The role of petroleum workers' education when transitioning to green industries

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Viktoria Maria Gundersen

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Abstract

In this master thesis I investigate the role of educational level in the transitioning from polluting industries to green industries when an oil price collapse occurs. The main focus is, (i) the effect of the oil price collapse on petroleum workers versus non-petroleum workers; (ii) the difference between high- and low-skilled petroleum workers in effects on wages, unemployment benefits and educational level after the oil price shock; (iii) whether displaced high- or low-skilled petroleum workers to a greater extent find a new job in a green industry; (iv) what educational level petroleum workers who transitioned to a green industry have versus petroleum workers staying in the petroleum industry. For this purpose, I use longitudinal data from Statistics Norway covering the period from 2009-2018. By using a difference in difference estimation, I show that high-skilled petroleum workers are more likely to transition to a green industry after an oil price collapse rather than low-skilled workers. All econometric methods were conducted using the software program Stata.

Key words: Labor market, retraining policies, environmental sustainability, recessions.

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1. Introduction

The importance of environmental changes and global warming is more discussed and agreed upon in recent years; changes are needed to reach environmental sustainability. Definitions for environmental sustainability are numerous and contented. The United Nations describes environmental sustainability as the capacity to feed the next generations and meet their own needs (United Nations, 1987). Transitioning from polluting industries like the petroleum sector, to a greater extent of environmentally friendly industries must take place. Changes towards sustainability are more than just limiting global warming and other negative consequences for the earth. It is also important for being equipped for the future and finding new economic and technological opportunities which provides a more sustainable and societal development (Haarstad and Rusten, 2018). All these changes in the petroleum- and renewable industries forces the established actors in the market to adapt not to go bankrupt (Hartshorn et al. 2005).

Norway seeks to become a low-emission country by 2050 and reduce its emissions by 50-55 percent by 2030 compared with the 1990 emission level. This is a part of the Paris agreement. To be able to achieve this goal there is a need of change towards a society where growth and development takes place within nature's own limits. Products and services in all industries need to have significantly fewer negative consequences for the environment than it has today (Regjeringen, 2020). Norway's most important economic sector is the petroleum industry which is a huge source of CO2-emissions. It creates path-dependency that can prevent changes, but it also contains valuable technological expertise and human resources that can contribute to restructuring processes and innovation towards a greener economy (Haarstad and Rusten, 2018). Due to technological changes and the world market race to be the first to invent new ways in the renewable industry, Norway is in the demand for higher working skills and research to outcompete other countries (NHO, 2021). According to Katz and Murphy (1992), an increase in technological changes can increase the demand for higher educational levels over less-skilled workers. Technological changes are likely to increase the demand for educated and flexible workers, while the demand for physical labor reduces.

Job losses tend to increase during an economic shock and the sudden international oil price collapse in 2014 led to job uncertainty for petroleum workers and workers in related activities. When the labor force in polluting industries reduces, the green shift can contribute to economic development through new thinking, solutions and in that way create more jobs (Statistics Norway, 2019). Climate policies can be viewed as negative for employment, particularly in areas where polluting industries contribute to a lot of the employment (Vona, 2019). One problem towards environmental sustainability is the job-killing argument where the downsizing in the petroleum industry destroys jobs and capital. Distance in skill requirements can be one reason why displaced petroleum workers find it difficult to be employed in other industries. The 'job-killing' argument in climate policies is obviously not only negative. It can also create winners in new firms and create new jobs by expanding the green sector. In Ruhr-Germany, competences from mining were used in production of renewable energy and recycling technologies, where skills easily could transition from a pollution industry to a green industry (Energy Transition, 2018).

In mid-2014, the oil price decreased due to competition in the world market and decreased demand for petroleum. In 2014 and 2015, the supply of petroleum was higher than the demand which led to a further decrease in the oil price. The oil price reached its bottom under 30 dollar per barrel in January 2016 (NOU 2016:15). In 2016 and 2017 the oil price decreased even further. Globalization, new technology, and the changes in the demand for working skills in the labor market, makes it interesting to study educational level for workers transitioning to green industries after the 2014 oil price collapse.

In this thesis I study the impact of education on petroleum workers, whether educational level is essential for petroleum workers to be hired in a green industry. Specifically, I address the following research questions:

(i) Do high- or low-skilled petroleum workers to a greater extent transition to a green industry after the 2014 oil price collapse?
(ii) Is there any difference between high- and low-skilled petroleum workers in effects on wages, unemployment benefits and educational level after the oil price shock?
(iii) What type of educational level did petroleum workers transitioning to a green industry have compared to petroleum workers who stayed in the petroleum industry after an oil price collapse?

In this thesis I use longitudinal data from Statistics Norway. The data gives the opportunity to focus on an individual level instead of a business level and compare pre- and post-trends to the petroleum workers in the same labor markets using difference in difference estimation. I use a matching method to find the best comparable control group for the petroleum workers. Further in the estimation, I divide the workers into high- and low skilled using educational codes from Statistics Norway. Low-skilled workers are workers with an education lower than a bachelor's degree, while high-skilled workers are workers with a minimum bachelor's degree. By dividing the workers into high-and low skilled, the focus is directed towards the possibility for high- and low skilled workers to start in a green industry after an oil price collapse occurs.

I found that workers with a higher educational level with a Bachelor of Engineering are more likely to change to a green industry after an oil price shock rather than low-skilled workers. From the empirical results, only the end of the post-period turns out to be statistically significant and the petroleum workers transitioned to a green industry in 2014 and 2015 cannot with certainty be explained by the oil price shock. Low-skilled petroleum workers during the recession experienced a larger decrease in yearly average wages and they received approximately four times more in unemployment benefits in 2016 than high-skilled petroleum workers. Regarding the educational level, I estimate non-statistically significant results, and that the increase- or decrease in education for petroleum workers in the post-period do not depend on the oil price shock. The educational level for the high-skilled petroleum workers did not have a remarkable increase before 2018.

This thesis is organized as follows. Chapter 2 is the background of this study; development of the petroleum prices and the job loss risk in Norway compared to other OECD countries. Chapter 3 gives an overview of relevant literature for this thesis followed by theoretical framework in Chapter 4. Chapter 5 is a description of the data and an interpretation of the chosen control- and treatment groups. In Chapter 6, I present the econometric framework and methodology used in this master thesis. I also describe the progress of how I find the treatment- and control groups, by using a matching method. The results I find from the econometric framework are represented in Chapter 7. To strengthen and verify my results, I do a robustness test in Chapter 8. The oil price collapse also affected industries delivering goods and services to the petroleum industry. I carry out the same analysis using sub-industries to the petroleum industry finding the same results, though I find the subgroup a better match. Discussion and conclusion of this thesis are represented in Chapter 9 and 10.

2. Background of the study

The annual average oil price measured in dollars per barrel between 2011 and 2013 was at a historically high level before it started to decrease in June 2014. In January 2016 it reached the lowest price per barrel, (NOU 2016:15), see Figure 1. Unexpected high shale oil production in the United States and the international competition for the market shares together with decreased demand for petroleum, contributed to the fall in the oil prices. Job uncertainty tends to increase during economic shocks and the reduced oil price in 2014 lead to a decrease in petroleum activities and in employment. Hungnes et al., (2016) find that 240,000 employed persons could be linked to the petroleum industry in 2013. Over the next two years according to Brasch et al., (2019), a reduction in employers, linked to the petroleum industry was around 150,600 people. This was a huge drop in two years which can be linked to reduced investments in the petroleum industry due to the price fall in 2014.

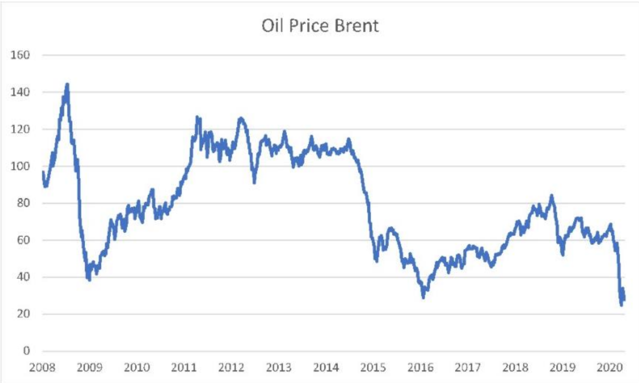

Figure 1. Movements in the oil price Brent, 2008-2020. Source: (DnB, 2020).

Concerning the level of job loss risk, unemployment benefits in Norway compared to other OECD countries was among the lowest from 2006 until 2014 (OECD, 2021), see Figure 20 in the appendix. The Norwegian level of unemployment benefits was at a rate under four percent. The oil price collapse in 2014 led to a deterioration of the labor market conditions and the unemployment rate in Norway increased. Barth (2019) did a comparison on the employment between Norwegian and European countries from the financial crisis in 2008 and through the 2014 oil price drop. In 2008 the employment fell for most of the European countries and so did the oil price. The oil price started to increase again in 2009, but comparing the employment rate, Norway lagged behind. By 2016, Sweden and Denmark had a higher employment rate with an upward slope, while for Norway it was downward. The explanation of this can be the lower employment in the petroleum industry and related activities.

3. Literature review

Several papers have studied the 2014 oil price shock in different ways, but not so many through an environmental perspective. Juelsrud and Wold (2020) studied the savings rates of engineers in oil regions compared to other high-skilled workers during the 2014 oil price collapse. The study finds a three and a half percent higher increase in savings for engineers relative to the increase for other high-skilled workers. The paper uses tax data merged with labor market data which gives detailed information on the labor market status. Though this thesis has similarities in studying the same shock and the method and data used are similar, this thesis differs from Juelsrud and Wold (2020) on several points. First, the research question and focus in my thesis is on the educational level of the petroleum workers rather than the savings like in Juelsrud and Wold (2020). This master thesis focuses specifically on what facilities the transition to green industries. Juelsrud and Wold (2020) study how the savings increases during a recession, and by using a difference in difference estimation, they study the savings of petroleum workers versus other workers residing in oil regions. In this thesis I use received unemployment benefits, but savings are excluded. Second, Juelsrud and Wold (2020) focus only on high-skilled workers divided into engineers and other high-skilled workers. In contrast to this study, I include both high- and low-skilled petroleum workers. Third, Juelsrud and Wold (2020) only uses men in the study. Though the petroleum industry mainly consists of men, I do include both men and women in this thesis.

This master thesis contributes to a broader literature on worker-level impacts of climate policy and negative shocks that affect emission-intensive industries. Walker (2013) studies the effect of climate policy at an individual level, in a context of the workers outcome in regulated industries in the United States. The policy introduced was a Clean Air Act amendment (CAAA) in 1990 pertaining to reducing air pollution. Using longitudinal data on workers and firms, Walker follows workers before and after the environmental policy started and compares different outcomes using difference-in-difference-in-difference estimation (DDD). The focus in Walker (2013) is on oil price shock and conversion to green industries. This master thesis focuses on the petroleum workers educational level transitioning to a green industry after an oil price drop. I also estimate the yearly average wages for petroleum workers who changed to a green industry, and petroleum workers who stayed in the petroleum industry. According to Walker (2013), the permanent loss in earnings can be large for displaced workers who changed industries and sectors that were affected by the Clean Air Act policy experienced a decrease in aggregate employment but the wages for workers in affected sectors did not decrease.

The attention toward job losses in polluting industries when new climate policies take place, are widely discussed, and called the 'job killing argument'. General equilibrium model (Haefstad and Williams, 2018) and input-output model (Wei et al., 2010), finds that jobs destroyed in polluting industries are likely to be replaced by new well-paid jobs in green industries. However, the reallocation from polluting to green industries can be difficult given the differences in the workers educational level and skills (Vona, Marin, Fransesco & Popp, 2018), though the overall employment is not affected by environmental regulations.

Davide et al., (2016) compare workers' skills in green versus non-green jobs in the United States. He finds that green jobs have higher levels of education, job training and work experience compared to non-green jobs. David uses cross-sectional data from O*NET (Occupational Information Network). The data is a description of different jobs and the skills required for the jobs. This is skills like the minimum years of education, training, and the required years of experiences. Davide results are interesting for this master thesis. I study whether the educational level for petroleum workers can have an impact on the transitioning to a green industry - although, one thing to notice is that the definition of green industries is defined differently in Davide et al., (2016), than in this thesis. The definition in Davide et al., (2016), relies on the industrial process such as recycling, treatment, and waste management, how the association between the products and services contributes to environmental sustainability or industries that actively engage in the environmental and conservation goals like wind turbines or solar panels.

4. Theoretical framework

In a situation where industries are rapidly declining and those that become redundant must find jobs in other industries, can create a maladaptation in the labor market. This is a situation where the employers have difficulty to find the right candidate for the particular job position, (for example due to lack of the right education, Hvinden and Nordbø (2016). In the petroleum industry, a high proportion of the workers are engineers. If the market demands doctors, engineers will not be able to get the job. Petroleum workers without oil-specific expertise in a recession can be better off. Electricians or electrical engineers might easily find a new job in other industries compared to for example petroleum engineers. Though petroleum workers find a new job, the conditions may not be as good as they were in the petroleum industry. In the theory, if there is a shortage of skills, the wages should increase for the high-skilled workers, and opposite. Abundance of highly educated workers in the labor market, increases the competition for jobs in the market and pushes the wages down. A mismatch like this between the skills in the labor market and the demands from employers, is called structural unemployment.

Kahn (2015) discusses how policymakers can handle structural unemployment and mismatch in the labor market for high-or low skilled workers, by increasing the workers skills if there is a shortage of skilled workers. If there is structural unemployment in the market, it is more efficient to invest in workers skills, like for example better information about working skills or increased geographic mobility, compared to fiscal and monetary policies. Fiscal- and monetary policies might be limiting in a situation with structural unemployment. If the demand in the labor market is pointed to high-skilled workers, then investments in skills can give payoffs in the long term. Maladaptation in the labor market can also occur regionally if the unemployed workers are not willing to move to other municipalities. The unemployment might be high in some parts of the country while the vacancies are placed somewhere else. Petroleum workers are mainly residents on the west coast of Norway, and if the workers are not willing to move, the unemployment can be high on the west coast while the demand for labor is high in other municipalities in Norway.

5. Data sources

In this thesis I use longitudinal data on labor conditions from Statistics Norway covering the period from 2009-2018, relevant for this study. I use the dummy variable employment in a green industry as the main outcome variable, equal to one if the worker is employed in a green industry and zero if not. Several other outcomes are also examined like wages, unemployment benefits and the worker's educational level.

The data from Statistics Norway is at an individual level linked with information on the employer and includes variables like industry, working hour per week, fulltime- or parttime job. The data gives detailed information on the labor market status and occupation. Until 2015 it was the labor and welfare service in Norway (NAV) who was the main source of the register-based employment statistics (aa-registry). From January 2015, the main source was changed to the a-scheme to get more detailed information on working conditions and working time. Especially, to get a better distinction between fulltime- and part time employees. The a-scheme is more detailed due to its monthly data while the aa-register only consists of yearly data measured at the end of the year. Since the source of the dataset is different during the period of the analysis, it might give uncertainty in the comparison over time.

The labor data can be merged with a dataset including the worker's educational level. This dataset makes it possible to answer the question; if educational level has an impact on the transitioning to a green industry, and if so, what kind of education did the workers have. Educational level for the workers is based on the standard education grouping (NUS) from Statistics Norway. The code is a six-digit code describing the exact finished educational course for the individual. The individual-based educational data informs the highest educational level annually at the reference time 1st October.

At the end, this dataset is merged with an income file including wages, unemployment benefits, pension and more, available to 2018. This gives a full and selected dataset covering the period from 2009-2018. Employees in the aa-registry are defined as persons who performed work during the reference period and received payment in form of cash or goods. If the employee was temporarily absent from work during the reference period, the worker still counts as an employee if the worker received payment, assurance that the employee returns to work after the absent period, Aukrust et al., (2010). To receive unemployment benefits the worker must lose 40 percent or more of their working hours per week or have reduced monthly income due to downsizing or lost a job. If the income is reduced, the individuals may still have some earnings from other industries. In this thesis, I therefore use yearly average unemployment benefits calculated for different groups like the petroleum workers, non-petroleum workers, high- and low-skilled workers. The data on labor conditions do not include information regarding unemployment status, so it is not possible to distinguish between employed and unemployed individuals. The unemployment benefits from the income file will provide an insight if the petroleum workers considerably reduced their income in the pre-period, thus the income file does not include the exact reason for why the worker received unemployment benefits.

Due to the case that one individual can be employed parallel in different working conditions, there are occasions in the dataset where individuals occur several times within the same year. To control for duplicates, I summarize each individuals total income sorted by employee, year, and industry. If the individual had two different jobs, assignments, or projects within the same industry, those wages will be merged and so left with only one individual per industry with one summarized wage. If there still are cases of duplicates in the dataset, meaning that one person can be employed in two or more different industries, I choose the industry that provides the main income to the individual based on the highest income each year. To be employed in two different industries is especially normal for workers in the petroleum industry and the health care due to their shift work.

I do some sample restrictions in the dataset that are worth mentioning. First, I narrow the data to individuals in the treatment- and control group, see Table 15 and 16 in the appendix. The requirement to be divided into the control- or treatment group is that the worker needs to be employed in the treatment- or control group in 2013, one year before the oil price shock. This gives a dataset with 24,397 workers both in the petroleum industry and control group in 2013. I follow these workers from 2009-2018, irrespective of whether the worker got unemployed or moved to other municipalities during the period.

I geographically divide the workers into labor market regions, defined by Bhuller (2009). The labor markets are based on the commuting level and travel time between municipalities. Labor markets 41 and 44 are the two regions with the highest number of employed persons in the petroleum industries. I use workers residing in the labor markets 41 and 44 in 2013. Workers residing in the same regions, will be exposed to the same type of local shock. In the years between 2009 and 2018, several municipalities merged, especially in 2018. I am therefore using the 2009 version of labor markets to avoid erroneous conclusion with relocation of individuals. This do not cause any problem for the analysis because merged municipalities in 2018 are in the same labor markets groups as in 2009 used in this analysis

Table 1 reports the summary statistics for the main sample used in the analysis for workers resident in labor market 41 and 44 in 2013. Only workers between eighteen- and sixty-one years old in 2013 are used in the analysis. In that way, all the workers have the same basis for having a certain amount of education. All the workers have at least a High School education when they become a part of the statistics. I also include workers below the pension age which might affect the employment status, see Table 1. The mean age in the sample is 42.5 years, and 19 percent of the workers in the sample are females. The educational level is divided into high- and low-skilled, equal to zero if the worker has a low educational level and one for the high educational level. As represented in Table 1, the educational level is somewhat equally distributed with 51 percent high-skilled workers.

	count	**mean**	**sd**	**min**	**max**
Female (1/0)	479 097	.1942675	.3956362	0	1
Age	479 097	42.46225	10.66272	18	66
Wages	475 408	780009	479053.1	-708	4.60e+07
Unemployment benefits	475 408	2172.19	17873.06	0	371344
Working hours per week	479 097	21.68509	17.95554	0	99
High- or low educational level (1/0)	479 097	.510882	.499882	0	1
N	479 097				

Table 1. Summary Statistics for the treatment- and control group, 2009-2018.

5.1. Defining the green industries

The word "green" is widely used either in goods, products, industries, or the consumers choices. There is no standard definition of green industries. Statistics Norway focuses on goods and services. They define green goods and services where the output product results in reduced consumption of non-renewable natural resources or goods and services that helps to protect the environment - even though the input factors or the production process may not be sustainable. This includes industries like waste and recycling, products that contribute to environment savings like energy saving bulbs or products that are used in renewable energy production like wind turbines or solar cells (Statistics Norway). Considering from an industrial view, United Nations Industrial Development (UNIDO), define green industries as industries who strive for a more sustainable growth and policy which encourages environmentally private investments. They also define "greening of industries", which include policymaking and improving production to be able to achieve sustainable growth. O*NET define the green economy encompassing activities in the economy that reduces the use of fossil fuels, decreasing the greenhouse gas emissions, recycling materials, helps to develop renewable energy and increases efficiency of the energy use (Dierdorff et al., 2009).

In this thesis, I focus at an industrial level. Green industries are defined by using a report from Menon Norway, Espelien and Grunfeld (2010). The report shows statistics for persons working with clean energy in Norway. Espelien and Grunfeld (2010) define green industries who focus on products and services that produce low emission energy and environmentally friendly solutions as clean industries. They divide the green industries into four main categories.

1. Renewable energy. Consists of industries that supply renewable energy like hydropower, solar energy, wind power bioenergy and other clean energy (geothermal heat, thorium etc.)
2. Environmental technology and services. Companies that through their products and services minimize emissions of harmful greenhouse gases, delivering products and services within CCS, monitoring of the environment and research and development (R&D).
3. Traditional environmental relationship. Companies with services and technology related to recycling, waste management. Companies that utilize, transform, or remove waste and other harmful environmental fractions.
4. Distribution and trade with power. These companies do not provide directly environmentally friendly products but are important to the pure energy that produces due to their deliveries and services.

Further, these four main categories are divided into segments. I use these segments in line with the standard definition of industries from Statistics Norway (SN2007) to define the group of green industries. Production, transmission, and distribution of electricity *(35.1)*, steam- and hot water supply *(35.3),* extraction, purification, and distribution of water *(36),* collection, treatment, and disposal and recycling of waste *(38),* environmental treatment, cleaning and similar activities *(39),* construction of facilities for electricity and telecommunications *(42.2)*, and research and development in biotechnology *(72.1)*, see Table 17 in the appendix. This definition of green industries is relatively narrow. In a broader perspective some workers might change to green industries in other definitions even though they are not considered in this master thesis.

6. Methodology

To be able to compare petroleum workers to non-petroleum workers transitioning to green industries after the oil price shock, I use difference in difference estimation. This gives the possibility to estimate credible causal effects due to the longitudinal data, following the workers over time. Using difference in difference with fixed effects can remove unobserved heterogeneity in the outcome variable due to factors that might influence the outcome. It also controls for differences in the treated- and control group by eliminating biases from the time invariant factors. Time fixed effects change over time but stay constant across individuals and individual fixed effects eliminate factors that change across individuals but stay constant over time. One example of this can be the individual's motivation to work or the individual's motivation to take an educational course. It can also be the workers ability, for example measured in IQ.

Equation (1) is the dynamic difference in difference regression model. Employment in the green industry is the main- and one of the outcome variables used in this thesis. Y_{it} is the outcome variable, equal to one if the individual is employed in a green industry in year *t*, or equal to zero if the worker is employed in other industries than the green industry. T_i is an indicator variable that equals one if the individual is in the treatment group and zero if the individual is in the control group. In the analysis, $T_i = 1$ for petroleum workers in labor market 41 and 44, and $T_i = 0$ for non-petroleum workers in labor market 41 and 44. Treatment status is defined based on the employment in 2013. The intercept α_i captures individual factors that are constant through time but vary across individuals. δ_t is the time fixed effect which is common to all individuals but varies through time. β_t is the coefficient of interest, capturing the interaction term between treated status and the year indicator variables (1_t).

$$Y_{it} = \alpha_i + \sum_t \delta_t 1_{year=t} + \sum_t \beta_t (Treated_i \times 1_{year=t}) + \varepsilon_{it} \quad (1)$$

$$Y_{it} = \alpha_i + \sum_t \delta_t 1_{year=t} + \beta_t (Treated_i \times P_t^{Post}) + \varepsilon_{it} \quad (2)$$

Further, I estimate a more confining difference in difference regression outlined in equation

(2). T_i is the same as in the first equation, defining if the individual is in the treatment group or not. $P_t^{post} = 1$ if $t \geq 2014$, also an indicator variable equal to one if the individual is in the post period, that is after the oil price shock in 2014, and it equals zero if the individual is in the pre period. θ_t is the coefficient on the interaction between $P_t^{Post} * T_i^{Treated}$ which is the difference-in difference estimate. $P_t^{Post} * T_i^{Treated}$ will therefore be an indicator variable equal to one with observations of the treatment group in the post period. The last term ε_{it} is the error term which will vary between time and individuals.

When I estimate different outcomes using equation (1) and (2), the dependent variable (Y_{it}), varies between wages, unemployment benefits and educational level. The regression analysis is done first for all the workers in the treated- and control group as a main analysis. Further I estimate heterogeneous effects where I divide the petroleum workers into high- and low skilled workers using equation (2) with different outcome variables. At the end of the analysis, I study the result for three different outcomes for the petroleum workers in labor markets 41 and 44. Petroleum workers who stayed in the petroleum industry after the 2014 oil price drop, petroleum workers who changed jobs to a green industry, and petroleum workers who changed to other industries or got unemployed.

6.1. Treatment and control group

The main petroleum industry is defined by using industry codes from the national account (2013), Statistics Norway. The main petroleum industry consists of extraction of oil and natural gas *(06),* services related to the extraction of crude oil and natural gas *(09.1),* production of refined petroleum products (*19.2),* and pipe transport *(49.5)*, see Table 15 in the appendix.

To get an idea of how the petroleum workers would have developed without the 2014 oil price drop, there will be a need for a control group that is not affected by the oil price drop, but at the same time as similar as possible to the treated group compared at an individual level. To avoid the control group being directly or indirectly affected by the 2014 oil price drop, I use an input-output table (2007) from Statistics Norway together with a report from Hungnes et al., (2016). The input-output table reports the flows from each industry to others. The report studies the direct and indirect deliveries to the petroleum industry throughout their supply of goods and services using a cross-sectional model with numbers from product cross- section in the national accounts. I am then left with several control industries that are minimally affected by the oil price drop as possible. These are industries within education, health- and social services, fishing and aquaculture, trade and repair of motor vehicles, public administration and defense, cultural activities, and research- and development in social science and humanities and more, see Table 16 in the appendix.

6.2. Comparing control- and treatment group at individual level

To ensure internal validity in the difference in difference estimation, the assumption about the treatment and control group having parallel trends in the outcome in the pre-period are important to fulfill. This means that the difference between the treatment- and control group needs to be constant over time. For as similar as possible development in the outcome variable before the oil price shock in 2014, I use a matching method with propensity score. Propensity score is the probability of being in the treated group as a function of numerous variables Donald (2001). Following Stuart (2010), having a smaller sample, all variables that are known or believed to be related to the outcome should be included in the matching procedure when it is not possible to include a large set of variables. Some special industries might demand a specific education, experience or skills when hiring workers. Therefore, I control the educational level in the matching procedure. I measure the educational level using the first number in the NUS-code. This is a number from zero to eight, where a higher number indicates higher educational level. Second, I include age in the matching procedure. Using workers in the treatment- and control group resident in labor market 41 and 44 in 2013, I check if younger workers are more flexible in moving between municipalities in Norway. Since the oil price shock in mid-2014 might affect workers to move, I observe if resident municipalities changed to workers before the oil price shock, between 1st January 2009 and 1st January 2014. 37.3 percent of the workers between 18-35 years old did move to other municipalities in the years between 2009-2013, while 13.3 percent of the workers between 36-66 years did move to other municipalities in the same period. I assume therefore younger workers are more flexible to move geographically to change jobs. One reason for younger workers to be more flexible, can be that they have not yet settled down and started a family. Another reason might be that younger people move to major cities to study. Average yearly income, gender and working hours per week are also variables I control for in the matching procedure.

There are several different matching methods to use, Stuart (2010) lists different methods. I use neighbor matching which finds the best compatible match in the dataset to everyone in the treatment group. I compare the treatment- and control group at an individual level in pre-treatment levels in 2013. I am then left with 24,397 petroleum workers, and 27,397 workers in the control group in 2013, see Table 2.

Treatment group	**count**	**mean**	**sd**	**min**	**max**
Female (1/2)	24,397	1.266877	.4423367	1	2
Age	24,397	42.46225	10.5287	20	61
Wages	24,139	977,724.2	523,101	932	1.50e+07
Unemployment benefits	24,139	309.6141	5842.653	0	25095
Working hours per week	24,397	36.0601	4.061449	4.5	86.52
High- or low educational level	24,397	.4794442	.4995875	0	1
N	24,397				
Control group					
Female (1/2)	24,397	1 .122146	.3274613	1	2
Age	24,397	42.03156	10.20483	20	61
Wages	24,139	684784.8	296,021	1200	6,406,451
Unemployment benefits	24,139	314.8797	5189.507	0	287005
Working hours per week	24,397	35.78044	6.23527	4	84
High- or low educational level	24,397	.5396155	.4984384	0	1
N	24,397				

Table 2. Summary Statistics for treatment- and control group, 2013.

The distribution between men and women in the treatment- and control group are quite similar. 26 percent of the treatment group are females, and 12 percent in the control group, indicating that both the treatment- and control group consists mostly of men. Working hours per week, unemployment benefits and age are also variables that are somewhat similar. Wages on the other hand, are quite contrary. The mean wages for petroleum workers are NOK 977,724 and the mean wage for non-petroleum workers are NOK 648,478 with a difference of NOK 329,246. This is a huge difference in Norwegian wages. Contrary wages can cause problems in the difference- in difference estimates validity. As mentioned earlier, it is important to fulfill the parallel-trend assumption. Differences in wages makes the difference-in difference estimation less reliable since the treatment and control group are different at individual's levels and less similar to each other.

According to the report from Hungnes et al., (2016), most of the Norwegian industries are connected to the petroleum industry, either directly or as subcontractors. Especially shipyard, workshop industries and service industries like transporting, bank, financing, and real estate. It can therefore be difficult to find a control group that's not affected by the 2014 oil price drop and at the same time similar at an individual level. The petroleum industry in general often has higher wages compared to other industries. From Table 2, the treatment group have higher wages than the control group in 2013. Higher wages can be explained by higher investments in the petroleum industry due to strong demand for the product, combined with a shortage of the skilled labor that has driven the wages up. Also, high wages can be explained by high bonus payouts in the petroleum industry. Many of the service industries that provide indirect services to the petroleum industry have wages at the same level as the petroleum industry (for example finance and banking, Hungnes et al., 2016), but since they provide indirect services, those industries are not used in the matching method. The rest of the variables comparing the treatment- and control group in Table 2 have approximately the same values.

7. Results

In the following section, I present the results in this thesis found from equation (1) and (2). Both equations use (Y_{it}) as employed in a green industry, wages, unemployment benefits and educational level. Further I do the same estimations, dividing the main petroleum- and control group into high- and low skilled workers. Third, in Section 7.3, I present descriptive statistics of the wages and educational level for the petroleum workers who transitioned to a green industry after the oil price collapse (called leavers to green), petroleum workers who stayed in the petroleum industry (called stayers), and petroleum workers who transitioned to other industries (called leavers to others). I also depict yearly average trends for wages, unemployment benefits and educational levels.

7.1. Main petroleum group

The results from the dynamic regression model from equation (1) are depicted in the left panel of Figure 2, using Y_{it} = *Employment in a green industry*$_{it}$, equals to one if the worker is employed in a green industry. The coefficients before 2014 are close to zero and not statistically significant. This implies that the assumption about the treatment- and control group having parallel trends are satisfied. From 2016 and the following years, the coefficients are above zero and statistically significant. In 2018 the probability to work in a green industry was approximately 0.1 percent higher for the petroleum workers than the non-petroleum workers resident in labor market 41 and 44, see left panel of Figure 2. This is relatively small and the effect of being in the treatment group does not have a remarkable result on the workers choosing to transition to a green industry after an oil price shock compared to non-petroleum workers.

The negative coefficient in 2014, can be explained by that the oil price shock did not occur before in mid-2014. The effect of being in the treatment group when transitioning to a green industry in 2014 was smaller than the control group in 2014. The effect from the oil price collapse is not seen before one year after, in 2015 with an increasing trend every year. Right panel of Figure 2 depicts the proportion of employed workers in treatment- and control groups from 2009-2018. In 2015, the petroleum workers had a steeper increase in the employment in the green industry compared to the non-petroleum workers, and the graph illustrates the 0.1 percent effect in 2018 found from the coefficient estimates in the left panel of Figure 2. Out of the 24,397 petroleum workers in the main analysis, 1.2 percent worked in a green industry during 2009-2018.

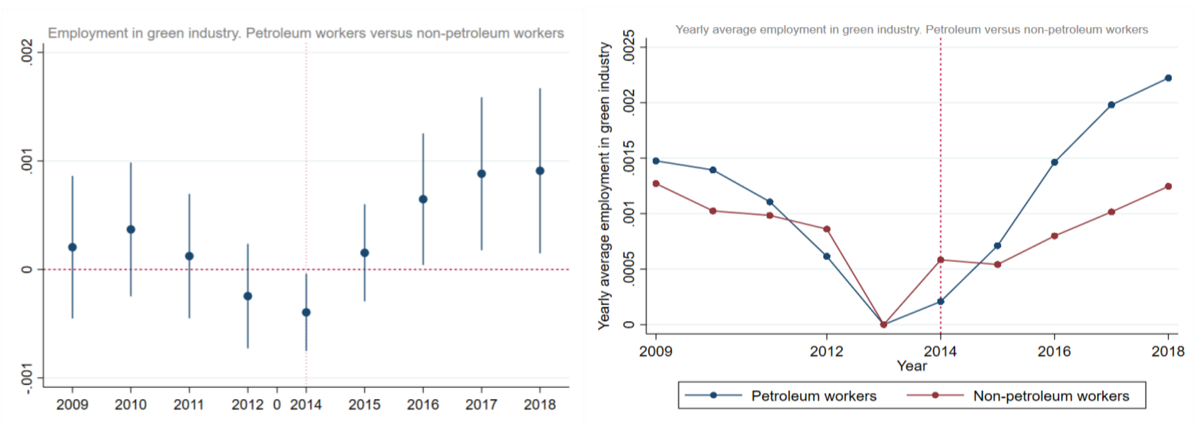

Figure 2. Employment in green industry and yearly average employment in green industry. Workers resident in the labor market 41 and 44. Coefficient estimates from equation (1). Left panel: *(Y_{it}) = employment in the green industry$_{iy}$*. *$(Y_{it}) = 1$* if a worker is employed in a green industry$_{it}$, *$(Y_{it}) = 0$* if a worker is employed in other industries. Right panel: Yearly average employment in the green industry, petroleum workers versus non-petroleum workers. Reference year: 2013. Std. errors clustered at individual level. Regression includes year and individual fixed effects. 95% Conf. Interval.

Since the oil price shock occurred in mid-June, it can be unclear if 2014 should be defined as the pre-period or post-period. Figure 3 depicts equation (1), using *(Y_{it}) = employment in green industry$_{it}$* where 2014 is excluded and used as the reference year. The increasing trend for petroleum workers to be employed in a green industry started in 2013, with 0.04 percent higher chance for petroleum workers to work in a green industry than non-petroleum workers, see Figure 3. The estimates in Figure 3 are higher compared to the estimates in Figure 2. In 2018, the probability for petroleum workers to be employed in a green industry compared to non-petroleum was approximately 0.1 percent in Figure 2. Excluding 2014 (Figure 3), the probability increased to 0.14 percent in 2018, with a difference on 0.04 percent in 2018.

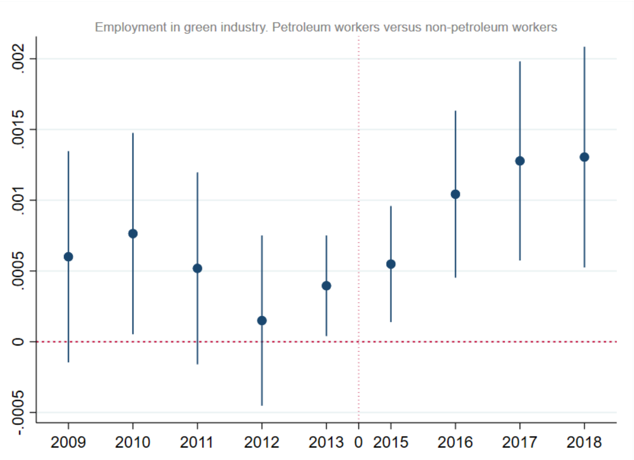

Figure 3. Employment in the green industry. Coefficient estimates from equation (1) with the dependent variable *(Y_{it}) = employment in the green industry*, using workers in the labor market 41 and 44. *$(Y_{it}) = 1$* if a worker is employed in a green industry$_{it}$, and *$(Y_{it}) = 0$* if a worker is employed in other industries. Reference year: 2014. Std. errors clustered at individual level. Regression includes year and individual fixed effects. 95% Conf. Interval.

Left panel of Figure 4 depicts the yearly average wages in labor markets 41 and 44 for the petroleum workers versus the non-petroleum workers. The petroleum workers experienced a drop in their average yearly wages after 2014 and through 2016, while the non-petroleum workers had an increasing trend in their yearly average wages, where the fall in yearly average wages can be explained by the 2014 oil price drop. I assume there is no increase in job loss risk for the control group so they can show the counterfactual trend. The right panel of Figure 4 depicts the yearly average unemployment benefits in NOK for the petroleum- and non-petroleum workers in labor market 41 and 44. The steep increase in payouts for petroleum workers after 2014 illustrates the considerably reduced income or lower working hours per week for the petroleum workers. In the pre-period, the level of unemployment benefits for petroleum workers was approximately NOK 1,000 yearly. In 2016, yearly average unemployment benefits increased to NOK 10,000 per petroleum worker. After 2016, the yearly average unemployment rate starts to decrease and the petroleum workers after the oil price shock may have found new jobs either in the petroleum industry or other industries.

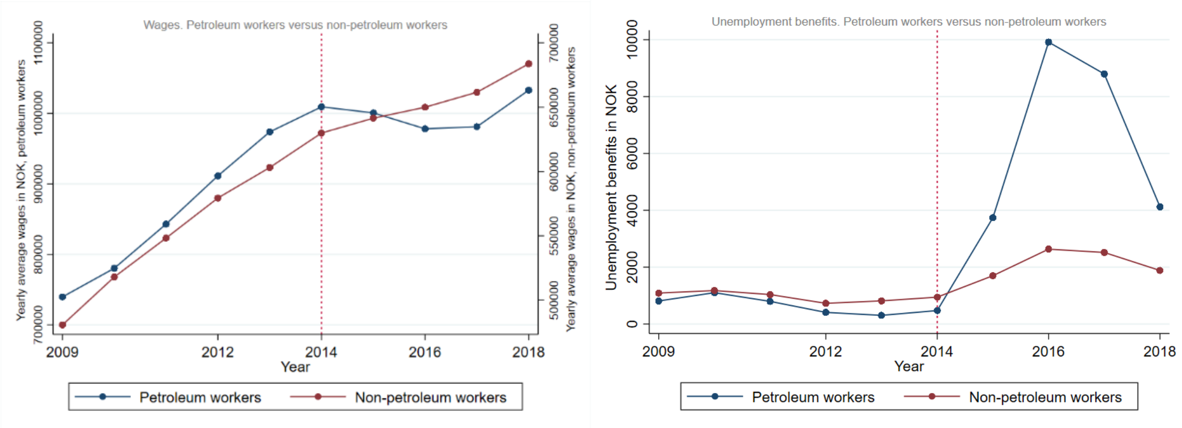

Figure 4. Yearly average wages and unemployment benefits in NOK. Workers resident in labor market 41 and 44. Left panel: Yearly average wages for petroleum workers and non-petroleum workers. Right panel: Yearly average unemployment benefits for petroleum workers and non-petroleum workers.

As mentioned in Chapter 6, comparing the treatment- and control group at individual levels can be difficult, especially when it comes to wages. Petroleum workers have high wages due to the high investments, high demand in the petroleum industry, and the high bonus payouts. From the left panel of Figure 5, the treatment- and control group do not have similar pre-trends in wages and the parallel-trend assumption in wages are not satisfied. Wages is an important outcome variable that should be satisfied in the pre-period. The non-satisfied parallel-trend assumption makes the treatment- and control group less comparable and the results might be seen with a critical view.

The parallel trends for the unemployment benefits are better satisfied in 2010-2012 (right panel of Figure 5). The parallel-trend assumption is important to fulfill for this study thus it can ease the concern about those two groups not being comparable for the analysis. If the petroleum- and non-petroleum workers develop differently in the pre-period, the results in the post-period might be less reliable. A control group that has contrasting trends in the pre-period, are most likely to develop differently in the post-period as well, and the results of how the treatment group would have developed without the oil price shock might be misleading. After the oil price shock, in 2015, the probability for petroleum workers to receive unemployment benefits was NOK 2,000 larger than the control group, with its largest effect in 2016. In 2016 petroleum workers on average received NOK 8,000 more than the control group, see right panel of Figure 5.

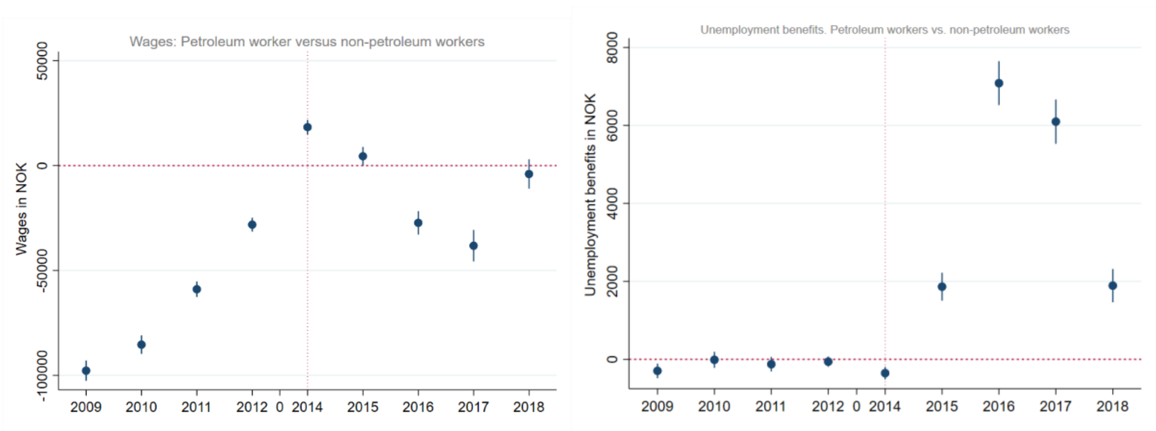

Figure 5. Wages and unemployment benefits for petroleum workers relative to non-petroleum workers resident in labor market 41 and 44. Coefficient estimate from equation (1). Left panel: *(Y_{it}) = wages.* Right panel: *(Y_{it}) = unemployment benefits.* 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects. The markers are the estimated coefficient β_t, using wages (left panel) and unemployment benefits (right panel) as the outcome variable.

Table 3 reports the regression output from equation (2). In Table 3 panel A, the outcome variable *(Y_{it})* is employment in a green industry. The p-value turns out to be larger than level of significance (0.05), and the treated group is not different from the control group in transitioning to a green industry. The estimates from Table 3 panel A, reports that the average effect for the post- period is not significantly different from zero, but at the same time, shown in the left panel of Figure 2, the effect increases over time with significant results in 2016-2018. I therefore find a significant effect in the end of the post-period, but not for the entire period 2014-2018. The petroleum workers who transitioned to a green industry after the oil price shock in 2014 and 2015 can therefore not with certainty be explained by the oil price shock, the transitioning might have happened anyway.

Panel A: Employment in green industry:

Employment in green industry	Coef.	Std. Err.	t	P> |t|	[95% Conf. Interval]	
Treated x P_t^{post}	.0003377	.0003053	1.11	0.269	- .0002607	.0009362
_cons	.0008843	.0000742	11.92	0.000	.0007389	.0010298
Clusters	48,794					
N	479,097					

Panel B. Wages

Wages	Coef.	Std. Err.	T	P> |t|	[95% Conf. Interval]	
Treated x P_t^{post}	45025.27	2294.866	19.62	0.000	40527.3	49523.23
_cons	769099.6	556.0251	1383.21	0.000	768009.8	770189.4
Clusters	48,554					
N	475,408					

Panel C: Unemployment benefits

Unemployment - benefits	Coef.	Std. Err.	t	P> |t|	[95% Conf. Interval]	
Treated x P_t^{post}	3381.402	135.709	24.92	0.000	3115.411	3647.394
_cons	1352.907	32.88106	41.15	0.000	1288.46	1417.354
Clusters	48,794					
N	479,097					

Table 3. Employment in green industries, wages, and unemployment benefits. Petroleum workers compared to non-petroleum workers. Outlined from equation (2). Panel A: *(Y_{it}) = Employment in green industry*. Panel B: *(Y_{it}) = wages.* Panel C: *(Y_{it}) = unemployment benefits*. 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

The wages for petroleum workers compared to the non-petroleum workers are reported in Table 3, panel B. The average petroleum workers received NOK 45,025 more than the non-petroleum workers in the post-period. However, due to the not satisfied parallel-trend assumption in the left panel of Figure 5, this result might be misleading. The dynamic results in the left panel of Figure 5 depicts a drop in petroleum workers' wages compared to non-petroleum workers after 2014 until 2017. Based on this result, it can therefore not with certainty be concluded that the petroleum workers on average received NOK 45,025 more than the non-petroleum workers in the post-period.

As mentioned in Chapter 2, petroleum workers experienced high uncertainty and downsizing of jobs in 2014 and following years. Panel C in Table 3, reports that petroleum workers in the post period received more unemployment benefits, on average NOK 3,381 more than the non-petroleum workers in the post-period due to the 2014 oil price shock. This is more than twice as much if the oil price shock would not have affected the petroleum industry, see Panel C Table 3.

Using the eight-digit NUS-code from Statistics Norway to divide the workers into high- and low skilled as the dummy outcome variable, the educational level for the petroleum workers on average was higher compared to the control group in the post-period, see Table 4. The increase is not especially noticeable and perhaps not surprising. It takes years to complete a degree, and the average increase in high-skilled petroleum workers compared to non-petroleum workers can probably be explained by workers who started the degree before the oil price shock, and now finished their degree. The higher educational level on average to the petroleum workers can therefore not be explained by the oil price shock in 2014.

Educational level	**Coef.**	**Std. Err.**	**T**	**P> |t|**	**[95% Conf. Interval]**	
Treated x P_t^{post}	8.71e-18	3.99e-17	0.22	0.827	-6.95e-17	8.70e-17
_cons	.5108882	1.15e-16	4.5e+15	0.000	.5108882	.5108882
Clusters	48,794					
N	479,097					

Table 4. Educational level in NUC-codes, high-or low, outlined from equation (2). Petroleum workers compared to non-petroleum workers. *(Y_{it}) = High- or low educational level.* 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

Because of the results from Table 4, estimates from equation (1) with dummy variable high- or low educational levels as the outcome variable are depicted in Figure 6. The parallel trend assumption in the pre-period is satisfied. In the post period 2014 and 2018, the probability for petroleum workers to have a high-educational level was lower than non-petroleum workers. A high educational level is a bachelor's degree or higher.

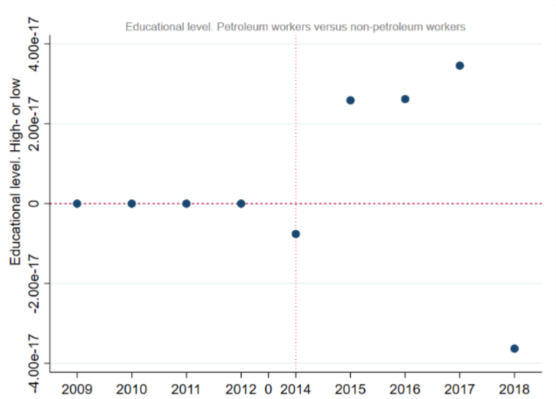

Figure 6. Educational level. Petroleum workers versus non-petroleum workers. *(Y_{it}) = High- or low educational level. (Y_{it}) = 1* for high educational level. (*Y_{it}) = 0* for low educational level outlined from equation (1). 95% Conf. Interval. Std. errors

clustered at individual level. Regression includes year and individual fixed effects. The markers are the estimated coefficient β_t from equation (1) using educational level.

7.2. High-skilled versus low-skilled petroleum workers

I divide the workers into two different groups to estimate for heterogeneous effects. The first group consists of the high-skilled workers with a bachelor, master- or doctor degree. This is an educational level requiring a minimum three years at a college or university. The second group is what I call the low- skilled workers. This group consists of workers with high school education, trade certificate and journeyman tests or education not approved by Norwegian colleges and universities or no registered education at all.

The dynamic regression model from equation (1) is outlined in Figure 7 with high-skilled workers on the left panel and low-skilled workers on the right panel. The parallel-trend assumption for the high-skilled workers is only satisfied in 2011 and 2012. Wages developed differently for the high-skilled petroleum workers compared to the other high-skilled workers. The treatment effect for the high-skilled petroleum workers is decreasing in the pre-period and increasing in the post period with its largest effect in 2018 of 0.14 percent. As seen from the right panel of Figure 7, there are no effects of being a low-skilled petroleum worker in transitioning to a green industry compared to other low-skilled workers, with coefficients close to zero, except in 2012 with a negative effect of -.094 percent. The parallel trend assumption for low-skilled workers, is also more satisfied than for the high-skilled workers. High-skilled workers compared to other high-skilled workers seem therefore to transition more to a green industry after an oil price shock, than what low-skilled workers compared to other low-skilled workers do. 0.62 percent of the 24,397 petroleum workers who worked in the petroleum industry in 2013 changed to a green industry. 64.9 percent of these workers were high-skilled, and 35.1 percent were low-skilled.

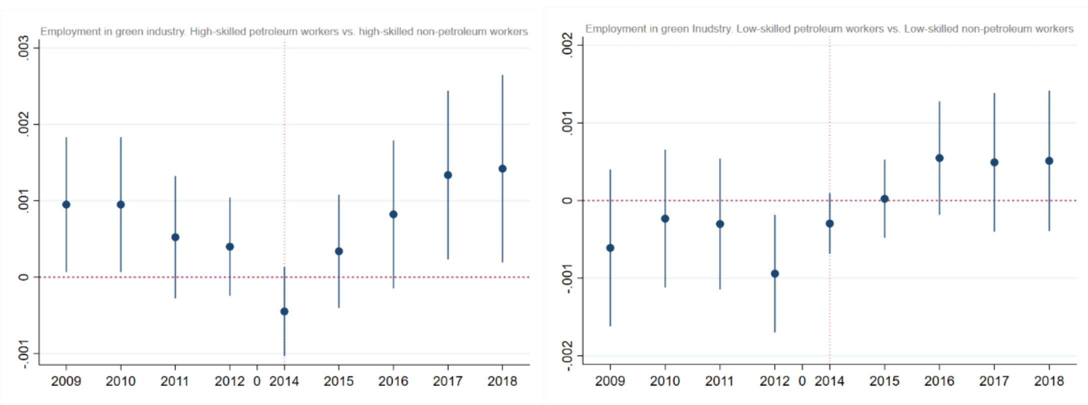

Figure 7. Employment in the green industry outlined from equation (1), 2009-2018. *(Y_{it}) = employment in the green industry. (Y_{it}) = 1* if a worker is employed in a green $industry_{it}$, *(Y_{it}) = 0* if a worker is employed in other industries. Left panel: High-skilled petroleum workers versus high-skilled non-petroleum workers. Right panel: Low-skilled petroleum workers versus low-skilled non-petroleum workers. 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

The more restrictive regression estimation from equation (2), with *(Y_{it}) = employment in green $industry_{it}$*, is reported in Table 5. The result for the high- and low-skilled workers are not statistically significant. Low-skilled petroleum workers are significant at a 10 percent level, but still uncertain whether the oil price shock in 2014 is the reason for the petroleum workers changing to a green industry.

Employment in green industry	**Conf.**	**Std. Err.**	**t**	**P> |t|**	**[95% Conf. Interval**	
High-skilled petroleum workers						
Treated x P_t^{Post}	.0001147	.000468	0.25	0.806	-.0008025	.001032
_cons	.001024	.000107	9.84	0.000	.0008426	.0012621
Clusters	23,698					
N	244,765					
Low-skilled petroleum workers						
Treated x P_t^{Post}	.0006649	.0003997	1.66	0.096	-.0001187	.0014484
_cons	.0006777	.0001032	6.57	0.000	.0004755	.0008798
Clusters	23,932					
N	234,332					

Table 5. Employment in the green industry for high- and low skilled workers outlined from equation (2). *(Y_{it}) = employment in green industry,* outlined from equation (2). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

Left panel of Figure 8 depicts yearly average wages and unemployment benefits received, for high- and low skilled petroleum workers compared to high- and low skilled non-petroleum workers. The high-skilled petroleum workers did experience a smaller decrease in their wages than the low-skilled petroleum workers. Petroleum workers with higher education level also received less average yearly unemployment benefits than the low-skilled petroleum workers, see right panel of Figure 8. The low-skilled workers in the petroleum industry were then probably affected by the fall in oil prices to a greater extent than the high-skilled workers, in outcomes of losing their jobs or reducing income by lowering their employment contract to a part-time job.

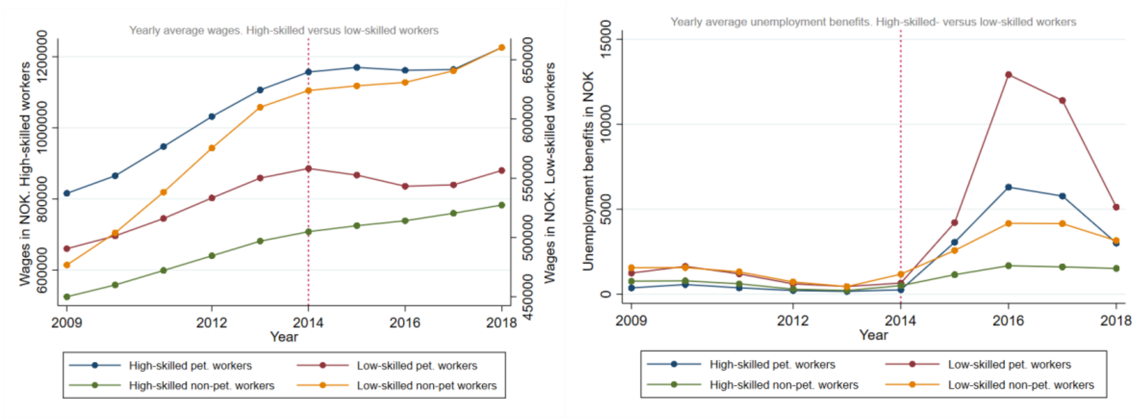

Figure 8. Left panel: Yearly average wages in NOK for high- and low-skilled petroleum workers versus high- and low skilled non-petroleum workers. Right panel: Yearly average unemployment benefits in NOK for high-and low-skilled petroleum workers versus high- and low skilled non-petroleum workers.

Figure 9 depicts the wages for high- and low skilled workers outlined from equation (1). Like the result from the main analysis, the parallel trends for the wages are not satisfied. The trends for both groups are not similar in the pre-period. Since the parallel-trend assumptions are not satisfied, it can be difficult to interpret any conclusions. Though due to the deviating pre-trend in Figure 9, low-skilled petroleum workers seem to be hit harder by the oil price shock than high-skilled, relative to their respective control group. The downward slope for the low-skilled petroleum workers is steeper compared to their control group. In 2017 low-skilled petroleum workers received NOK - 52,758 less than their representative control group, and high-skilled workers received NOK - 16,073 than their representative control group.

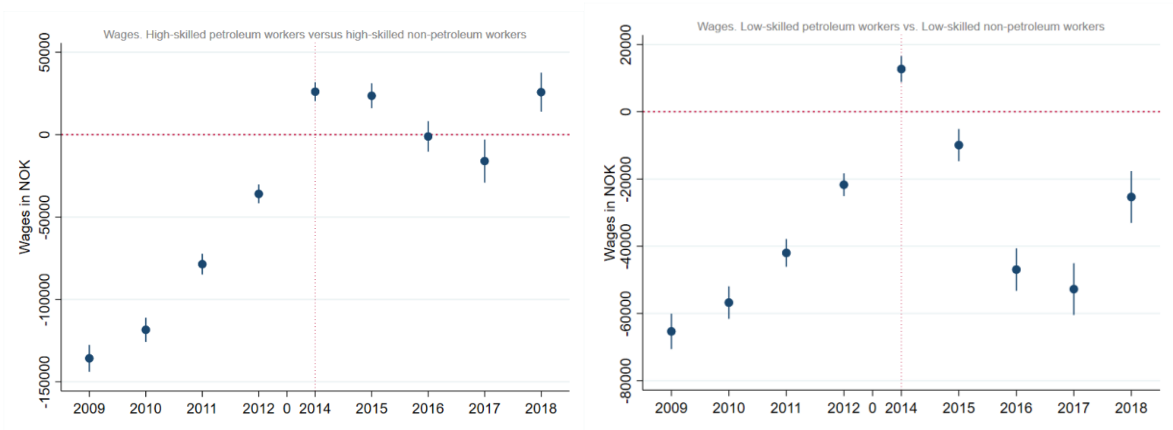

Figure 9. (Y_{it}) = *wages*, outlined from equation (1), 2009-2018. Left panel: High-skilled petroleum workers versus high-skilled non-petroleum workers. Right panel: Low-skilled petroleum workers versus low-skilled non-petroleum workers. 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects. The markers are the estimated coefficient β_t from equation (1) using wages and unemployment benefits.

Table 6 reports the result from equation (2) for high- and low skilled workers with *(Y_{it}) = wages*. Both high- and low skilled petroleum workers received more in wages than their representative control group. These results are statistically significant due to different trends in wages in the pre-period and might be misleading. From figure 9, petroleum workers seem to earn less than their representative control group in the post-period, especially for low-skilled petroleum workers.

Wages	**Conf.**	**Std. Err.**	**t**	**P> |t|**	**[95% Conf. Interval**	
High-skilled petroleum workers						
Treated x P_t^{Post}	85532.44	3866.306	22.12	0.000	77954.25	93110.63
_cons	833610.5	880.4819	946.77	0.000	831884.7	835336.3
Clusters	23,856					
N	234,826					
Low-skilled petroleum workers						
Treated x P_t^{Post}	13175.45	.2435.734	5.41	0.000	8401.256	17949.65
_cons	699670.5	627.4922	1115.04	0.000	698440.6	700900.5
Clusters	23,698					
N	231,582					

Table 6. Wages for high- and low skilled workers. *(Y_{it}) = wages,* outlined from equation (2). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

Figure 10 illustrates that both high- and low skilled petroleum workers did receive more in unemployment benefits in the post-period compared to other high- and low skilled non-petroleum workers in labor market 41 and 44. The parallel-trend assumption for the low-skilled workers is satisfied. The high-skilled workers have a satisfied parallel-trend assumption in 2010 and the following years until the oil price shock in 2014 (left panel in Figure 10). Low-skilled workers received almost twice as much in unemployment benefits compared to the low-skilled control group, then what the high-skilled petroleum workers did to their respective control group. In 2016, low-skilled workers did receive NOK 9,000 more than the low-skilled control group, while for the high-skilled petroleum workers only received NOK 5,000 more than other high-skilled workers resident in the same area.

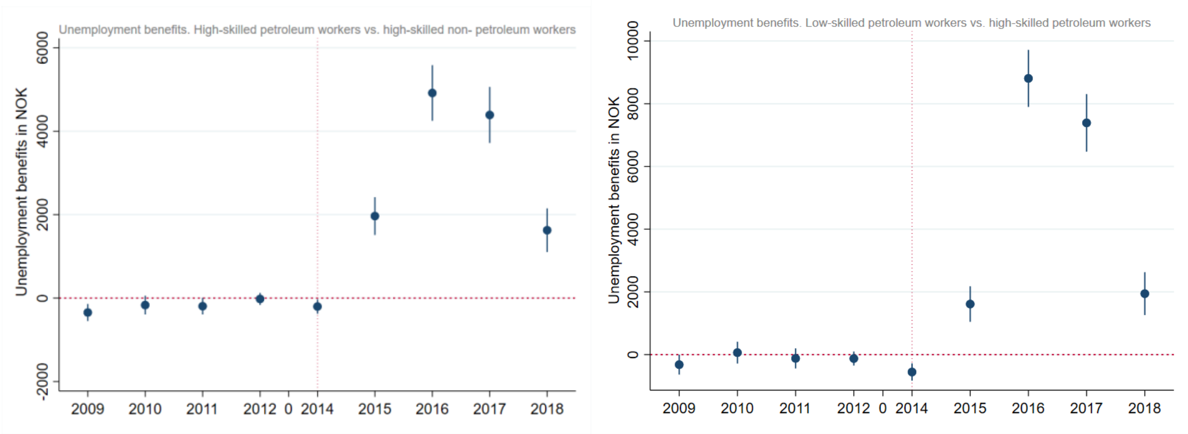

Figure 10. Unemployment benefits in NOK. *(Y_{it}) = unemployment benefits*, outlined from equation (1). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

Further, the more restrictive difference in difference estimation results from equation (2) using unemployment benefits as the outcome variable, are reported in Table 7. Both the high- and low-skilled petroleum workers received more on average in the post-period in unemployment benefits than their respective control group.

Unemployment benefits	Conf.	Std. Err.	t	P> |t|	[95% Conf. Interval	
High-skilled petroleum workers						
Treated x P_t^{Post}	2662.689	164.8353	16.15	0.000	2339.602	2985.776
_cons	784.0966	37.53829	20.89	0.000	710.5193	857.6739
Clusters	23,856					
N	234,826					
Low-skilled petroleum workers						
Treated x P_t^{Post}	3893.511	217.1658	17.93	0.000	3467.852	4319.17
_cons	1992.189	55.94611	35.61	0.000	1882.531	2101.847
Clusters	23,698					
N	231,582					

Table 7. Unemployment benefits for high- and low skilled workers. *(Y_{it}) = unemployment benefits,* outlined from equation (2). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

The educational level for both the petroleum workers and non-petroleum workers started to increase in 2013, one year before the oil price shock, see left panel of Figure 11. The educational level had a stable level in the pre-period. According to the labor and welfare administration in Norway (NAV), the demand for higher educational levels in Norway has increased in recent years. In 2006, 33 percent of the employment were high-skilled and in 2018 it increased to 41 percent. The right panel of Figure 11 depicts the educational level for the high-skilled and low-skilled petroleum workers. The educational level for low-skilled workers started to increase in 2014. This can be explained by other factors like technological changes or changes in the regulation for specific jobs. For the high-skilled petroleum workers, the yearly average education level started to increase after 2014. Further looking at the descriptive statistics, see table 14 in the appendix, the percentage of the 24,397 petroleum workers did have a minimalist increase in the yearly average educational level (NUS-codes) for both men and women and a minimalist decrease in low-skilled workers from year 2013 to 2018 on average.

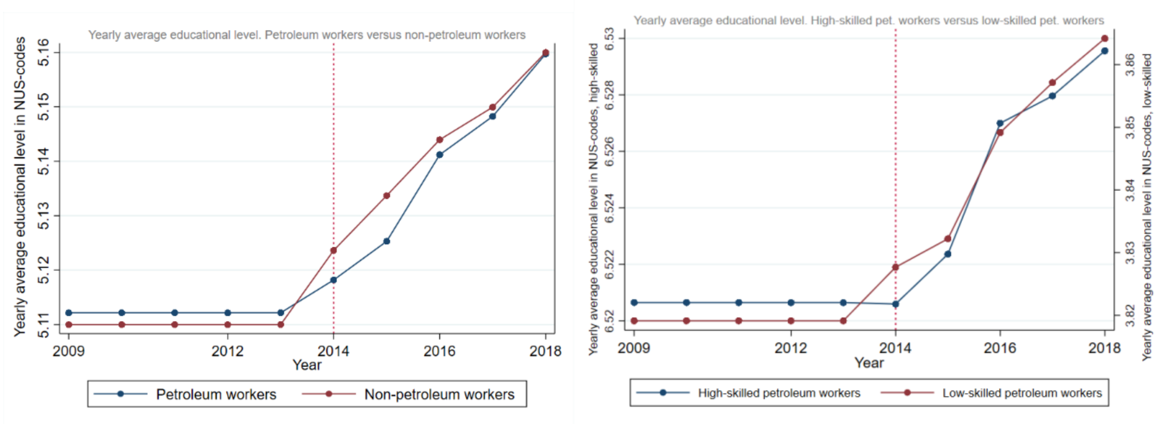

Figure 11. Yearly average educational level for workers resident in the labor market 41 and 44. High-skilled petroleum workers compared to low-skilled petroleum workers.

Using the dynamic regression model from equation (1), the development between high-skilled petroleum workers compared to other high-skilled workers, and low-skilled petroleum workers compared to other low-skilled workers are depicted in Figure 12. The average yearly educational level for high-skilled petroleum workers was similar until 2018, where the educational level for high-skilled petroleum workers had an increase compared to other high-skilled workers resident in the same labor market in 2013, see left panel of Figure 12. As mentioned earlier, it takes time to finish a degree, and the increase in the educational level for the high-skilled petroleum workers, probably are explained by petroleum workers starting a higher education right after the oil price shock, and finishing in 2018. The right panel of Figure 12 depicts the educational level to low-skilled petroleum workers compared to other-low skilled workers. Low-skilled petroleum workers on average in the post-period, had a lower educational level than other low-skilled workers. Though these differences are minimalistic, and close to zero, it might be that other low-skilled workers in the same municipalities were educated more than low-skilled petroleum workers.

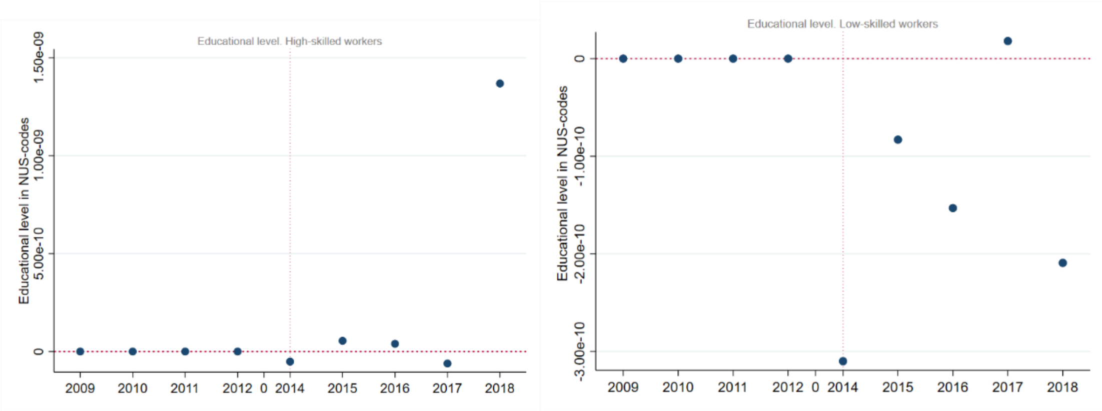

Figure 12. Educational level in NUS-codes for workers resident in labor market 41 and 44. *(Y_{it}) = educational level,* outlined from equation (1). Left panel: High-skilled petroleum workers versus high-skilled non-petroleum workers. Right panel: Low-skilled petroleum workers versus low-skilled non-petroleum workers. 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects

Table 8 reports the results outlined from equation (2). The average educational level in the post-period to the high- and low-skilled petroleum workers are not statistically significant. The higher educational level for high-skilled petroleum workers - and the lower educational level for low-skilled petroleum workers compared to their respective control groups, can neither be explained by the oil price drop in 2014.

Educational level	Conf.	Std. Err.	t	P> |t|	[95% Conf. Interval	
High-skilled petroleum workers						
Treated x P_t^{Post}	26e-10	9.94e-10	0.26	0.792	-1.69e-09	2.21e-09
_cons	6976610	9.85e-09	7.1e+14	0.000	6976610	6976610
Clusters	23,862					
N	244,765					
Low-skilled petroleum workers						
Treated x P_t^{Post}	-1.49e-10	1.51e-10	-0.98	0.325	-4.44e-10	1-47e-10
_cons	4137941	1.73e-09	2.4e+15	0.000	4137941	4137941
Clusters	23,932					
N	234,332					

Table 8. Educational level in NUS-codes for high- and low skilled workers outlined from equation (2). *(Y_{it}) = Educational level*. 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

7.3. Descriptive statistics for petroleum stayers and leavers

When looking at the broader picture it can be interesting to split the petroleum workers into three different groups depending on which industry they worked in after the oil price drop. The "petroleum stayers" are the petroleum workers who stayed in the petroleum industry after the oil price drop, "petroleum leavers to green industry", are petroleum workers changing to a green industries after the oil price drop and "petroleum leavers", are petroleum workers changing to all other industries except the petroleum industry or the green industry. Left panel of Figure 13 depicts the yearly average wages in NOK for the three different groups of petroleum workers and the right panel depicts the yearly average unemployment benefits received. The left panel illustrates that petroleum workers changing to a green industry on average had higher wages in the pre-period than "petroleum stayers" and "petroleum leavers to others". Petroleum workers with lowest yearly average wages transitioned to other industries. Figure 13 also illustrates that petroleum workers changing to green industries lost their yearly average wages at around NOK 200,000 from 2012 to 2018. Petroleum workers that changed to other industries received the highest amount of unemployment benefits in NOK. The blue line in the right panel of Figure 13, illustrates an increase in yearly average unemployment benefits for petroleum stayers. In 2014, yearly average unemployment benefits for petroleum workers was approximately NOK 0 and increased to NOK 5,000 in 2016. Although, this blue line are workers staying in the petroleum industry after the oil price shock, the increase can be explained by reduced working hours per week.

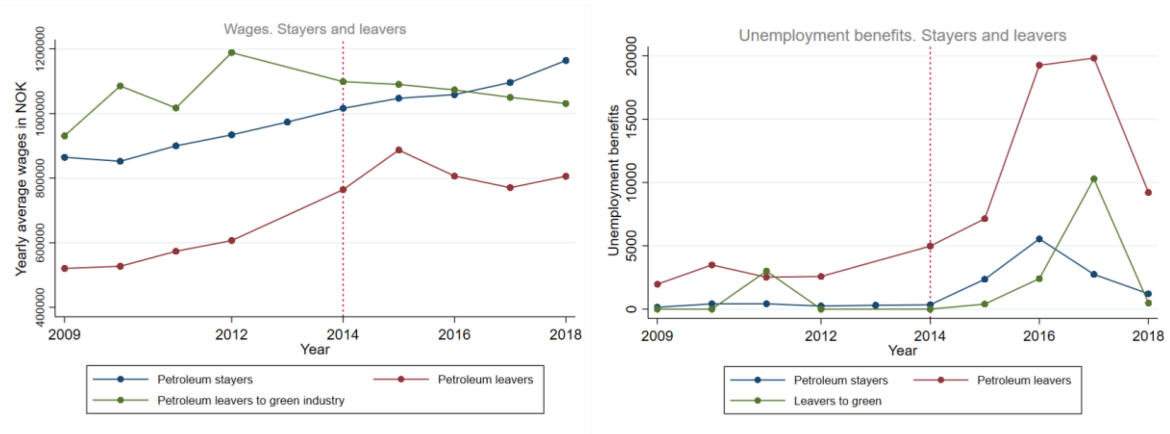

Figure 13. Yearly average wages and unemployment benefits. Stayers and leavers resident in labor market 41 and 44. Left panel: Yearly average wages in NOK for stayers, leavers, and leavers workers to green industries. Right panel: Yearly average unemployment in NOK for stayers, leavers, and leavers workers to green industries.

Left panel of Figure 14 illustrates that petroleum workers employed in a green industry in 2018, on average had the highest educational level, with a level of 6.2 (NUS-code), and petroleum workers who were employed in other industries than the petroleum or green in 2018, had the lowest educational level of 5.5. The right panel of Figure 14 illustrates the yearly average educational level. The fall in educational level for workers who transitioned to other industries (red line in the right panel Figure 14), are due to the compositions to the group changes. Again, the green industry has the highest educated workers. The petroleum industry and other industries had similar educational levels for workers around 5 (NUS-code), due to the matching method. After 2014 the level changed. Petroleum industry had a small increase while for others it fell from 5 to 4.5 and can be explained by the fact that low-skilled petroleum workers transitioned to other industries after the oil price collapse.

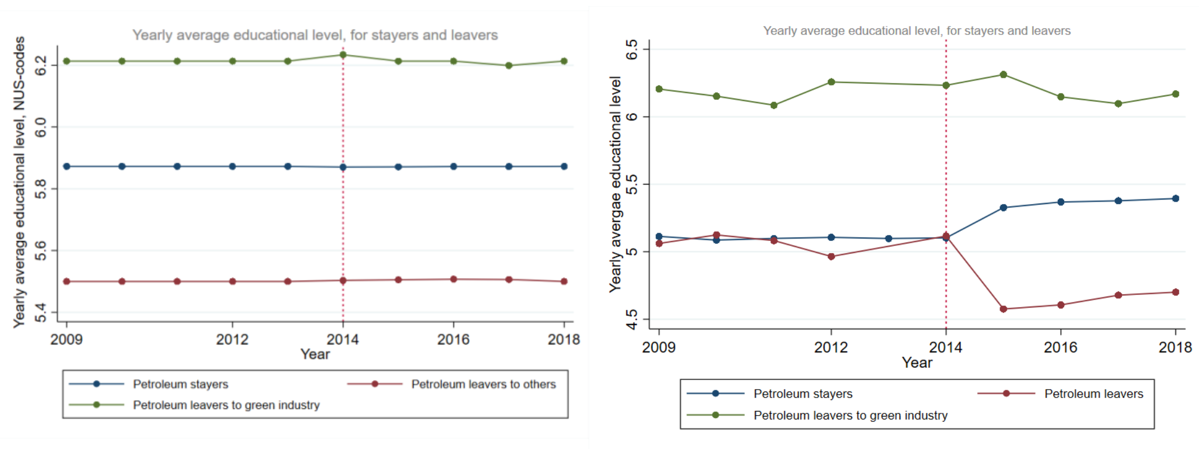

Figure 14. Yearly average educational level (NUS-codes, 0-8) for green industry, petroleum industry and other industries for workers resident in labor market 41 and 44. Left panel: Yearly average educational level in NUS-codes for petroleum workers employed in a green industry in 2018. Right panel: Yearly average educational level in petroleum industry, green industry, and other industries.

According to the educational level, 57.0 percent of the petroleum workers who worked in a green industry during the period from 2009-2018 had a higher educational level, and the remaining 43.0 percent of the petroleum workers had a low-skilled educational level. 26 percent of the petroleum workers who worked in the petroleum industry in 2013, transitioned to production of electricity from hydropower in the post-period *(35.111),* and 22.4 percent transitioned to purification and distribution of water *(36.0).* Petroleum workers who stayed in the petroleum industry after the 2014 oil price shock were mainly workers with only primary school education at secondary school level *(201 2013).* The second largest educational group that stayed in the petroleum industry was at High School level within general subjects *(401 101),* and the third largest was for high-skilled petroleum workers within science subjects, craft- and technical subjects *(759 999).*

Most of the workers transitioning to a green industry after the 2014 oil price shock had a high educational level with a Bachelor of Engineering, NUS-code *(655 106),* 6.62 percent. Most of the low-skilled workers who transitioned to a green industry after the 2014 oil price shock were educated as electricians in High School, NUS-code *(455 103),* 5.96 percent, see Table 19 in the appendix. Other high-skilled petroleum workers who transitioned to green industries after 2013, had educational level within science subjects, craft and technical subjects, and other unspecified higher level education, NUS-code *(759 999),* and master's in civil engineering, NUS-code *(741 125).* Other low-skilled workers had High School education within the industrial mechanism subject, NUS-code (*455 216)*, see Table 19 in the appendix. None of the workers who transitioned to a green industry after an oil price collapse did have an educational level specified to petroleum industry like for example petroleum engineering, petroleum technology or well operator.

8. Robustness test

As a robustness test in this analysis to strengthen the results, I use a sub-group of the petroleum industry as an alternative estimation of the oil price drop, still using workers resident in labor market 41 and 44 (Bhuller, 2009), in 2013. The petroleum industry so far has focused directly on the extraction of petroleum and petroleum related activities. As mentioned, the sudden oil price collapse did not only affect the petroleum industry directly but also industries delivering goods and services to the petroleum industry.

First, I change the treatment group to workers in petroleum-related industries producing products and services as specific input factors in the main petroleum industry. The related supplier- and extraction services are found from Statistics Norway; "*Industry subgroups, standard for industry grouping (SN2007*)". The table reports subgroups suppliers and extraction services to the petroleum industry between 2010-2013. The remaining industries in the subgroup are industries associated with the petroleum industry from the standard grouping (SN2007) not mentioned in the main petroleum group. This includes industries like storage and transport services, logistics related to the petroleum activities, supply and other maritime transport activities, geological services including localization of oil and gas, leasing and rental of machineries and technical consulting services, see Table 18 in the appendix. Second, the control group is changed by using the same matching procedure. I use industries in the control group that are little affected by the oil price shock, using the report from Hungnes et al., (2016), together with the input-output table (2007) from Statistics Norway. When the best compatible match for the sub-petroleum industry workers is found, I do the regression analysis over again, using equation (1) and (2). The subgroup consists of 18,080 workers in the sub-petroleum group and 18,080 workers in the control group resident in labor market 41 and 44 in 2013, see Table 9. Gender, age, working hours per week and educational level are similar variables in the sub-petroleum- and control group. The sub-petroleum group has somewhat higher wages, but more similar than the main petroleum's presentative control group. The average unemployment benefits on the other hand is more contrary for the sub-petroleum. Sub-petroleum workers received averagely more in unemployment benefits in 2013 than their representative control group.

Sub-petroleum group	**Count**	**mean**	**sd**	**min**	**max**
Female (1/0)	18,080	.190708	.3928702	0	1
Age	18,080	42.1396	11.66677	23	66
Wages	18,080	698372.4	360887.3	1447	9729417
Unemployment benefits	18,080	846.111	9270.898	0	291359
Working hours per week	18,080	36.86295	4.706197	4	84
Educational level, High- or low (1/0)	18,080	.3207965	.4667956	0	1
N	18,080				

Control group					
Female (1/0)	18,080	.1782663	.3827448	0	1
Age	18,080	42.08385	11.75249	23	66
Wages	18,080	668952.5	426319.8	0	1.35e+07

Unemployment benefits	18,080	520.5376	6668.457	0	224361
Working hours per week	18,080	36.22305	5.778432	43	99
High- or low educational level (1/0)	18,080	.3461283	.4757479	0	1
N	18,080				

Table 9. Summary statistics sub-petroleum and control group, 2013.

Figure 15 depicts that the new control group did not experience any yearly average decrease in wages or yearly average increase in unemployment benefits after the oil price shock in 2014. The left panel of Figure 15 depicts the yearly average wages in NOK for the sub-petroleum workers and the non-petroleum workers, illustrating the same drop in wages after 2014 with an increase in 2017. The left panel depicts the same drop in yearly average wages for sub petroleum workers from 2014 as for petroleum workers, with a small increasing trend in wages for the control group. The increase in unemployment benefits is almost identical as for the main petroleum group, though the average received unemployment benefits for the sub petroleum group in NOK was higher, see right panel of Figure 15. In 2016, the main petroleum group received approximately NOK 10,000 on average, while the sub petroleum group the same year received approximately NOK 17,000 on a yearly average basis.

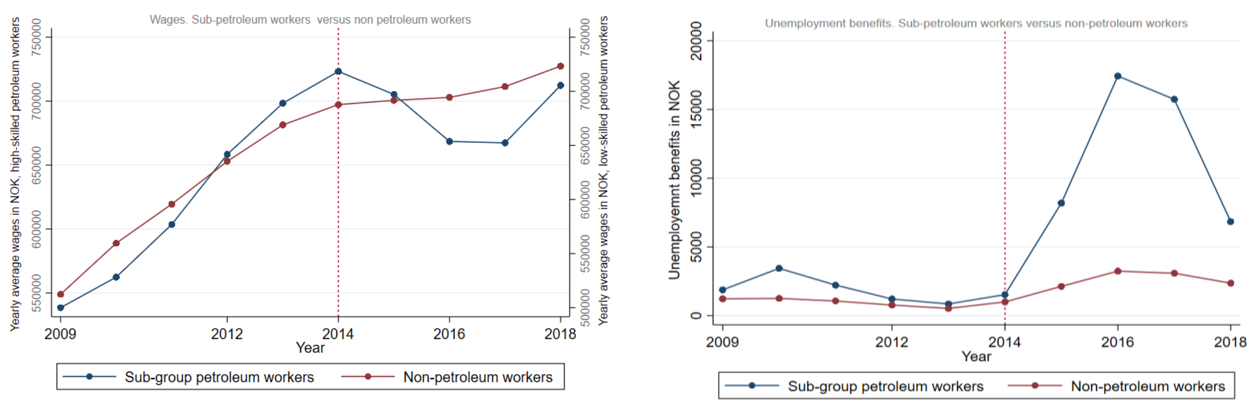

Figure 15. Yearly average wages and unemployment benefits in NOK, sub-petroleum workers versus non-petroleum workers resident in labor market 41 and 44. Left panel: Yearly average wages for sub-petroleum workers and non-petroleum workers. Right panel: Yearly average unemployment for sub-petroleum workers and non-petroleum workers.

Figure 16 depicts the yearly average educational level for the sub-petroleum workers and non-petroleum workers, where the development is similar to the main petroleum group (from the left panel of Figure 11).

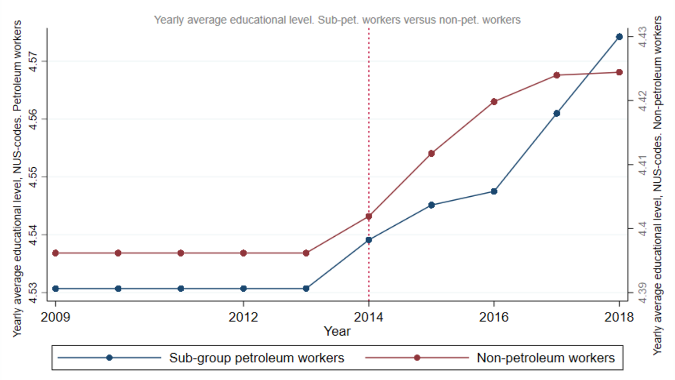

Figure 16. Yearly average educational level in NUS-codes for sub-petroleum workers and non-petroleum workers resident in the labor market 41 and 44.

The dynamic regression output from equation (1) is depicted in Figure 17 with employment in a green industry as the outcome variable. The coefficients between 2009 and 2014 are close to zero and not statistically significant, while for the coefficients after 2014 are above zero and statistically significant and the assumption about parallel trends is satisfied. Having 2014 close to zero can be explained by the fact that the sub-petroleum industries were not immediately affected, but instead got after-effects in 2015 and the years to follow. The largest effect of being in the treated group is in 2018 at 0.28 percent. This effect is somewhat larger than for the main petroleum group, but it is still small, see Figure 17. Employees in supplier industries might find it easier transitioning to green industries than extractive industries.

Figure 17. Employment in the green industry. Sub-petroleum workers versus non-petroleum workers resident in the labor market 41 and 44. *(Y_{it}) = Employment in green industry,* outlined from equation (1). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

Figure 18 depicts equation (1) with wages as the outcome variable in the left panel, and unemployment benefits in the right panel. The coefficients for wages are under zero in 2010 and 2011 and the parallel-trend assumption is not valid, though the control group used in the sub-petroleum group is a better match than the control group in the main analysis. After the oil price shock in 2014, the sub-petroleum group has a decreasing trend in wages. The largest difference between the sub-petroleum workers and non-petroleum workers is in 2017, where sub-petroleum workers yearly received around NOK 70,000 less than non-petroleum workers. In the right panel of Figure 18, the unemployment benefits increased for the sub-petroleum workers after 2014 in line with the main petroleum group, though sub-petroleum workers received approximately NOK 8,000 in unemployment benefits in 2016, sub-petroleum workers received approximately NOK 15,000.

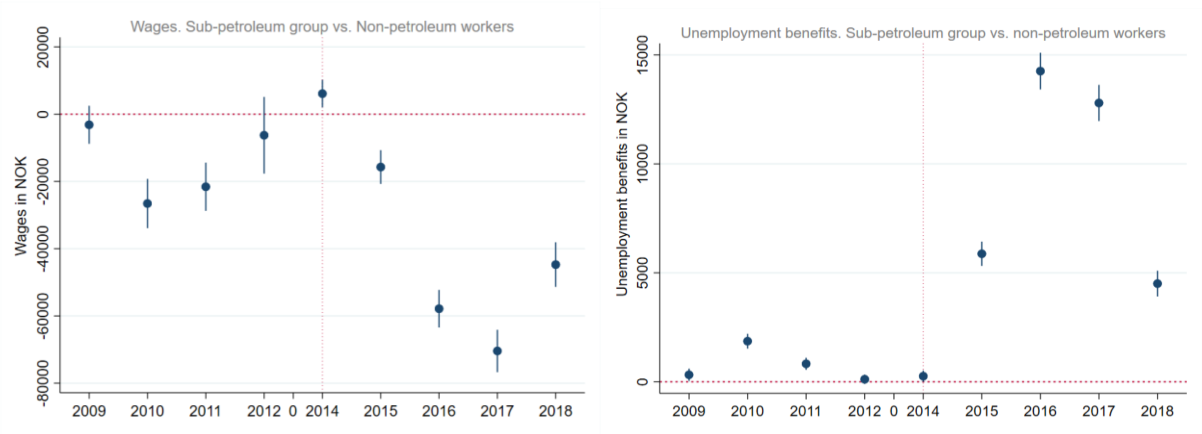

Figure 18. Wages and unemployment benefits. Sub-petroleum group versus non-petroleum workers resident in labor market 41 and 44. Outlined from equation (1). Left panel: (Y_{it}) =*Wages.* Right panel: (Y_{it}) = *unemployment benefits.* 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

Estimations from equation (1) using employment in the green industry as the outcome variable is reported in Table 10. The employment in a green industry is statistically significant for the sub petroleum workers with 0.17 percent chance of changing to a green industry after the oil price drop in 2014. Sub petroleum workers might to a greater extent transition to a green industry after an oil price shock than what the main petroleum workers do, for example due to an educational level that is easier to use across industries.

Employment in green industry	Coef.	Std. Err	t	P> |t|	[95% Conf. Interval]	
Treated x P_t^{Post}	.0017011	.0005109	3.33	0.001	.000699	.0027024
_cons	.0015299	.0001226	12.48	0.000	0012896	.0017701
Clusters	36,160					
N	351 901					

Table 10. Employment in the green industry. *(Y_{it}) = Employment in green industry,* outlined from equation (2). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

In contrast to the main petroleum group, the sub petroleum group had averagely lower wages in the post-period than the control group, see Table 11. The representative control group to the subgroup might be a better match than the control group used in the main analysis. The subgroup, in line with the main petroleum group, received more in unemployment benefits than the control group, see Table 12.

Wages	Coef.	Std. Err	t	P> |t|	[95% Conf. Interval]	
Treated x P_t^{Post}	-24,154.59	2,909.756	-8.30	0.000	-29,857.8	-18,451.38
_cons	65,0912.1	697.515	939.18	0.000	653,724.9	656,459.2
Clusters	36,160					
N	351 345					

Table 11. Wages outlined from equation (2). *(Y_{it}) = wages,* outlined from equation (2). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

Unemployment benefits	Coef.	Std. Err	t	P> |t|	[95% Conf. Interval]	
Treated x P_t^{Post}	6,815.077	200.6261	33.97	0.000	6,421.844	7208.31
_cons	2,041.047	48.09327	42.44	0.000	1,946.782	2,135.311
Clusters	36,160					
N	351,345					

Table 12. Unemployment benefits outlined from equation (2). *(Y_{it}) = unemployment benefits,* outlined from equation (2). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

The probability of having a high educational level for the sub-petroleum workers was lower compared to the representative control group. Further, from Table 13, the decrease in the educational level cannot be explained by the oil price shock, similar to the answer found from the main petroleum group. Compared to the main petroleum group from Figure 6, petroleum workers had a small increase in the probability of being high-skilled compared to the representative control group. For the sub-petroleum workers on the other hand, the probability of being high-skilled workers was lower in the post-period, except in 2017.

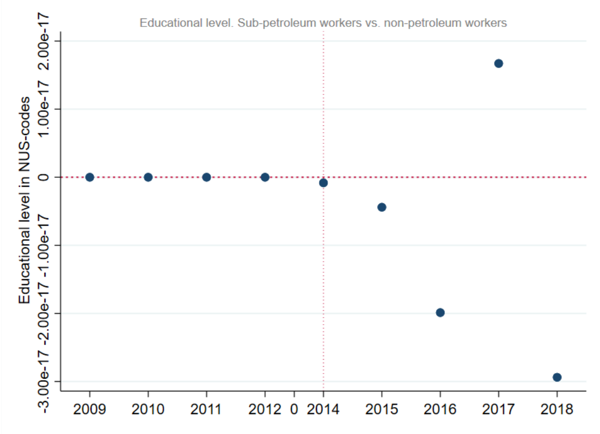

Figure 19. Educational level in NUS-codes. *(Y_{it}) = High- or low educational level,* outlined from equation (1). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

Wages	Coef.	Std. Err	t	P> |t|	[95% Conf. Interval]	
Treated x P_t^{Post}	-7.40e-18	3.54e-17	-0.21	0.835	-7.69e-17	6.21e-17
_cons	.3351283	5.45e-16	6.24e+14	0.000	.3351283	.3351283
Clusters	36,160					
N	351,901					

Table 13. Unemployment benefits outlined from equation (2). *(Y_{it}) = wages,* outlined from equation (2). 95% Conf. Interval. Std. errors clustered at individual level. Regression includes year and individual fixed effects.

8.1. Spillovers to other industries

For the difference-in difference estimation to be valid, it is important that spillovers do not occur. Most of the companies operating in the petroleum sector are private companies in Norway, but an oil price collapse will negatively affect both the private and public sector. Since the ownership of the petroleum resources belongs to the community, Norway secures a large share of values created in the petroleum industry through taxation and schemes. The state's direct financial involvement in the petroleum sector (SDØE), is a scheme where the state owns several shares in many oil and gas fields and pipelines. In an oil price collapse, the public sector will meet lower income and lower oil tax revenues and therefore meet lower profits. A huge part of the control group consists of public administration, defense and social security schemes, education and health services which have many companies which belongs to the public sector. The control group consists of both private- and public sector where the private sector delivers products and services to the petroleum industry, it can also experience a lower demand and a decrease in income. A decrease in income can also lead to a decrease in the employment for the private sector. The lowering income due to the oil price shock reduces the domestic private demand affecting other industries when the demand decreases. From Figure 15, also industries delivering goods and services to the petroleum industry experienced a shock from the recession in form of lower wages and higher unemployment benefits.

Because of the lower oil price, the exchange rate fell. The exchange rate has an impact on economic development and affects the petroleum industry and control groups differently. The treatment group consists of the oil and gas industry, which is one of the most important exports for the Norwegian economy. Companies exporting abroad will be more competitive, as their goods become cheaper on the world market. The depreciation of NOK will thus be favorable for Norwegian export companies. The control group consists both of private and public companies. The public sector is usually well diversified and protected in their loans and since the petroleum sector is considered as a stable income source, the public sector also invests in the petroleum industries. Lower oil prices and reduced activity in the petroleum sector, reduces the profits in the public sector, depending on the public sector's size of the investments in the petroleum sector. If the public sector, and a huge part of the control group are affected by the depreciation in NOK, at the same line as the petroleum sector, the control group reduces their investments, activities, and employment. Thus, non-petroleum workers might mobilize across municipalities due to lost jobs and reduced incomes. This spillover effect might underestimate the effect of the petroleum workers after the oil price shock and how bad the petroleum workers were hit.

9. Discussion

From the estimated results in this master thesis I found that petroleum workers with higher educational levels are more likely transitioning to a green industry after the 2014 oil price shock, than what low-skilled petroleum workers are. From the descriptive statistics I found that especially workers with education within a Bachelor of Engineering, but also other high-skilled workers like workers with education within science subjects, craft- and technical subjects and civil engineers did transition to a green industry after 2013. I found that most of the low-skilled petroleum workers who transitioned to a green industry after 2013, had High School education as electricians or in industrial subjects. None of these are education specific to the petroleum industry, so the transition from a polluting industry to a green industry might be easier for workers with a broader education that can easily be used in several different industries, like civil engineers rather than the education specified to the petroleum industry. According to data from Universities in Norway, the percentage graduated within petroleum science and technology are declining, especially after the oil price shock (E24, 2021).

Since the definition of green industries in this thesis has been relatively narrow, the results for the demanding educational level are also relatively small, finding two main schooling directions. If there was a broader definition of green industries, for example also including "greening industries" from UNIDO, the effect of being in the treatment group, calculated from equation (1), may have been larger. From Figure 2, I found that the largest effect of being in the treated group was approximately 0.1 percent in 2018. Some petroleum workers may have shifted to other green industries not defined in this thesis. Since the effect of petroleum workers transitioning to a green industry after an oil price shock is so small, the empirical results were not statistically significant before 2016, 1.5-2 years after the oil price shock. Since the results turned out to be not statistically significant, I cannot conclude that the oil price shock in 2014 and 2015 was the reason for why the petroleum workers transitioned to green industries. I would rather be critical to how well the control group matches the petroleum group, which may have a huge impact on the results validity. Though the treatment- and control group did have similar pre-trends in Figure 2, the control group was not a good match on wages from the left panel of Figure 5, and the question is whether the other outcome variables are reliable enough to trust the parallel-trend assumption in Figure 3. No parallel trends in the pre-period gives a weakness in this study. From Hungnes et al., (2016), most of the petroleum industries are related to the petroleum industry either by direct or indirect goods or services the control group might in some way be affected by the 2014 oil price shock. Having a control group that is affected by the oil price shock in 2014, can also affect the validity to the results.

As mentioned earlier in this thesis, petroleum workers are often seen to have higher wages compared with other industries, and they have specific educational levels directed to the petroleum industry. It can therefore be difficult to find a good match based on wages, but still, wages are a central outcome variable that should be a good match for the results to be valid.

In this master thesis I only use the educated level to the petroleum workers measure in NUC-codes from Statistics Norway. Another important thing demanded in the labor market are skills and workers' years of experience. One alternative measure is occupational codes used to identify the workers skill, as done in Acemoglu et al., (2010). Occupational skills divide workers into different skills and knowledge required for specific working tasks in the job market. The workers in the same occupational group might be a better measurement for workers positions in the job market than educational level.

10. Conclusion

In this thesis by using longitudinal data from Statistics Norway, I have studied workers during an oil price drop and labor market changes towards a green economy. The increased debate about sustainability, the 'job-killing' argument, and the demand for higher educational levels has increased in recent years. It has therefore been captivating to study the oil price shock in line with the demand for specific education.

The main findings in this thesis are that high-educated petroleum workers are more likely to transition to a green industry after the oil price shock in 2014. I cannot conclude that the oil price shock was the reason for why the petroleum workers transitioned to a green industry in 2015 and 2016, but I found an increasing trend in the employment in green industries after the oil price shock.

High-skilled petroleum workers received a smaller amount of unemployment benefits than the low-skilled petroleum workers. High-skilled petroleum workers who transitioned to a green industry, had higher yearly average wages than petroleum workers who stayed in the petroleum industry or transitioned to other industries. I also found that workers employed in green industries on average had the highest educational level compared to other industries, including the petroleum industry.

From the descriptive statistics I found that especially workers within a Bachelor of Engineering and higher education within science subjects, craft- and technical subjects and civil engineers did transition to a green industry after 2013. I found that most of the low-skilled petroleum workers who transitioned to a green industry after 2013, had High School education as electricians or in industrial subjects.

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12. Appendix

12.1 Figures

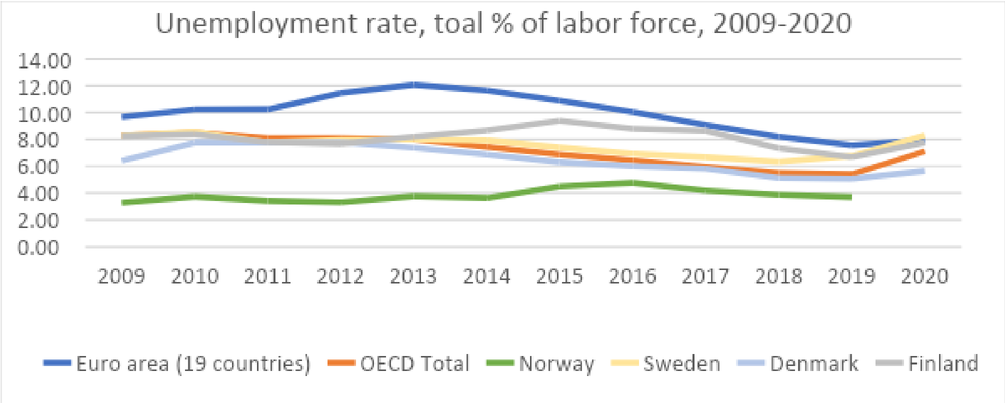

Figure 20. Unemployment rate in OECD countries, European countries, and Nordic countries, 2009-2020. The indicator is the percentage of unemployed persons of the total labor force.

Source: OECD (2021), Unemployment rate (indicator). doi: 10.1787/52570002-en (Accessed on 01 May 2021)

12.2 Tables

13.	High-skilled 2013	Low-skilled 2013	High-skilled 2018	Low-skilled 2018
Men	43.1	56.9	43.5	56.5
Women	59.5	40.5	60.7	39.3

Table 14. Percentage of high- and low-skilled petroleum workers in the labor market 41 and 44, 2013 and 2018.

	Treatment group
06.1.	Extraction of crude oil
06.2	Extraction of natural gas
09.1.	Drilling and other services related to extraction of crude oil
19.2.	Production of refined petroleum products
49.5	Pipe transport

Table 15. Definition of treatment group from Statistics Norway, (SN2007)

	Control group
03.	Fishing and aquaculture
45.	Trade and repair of motor vehicles
46.	Agency and wholesale trade, except motor vehicles
47.	Retail trade, except motor vehicles
58.	Publishing
59.	Film, video, television, and production of music
63.	Information services
72.2.	Research and development in social science and humanities;
84.	Public administration and defense and social security schemes to public administration
85.	Education

Table 16. Definition of the control group from Statistics Norway, (SN2007)

	Green industries
35.1.	Production, transmission, and distribution of electricity.
35.3.	Steam- and hot water supply
36.0.	Extraction, purification, and distribution of water
37.0.	Collection and treatment of wastewater, including treatment of wastewater to prevent polluting
38.0.	Collection, treatment, disposal and recycle of waste
39.0.	Environmental treatment, cleaning, and similar activities.
42.2.	Construction of facilities for electricity.

Table 17. Definition of green industries, from Statistics Norway, (SN2007)

	Sub-petroleum group
25.110 – 25.120	Production of metal structures and parts
25.210.	Manufacture of radiators and boilers for central heating
25.290 - 25.300	Manufacture of other tanks, cisterns and containers of metal and productions of steam boilers
25.610 – 25.620	Treatment and processing of metals
25.910 – 25.940	Production of steel, containers of iron, metal wire, bolts and more
25.990	Production of metal products not specified other places
26.510.	Production of measuring- control – and navigations systems
27.11 - 27.12.	Production of electric motors, generators, transformers, and control panels
27.200.	Production of batteries and accumulators
27.900.	Production of other electrical equipment
28.11 – 28.15.	Production of engines and turbines, excluding engines for aircraft and motor vehicles. Production of pumps, compressors, cranes, bearings, gears, and other power transmission equipment.
28.210.	Production of industrial and laboratory furnaces and burners
28.221.	Production of lifting and handling equipment for ships and boats
28.229.	Production of lifting and handling equipment otherwise
28.250.	Production of refrigeration and ventilation systems, except for household use
28.290.	Production of machinery and equipment of general use, not elsewhere specified or included
28.910 – 28.920.	Production of machinery and equipment for the metallurgical- and mining industry
28.990.	Production of special machinery not specified other places
30.111 – 30.116.	Construction of ships. Furnishing and installation work carried out on ships over 100 gross tonnage. Construction of oil platforms and modules and furnishing and installation work carried out on oil platforms and modules
33.120.	Repair of machines
33.140 – 33.150.	Repair of electrical equipment and repair and maintenance of ships and boats
33.200.	Installation of industrial machinery and equipment
50.204	Supply and other offshore maritime transport services
52.223	Supply base. Logistics and services related to oil-and gas activities

71.122	Geological surveys, including localization of oil and gas.
71.129	Technical consulting services
77.390	Leasing and rental of machineries and other equipment, including equipment for oil extraction

Table 18. Definition of sub-petroleum group from Statistics Norway, (SN2007).

Education low	**Percent**	**Education high**	**Percent**
201 103	0.66	641 130	2.65
357 121	0.66	641 141	0.66
455 103	5.96	641 199	0.66
455 106	2.65	641 999	2.65
455 107	1.32	644 109	0.66
455 216	4.64	644 299	1.32
457 113	3.97	654 101	0.66
457 121	3.31	655 102	1.99
481 905	0.66	655 106	6.62
555 102	0.66	655 199	1.99
555 108	1.99	655 207	1.32
555 109	2.65	655 213	1.99
555 199	1.32	657 109	2.65
555 205	1.32	699 902	0.66
555 211	1.99	737 101	1.32
558 404	1.32	737 102	0.66
		741 111	1.32
		741 115	2.65
		741 121	0.66
		741 125	3.31
		741 199	2.65
		754 102	0.66
		754 108	0.66
		754 112	2.65
		755 106	2.65

		755 207	1.32
		755 223	2.65
		757 105	1.32
		757 107	1.99
		759 915	1.32
		759 916	1.99
		759 928	1.32
		759 999	3.31
		782 101	1.99
		859 904	1.99
Total percent	35.08		64,92

Table 19. Educational level for petroleum workers who transitioned to a green industry after 2013. Measured in percentage per educational study in NUS-codes.