ferraz, Finan et al. 2015). Thirdly, public procurement may stimulate innovation by developing new technologies, products and new investment in R&D. The effects may be heterogeneous due to the difference of firms' size, industry, and region (Aschhoff and Sofka 2009).

The effects of public procurement could be more critical for firms that are smaller and younger which have limited access to finance, resources and gain customers (Ferraz, Finan et al. 2015). Besides, "home bias" could be existed that public procurement is tended to make contracts to local firms which might steer domestic tax revenues(Shingal 2015).

In order to study on the effect of public procurement on firm performance in Norway, municipality level of procurement is studied. The primary hypotheses for the thesis are proposed as follows:

Hypothesis 1: There exists a positive relationship between public procurement and firm performance in Norway.

Hypothesis 2: There exists a positive relationship between firms' higher share of sales to public procurement and firm performance in Norway.

The motivation of Hypothesis 2 is a further study based on Hypothesis 1. If this study is able to test a positive relationship between public procurement and firm performance. Then, it would be interesting to test whether the companies which consist of higher share of sales to municipalities can have positive effects on the firm performance.

To test the hypothesis, the problem is framed as a quasi-experiment. This thesis uses two methodologies to test the relationship. Firstly, Propensity Score Matching method is used in

order to create a control group with identical age, industry, and region compared to treated group. After matching, the average treatment effect on the treated (ATT) can be analyzed for differences of outcomes. The treated group is the municipalities' suppliers, and the control group is identified after Propensity Score Matching. This method is only for Hypothesis 1.

Secondly, regression analysis is adopted to test both hypotheses. Two regressions will be run on matched sample for Hypothesis 1 and Hypothesis 2, respectively. For Hypothesis 1, independent variable *Matched Group* will be used to test whether there is a positive relationship between public procurement and firm performance in Norway. *Matched Group* is the treated group plus control group after matching. *Matched Group* equals to 1 represents treated group which the firms are suppliers to municipalities, *Matched Group* equals to 0 represents control group which the firms are not suppliers to municipalities. For Hypothesis 2, independent variable *Share of sales to municipalities* will be used to test whether there exists a positive relationship between firms' higher shares of sales to municipalities and firm performance in Norway.

5. Data

5.1 Data Sources

5.1.1 Municipality Public Procurement Data Source

Municipality data comes from Kommunal Rapport's Leverandørdatabasen[2]. Kommunal Rapport (meaning Municipal Report in English) is a Norwegian daily news website and weekly newspaper which covers municipal affairs[3].

The dataset includes all the Norwegian counties' and municipalities' purchasing amount and purchasing suppliers from year 2012 to 2016. In addition, detailed information of suppliers, such as established year, industry, region, etc. is included.

The dataset has also been supplemented with a centralization index from the Norwegian Institute for Urban and Regional Research (NIBR). All the municipalities are ranked from 1 to 10 based on their location relative to large Norwegian cities, where 1 is most central.

[2] https://www.leverandordatabasen.no/
[3] https://en.wikipedia.org/wiki/Kommunal_Rapport

5.1.2 Firm Level Data Source

Firm level data source is from SNF's[4] and NHH's[5] Database of Accounting and Company Information for Norwegian Companies. The database contains company and consolidated accounts for all Norwegian enterprises and groups for the years from 1992 to 2016. The data have been submitted to SNF annually by the Brønnøysund Register Centre via Bisnode D&B Norway AS[6] and in collaboration with Menon Business Economics AS.

The dataset includes both the accounting figures and the company variables with organization number, name, address, year of formation, number of employees, industry code(s) and form of incorporation.

The dataset received inconsistent data and due to the changes to the new accounting rules introduced during the period, which creates a need for both standardization and straightforward quality assurance. The variables in the accounting files have largely been organized in accordance with the structure of the Accounting Act in relation to income statement, assets and equity/liabilities. It is important to note that all amounts are in thousand NOK, while the ratios are stated as decimals.

The dataset has been reviewed and expanded by Aksel Mjøs, dr.oecon., associate professor at the Department of Finance at NHH and is perceived to be of high quality.

[4] Institute for Research in Economics and Business Administration
[5] Norwegian School of Economics
[6] Dun & Bradstreet Norway AS

5.2 Sample Selection

The natural testing period is from 2012 to 2016, because municipality public procurement dataset is from 2012 to 2016, and firm level dataset is updated to 2016. After merging municipality data and firm level data, the unmatched data, which are missing accounting or industry information are dropped. Firms with Total Revenue and Total Assets below or equal to 0 have been removed from the dataset. Firms which is going to become bankrupt have been removed from the dataset as well.

In order to only include active commercial companies which are likely to be suppliers to municipalities, industries which are not normally seen as profit maximizers or are heavily involved by government are excluded. To be more specific, pure financial holding companies, regulated firms, political and religious groups, cultural services and non-governmental organizations (NGOs) are dropped from the dataset.

New variables have been created in order to conduct further analysis. In order to reduce the effects of outliers in the statistical data, the sample was winsorized. Code *winsor2* was conducted in STATA and relevant variables such as *Total Revenue, Employees, Total Assets, Return of Asset, EBITDA, EBITDA Margin, Revenue Growth Rate, Age, and Share of sales to municipalities, Centralization index of companies* was winsorized at 1th and 99th percentiles.

Table 1 illustrates all used variables with description, formulas, and type. *Total Revenue, Employees, Total Assets, EBITDA, and EBITDA Margin* are standard variables from original firm level dataset. *Return of Assets* is total return on Total Assets. And *Revenue Growth Rate* illustrates revenue increases or decreases comparing to last year.

Table 2 describes dummies on year, age, size, region, industry, and ownership have been developed. Year dummy is from year 2012 to 2016. Age dummy has been classified into three stages of companies, startup stage from 0-3 years, growth stage from 4-9 years, and mature stage more than ten years. The size is classified based on employees which results in small firms with 10 or less employees, medium firms with 11-49 employees and large firms with 50 or more employees. The region, ownership and industry dummies are relatively straight forward with respect to the firm's region, majority owner and industry classification.

The *Centralization index of companies* is based on the municipalities the companies are located in. Municipalities have centralization index of a 1-10 scale based on distances to the urban core where 1 is most central. *Selling in the same municipality* dummy equals to 1 if the municipalities choose suppliers which are located in own municipality. *Share of sales to municipalities* represents the sales value of a firm that is from municipalities as part of Total Revenue.

TABLE 1: Description of variables

Variable	Description [Formula in parentheses]	Type
Total Revenue	Total revenue in one year [totinn = Salgsinn + adrinn]	000'NOK.
Employees	Number of total employees in the firm in one year	Nr people
Total Assets	Fixed assets plus current assets [anl + oml]	000' NOK.
Return of Assets (ROA)	Total return on Total Assets [driftsrs + avskr + nedskr /sumeiend]	Percent(decimal)
EBITDA	Earnings before interest, tax, depreciation, and amortization. [driftsrs + avskr + nedskr + nedskranl]	000' NOK.
EBITDA Margin	EBITDA as a share of Total Revenue in decimals. [ebitda / totinn]	Percent(decimal)
Revenue Growth Rate	(Total Revenue this year/ Total Revenue last year)-1	Percent(decimal)
Age	Time since establishment of the firm	Years
Centralization index of companies	All municipalities have index from 1-10 based on their centralization, where one is most central.	1-10 index
Share of sales to municipalities	Percentage of total sales revenue [sales value from municipality procurement / total sales revenue]	Percent (decimal)

TABLE 2: Description of Dummy Variables

Variable	Description [Formula in parentheses]	Type
Matched Group	Dummy=1 if firms are suppliers to municipalities	Dummy
Selling in the same municipality	Dummy=1 if Public procurement in the same municipality [= 1 if kommnr-kommpronr =0]	Dummy
Year		Dummy
Dummy 2012	Dummy=1 if Year is 2012	Dummy
Dummy 2013	Dummy=1 if Year is 2013	Dummy
Dummy 2014	Dummy=1 if Year is 2014	Dummy
Dummy 2015	Dummy=1 if Year is 2015	Dummy
Dummy 2016	Dummy=1 if Year is 2016	Dummy
Age		
Startup stage 0-3	Dummy=1 if company's age is between 0-3 years, 0 otherwise.	Dummy
Growth stage 4-9	Dummy=1 if company's age is between 4-9 years, 0 otherwise.	Dummy
Mature stage >=10	Dummy=1 if company's age is equal or larger than ten years, 0 otherwise.	Dummy
Size		
Small 0-10	Dummy = 1 if the firm has 10 or fewer employees, 0 otherwise. [= 1 if ansatte < 11]	Dummy
Medium 11-49	Dummy = 1 if the firm has 11 - 49 employees, 0 otherwise. [=1 if ansatte >10 & < 50]	Dummy
Big >=50	Dummy = 1 if the firm has 50 or more employees, 0 otherwise. [=1 if ansatte >49]	Dummy
Region		
Innlandet	Dummy = 1 if the firm located in Innlandet, 0 otherwise.	Dummy
Nordnorge	Dummy = 1 if the firm located in Nordnorge, 0 otherwise.	Dummy
Sørlandet	Dummy = 1 if the firm located in Sørlandet, 0 otherwise.	Dummy
Trøndelag	Dummy = 1 if the firm located in Trøndelag, 0 otherwise.	Dummy
Vestviken	Dummy = 1 if the firm located in Vestviken, 0 otherwise.	Dummy
Vestlandet	Dummy = 1 if the firm located in Vestlandet, 0 otherwise.	Dummy
Østviken	Dummy = 1 if the firm located in Østviken, 0 otherwise.	Dummy
Industry		
Agriculture	Dummy = 1 if the firm is in agriculture industry, 0 otherwise.	Dummy
Offshore	Dummy = 1 if the firm is in offshore or shipping industry, 0 otherwise.	Dummy
Transport	Dummy = 1 if the firm is in transport industry, 0 otherwise.	Dummy
Manufacture	Dummy = 1 if the firm is in manufacture industry, 0 otherwise.	Dummy
Tech	Dummy = 1 if the firm is in IT/tech/telecom industry, 0 otherwise.	Dummy

Table 2 continued:

Electricity	Dummy = 1 if the firm is in electricity industry, 0 otherwise.	Dummy
Construction	Dummy = 1 if the firm is in construction industry, 0 otherwise.	Dummy
Trade	Dummy = 1 if the firm is in trade industry, 0 otherwise.	Dummy
Other	Dummy = 1 if the firm is in other service, 0 otherwise.	Dummy
Ownership		
Listed	Dummy = 1 if the firm is publically listed, 0 otherwise. [= 1 if eierstruktur = 1]	Dummy
Government	Dummy = 1 if more than 50 % of the firm is owned by the government, 0 otherwise. [= 1 if eierstruktur = 5]	Dummy
Cooperation	Dummy = 1 if the firm is owned by a cooperation, 0 otherwise. [= 1 if eierstruktur = 7]	Dummy
Foreign	Dummy = 1 if the firm is owned by a foreign person/company, 0 otherwise. [= 1 if eierstruktur =9]	Dummy
Private	Dummy = 1 if the firm is owned by a private person or a private company, 0 otherwise. [= 1 if eierstruktur = 2 or 3 or 4 or 6].	Dummy

5.3 Summary Statistics

In this section, summary statistics of firms before and after matching, and summary statistics of municipality will be represented.

5.3.1 Firm Statistics before Propensity Score Matching

TABLE 3: Before Matching, Firm Level Summary Statistics of Treated and Non-Treated Group

Variables	Treated Group Observations： 207,496		Non-treated Group Observations: 517,198	
	Mean	Median	Mean	Median
Total Revenue	30,246	7,803	10,359	1,652
Employees	15	6	5	1
Total Assets	22,549	4,082	14,432	1,586
Return of Assets	13%	12%	9%	10%
EBITDA	2,274	463	1,077	137
EBITDA Margin	8%	6%	-1%	8%
Revenue Growth Rate	22%	4%	42%	3%
Age	15	13	11	8
Established year	2000	2002	2004	2007
Share of sales to municipalities	7%	1%	-	-
Centralization index for companies	4.5	4	3.8	3

TABLE 4: Before Matching, Firm Level Dummy Statistics of Treated and Non-Treated Group

Variables	Treated Group		Non-Treated Group	
	Observations	207,496	Observations	517,198
	Mean	Std.Dev.	Mean	Std.Dev.
Year				
2012	19%	0.39	18%	0.39
2013	20%	0.40	19%	0.39
2014	22%	0.41	20%	0.40
2015	19%	0.39	22%	0.41
2016	19%	0.40	20%	0.41
Age				
Startup stage 0-3 years	14%	0.35	28%	0.45
Growth stage 4-9 years	25%	0.43	31%	0.47
Mature stage >=10 years	61%	0.49	41%	0.49
Size				
Small 0-10 employees	64%	0.48	85%	0.36
Medium 11-49 employees	28%	0.45	9%	0.28
Big >=50 employees	8%	0.27	6%	0.24
Region				
Innlandet	8%	0.27	5%	0.22
Nordnorge	12%	0.32	7%	0.26
Sørlandet	6%	0.24	6%	0.24
Trøndelag	7%	0.26	6%	0.23
Vestviken	13%	0.33	12%	0.33
Vestlandet	25%	0.43	25%	0.43
Østviken	28%	0.45	37%	0.48
Industry				
Agriculture	2%	0.13	2%	0.15
Offshore	1%	0.08	2%	0.12
Transport	3%	0.18	3%	0.18
Manufacture	8%	0.27	4%	0.20
Tech	3%	0.18	4%	0.20
Electricity	1%	0.08	1%	0.07
Construction	19%	0.39	28%	0.45
Trade	30%	0.46	17%	0.37
Others	31%	0.46	36%	0.48
Ownership				
Listed	0.1%	0.02	0.1%	0.02
Government	3%	0.16	1%	0.08
Cooperation	1%	0.10	1%	0.08
Foreign	4%	0.19	5.5%	0.23
Private	93%	0.26	93%	0.26

Table 3 and 4 above summarize mean and median of firm level performance and characteristics for Treated Group and Non-Treated Group before matching. Treated Group is firms which are suppliers to municipalities, and Non-Treated Group is firms which are not suppliers to municipalities each year from 2012 to 2016. The total number of observations of Treated Group is 207,496, and the total number of observations of Non-Treated Group is 517,198. Accounting numbers are in thousand NOK.

Concerning firm performance, there are better firm performance in Treated Group than Non-Treated Group regarding mean and median of Total Revenue and EBITDA. The mean of total income of Treated Group is about three times than the mean of total income of Non-Treated Group. And the mean of EBITDA of Treated Group is around twice than the mean of EBITDA of Non-Treated Group. However, Revenue growth rate is higher in Non-Treated Group than in Treated Group, which is 42% and 22% respectively. Total numbers of firms in Treated Group and Non-Treated group are distributed quite even from year 2012 to 2016.

For firm size perspective, firms in Treated Group are larger than in Non-Treated group regarding mean and median of employees. The mean of employees is 15 and median is 6 for Treated Group, while the mean of employees is 5 and median is 1 for Non-Treated Group. For treated Group, around 64% firms are small firm with 0-10 employees, around 28% firms are medium-sized with 11-49 employees, and 8% firms are big firms with employees more than 50. While for Non-Treated Group, small-sized firms are accounted for around 85%, median-sized and big-sized firms are accounted for 9% and 6%, respectively. In addition, the mean of Total Assets is bigger for Treated Group than Non-Treated Group.

Speaking about firm age, the mean of age of Treated Group (around 15years) is larger than Non-Treated Group (around 11 years). The mean of established year is around 2000 which is established longer than Non-Treated Group with mean of established year at 2004. For treated Group, around 61% firms are more than ten years, around 25% firms are between 4 to 9 years, and 14% firms are between 0 to 3 years. For Non-Treated Group, around 41% firms are more than ten years, around 31% firms are between 4 to 9 years, and 28% firms are between 0 to 3 years.

For industry, Treated Group tends to be more in trade industry (around 30%) than Non-Treated Group (around 17%), while Non-Treated Group tends to be more in construction industry (around 28%) than Treated Group (around 19%).

Ownership variables present that most firms (around 93%) are privately owned for both Treated Group and Non-Treated Group. Treated Group has more Government owned companies with mean of 3% than Non-Treated Group with mean of 1%. Listed ownership firms are quite few in Norway which are around 0.1% for both groups.

The Centralization index of companies shows that most firms are located relatively central with a mean around 4 for both Treated Group and Non-Treated Group. For Treated Group, the data of share of sales to municipalities have a mean of around 7% and median of 1%.

5.3.2 Firm Statistics after Propensity Score Matching

Propensity Score Matching (PSM) tempts to reduce the bias due to confounding variables that could be found in an estimate of the treatment effect obtained from simply comparing outcomes among units that received the treatment versus to those that did not (Rosenbaum and Rubin 1983). In the thesis, Propensity Score Matching is conducted to select a control group based on identical firm characters in age, region, and industry. See more details of Propensity Score Matching in Chapter 6.

TABLE 5: After Matching, Firm Level Summary Statistics of Treated and Control Group

Variables	Treated Group		Control Group			
	Observations: 195,165					
	Mean	Median	Mean	Median	Difference of mean	T-test
Total Revenue	31,099	8,271	14,791	2,429	16,308***	85.8633
Employees	15	7	6	2	9***	1.3e+02
Total Assets	22,658	4,262	16,678	2,119	5,980***	28.9293
Return of Assets	13%	12%	10%	9%	3%***	27.3108
EBITDA	2,321	494	1,322	178	999***	54.4556
EBITDA Margin	8%	6%	0.3%	7%	1%***	38.1461
Revenue Growth Rate	21%	4%	30%	2%	-9%***	20.3779
Age	15.7	13	15.5	13	0.2***	5.4652
Established year	1999	2002	1999	2003	0	1.3316
Share of sales to municipalities	7%	1%	0%	0%	7%***	2.1e+02
Centralization index of companies	4.5	4	4.3	4	0.2***	15.6516

t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

TABLE 6: After Matching, Firm Level Dummy Statistics of Treated and Control Group

Variables	Treated Group		Control Group		Observations	195,165
	Mean	Std.Dev.	Mean	Std.Dev.	Difference of mean	T-test
Year						
2012	19%	0.43	23%	0.42	-4%***	38.0296
2013	20%	0.43	20%	0.45	0%	0.9849
2014	22%	0.44	20%	0.44	2%***	17.8426
2015	20%	0.43	20%	0.43	0%	2.4685
2016	19%	0.43	27%	0.40	-8%***	23.0138
Age						
Startup stage	10%	0.31	12%	0.33	-2%***	11.2815
Growth stage	26%	0.44	27%	0.44	-1%***	9.9199
Mature stage	64%	0.48	61%	0.49	3%***	16.3362
Size						
Small	63%	0.48	84%	0.37	-21%***	155.6639
Medium	29%	0.46	11%	0.32	18%***	1.4e+02
Big	8%	0.27	4%	0.20	4%***	53.3918
Region						
Innlandet	8%	0.27	6%	0.23	2%***	24.2774
Nordnorge	11%	0.32	11%	0.31	0%***	7.5030
Sørlandet	6%	0.24	6%	0.24	0%***	2.6449
Trøndelag	7%	0.25	7%	0.25	0%***	2.6983
Vestviken	13%	0.33	13%	0.33	0%	1.5821
Vestlandet	25%	0.43	28%	0.45	-3%***	15.4772
Østviken	28%	0.45	29%	0.45	-1%***	5.5270
Industry						
Agriculture	2%	0.13	4%	0.20	-2%***	46.2131
Offshore	1%	0.08	2%	0.13	-1%***	31.0877
Transport	3%	0.18	4%	0.19	-1%***	7.7152
Manufacture	8%	0.27	7%	0.26	1%***	7.4489
Tech	3%	0.18	4%	0.19	-1%***	5.8908
Electricity	1%	0.08	1%	0.09	0%***	6.0481
Construction	19%	0.39	23%	0.42	-4%***	29.8133
Trade	30%	0.46	23%	0.42	7%***	45.5179
Others	31%	0.46	29%	0.45	2%***	14.2275
Ownership						
Listed	0%	0.02	0%	0.03	0%***	8.1433
Government	3%	0.16	1%	0.09	2%***	44.7507
Cooperation	1%	0.09	1%	0.10	0%	1.2868
Foreign	4%	0.19	5%	0.22	-1%***	21.9714
Private	93%	0.26	93%	0.26	0%***	3.9020

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5 and 6 above summarize mean and median of firm level performance and characteristics for Treated and Control Groups after matching. Treated Group is firms which are suppliers to municipalities after matching, and Control Group is firms which are not suppliers to municipalities, and selected by matching method with identical firm characters to Treated Group from 2012 to 2016. Propensity Score Matching uses one to one nearest neighbor, and therefore the numbers of observations of Treated Group and Control Group are both 195,165. Accounting numbers are in thousand NOK.

Concerning firm performance, there are better firm performance in Treated Group than Control Group regarding mean and median of Total Revenue and EBITDA. The mean of Total Revenue of Treated Group is more than twice of the mean of total income of Control Group. Regarding Revenue Growth Rate, the mean of Control Group (30%) is better than Treated Group (21%). Total numbers of firms in Treated and Control group, are distributed quite even from year 2012 to 2016.

For firm size perspective, firms have larger size in Treated Group than Control group regarding mean and median of employees. The comparison between Treated and Control Groups are more or less the same to two groups before matching. The mean of employees is 15 and median is 7 for Treated Group, while the mean of employees is 6 and median is 2 for Control Group. The distribution of the age status is quite similar for Treated and Control Groups. For Treated Group, around 63% firms are small firm with 0-10 employees, around 29% firms are medium-sized with 11-49 employees, and 8% firms are big firms with employees more than 50. While for Control Group, small-sized firms are accounted for around 84%, median-sized is and big-sized firms are accounted for 11% and 4%, respectively. In addition, the mean of Total Assets is bigger for Treated Group than Control Group.

Speaking about firm age, the mean of established year, Treated and Control Groups have similar established year 1999 and age around 16 years. Age is a firm character as independent variables in matching. Treated and Control Groups have similar distribution of firm age, which are around 61-64% firms more than ten years, around 26-27% firms between 4 to 9 years, and 10-12% firms between 0 to 3 years.

For industry, Treated Group tends to be more in trade industry (around 30%) than Control Group (around 23%). Control Group tends to be more in construction industry (around 23%) than Treated Group (around 19%).

Ownership variables present that the comparison between Treated and Control Groups are identical as two groups before matching. Most firms (around 93%) are privately owned for both Treated and Control Groups. Treated Group has more Government owned companies with mean of 3% than Control Group with mean of 1%.

The Centralization index of companies and Total sales value from municipality show the comparison between Treated Group and Control Group are identical as two groups before matching. The firms are located relatively central with a mean around 4.5 for both Treated Group and Control Group. For Treated Group, share of sales to municipalities has a mean of around 7% in and a median of 1%.

T-test is conducted to check for the difference of variables between Treated and Control Group after matching in section 6.2.3, which has more detail about matching quality assessment.

TABLE 7: Firm Level Statistics of Treated and Control Group after matching in 2012 and 2016

Variables	2012		2016	
	Treated Group Observations：36,259	Control Group Observations: 45,928	Treated Group Observations：37,943	Control Group Observations: 32,557
Total Revenue	31,565	15,144	31,431	14,373
Employees	14	6	17	7
Total Assets	22,822	16,528	23,464	17,421
Return of Assets	15%	12%	13%	9%
EBITDA	2,360	1,345	2,386	1,314
EBITDA Margin	8%	1.3%	8%	-0.3%
Revenue Growth Rate	20%	25%	23%	31%
Age	16	15	16	16
Established year	1997	1998	2001	2001
Total sales value from municipality	1,729,681	-	2,251,425	-
Share of sales to municipalities	6%	-	7%	-
Centralization index of companies	4.4	4	4.5	4.6

After an overview of firm level statistics, statistics analysis of year 2012 and 2016 is conducted respectively, in order to observe firm development over time. Table 7 above illustrates firm level statistics of Treated and Control Groups after matching in 2012 and 2016. For Treated

Group from 2012 to 2016, firm performance regarding Revenue Growth Rate increases from 20% to 23%, Return of Assets decreases from 15% to 13%, and Total Revenue and EBITDA are around the same.

The mean of Total Assets, Employees, and Age have little growth. The mean of Total sales value from municipality is added in analysis. Comparing to year 2012, the data shows that total sales value from municipality increases by 30% in year 2016.

In summary of statistics above, firm performance is better for Treated Group than Control Group regarding Total Revenue, EBITDA, Return of Assets, and EBITDA Margin, but Revenue Growth Rate is lower for Treated Group than Control Group. Treated Group has more employees, larger Total Assets, fewer small companies with 0 to10 employees, and longer age than Control Group.

The description above may indicate that government procurement chooses more stable and bigger companies with better firm performance, due to the fact that government is more risk averse as discussed in literature review. Government has the responsibility to allocate taxpayers' money in a good way (Maltaverne, 2018).

However, on the other hand, public procurement as a demand may positively affect firm performance in different ways. Public procurement may stimulate innovation by developing new technologies, products and new investment in R&D (Aschhoff and Sofka 2009), help solving firms' problems such as access to finance and mobilizing resources (Lee 2017). Firms may benefit from winning procurement bids by increasing firm size, winning more contracts in the future, and to be more importantly enter more valuable auctions, penetrate more markets, and also increase the variety of product lines (Ferraz, Finan et al. 2015).

Therefore, regression analysis will be further conducted to analyze relationship between public procurement and firm performance. For further analysis, interaction terms are added to check whether the effects on firm performance regarding firms' size, age, centralization index of companies, ownership, and industry are affected by being suppliers to municipalities. More detail information is in Section 6.3.1.

5.3.3 Firm Statistics of Share of sales to municipalities

TABLE 8: Public Procurement across firm characteristics and sector

Variables	Treated Group after Matching		
	Mean	Median	Observations
Year			
2012	6%	1%	36,259
2013	7%	1%	39,950
2014	7%	1%	42,592
2015	7%	1%	38,410
2016	7%	1%	37,954
Age			
Startup stage 0-3 years	7%	1%	20,301
Growth stage 4-9 years	7%	1%	50,831
Mature stage>=10 years	6%	1%	124,033
Size			
Small 0-10 employees	8%	1%	123,675
Medium 11-49 employees	5%	1%	56,522
Big >=50 employees	7%	1%	14,968
Region			
Innlandet	7%	1%	15,408
Nordnorge	8%	1%	22,351
Sørlandet	7%	1%	12,664
Trøndelag	7%	1%	14,571
Vestviken	7%	1%	25,671
Vestlandet	7%	1%	49,503
Østviken	6%	1%	54,997
Industry			
Agriculture	5%	1%	3,516
Offshore	9%	1%	1,289
Transport	6%	1%	6,469
Manufacture	3%	1%	15,418
Tech	9%	2%	6,671
Electricity	16%	6%	1,250
Construction	10%	2%	37,181
Trade	2%	0.4%	58,703
Others	10%	2%	60,417
Ownership			
Listed	4%	0.1%	64
Government	21%	10%	5,324
Cooperation	9 %	1%	1,722
Foreign	6%	1%	7,397
Private	6%	1%	180,658

Table 8 above represents the difference of share of sales to municipalities by firm- and industry-specific characters and how government matters as a source of demand.

The data does not indicate that small and young companies have larger share of sales to municipalities than larger and older companies.

In different regions, companies in northern Norway have a little higher share of sales to municipalities, while companies in other regions have similar share of sales to municipalities.

The importance of public procurement is different across sectors. Not surprisingly, firms in electricity industry sector report significantly higher share of sales to municipalities. While manufacture and trading industry sell less to government.

In addition, large differences are also observed in different ownership. It's naturally that government-owned firms report significantly higher share of sales to municipalities. There are very few listed companies selling to municipalities in Norway, and share of sales to municipalities are relatively lower than the other kinds of ownership.

Some researches show that foreign firms are less likely to be chosen as suppliers to government (Hoekman and Sanfilippo 2018). In this study, foreign firms are observed to be around 4% as suppliers to municipalities, and 5% as non-suppliers to the government after matching. This indicates that although foreign firms accounted for only a small amount in Norway, Norwegian government purchases from foreign firms. Furthermore, share of sales to municipalities of foreign firms are very similar to private-owned companies.

5.3.4 Municipality Statistics

Norway has a total government expenditure approximately 50 billion Euros every year which is around 486 billion NOK, and public procurement accounts for 15% of GDP. According to summary of municipality purchase data in table 9, the average of total municipality purchase from 2012 to 2016 accounts about 16% of total public procurement in Norway.

TABLE 9: Total municipality purchases value (in million NOK) from year 2012 to 2016

	Total Value			**Mean Value**		
	Municipality	County	Sum	Municipality	County	Total average
2012	51,500	13,500	65,000	1.6	1.8	1.6
2013	61,300	14,900	76,300	1.8	1.9	1.8
2014	67,400	18,000	85,400	1.8	2.2	1.9
2015	65,900	11,900	77,800	2.0	1.7	2.0
2016	73,700	16,500	90,200	2.3	2.2	2.2

Norway is divided into 18 counties and 422 municipalities with a population around 5,300,000 in 2018.[7] Norwegian municipalities to some degree have independence on public procurement and carry out own procurement based on Public Procurement Act and Regulations and EU public procurement (Jacobsen, 2017).

For example, some municipalities provide services such as care of the elderly, road maintenance and garbage collection themselves, while others choose to outsource this to private companies, institutions, and non-profit organizations (Michelsen and de Boer 2009). In addition, some municipalities have established public procurement department dealing with purchasing, while others may allocate in different department, thereby blurring the overview of a municipality's procurement activities. (Michelsen and de Boer 2009).

[7] The counties are changing to 18 from 2018. https://en.wikipedia.org/wiki/Counties_of_Norway

TABLE 10: Municipality Level Summary Statistics before Matching

Variables	Municipality			
	2012		2016	
	Observations	31,841	Observations	32,707
	Mean	Median	Mean	Median
Total municipality purchase	1,618,272	71,615	2,253,749	34,900,000
Total Suppliers for municipalities	98	50	93	52
Municipalities chooses suppliers in own municipality	58%	1	55%	1
Centralization index of municipalities	4.7	5	4.9	5

Therefore, it's not difficult to understand the significant difference of public procurement in different municipalities. Table 10 above presents Municipality Level Summary Statistics for Treated Group. Municipality is classified into two categories which are County Municipality and Municipality. In this thesis, only data from municipalities are analyzed.

Table 10 shows total municipality purchase increases from year 2012 to 2016. The mean amount of total public procurement purchase, and the mean number of total suppliers increase from year 2012 to 2016. Municipalities choose fewer suppliers in own municipalities, which are 58% in 2012 and 55% in 2016. The Centralization index of municipalities shows that most municipalities are located relatively central with a mean around 5.

6. Methodology

This section will present the methodologies used to test the relationship between public procurement and firm performance.

Firstly, the analysis will use Propensity Score Matching method to create a control group with identical firm characteristics comparing to treated group. The matching procedure and matching quality assessment will be introduced in this section. After matching, the expected value of average treatment effect on the treated (ATT) will be analyzed for difference of outcome values between Treated and Control Group, as seen in Chapter 7.

The second part of this section will use regression analysis on matched sample to test the effects of public procurement on firm performance. Besides independent variables used in Propensity Score Matching, here the analysis will also add dummies of age, size, industry, ownership, and interaction terms. Using regression analysis on matched sample can be a good supplement for Propensity Score Matching to explain causal effect.

6.1 Theory of Propensity Score Matching (PSM)

6.1.1 Introduction of Propensity Score Matching

Propensity Score Matching (PSM) is a statistical matching technique which was first published by Paul Rosenbaum and Donald Rubin in 1983, and implements the Rubin causal model for observational studies (Rosenbaum and Rubin 1983), which aims to find a control group similar to the treated group in all the relevant pre-treatment characteristics and to use this group as a close substitute for the unobservable counterfactual situation in which the treated group is not receiving the treatment (Caliendo and Kopeinig 2008).

PSM attempts to reduce the bias due to confounding variables that could be found in an estimate of the treatment effect obtained from simply comparing outcomes among units that received the treatment versus to those that did not (Rosenbaum and Rubin 1983). Rosenbaum and Rubin (1983) simplified the multi-dimensional matching problem to a univariate one, the propensity score, which is defined as the probability of being treated conditional to observable and relevant pre-treatment characteristics (Rosenbaum and Rubin 1983). Propensity score is stated as $P(x) = Pr(D=1| x)$, X is independent variables, D=1 is for treated group.

In the light of evaluation parameter of a treatment on the outcome, average treatment effect on the treated (ATT) is more prominent comparing to average treatment effect (ATE). Average treatment effect (ATE) means simply the difference of the expected outcomes after participation and non-participation (Caliendo and Kopeinig 2008). ATE is noted as:

$$\tau ATE = E(\tau) = E[Y(1) - Y(0)] \quad (1)$$

While the expected value of average treatment effect on the treated (ATT) is defined as the difference between expected outcome values with and without treatment for those who actually participated in treatment (Caliendo and Kopeinig 2008). In this thesis, ATT will be used to estimate the treatment effect. ATT is noted as:

$$\tau ATT = E(\tau|D = 1) = E[Y(1)|D = 1] - E[Y(0)|D = 1] \quad (2)$$

6.1.2 Conditions of Propensity Score Matching

Propensity Score Matching reduces selection bias in the observational data which are bias due to different density weighting, and bias due to lack of distribution overlap (Heckman, Ichimura et al. 1997). In order to fulfill estimation and reduce selection bias, three conditions have to hold. The first one is the balance property of the propensity scores, the second one is conditional independence assumption (CIA), and the last one is the common support requirement (Rosenbaum and Rubin 1983).

The balance property of the propensity scores: The assumption requires that "the balancing property is always true and says that treated (D=1) and control (D=0) groups with the same propensity score e(*x*) have the same distribution of the observed covariates *x*" (Rosenbaum and Rubin 1983) :

$$\Pr\{x \mid D = 1, e(x)\} = \Pr\{x \mid D = 0, e(x)\} \quad (3)$$

The conditional independence assumption (CIA): The CIA assumption states that given a set of observable covariates x which are not affected by the treatment. Potential outcomes Y (0) and Y (1) are independent of observable covariates *x*, and treatment conditional on balancing scores (Caliendo and Kopeinig 2008). And can be written as, $\perp\!\!\!\perp$ is the symbol for independence.

$$Y(0), Y(1) \perp\!\!\!\perp D \mid x \quad (4)$$

$$Y(0), Y(1) \perp\!\!\!\perp D \mid P(x) \quad (5)$$

The common support condition: The common support condition is the so-called "Overlap" assumption, meaning that individuals with the same *x* values have the probability of being both participants and non-participants (Caliendo and Kopeinig 2008). It requires that the relevant observable characteristics not been able to correctly predict whether a unit is assigned to the treated or to the control group and, therefore, that units sharing the same pre-treatment attributes can be found both in the treated and in the control group with positive probabilities (Raiteri 2018). Generally, bias arises in matching when this assumption is not satisfied or ignored during PSM procedure (Heckman, Ichimura et al. 1997) . If P(*x*)=1 then it means there are no matching units, and if P(*x*)=0 which means there are no treated firms (Cappelen A., et al., 2015). The formula is stated as follows,

$$0 < P(x) = Pr \{D = 1 \mid x\} < 1 \qquad (6)$$

A main problem with matching is the choice of matching variables. If there are too many matching variables, the common support assumption might fail, but with two few matching variables, CIA might fail. With regard to Norwegian firm-level data, the balancing properties of the propensity score may be poor in finite samples even when matching variables only contains a few continuous variables (Kvitastein 2010).

In addition, matching estimator is based on unconfoundedness or selection on observable assumption, which means that might occur “hidden bias” due to unobservable data. This is very hard to do applied research, therefore, even though there are research of analyses mentioned far back in the literature, only a few applied studies take them into account (Caliendo and Kopeinig 2008).

6.2 Implementing Propensity Score Matching (PSM)

There are four steps in implementing Propensity Score Matching methods, with the first three steps to design the matching and the fourth steps to conduct the analysis (Caliendo and Kopeinig 2008). The first three steps will be introduced in this chapter as follows, and the fourth step will be introduced in Chapter 7.

Step 1: Model and variable choice.

Step 2: Matching Algorithm choice.

Step 3: Matching quality assessment.

Step 4: Analysis of the outcome and estimation of the treatment effect.

6.2.1 Step 1 Model and Variables Choice

A simple matching estimator is the average of differences of the outcome variables between matched pairs of units with the same propensity score (Cappelen Å., et al., 2015). In order to conduct Propensity Score Matching, firstly, binary treatment logit or probit model should be chosen, and both of them usually yield similar results (Caliendo and Kopeinig 2008). In the thesis, STATA is used for matching procedure by coding *psmatch2.* And default probit model is chosen to estimate the propensity score.

Secondly, dependent variables, independent variables and outcome variables should appropriately be identified. Dependent variable is a dummy variable when public procurement equal to 1 for Treated Group, and public procurement equals to 0 for Control Group. Treated Group includes suppliers to municipalities. Control Group is identified based on the established year-age-industry-region category regarding Treated Group. Therefore, independent variables are established by year, age, industry and region. Age means how long does the firm established to the year of public procurement, industry classification follows two-digit NACE and the regional classification is based on municipality.

With regard to outcome variables, in order to fulfill the Conditional Independence Assumption (CIA) introduced in section 6.1.2, which requires that the outcome variables must be independent of treatment conditional on the propensity score (Caliendo and Kopeinig 2008). In addition, omitting essential variables can seriously increase bias in resulting estimates (Heckman, Ichimura et al. 1997) .

In the thesis, Propensity Score Matching is used to analyze whether public procurement has positive effects on firm performance. Therefore, outcome variables are firm performance indicators which are denoted as EBITDA Margin, Return of Asset (ROA), or Revenue Growth Rate.

6.2.2 Step 2 Matching Algorithm Choice

The step 2 is to choose a Matching Algorithm. The choice of the algorithm is a matter of trade-off between bias and efficiency (Caliendo and Kopeinig 2008). Bias refers to distance of estimated treatment effect from true effect, and efficiency means precision of estimated treatment effect[8].

Sample size, available number of treated or control observations and the distribution of the propensity scores need to be considered before choosing matching algorithm (Caliendo and Kopeinig 2008). See overview of different Matching Algorithm in Appendix Figure 1.

Based on consideration of sample size, available number of treated or control observations and the distribution of the propensity scores, the one to one Nearest Neighbor Matching algorithm among the different Matching algorithms is adopted. One to one matching has higher precision and similar matching if treated group remains the same size and only the control group decreases in size (Stuart 2010).

The one to one nearest neighbor matching is without replacement, which means that the data in non-treated group can only be used once which is more suitable for the similar propensity score in the treated group and non-treated group before matching (Caliendo and Kopeinig 2008), where it suits the data analysis in this thesis.

In addition, a caliper threshold of 0.01 standard deviations was used to find the nearest partner. The caliper threshold improves the performance of Propensity Score Matching by imposing a tolerance level on the maximum propensity score distance, a significant reducing bias due to bad matches (Caliendo and Kopeinig 2008).

[8] http://npcrc.org/files/NPCRC.Observational-PropensityScoreMethodsWkshop.10-20-14.pdf

6.2.3 Step 3 Matching Quality Assessment

After implementation of matching procedure, matching quality should be assessed. Matching quality Assessment is based on whether the common support condition holds, and whether the balance property of the propensity scores holds.

Firstly, **whether the common support condition holds:** it is essential to check if common support condition mentioned in 6.2.1 holds, which ensures the observed characteristics in the treatment group can be observed in the control group as well (Caliendo and Kopeinig 2008). This overlapping between Treated and Control Group can be assessed by a graphic analysis of distribution of Propensity Score Matching before the matching (Lechner 2008).

Figure 2 displays the kernel density of propensity score before matching, which illustrates a large overlapping between the distributions of the propensity score for the treated and the non-treated group, no matter that there is difference between the shape of distribution. This ensures that the common support condition holds. In addition to that, Figure 3 represents the kernel density of propensity score after matching, which represents almost perfect match between the distributions of the propensity score for the Treated and the Control Group after matching. Furthermore, the result of checking for common support hold by STATA shows 99.86% is on support. See Figure 4 and Table 11. These prove the common support condition holds, and confirm the quality of Propensity Score Matching is in a good situation.

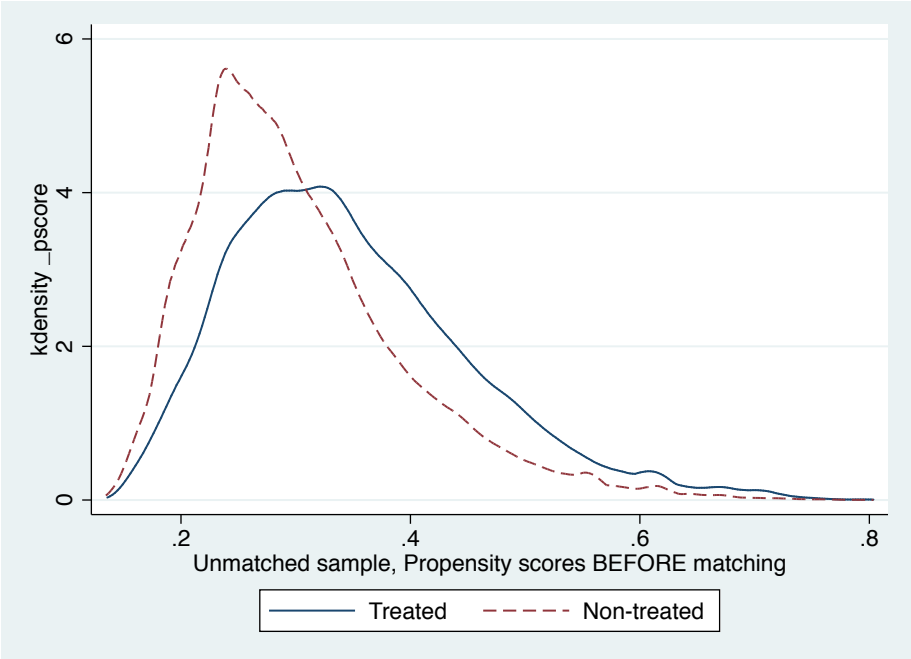

Figure 2: Distribution of Propensity Score before matching

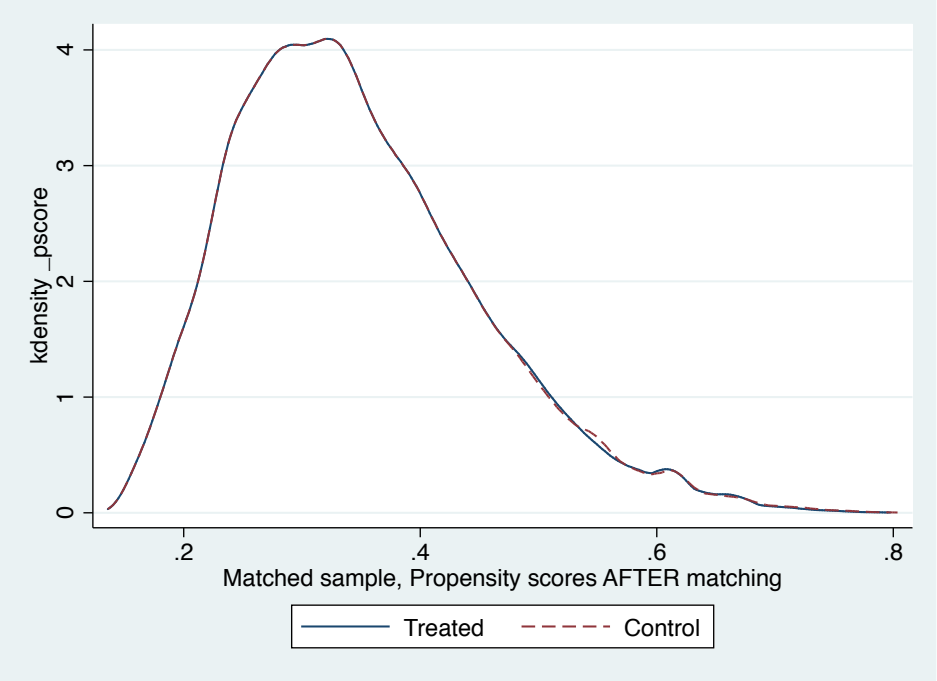

Figure 3: Distribution of Propensity Score after matching

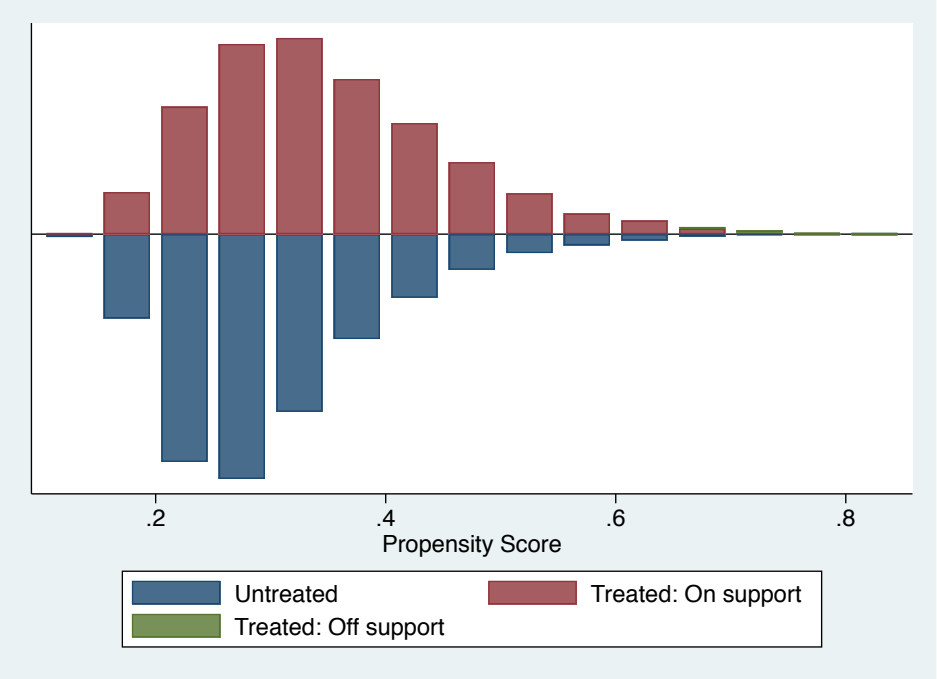

Figure 4: Common support distribution

TABLE 11: Common Support

Common Support	Freq.	Percent
Off support	837	0.14
On Support	615,746	99.86
Total	616,583	100,00

Secondly, whether the balance property of the propensity scores holds: it is essential to check for covariance balance to reduce selection bias between the Treatment and Control Groups. In this respect, there are several criteria need to be met, such as insignificant differences or larger P-values for the covariance mean, low mean differences as a percentage of the average standard deviation, and 100% reduction bias in the mean of explanatory variables (Baser 2006).

One method to check for matching quality is first introduced by Rosenbaum and Rubin (1985) to conduct two sample t-test to examine for significant difference in covariate mean for treated and control group before and after matching (Rosenbaum and Rubin 1985).

TABLE 12: Descriptive statistics for unmatched and matched sample

Variable		Mean		Diff	% bias	% reduct bias	t-test	
		Treated Group	Control Group				t	p>|t|
Age	Unmatched	15.835	11.958	3.877	35.8	94.8	134.40	0.000
	Matched	15.666	15.465	0.201	1.9		5.47	0.000
Region	Unmatched	927.77	823.68	104.09	18.2	98.3	67.23	0.000
	Matched	925.93	927.75	-1.82	-0.3		**0.98**	**0.329**
Industry	Unmatched	52.887	57.965	-5.078	-26.3	88.1	95.23	0.000
	Matched	52.967	52.361	0.606	3.2		9.56	0.000

Table 12 represents t-test for dependent variables age, region and industry in the Probit Regression. It shows the significant difference in the mean of three variables between Treated and Control Group before matching. After matching, the mean difference for Region is not significant different, but the mean of the other two variables Age and Industry are still significant. The results show the percentage of reduction bias of three variables have the percentage of reduction bias around 88% to 98%. The results suggest that Propensity Score Matching has removed most of the mean difference. And there has been substantial reduction

in the standardized differences for most variables. Covariance imbalance for two variables is still existed.

TABLE 13: Mean and median standardized bias for unmatched and matched sample

Sample	Mean Bias	Median Bias
Unmatched	26.8	26.3
Matched	1.8	1.9

In addition, the standard bias after Propensity Score Matching is a suitable indicator to assess the distance of the variables (Rosenbaum and Rubin 1985). According to Caliendo and Kopeinig (2008), there is no clear indication for the success of matching procedure, but a standard bias after matching below 3% or 5% is generally considered as sufficient. Table 13 represents mean and median standardized bias for unmatched and matched sample. The results show that the standard bias for mean bias and median bias after matching are both below 3%. This confirms a good performance of Propensity Score Matching in this thesis.

To sum up the quality assessment, the results show that the common support condition holds well, and the low standard bias for mean bias and median bias after matching. These two confirm the quality of Propensity Score Matching is in a good situation. The results show that Propensity Score Matching has removed most of the mean difference. Still, after Propensity Score Matching, covariance imbalance for two variables is still existed which may cause selection bias. Regression analysis will be conducted based on matched sample. Regression adjustment is used to “clean up” small residual covariate imbalance between the groups (Stuart 2010), and reduce selection bias in the analysis.

6.3 Regression Analysis

According to Li (2013), Propensity Score Method (PSM) as a technique that can be used to calculate causal effects to deal with endogeneity, which occurs when a predictor variable correlates with the error term (Li 2013). Multiple linear regression can be used to estimate treatment effects in observational data by regressing the outcome on the covariates, including an indicator variable for treatment status and interactions between the treatment variable and each of the covariates (Zanutto 2006). Some researchers view Propensity Score Matching and regression adjusted analysis as competitive relationship (Zanutto 2006). However, Heckman, Ichimura et al. (1997) believe matching method is not competing with modeling adjustment such as linear regression, instead working best in combination.

Therefore, researchers generally adopt regression adjustments based on matched samples to conduct outcome analysis (Stuart 2010). This is similar to the idea of "double robustness," and the intuition is the same as that behind regression adjustment in randomized experiments, where the regression adjustment is used to "clean up" small residual covariate imbalance between the groups (Stuart 2010). The combination of regression adjustment on matched samples generally produces the least biased estimate (Rubin 1973).

This section is going to explain how regression analysis is conducted in this study. There are two regressions and both on them are run based on matched sample after Propensity Score Matching. Regression 1 is going to test Hypothesis 1, and Regression 2 is going to test Hypothesis 2. The data are clustered on firms with organization number, which clusters the same firm in each year.

6.3.1 Regression 1

Here, regression 1 is conducted based on propensity score matched sample, and linking firm performance to a vector of firm-specific factors. Firm performance indicator is EBITDA Margin, Return of Asset (ROA), and Revenue Growth Rate. Firm-specific variables have been introduced in section 5.2. According to STATA, for nearest neighbor matching, it holds the frequency with which the observation is used as a match. When estimating The Average Treatment Effect of The Treated (ATT) only *Weight* equals to 1 for the treated. Thus, variable *Weight* equals to1 is used as matched sample for regression.

The regression formula is as follow:

$$Y = \alpha + \beta_1 \text{Matched Group} + \beta_2 \text{Total Assets} + \beta_3 \text{Employees} + \beta_4 \text{Age} + \beta_5 \text{Centralization index of companies} + \beta_6 \text{Year 2013} + \beta_7 \text{Year 2014} + \beta_8 \text{Year 2015} + \beta_9 \text{Year 2016} + \beta_{10} \text{Government} + \beta_{11} \text{Foreign} + \beta_{12} \text{Cooperation} + \beta_{13} \text{Private} + \beta_{14} \text{Agriculture} + \beta_{15} \text{Offshore} + \beta_{16} \text{Transport} + \beta_{17} \text{Manufacture} + \beta_{18} \text{Tech} + \beta_{19} \text{Electricity} + \beta_{20} \text{Construction} + \beta_{21} \text{Trade} + \varepsilon. \quad (6)$$

In this model, Y is a performance indicator for firms which are EBITDA Margin, Return of Asset (ROA) or Revenue Growth Rate. α refers to the constant variable and ε is the error term. B_2 to β_{21} represent the coefficients for the control variables. Control variables are used to account for firm heterogeneity which include Total Assets, Employees, Age, Centralization index of companies, Year Dummy (year 2013 to year 2016), Industry Dummy (Agriculture, Offshore, Transport, Manufacture, Tech, Electricity, Construction, and Trade), and Ownership Dummy (Government, Foreign, Cooperation and Private).

β_1 represents the coefficient for publication procurement in Matched Group which is the main independent variable. In the regression analysis, the results of the variable are expected to be positively related with firm performance indicators.

For further analysis, interaction terms are added to check for whether there are effects on firm performance related to firms' year, size, age, centralization index of companies, tech industry, ownership especially domestic or foreign owned companies, and selling in the same municipalities. The descriptions of interactions are in table 14.

TABLE 14: Description of interaction variables 1

Variable	Description	Type
Matched Group Year 2013 or 2014 or 2015 or 2016	Matched Group * Year 2013 Matched Group * Year 2014 Matched Group * Year 2015 Matched Group * Year 2016	Year
Matched Group Small size	Matched Group * Small size	Nr people
Matched Group Employees	Matched Group * Employees	Nr people
Matched Group Age	Matched Group * Age	Years
Matched Group Startup stage	Matched Group * Startup stage	Dummy
Matched Group Mature stage	Matched Group * Mature stage	Dummy
Matched Group Centralization index of companies	Matched Group * Centralization index of companies	1-10 index
Matched Group Tech	Matched Group * Tech	Dummy
Matched Group Foreign ownership	Matched Group * Foreign ownership	Dummy
Matched Group Selling in the same municipality	Matched Group * Selling in the same municipality	Dummy

6.3.2 Regression 2

The motivation to run regression 2 on Treated Group is based on regression 1. If regression 1 is able to test a positive relationship between public procurement and firm performance. Then, it would be interesting to test whether the companies which consist of higher share of sales to municipalities can actually have positive effects on firm performance.

Therefore, regression analysis 2 will also be conducted based on matched group after matching, and linking firm performance to a vector of firm-specific factors. Firm performance indicator is the same as regression 1, which are EBITDA Margin, Return of Asset (ROA) or Revenue Growth Rate. Firm-specific variables have been introduced in section 5.2.

The regression formula is as follow:

$$Y = \alpha + \beta_1 \text{Shares of sales to municipalities} + \beta_2 \text{Shares of sales to municipalities}^{\wedge 2} + \beta_3 \text{Total Assets} + \beta_4 \text{Employees} + \beta_5 \text{Age} + \beta_6 \text{Centralization index of companies} + \beta_7 \text{Year 2013} + \beta_8 \text{Year 2014} + \beta_9 \text{Year 2015} + \beta_{10} \text{Year 2016} + \beta_{11} \text{Government} + \beta_{12} \text{Foreign} + \beta_{13} \text{Cooperation} + \beta_{14} \text{Private} + \beta_{15} \text{Agriculture} + \beta_{16} \text{Offshore} + \beta_{17} \text{Transport} + \beta_{18} \text{Manufacture} + \beta_{19} \text{Tech} + \beta_{20} \text{Electricity} + \beta_{21} \text{Construction} + \beta_{22} \text{Trade} + \varepsilon \quad (7)$$

In this model, Y is a performance indicator for firms which are EBITDA Margin and Return of Asset. α refers to the constant variable and ε is the error term.

The meaning of coefficients β_3 to β_{22} can refer to the descriptions above in Regression 1.

β_1 represents the coefficient for *Shares of sales to municipalities* in matched group. In the regression analysis, the results of the variable are expected to be positively related with firm performance indicators.

β_2 represents the coefficient for *Share of sales to municipalities*$^{\wedge 2}$. *Share of sales to municipalities*$^{\wedge 2}$ is added to test whether the non-linear relationship between municipality and firm performance. The motivation behind this is to check for if there are the obstacle to firm performance if firms lack alternative markets.

Interaction terms are added in Regression 2 as well, and the descriptions of interactions are in Table 15.

TABLE 15: Description of interaction variables 2

Variable	Description	Type
Share of sales to municipalities Year 2013 or 2014 or 2015 or 2016	Share of sales to municipalities * Year 2013 Share of sales to municipalities * Year 2014 Share of sales to municipalities * Year 2015 Share of sales to municipalities * Year 2016	Year
Share of sales to municipalities Small Size	Share of sales to municipalities * Small Size	Nr people
Share of sales to municipalities Employees	Share of sales to municipalities * Employees	Nr people
Share of sales to municipalities Age	Share of sales to municipalities * Age	Years
Share of sales to municipalities Startup stage	Share of sales to municipalities * Startup stage	Dummy
Share of sales to municipalities Mature stage	Share of sales to municipalities * Mature stage	Dummy
Share of sales to municipalities Centralization index of companies	Share of sales to municipalities * Centralization index of companies	1-10 index
Share of sales to municipalities Tech	Share of sales to municipalities * Tech	Dummy
Share of sales to municipalities Foreign ownership	Share of sales to municipalities * Foreign ownership	Dummy
Share of sales to municipalities selling in the same municipality	Share of sales to municipalities * Selling in the same municipality	Percentage

7. Results and Discussions

This section presents the results of Propensity Score Matching, and two regression analyses. In the end, discussion is provided based on all the analyses mentioned above.

7.1 The results of Propensity Score Matching

7.1.1 The Average Treatment Effect of The Treated (ATT) Analysis

The average treatment effect of the treated (ATT) is estimated by comparing the changes in individual outcome between participants and their matched counterparts ($\tau ATT = E(\tau|D = 1) = E[Y(1)|D = 1] - E[Y(0)|D = 1]$)which is illustrated in 6.1.1.

Table16 shows the results of Propensity Score Matching which present estimated treated effects (ATT) for all the firm indicators. The dependent variables are EBITDA Margin, Return of Asset (ROA), and Revenue Growth Rate.

The results in table 16 exhibit significant difference at 1% level regarding three variables: EBITDA Margin, Return of Asset (ROA), and Revenue Growth Rate. The positive ATT suggests that public procurement has a positive relationship to firm performance indicator EBITDA Margin and Return of Asset (ROA). The negative Revenue Growth Rate ATT suggests that public procurement has a negative relationship to firm performance indicator Revenue Growth Rate.

TABLE 16: Average treatment effect on the treated (ATT)

Dependent Variable	Treated Group	Control Group	Difference	SE	T-Stat
EBITDA Margin ATT	0.08	0.003	0.077***	0.002	38.13
ROA ATT	0.14	0.10	0.04***	0.001	27.31
Revenue Growth Rate ATT	0.21	0.30	-0.09***	0.004	20.38

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7.1.2 Robustness Checking of The Average Treatment Effect of The Treated (ATT)

To assess the robustness of The Average Treatment Effect of The Treated (ATT), an additional Propensity Score Matching by adding more independent variables was carried out. The additional independent variables are *Established year, Log Total Assets, Log Employees* and *Ownership.*

After implementation of PSM with new independent variables, matching quality should be assessed as well. Firstly, the common support condition holds. Figure A2 and A3 in Appendix displays the kernel density of propensity score before and after matching, suggesting a large overlapping between the distributions of the propensity score for the treated group before matching, and almost perfect match after matching. Furthermore, Figure A4 and Table A1 in Appendix show 95.12% is on support. These prove that the common support condition holds, and confirm the quality of Propensity Score Matching is in a good situation.

Secondly, the results from Table A2 in Appendix suggest a similar situation of covariates imbalance. The Propensity Score Matching with one to one nearest matching has removed most of the mean difference. And there has been substantial reduction in the standardized differences for most variables. Still, the results show covariance imbalance for all the variables.

Table A3 in Appendix shows that the standard bias for mean bias and median bias after matching are both below 5%. This confirms a good performance of Propensity Score Matching in this thesis.

Finally, the results of average treatment effect on the treated (ATT) in Table 17 present a similar result in table 16. The differences of dependent variables EBITDA Margin and Return of Asset (ROA) between Treated and Control Groups are positive and significant at 1% level. The number of the difference is similar. The positive ATT suggested that public procurement has a positive relationship to firm performance indicator EBITDA Margin and Return of Asset (ROA). The negative Revenue Growth Rate ATT suggested that public procurement has a negative relationship to firm performance indicator Revenue Growth Rate.

TABLE 17: Average treatment effect on the treated (ATT)

Dependent Variable	Treated Group	Control Group	Difference	SE	T-Stat
EBITDA Margin ATT	0.08	0.02	0.06***	0.002	30.29
ROA ATT	0.13	0.11	0.02***	0.0014	17.70
Revenue Growth Rate ATT	0.23	0.32	-0.09***	0.005	14.95

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7.2 The results of Regression Analysis

Section 7.2 presents the results of Regression 1 and 2, with firm indicators *EBITDA Margin, Return of Assets,* and *Revenue Growth Rate*, respectively. The data are clustered on firms with organization number, which clusters the same firm in each year.

7.2.1 The Results of Regression 1

TABLE 18: The results of regression 1

	(1) EBITDA Margin	(2) ROA	(3) Revenue Growth Rate
Matched Group	0.0456***	0.0441***	-0.312***
	(6.17)	(8.88)	(22.68)
Log Total Assets	0.0379***	0.0232***	0.0235***
	(25.00)	(24.46)	(13.10)
Employees	-0.000354***	-0.000544***	-0.00266***
	(2.87)	(9.74)	(14.07)
Age	0.000529**	0.000240**	-0.0145***
	(2.27)	(2.39)	(46.76)
Centralization index of companies	0.00833***	0.00200***	-0.00458***
	(9.16)	(4.26)	(3.53)
Year			
Year 2013	-0.0102**	-0.0140***	-0.0200**
	(2.16)	(5.21)	(2.06)
Year 2014	-0.0187***	-0.0190***	0.119***
	(3.55)	(6.59)	(11.15)
Year 2015	-0.00481	-0.0228***	0.107***
	(0.91)	(7.78)	(10.30)
Year 2016	-0.0122**	-0.0286***	0.0713***
	(2.14)	(9.00)	(6.62)
Ownership			
Government	1.333***	0.120***	-0.228**
	(5.86)	(5.01)	(2.21)
Foreign	1.331***	0.159***	-0.229**
	(5.85)	(6.50)	(2.21)
Cooperation	1.352***	0.113***	-0.247**
	(5.94)	(4.70)	(2.41)
Private	1.381***	0.222***	-0.207**
	(6.07)	(9.37)	(2.03)
Industry			
Agriculture	-0.0755***	-0.0719***	0.0360**
	(6.96)	(16.99)	(2.52)
Offshore	-0.163***	-0.108***	0.0452*
	(7.61)	(16.06)	(1.96)
Transport	-0.00213	-0.0313***	-0.0301***
	(0.34)	(8.24)	(2.84)

Table 18 continues.

Manufacture	-0.0809***	-0.0927***	-0.0136*
	(16.13)	(29.99)	(1.70)
Tech	-0.112***	-0.0759***	-0.0277
	(6.76)	(10.24)	(1.51)
Electricity	0.0559**	-0.118***	-0.0364
	(2.17)	(21.91)	(1.26)
Construction	0.00548	-0.0751***	0.0329***
	(1.36)	(31.81)	(5.23)
Trade	-0.0813***	-0.102***	-0.0437***
	(25.31)	(42.68)	(8.07)
Interactions			
Matched Group *Year 2013	0.00574	0.00323	-0.00406
	(1.12)	(0.97)	(0.34)
Matched Group *Year 2014	0.0150***	0.00714**	-0.126***
	(2.67)	(2.00)	(9.81)
Matched Group *Year 2015	0.0155***	0.0169***	-0.0967***
	(2.75)	(4.64)	(7.57)
Matched Group *Year 2016	0.0195***	0.0160***	-0.0550***
	(3.23)	(4.13)	(4.18)
Matched Group *Small size	0.0595***	0.0167***	0.0360***
	(29.66)	(8.15)	(7.34)
Matched Group *Startup stage	-0.00398	-0.0335***	0.982***
	(1.39)	(8.97)	(55.27)
Matched Group *Mature stage	0.00774***	0.0208***	-0.0623***
	(3.10)	(7.19)	(12.48)
Matched Group *Employees	-0.000632***	-0.000246***	0.00207***
	(6.07)	(4.21)	(11.08)
Matched Group *Age	-0.000766***	-0.00158***	0.0119***
	(3.12)	(11.87)	(34.25)
Matched Group *Centralization index of companies	-0.00764***	-0.00475***	-0.0000174
	(8.13)	(8.26)	(0.01)
Matched Group *Tech	0.0736***	0.0185**	0.0793***
	(4.19)	(2.08)	(3.42)
Matched Group *Foreign ownership	0.0153	0.00556	0.0535***
	(1.38)	(0.65)	(2.59)
Matched Group *Selling in the same municipality	0.00714***	0.000188	-0.0136***
	(4.42)	(0.10)	(2.92)
_cons	-1.662***	-0.229***	0.531***
	(7.30)	(8.84)	(5.12)
N	385,445	385,445	385,445
R-squared	0.0214	0.0209	0.0415

t statistics in parentheses

* p <0.1, ** p < 0.05, *** p < 0.01

Table 18 above reports the results of estimation regression equation (6) illustrated in 6.3.1, regarding performance indicators *EBITDA Margin, ROA* and *Revenue Growth Rate*. Independent variables show expected sign, and the model generally performs well. The main independent variable is *Matched Group*. When dummy variable *Matched Group* equals to 1, it means that companies in the group are suppliers to municipalities, while equals to 0 otherwise. The control variables and interactions are based on independent variable *Matched Group*.

Column 1 reports the effects on firm performance indicator *EBITDA Margin*. As expected, the coefficient for independent variable *Matched Group* represents positive results, and significant at 1% level. The result represents that for firms being suppliers to municipalities can gain EBITDA Margin around 5% more than firms which are not suppliers to municipalities.

In light of size, the result of the interaction variable *Employees* is negative significant at 1% level. This may suggest that firms with fewer employees benefit more from being suppliers to municipalities than companies which are not suppliers to municipalities. Furthermore, the result of the interaction variable small-sized (0 to 10 employees) companies is positive significant at 1% level. This suggests that for small-sized companies, being suppliers to municipalities can gain about 6% more EBITDA Margin than other small-sized companies which are not suppliers to municipalities.

The results of interaction year variables present a positive relationship with EBITDA Margin and significant at 1% in year 2014, 2015 and 2016. This indicates that companies being suppliers to municipalities have around 2% more EBITDA Margin than companies which are not suppliers to municipalities in year 2014, 2015 and 2016.

For industry perspective, the result of the interaction term of tech companies is positive and significant at 1% level, which may suggest that tech companies being suppliers to municipalities gain about 7% more EBITDA Margin than other tech companies which are not suppliers to municipalities.

The result of the interaction variables *Age* is negative significant at 1% level. This may suggest that younger firms benefit more from being suppliers to municipalities. The coefficient of interaction *Startup stage (0-3 years)* is not significant, which suggests being suppliers to municipalities or not does not affect EBITDA Margin of start-up companies (0 to 3 years).

The result of the interaction variables *Centralization index of companies* is negative significant at 1% level. This may suggest that firms which are more centralized benefit more from being suppliers to municipalities than companies which are not suppliers to municipalities. The *Centralization index of companies* scores all municipalities into a 1-10 scale based on distances to the urban core, where 1 means most central.

The result of interaction term for foreign companies is not statistically significant, suggesting that domestic or foreign companies are not affected significantly by being suppliers to municipalities. The result of the interaction term *Selling in the same municipality* is positive significant at 1% level, suggesting that companies sell to the same municipality gain about 1% more EBITDA Margin than other companies.

Column 2 reports the effects on firm performance indicator ROA. The results of ROA can be a robust-check of the findings of EBITDA Margin, and the results show similar effects. The coefficient of independent variable *Matched Group* represents positive result, and significant at 1% level. The result represents that for firms being suppliers to municipalities can gain ROA around 4% more than firms which are not suppliers to municipalities.

The result of interaction term *Startup stage (0-3 years)* is negative significant at 1% level, suggesting start-up companies (0-3 years) have 3% less ROA by being suppliers to municipalities than other start-up companies which are not suppliers to municipalities.

The results of the interaction variables *Employees, Age, and Centralization index of companies, Year*, *Ownership*, *Tech industry*, and *Small size* show similar results to the results of EBITDA Margin. The result of the interaction term *Selling in the same municipality* is not significant, suggesting that ROA of companies are not affected significantly by selling in the same municipality or not.

Column 3 reports the coefficient for independent variable *Matched Group* is negatively associated with Revenue Growth Rate, and significant at 1% level. The result represents that firms being suppliers to municipalities have Revenue Growth Rate around 31% less than firms which are not suppliers to municipalities.

Furthermore, in light of size, the result of the interaction variable *Employees* is positive significant at 1% level. This may suggest that firms with more employees grow faster by being suppliers to municipalities than companies which are not suppliers to municipalities. The

result of the interaction variable small-sized (0 to 10 employees) companies is positive significant at 1% level. This suggests that for small-sized companies, being suppliers to municipalities can have revenue growth rate around 4% more than other small-sized companies which are not suppliers to municipalities.

The results of interaction year variables present a negative relationship with Revenue Growth Rate and significant at 1% in year 2014, 2015 and 2016. This suggests that companies being suppliers to municipalities grow slower than companies which are not suppliers to municipalities in year 2014, 2015 and 2016.

For industry perspective, the result of the interaction term of tech companies is positive and significant at 1% level, which suggests that tech companies being suppliers to municipalities have revenue growth rate about 8% more than other tech companies which are not suppliers to municipalities.

The result of the interaction variables *Age* is positive significant at 1% level. This may suggest that older firms grow faster by being suppliers to municipalities than companies which are not suppliers to municipalities. The coefficient of interaction *Startup stage* is positive significant at 1% level. This suggests that start-up suppliers (0 to 3 years) to municipalities grow faster than other startup companies which are not suppliers to municipalities.

The result of interaction term for foreign companies is positive and statistically significant at 1% level, suggesting that foreign companies grow faster than domestic companies by being suppliers to municipalities. The result of the interaction term *Selling in the same municipality* is negative significant at 1% level, suggesting that companies sell to the same municipality grow about 1% slower than other companies. The result of *Centralization index of companies* is not significant.

The constant is the expected mean value dependent variable when independent variables and control variables equal to 0. The constant doesn’t usually have a meaning, because it is impossible to set all independent variables to 0. In this analysis, all independent variables and control variables cannot equal to 0. For example, employees cannot be 0 for a firm to exist. Therefore, the constant in this analysis does not have a meaning.

7.2.2 The Results of Regression 2

TABLE 19: The results of regression 2

	(1) EBITDA Margin	(2) ROA	(3) Revenue Growth Rate
Share of sales to municipalities	0.155***	0.0689**	-1.025***
	(2.96)	(2.03)	(11.38)
Share of sales to municipalities^2	-0.693***	-0.188***	0.600***
	(12.01)	(4.55)	(5.59)
Log Total Assets	0.0395***	0.0246***	0.0108***
	(27.42)	(26.27)	(6.20)
Employees	-0.000992***	-0.000756***	-0.00155***
	(12.86)	(19.74)	(15.28)
Age	-0.0000155	-0.000189***	-0.0140***
	(0.11)	(2.61)	(65.02)
Centralization index of companies	0.00521***	-0.0000138	-0.00569***
	(9.89)	(0.04)	(6.67)
Year			
Year 2013	-0.00505*	-0.0115***	-0.0226***
	(1.81)	(6.75)	(3.52)
Year 2014	-0.00700**	-0.0136***	0.0700***
	(2.31)	(7.40)	(10.17)
Year 2015	0.00115	-0.0146***	0.0699***
	(0.37)	(7.60)	(10.14)
Year 2016	-0.00204	-0.0196***	0.0507***
	(0.63)	(9.73)	(7.24)
Ownership			
Government	1.346***	0.137***	-0.304***
	(5.89)	(5.58)	(2.94)
Foreign	1.340***	0.168***	-0.269***
	(5.86)	(6.85)	(2.61)
Cooperation	1.364***	0.123***	-0.315***
	(5.97)	(5.01)	(3.05)
Private	1.391***	0.232***	-0.281***
	(6.09)	(9.60)	(2.73)
Industry			
Agriculture	-0.0824***	-0.0771***	0.0630***
	(7.61)	(18.31)	(4.41)
Offshore	-0.169***	-0.114***	0.0704***
	(7.93)	(16.98)	(3.06)
Transport	-0.00374	-0.0333***	-0.0317***
	(0.60)	(8.76)	(2.93)
Manufacture	-0.0808***	-0.0944***	-0.0138*
	(15.90)	(30.27)	(1.67)
Tech	-0.0824***	-0.0686***	-0.00728
	(7.96)	(13.00)	(0.55)

Table 19 continues.

Electricity	0.0405	-0.126***	0.000175
	(1.58)	(23.37)	(0.01)
Construction	-0.000417	-0.0777***	0.0433***
	(0.10)	(32.82)	(6.75)
Trade	-0.0767***	-0.102***	-0.0511***
	(23.18)	(42.33)	(9.13)
Interactions			
Share of sales to municipalities * Year 2013	0.0389	0.0324**	-0.00143
	(1.19)	(2.02)	(0.03)
Share of sales to municipalities * Year 2014	0.0258	0.0147	-0.221***
	(0.77)	(0.84)	(3.61)
Share of sales to municipalities * Year 2015	0.103***	0.0401**	-0.148**
	(2.95)	(2.21)	(2.35)
Share of sales to municipalities * Year 2016	0.0967***	0.0452**	-0.105*
	(2.85)	(2.58)	(1.75)
Share of sales to municipalities * Small size	0.193***	0.0209	0.0590*
	(10.02)	(1.40)	(1.65)
Share of sales to municipalities * Startup stage	0.0274	-0.0804***	2.380***
	(0.74)	(3.04)	(21.08)
Share of sales to municipalities * Mature stage	0.0119	0.0745***	-0.212***
	(0.33)	(3.85)	(5.01)
Share of sales to municipalities * Employees	0.000248	0.0000677	0.00359***
	(0.85)	(0.28)	(5.53)
Share of sales to municipalities * Age	0.00219	-0.00329***	0.0307***
	(1.38)	(4.83)	(17.70)
Share of sales to municipalities * Centralization index of companies	-0.00694	-0.00334	-0.00186
	(1.55)	(1.32)	(0.27)
Share of sales to municipalities * Tech	0.0864	0.0160	0.313***
	(1.24)	(0.42)	(2.78)
Share of sales to municipalities * Foreign ownership	0.0765	0.00369	0.141
	(1.11)	(0.06)	(0.96)
Share of sales to municipalities * Selling in the same municipality	0.0978***	-0.00657	0.0111
	(4.06)	(0.48)	(0.31)
_cons	-1.644***	-0.225***	0.681***
	(7.19)	(8.60)	(6.56)
N	385,445	385,445	385,445
R-Squared	0.0185	0.0188	0.0213

t statistics in parentheses
* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Table 19 above reports the results of estimation regression equation (7) illustrated in 6.3.1, regarding performance indicator *EBITDA Margin, ROA* and *Revenue Growth Rate*. The main independent variable is *Share of sales to municipalities*, which means the percentage of sales value from municipality procurement to total sales revenue. Control variables and interactions are based on independent variable *Share of sales to municipalities*.

Column 1 shows that the *Share of sales to municipalities* is positively associated with firm performance EBITDA Margin, and significant at 1% level. The result demonstrates a strong correlation between municipality procurement and firm performance. The coefficient is economically significant, which means that for firms being suppliers to municipalities increasing 10% share of sales to municipalities can gain around 1.6% more EBITDA Margin.

Considering that selling to municipalities may help companies gain more EBITDA Margin, which may be dependent on the obstacle to firm performance if firms lack alternative markets. For this reason, the variable *Share of sales to municipalities^2* is added to test the non-linear relationship between municipality procurement and firm performance. The result is negative significant at 1% level, which represents a turning point reached when about 11% of total sales are to the municipalities.

Furthermore, in light of size, the result of the interaction variable small-sized (0 to 10 employees) companies is positive significant at 1% level. This suggests that for small-sized companies, increasing 10% share of sales to municipalities can gain about 2% more EBITDA Margin. The result of *Employees* is not significant.

The results of interaction year variables present a positive relationship with EBITDA Margin and significant at 1% in year 2015 and 2016. This may suggest that companies increasing 10% share of sales to municipalities can gain about 1% more EBITDA Margin in year 2015 and 2016. The results are similar to the result table 18.

For industry perspective, the result of the interaction term of tech companies is not significant. This suggests that EBITDA Margin of tech companies is not affected significantly by increasing share of sales to municipalities.

In addition, the result of interaction term for foreign companies is not statistically significant, and this is similar to the result in table 18. The result of the interaction term *Selling in the same*

municipality is similar to the result in table 18. The result is positive significant at 1% level, suggesting that companies sell to the same municipality increasing 10% share of sales to municipalities can gain about 1% more EBITDA Margin. The results of the interaction variables *Age*, *startup stage* and *Centralization index of companies* are not significant.

Column 2 reports the effects on firm performance indicator ROA. The results of ROA show similar results to the findings of EBITDA Margin. The coefficient for independent variable *Share of sales to municipalities* represents positive result, and significant at 5% level. The result represents that for firms being suppliers to municipalities can gain around 1% more ROA by increasing 10% share of sales to municipalities. The result of *Share of sales to Municipalities*$^{\wedge 2}$ is negative significant at 1% level. This represents a turning point reached when about 18% of total sales are to the municipalities.

The results of interaction variables *Employees, Centralization index of companies, Tech and Small size* are not significant. This may indicate the ROA of companies is not affected by increasing share of sales to municipalities regarding size, Centralization index of companies, and being Tech companies or not. The result of interaction term for foreign companies is not statistically significant, and this is similar to the result in EBITDA Margin. The result of the interaction term *Selling in the same municipality* is not significant, which show similar results in table 18. The results of interaction year variables present a positive relationship with ROA and significant at 5% in year 2013, 2015 and 2016.

The result of the interaction variables *Age* is negative significant at 1% level. This may suggest that older firms gain more ROA by increasing share of sales to municipalities. The coefficient of interaction *Startup stage (0 to 3 years)* is negative significant at 1% level. This suggests that startup (0 to 3 years) suppliers to municipalities gain less ROA by increasing share of sales to municipalities. This is similar to results in table 18.

Column 3 reports the coefficient for independent variable *Share of sales to municipalities* is negatively associated with *Revenue Growth Rate*, and negative significant at 1% level. The result represents that firms being suppliers to municipalities with 10% increase of share of sales to municipalities can have around 10% less Revenue Growth Rate. The result of *Share of sales to municipalities*$^{\wedge 2}$ is positive significant at 1% level. This represents a turning point reached when about 85% of total sales are to the municipalities.

The result of the interaction variables *Employees* is positive significant at 1% level. This may suggest that firms with more employees grow faster by increasing share of sales to municipalities. The result of the interaction variable small-sized (0 to 10 employees) companies is positive significant at 10% level. This suggests that small-sized companies have revenue growth rate around 0.6% more by increasing 10% sales of share to municipalities.

For industry perspective, the result of the interaction term of tech companies is positive and significant at 1% level, which suggests that tech companies increasing 10% share of sales to municipalities can have around 3% more of Revenue Growth Rate.

The result of the interaction variables *Age* is positive significant at 1% level. This may suggest that older firms grow faster by increasing share of sales to municipalities. The coefficient of interaction *Startup stage (0 to 3 years)* is positive significant at 1% level. This suggests that startup (0 to 3 years) suppliers to municipalities grow 24% more by increasing 10% of share of sales to municipalities.

The result of interaction term for foreign companies is not statistically significant as EBITDA Margin and ROA, which suggests that the revenue growth of domestic or foreign companies are not affected significantly by increasing share of sales to municipalities. The result *Centralization index of companies* is not significant. These are similar to the results in table 18. The result of the interaction term *Selling in the same municipality* is not significant.

7.2.3 Additional results of regression analysis related to firm innovation

The results of main Regression 1 and Regression 2 from section 7.2.2 show that the positive correlation between public procurement and firm performance of small-sized and tech companies. This may suggest public procurement support firm innovation of small-sized and tech companies, since small firms are often characterized as being innovative (Saastamoinen, Reijonen et al. 2018). Public procurement can support innovation in two ways, buy regular innovated products, or demand for a product or service which does not yet exist but can be developed innovative (Saastamoinen, Reijonen et al. 2018).

Therefore, it would be interesting to gain further insight into the innovation support through public procurement. An additional regression analysis is conducted to test for the relationship between public procurement and firm innovation performance, and test for whether there is significant difference of firm innovation performance between the Treated and Control groups.

Firm innovation performance indicators are using R&D-related accounting items, which are *Research & Development* and *Patent*. According to Firm level data source, *Research & Development* concerns activities that aim to procure new knowledge, make results commercially viable or to describe or design new products or production processes. The accounting items cover capitalized parts of such activities. *Patent* includes permits, patents, licenses, trademarks, contract rights. The value is in the right to use or exploit what is covered by the contract. These numbers do not capture innovation well, but may be seen as crude indicators.

The regression analysis methodology is conducted similar to main Regression 1 and Regression 2. Dependent variables are changed from firm performance *EBITDA Margin, ROA* and *Revenue Growth Rate* to firm innovation performance *Research & Development* and *Patent.* Control variables and interaction terms are the same as Regression 1 and Regression 2. The value of *Research & Development* and *Patent* is in thousand NOK.

TABLE 20: The results of regression 1 related to firm innovation

	(1) Research & Development	(2) Patent
Matched group	-914.6***	-4392.2*
	(2.69)	(1.82)
Total assets	416.1***	1013.3***
	(2.71)	(4.78)
Employees	29.82	117.0*
	(1.39)	(1.91)
Age	-23.55**	-51.65***
	(2.53)	(3.49)
Centralization index of companies	-37.37*	-135.2**
	(1.87)	(2.43)
Year		
Year 2013	7952.9	-24952.2
	(1.51)	(0.85)
Year 2014	-915.3	-34370.4
	(0.39)	(1.17)
Year 2015	-2419.4	-42826.6
	(1.11)	(1.48)
Year 2016	-2385.8	-40736.8
	(1.12)	(1.41)
Industry		
Agriculture	313.0*	6975.3***
	(1.68)	(9.61)
Offshore	6211.2*	16498.0**
	(1.91)	(2.38)
Transport	3613.3*	5499.3**
	(1.92)	(2.57)
Manufacture	399.3**	-366.5
	(2.23)	(1.50)
Tech	489.6***	-506.7
	(3.91)	(1.25)
Electricity	-4349.0**	12618.4*
	(2.06)	(1.70)
Construction	51.66	-10.13
	(0.88)	(0.04)
Trade	318.4*	624.0
	(1.91)	(1.08)
Interactions		
Matched Group *Year 2013	217.2	221.9*

Table 20 continues.	(1.15)	(1.85)
Matched Group *Year 2014	559.9**	26.92
	(2.35)	(0.11)
Matched Group *Year 2015	1199.0**	1790.7
	(2.27)	(1.11)
Matched Group *Year 2016	750.6**	2.412
	(2.25)	(0.01)
Matched Group *Small size	1484.2***	4093.5***
	(3.33)	(2.66)
Matched Group *Startup stage	-326.5	45.48
	(1.12)	(0.16)
Matched Group *Mature stage	158.1	1913.9
	(0.29)	(1.28)
Matched Group *Employees	-12.20	-1.270
	(0.55)	(0.01)
Matched Group *Age	-16.00	-87.18
	(1.02)	(0.96)
Matched Group *Centralization index of companies	-104.1**	-37.61
	(2.28)	(0.33)
Matched Group *Tech	-558.4	551.4
	(1.25)	(0.45)
Matched Group *Foreign ownership	869.3	2543.4
	(0.40)	(0.30)
Matched Group *Selling in the same municipality	-244.8	1072.0
	(0.60)	(0.87)
_cons	-768.8	33063.6
	(0.30)	(1.13)
N	385445	385445
R-Squared	0.0026	0.0024

t statistics in parentheses
* $p<0.1$, ** $p<0.05$, *** $p<0.01$

TABLE 21: The results of regression 2 related to firm innovation

	(1) Research & Development	(2) Patent
Share of Sales to Municipalities	-4752.9**	-13584.6***
	(2.34)	(5.43)
Share of Sales to Municipalities^2	4380.2***	14879.6***
	(3.25)	(3.79)
Total Assets	392.8**	898.7***
	(2.56)	(4.67)
Employees	14.28	99.60*
	(0.90)	(1.91)
Age	-27.70**	-66.76**
	(2.47)	(2.56)
Centralization index of companies	-86.30***	-142.9**
	(2.59)	(2.28)
Year		
Year 2013	86.70**	206.8**
	(2.00)	(2.57)
Year 2014	308.2*	389.9**
	(1.93)	(1.99)
Year 2015	615.2**	1213.5
	(2.10)	(1.31)
Year 2016	498.4**	-8.891
	(2.23)	(0.05)
Ownership		
Government	8110.6	-24555.2
	(1.48)	(0.83)
Foreign	-762.8	-33730.1
	(0.31)	(1.14)
Cooperation	-2648.8	-43346.0
	(1.22)	(1.50)
Private	-2746.3	-41614.4
	(1.29)	(1.44)
Industry		
Agriculture	341.6*	7109.6***
	(1.71)	(9.18)
Offshore	6323.4*	16796.9**
	(1.93)	(2.34)
Transport	3576.9*	5533.4***
	(1.93)	(2.61)
Manufacture	281.2*	-694.2**
	(1.88)	(2.42)

Table 21 continues.

Tech	173.2	-405.5
	(1.00)	(0.74)
Electricity	-4493.1**	12449.2*
	(2.08)	(1.69)
Construction	66.47	171.9
	(0.92)	(0.52)
Trade	183.4	361.9
	(1.20)	(0.61)
Interactions		
Share of sales to municipalities *Year 2013	-6.129	-248.2
	(0.05)	(0.80)
Share of sales to municipalities *Year 2014	-267.9	-928.5
	(0.57)	(1.27)
Share of sales to municipalities *Year 2015	-943.6	-2781.1
	(1.28)	(1.06)
Share of sales to municipalities *Year 2016	-449.4	957.0
	(1.02)	(1.22)
Share of sales to municipalities * Small size	3492.2**	7991.7***
	(2.47)	(4.57)
Share of sales to municipalities * Startup stage	833.4	2688.8***
	(1.49)	(3.91)
Share of sales to municipalities *Mature stage	-1339.2**	-1035.8
	(2.12)	(1.19)
Share of sales to municipalities *Employees	-59.56*	-263.3*
	(1.73)	(1.86)
Share of sales to municipalities *Age	-7.858	-11.74
	(0.35)	(0.19)
Share of sales to municipalities *Centralization index of companies	-158.5**	-354.5**
	(1.97)	(1.97)
Share of sales to municipalities *Tech	1838.3**	3494.6*
	(2.24)	(1.94)
Share of sales to municipalities *Foreign ownership	-3698.7	-19879.3*
	(1.20)	(1.71)
Share of sales to municipalities *Selling in the same municipality	-1342.1**	-1919.7**
	(2.23)	(2.45)
_cons	-90.17	34689.6
	(0.04)	(1.19)
N	385,445	385,445
R-Squared	0.0026	0.0024

t statistics in parentheses
* p <0.1, ** p < 0.05, *** p < 0.01

Table 20 and 21 above illustrate the results of regression analysis regarding firm innovation performance indicator *Research & Development* and *Patent.* The main dependent variable in table 20 is *Matched Group,* and control variables and interaction terms are the same as in table 18. The main dependent variable in table 21 is *Share of sales to municipalities,* and control variables and interaction terms are the same as in table 19.

Column 1 in table 20 and 21 reports the effects on firm innovation performance indicator *Research & Development.* The results of main variables *Matched Group* and *Share of sales to municipalities* are both negatively associated with *Research & Development*, and significant at 1% and 5% level, respectively. The result of *Matched Group* indicates that for firms being suppliers to municipalities have Research & Development around 915 thousand NOK less than companies which are not suppliers to municipalities. The coefficient of *Share of sales to municipalities* demonstrates that for firms being suppliers to municipalities increasing 10% share of sales to municipalities will lose around 475 thousand NOK Research & Development. The results may suggest that the lack of Norwegian government to support innovation through public procurement. The result of the variable *Share of sales to municipalities^2* is positive significant at 1% level. The result shows a non-linear relationship between *Share of sales to municipalities* and *Research & Development,* and represents a turning point reached when about 54% of total sales are to the municipalities.

For small-sized (0 to 10 employees) companies, the result of interaction *Small size* to *Matched Group* and *Share of sales to municipalities* are both positive significant at 1% and 5% level, respectively. This suggests that small-sized companies gain about 1484 thousand NOK more *Research & Development* by being suppliers to municipalities than companies which are not suppliers to municipalities. And when increasing 10% sales of share to municipalities, small-sized companies gain 349 thousand NOK more *Research & Development* than larger-sized companies.

Regarding tech industry, the coefficient of interaction with *Matched Group* is not significant, suggesting being suppliers to municipalities does not affect *Research & Development* of tech companies or other types of companies. However, the coefficient of interaction with *Share of sales to municipalities* is positive significant at 5% level, suggesting tech companies increasing 10% of sales of share to municipalities increases around 184 thousand NOK more *Research & Development*.

In light of start-up companies (0-3 years), the results of interaction to both *Matched Group* and *Share of sales to municipalities* are not significant. This suggests that being suppliers to municipalities or not does not affect Research & Development of start-up companies.

Column 2 in table 20 and 21 reports the effects on firm innovation indicator *Patent*. The results of *Patent* can be a robust-check of the findings of *Research & Development*, and the results show similar effects. The coefficients for independent variables *Matched Group* and *Share of sales to municipalities* are negative, and significant at 10% and 1% level, respectively. The results suggest that for firms being suppliers to municipalities have 4392 thousand NOK less patent than firms which are not suppliers to municipalities, and companies increasing 10% of sales of share to municipalities will lose 1358 thousand NOK patents. The result of the variable *Share of sales to municipalities*$^{\wedge 2}$ is positive significant at 1% level. The result shows a non-linear relationship between *Share of sales to municipalities* and *Patent.* This represents a turning point reached when about 46% of total sales are to the municipalities. This is similar to the result of *Research & Development.*

For small-sized (0 to 10 employees) companies, the result of interaction to *Matched Group* and *Share of sales to municipalities* are both positive significant at 1% level. This is a similar result to *Research & Development*. This suggests that small-sized companies have 4094 thousand NOK more patents by being suppliers to municipalities than companies which are not suppliers to municipalities. And when increasing 10% sales of share to municipalities, small-sized companies gain 799 thousand NOK more patents than larger-sized companies.

Regarding tech industry, the coefficient of interaction with *Matched Group* is not significant, suggesting being suppliers to municipalities or not does not affect patents of tech companies or other types of companies. However, the coefficient of interaction with *Share of sales to municipalities* is positive significant at 10% level, suggesting tech companies increasing 10% of sales of share to municipalities increase around 349 thousand NOK more patents.

In light of start-up companies (0 to 3 years), the result of interaction to *Matched Group* is not significant. This is similar to the result of Research & Development. The result of interaction to S*hare of sales to municipalities* is positive significant at 1% level. When increasing 10% sales of share to municipalities, start-up companies (0 to 3 years) gain 269 thousand NOK more patents than larger-sized companies.

7.3 Discussions

The methodologies used in the thesis are the combination of Propensity Score Matching and Regression analysis based on matched samples. The combination of the two methodologies can be "double robustness," and the intuition is the same as that behind regression adjustment in randomized experiments, where the regression adjustment is used to "clean up" small residual covariate imbalance between the groups (Stuart 2010). The results from the Average Treatment Effect of the Treated (ATT) of Propensity Score Matching, and two Regression Analysis, indicate a strong relationship between public procurement and firm performance. This section will introduce a discussion on the results, further research and shortcomings of the thesis.

The findings of the analysis suggest that public procurement has statistically significant effects on firm performance. In light of Hypothesis 1 and 2, the research shows that there exists a positive relationship between public procurement and firm performance in Norway, regarding EBITDA Margin and ROA, and a positive relationship between firms' higher share of sales to municipalities and firm performance in Norway, regarding EBITDA Margin and ROA.

On one hand, the findings may suggest that firm performance can be improved by participation in public procurement, and by selling more products or services to municipalities. This is in line with the research conducted by Hoekman and Sanfilippo (2018). They find that firms that sell a larger share of sales to government have better productivity performance. It is interesting for the two researches to have the similar findings. The research Hoekman and Sanfilippo (2018) focuses on investigating a firm-level dataset for 19 low-income Sub-Saharan African countries, while this thesis is studying on firm-level and municipality data in high-income country Norway. However, the methodology is comparable. This thesis conducts regression analysis as robustness for Propensity Score Matching, while Hoekman and Sanfilippo (2018) use Propensity Score Matching as robustness checks for regression analysis.

In addition, the relationship between share of sales to municipalities and firm performance are non-linear, which suggest the lacking of alternative markets is an obstacle to firm growth. For EBITDA Margin, a turning point reached when 11% of total sales are to the municipalities. For ROA, a turning point reached when 18% of total sales are to the municipalities.

On the other hand, the findings may indicate that Norwegian municipalities choose more profitable and bigger firms as government suppliers. Since long purse story argues that an entrant typically comes into the market with a more vulnerable financial structure than an incumbent (Telser 1966). This explains an entrant such as SME firms may issue more debt in order to do R&D and be more vulnerable to predation (Cestone 1999). In addition, due to the fact that public procurement is more risk averse (Maltaverne, 2018), and tries to avoid agency problem such as moral hazard as discussed in literature review (Cestone 1999). However, the results of testing Hypothesis 2 indicate that higher share of sales to municipalities leads to a higher firm performance in EBITDA Margin and ROA might suggest a positive effect for public procurement on firm performance in Norway.

Revenue growth rate can be used to measure the company's product life cycle and determine what the growth stage the company is. Generally speaking, start-up and growth stage companies have higher revenue growth rate than mature stage companies[9]. From the firm statistics of Treated and Control groups, Control Group (84% are small-sized) has more smaller firms than Treated Group (63% are small-sized). The findings of the negative statistically significant of public procurement on firm performance regarding Revenue Growth Rate, may indicate the public procurement prefer to choose bigger and more mature companies which have lower revenue growth rate than smaller companies in Control Group. On the other hand, the results may support the finding of positive effects of public procurement on firm performance related to EBITDA Margin and ROA. The suppliers of municipalities become to have better performance and grow bigger.

The findings also show that the economy situation affects the effects of public procurement on firm performance. From year 2014 to 2016, municipalities became more important customers for firm performance. This may due to the fact that the oil price collapsed from 2014 which affected the whole economy in Norway (Nordbø & Stensland 2015). Thus, it became harder for companies to survive from markets, while municipalities became stable supports for companies to realize firm performance in these difficult years.

Furthermore, the findings demonstrate that companies selling to municipalities they are located in have better performance than other companies. One of the possible explanation could be lower logistic cost for companies selling to the municipalities they are located in. The

[9] https://wiki.mbalib.com/wiki/revenue growth rate

other possible explanation could be that municipalities tempt to support companies located in own municipalities by paying higher price. Favoritism might be more widespread than thought simply because close-knit, small communities on local level and low awareness about corruption issues result in close connections between suppliers and public procurers (MAPS, 2018). In addition, in local markets there is weak competition and fewer suppliers, so particular favored choices may be more easily justified (UNDP, 2018).

In addition, the findings show more centralized companies benefit more from being suppliers to municipalities. However, a positive relationship whether domestic or foreign companies are affected significantly by being suppliers to municipalities is not obtained.

The findings show that small-sized (0 to 10 employees) companies have better performance regarding EBITDA Margin and ROA, and grow faster by being suppliers to municipalities. In addition, the findings suggest that tech companies perform better by being suppliers to municipalities. The findings also show start-up companies have worse firm performance regarding ROA but grow faster by being suppliers to municipalities. Thus, it would be interesting to check for whether firm innovation performances of small-sized (0 to 10 employees), tech and start-up companies (0 to 3 years) are affected by public procurement.

To gain further insight into the innovation support through public procurement, additional regression analysis is conducted to test for the effects of public procurement on firm innovation performance. The findings of the analysis confirm the support for innovation of small-sized (0 to 10 employees) and tech companies through public procurement. And the findings indicate a positive correlation between public procurement and Patent of start-up companies (0 to 3 years). However, the main findings of additional analysis suggest that companies which are suppliers to municipalities have lower firm innovation performance regarding Research & development and Patent than other companies. This may indicate a lack of innovation support through public procurement in Norway. The possible reason may be that the public procurement of innovations is often characterized by large contracts, and small firms lack resources to compete for public tenders (Saastamoinen, Reijonen et al. 2018).

Many questions are raised in the findings and indicate a number of areas for further research. One interesting question is how public procurement can balance spending the taxpayers´ money properly, and supporting SMEs and innovation effectively. Demand is a major potential source of innovation, yet the critical role of demand as a key driver of innovation has

still to be recognized in government policy (Edler and Georghiou 2007). In addition, risk aversion of public agencies has also been identified as a barrier to the procurement of innovation (Uyarra, Edler et al. 2014). The importance of risk management increases when the R&D itself is part of the procurement. Some OECD countries have introduced measures to reduce uncertainty or offset the perceived risks of purchasing innovations, for instance through the provision of financial incentives, insurance guarantees and the use of quality certificates (Uyarra, Edler et al. 2014) For this perspective, the study on improving the Norwegian public procurement procedure and risk management in order to promote innovation of SMEs through public procurement might be worth exploring.

The limitation of the thesis is that the data is only from year 2012 to 2016, and the years for companies to become suppliers to government are unknown. If the years when companies become suppliers are provided, methodology of difference in difference can be applied to analyze the increase or decrease of firm performance after companies become government suppliers. Furthermore, Propensity Score Matching is not perfect, although the common support condition of Propensity Score Matching holds, the results show the matching has removed most of the mean difference, and regression analysis is conducted to “clean up” small residual covariate imbalance between the groups. The exists of covariance imbalance for two variables after Propensity Score Matching may cause selection bias.

8. Conclusion

According to the previous research, public procurement as a demand may positively affect firm performance in different ways. For example, public procurement may support firms' access to finance and resources, stimulate innovation and developing new technologies, and explore and expand marketing opportunities. Public procurement may affect firm performance of small and domestic companies more than others. However, there are very few researches studying on the relationship between public procurement and firm performance. This creates an opportunity to conduct an empirical study of the effects of public procurement on firm performance in Norway.

In this thesis, the primary hypothesis 1 is that there exists a positive relationship between public procurement and firm performance in Norway. And hypothesis 2 is that there exists a positive relationship between firms' higher share of sales to public procurement and firm performance in Norway. The motivation of Hypothesis 2 is based on Hypothesis 1.

To test the hypothesis, two datasets of firm-level data and municipality-level data have been used, and the problem is framed as a quasi-experiment. This thesis uses two methodologies to test the relationship. Firstly, Propensity Score Matching method is used in order to create a control group with identical age, industry, and region compared to treated group. After matching, the average treatment effect on the treated (ATT) can be analyzed for differences of outcomes. Secondly, regression analysis is adopted to test both hypotheses. Both regressions will be run on matched sample. And an additional regression analysis is added to test the effects of public procurement on firm innovation performance.

The findings show that public procurement is positive related to firm performance regarding EBITDA Margin and Return of Assets. The results of Hypothesis 2 indicate that higher share of sales to municipalities leads to a higher firm performance in EBITDA Margin and ROA. This may suggest positive effects of public procurement on firm performance in Norway. In the meanwhile, the relationship between share of sales to municipalities and firm performance is non-linear, which suggests that the lacking of alternative markets is an obstacle to firm performance of companies.

In addition, the findings show that small-sized (0 to 10 employees) and tech companies have better firm performance and firm innovation performance by being suppliers to municipalities.

Start-up companies (0 to 3 years) have more patents by increasing share of sales to municipalities. However, the findings of additional analysis suggest that companies which are suppliers to municipalities have lower firm innovation performance regarding Research & development and Patent than other companies. This may indicate a lack of innovation support through public procurement in Norway.

Furthermore, additional results are found. The findings show that from year 2014 to 2016, municipalities became more important customers for companies to gain profits, due to the fact that the oil price collapsed from 2014. The findings demonstrate that companies selling to municipalities they are located in have better performance than other companies. Weak competition and close connections between suppliers and public procurers might cause corruption issues. The findings also show that fewer employees and more centralized companies benefit more from being suppliers to municipalities. However, a positive relationship whether domestic or foreign companies are affected significantly by being suppliers to municipalities is not obtained.

Overall, the findings suggest that government may enhance firm performance and firm innovation performance by public procurement. Such a result would suggest that it may be practical for Norwegian government to use public procurement as demand policy instrument, and support innovation by purchasing new products or investing in R&D process. In addition, in order to allocate taxpayer´s money properly on public procurement innovation projects, risk management in public procurement procedure should be enhanced.

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10. References

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11. Appendix

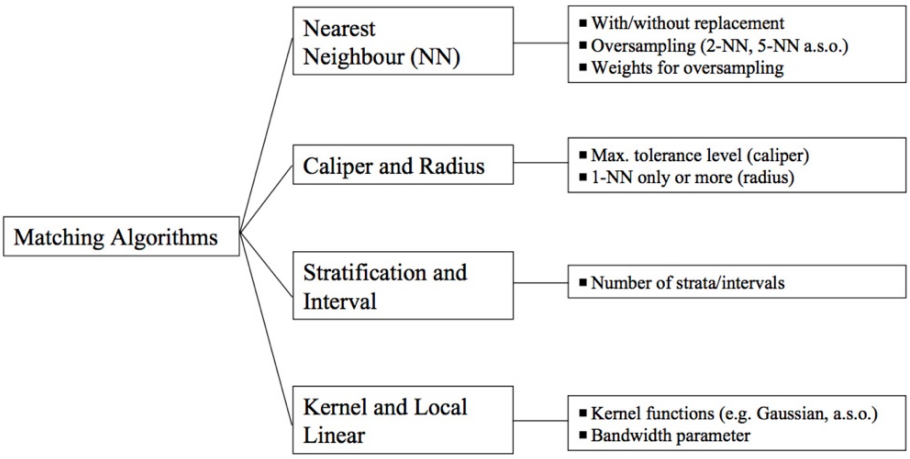

Figure A1: Different Matching Algorithms (Caliendo and Kopeinig 2008)

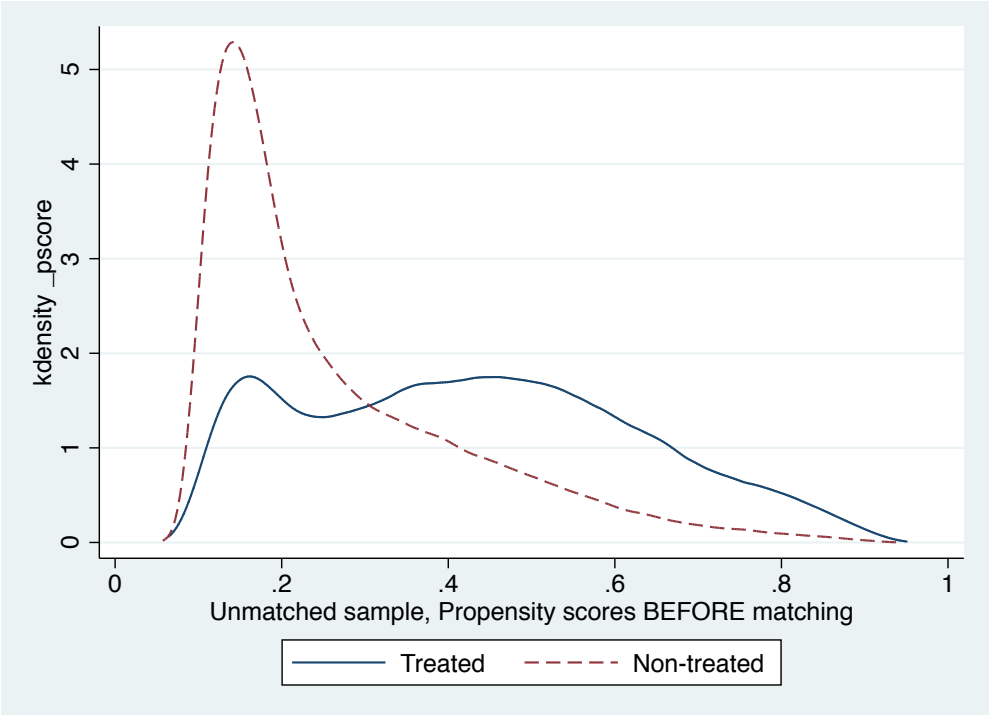

Figure A2: Distribution of Propensity Score before matching

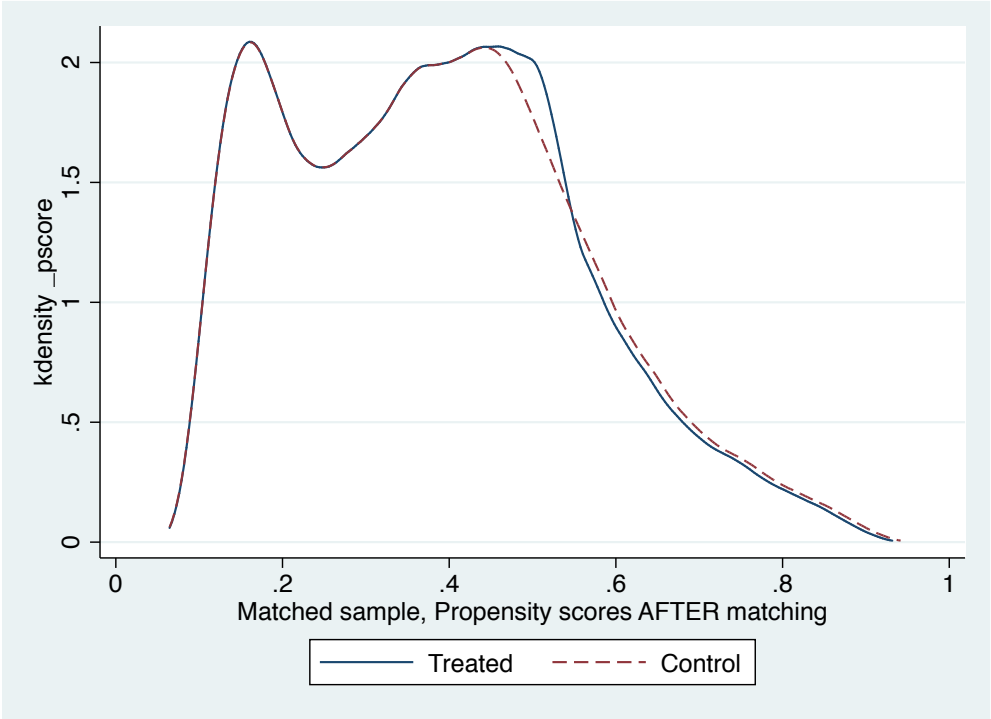

Figure A3: Distribution of Propensity Score after matching

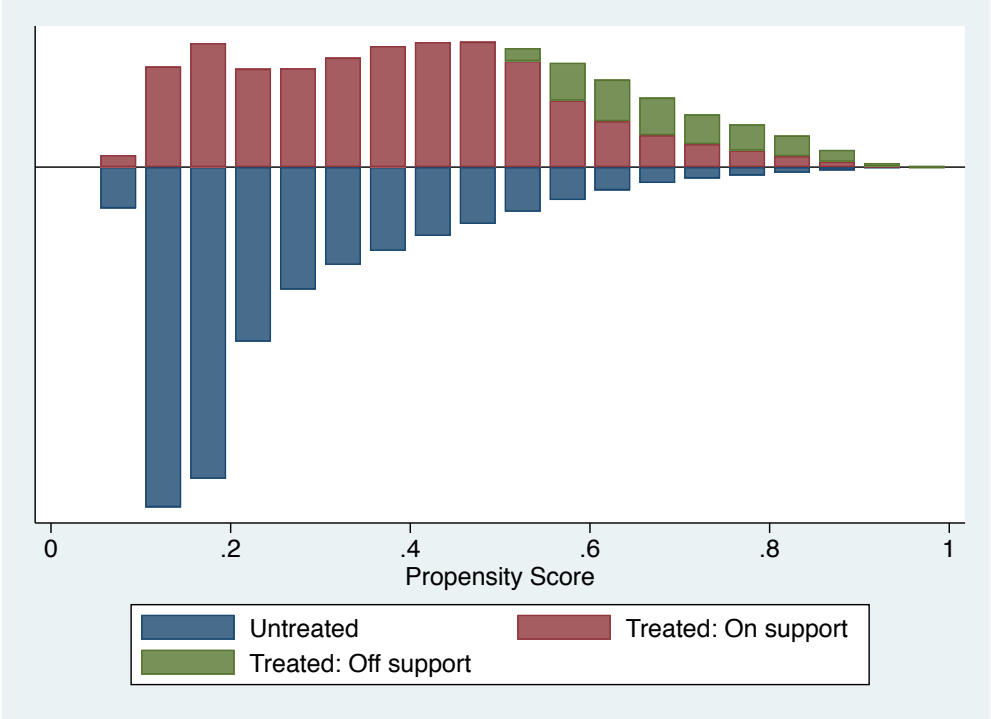

Figure A4: Common support distribution

Table A1: Common Support

Common Support	Freq.	Percent
Off support	30,096	4.88
On Support	586,487	95.12
Total	616,583	100,00

Table A2: Descriptive statistics for unmatched and matched sample

Variable	Mean			diff	%bias	% reduct bias	t-test t	p>|t|
		Treated Group	Control Group					
Age	Unmatched	15.835	11.958	3.877	35.8	94.7	134.40	0.000
	Matched	14.498	14.291	0.207	1.9		5.43	0.001
Region	Unmatched	927.77	820.68	107.09	18.2	97.0	67.23	0.000
	Matched	908.43	905.33	3.1	0.5		1.55	0.122
Industry	Unmatched	52.887	57.965	-5.078	-26.3	91.1	95.23	0.000
	Matched	54.034	54.486	-0.452	-2.3		6.51	0.000
Established Years	Unmatched	1999.2	2003.1	-3.9	-36.2	94.5	135.57	0.000
	Matched	2000.5	2000.7	-0.2	-2.0		5.67	0.000
Log Total Assets	Unmatched	8.4219	7.5898	0.8321	45.9	98.2	164.11	0.000
	Matched	8.1412	8.1259	0.0153	0.8		2.49	0.010
Log Employees	Unmatched	1.8806	0.8440	1.0366	86.3	97.2	325.91	0.000
	Matched	1.5973	1.6264	-0.0291	-2.4		7.00	0.000
Ownership	Unmatched	2.8858	3.0008	-0.115	-7.2	84.0	25.68	0.000
	Matched	2.9105	2.9289	-0.0184	-1.1		3.43	0.001

Table A3: Mean and median standardized bias for unmatched and matched sample

Sample	Mean Bias	Median Bias
Unmatched	36.5	35.8
Matched	1.6	1.9