When the Labor Demand Plunges

*Employment, wages and job mobility following a dramatic drop in the price of oil*

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The Oil Price Drop and the Labor Market

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Summary

The thesis analyzes how the oil price drop impacted employment, wages and job mobility for petroleum workers in Rogaland and Hordaland counties during 2014 – 2016 years. I compare these oil workers to the comparable non-oil workers that are not directly impacted by the low prices. Using individual fixed effects model combined with matching method, the results depict that employment among petroleum workers decreased significantly and the difference between oil and non-oil employed reached 8% at the end of 2016. Relative wages were not changed much, 8% of the petroleum workers in the end started to re-allocate to the other regions compared to the non-oil employed, while the number of workers that changed the industry is negligible and non-significant. Petroleum unemployed earned higher wages in the beginning but at the end of the period they started receiving significantly lower income compared to their employed counterparts in the sector. The thesis is relevant for the labor market researchers in order to evaluate the degree of the price drop reflected in wages and employment and the flexibility of petroleum workers towards changing the industry or the county when they lose the jobs.
Preface

This master thesis marks the final semester of my two-year master studies at the department of Economics at the University of Oslo. I have gained new valuable information, as well as used previously acquired knowledge during the coursework. The process of conducting the thesis has been filled with challenges as well as interesting findings that will be vital for further academic or non-academic career advancements.

The choice of the subject comes from the fact that I have decided to complement existing statistical analysis with econometric tools in order to make the results more applicable. Less attention has been paid describing Rogaland and Hordaland counties solely, thus I decide to make the relevant target group more niche. I am hoping that I give my contribution to the ongoing research in the field.

First and foremost, I would like to thank my supervisor Simen Markussen for his tremendous advice and valuable guidance and feedback during writing the thesis, his effort has been crucially important for developing the paper and the ideas. I also want to thank Frisch Center for Economic Analysis to give me the scholarship and an office space in the pleasant and friendly working environment. In the end I want to thank Dana Øye, Ruslana Datsenko, and Gøril Louis Andreassen and the rest of the friends and family for the important comments and support for their contribution and time.

The analysis in the thesis is carried out in statistical software package STATA, thus if someone wants to validate the results the dataset and do-files will be available upon request.
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1. Introduction

The dramatic drop of oil prices below USD 30 a barrel which started in 2014 made western European producer countries considerably worse off than they were during the 2008 financial crisis. Such a huge downward spike of prices slows down the economy of oil-exporter countries and shatters confidence of the job market participants remarkably. Particularly workers in the petroleum sector become drastically vulnerable when the price of oil changes. The subject is highly appealing, thus in this paper I explore the impact of the crude oil price drop which started in 2014 and continued several consequent years. I examine whether Norwegian petroleum workers have to cope with different levels of unemployment, wages and job mobility. I compare oil production and service workers in Rogaland and Hordaland to the workers who are not directly involved in the oil-related jobs. The paper illustrates if the employed in the petroleum sector leave the job market, how intensively they re-allocate and change industry of occupation and if they earn lower wages after the price decline first occurred compared to the non-oil workers. In addition, I look at the wage differences within petroleum sector and compare the outcome of the workers who stay three consequent months unemployed to the rest of the sector participants.

Policies introduced by the Central Bank of Norway for regulating petroleum industry are considered a successful pattern for the other resource-abundant countries. Efficient resource management has led to establishing the Norwegian Model in the oil and gas industry and thereafter, the country became an example of a well-diversified economy for the other petroleum exporters. Norway is amongst the 15 largest oil producer countries and ranks 21st with proven oil reserves. (CIA, 2017) The core questions are still under observation by the researchers: how efficient the Norwegian Model is? Is Norway well diversified enough to avoid the strongest impacts on workers caused by the slump in oil prices? I will address the behavior of petroleum workers following the price drop and discuss the important implications about the degree of exposure of the employed.

The thesis closely relates to the empirical work of Lima (2016). Rogaland oil workers suffered from lost jobs more severely than other counties, though significant increase in unemployment was marked in Aust-Agder, Vest-Agder, Hordaland, Møre og Romsdal. Also
the topic is under the ongoing debate whether there are “winners” and “losers” in the economy and if the downturn of the economy is of permanent nature.

My thesis is a complement of already existing studies that have been published during the recent years. In the study I restrict attention to the petroleum workers only in Rogaland and Hordaland counties. These two regions are marked with the highest employment in the oil sector and thus the changes are likely to be more clearly announced in the two regions compared to the other counties. Based on the importance of the subject in Norway, the scope of the study is to measure the dependence of the oil workers on the price fluctuations and observe their behavior on the job market.

The research includes essential implications for understanding the intensity of the petroleum price spikes for policymakers and statisticians in order to estimate structural changes in the oil industry and the amplitude to which local petroleum employees are impacted by the unstable crude oil prices. The thesis could be taken into consideration by the institutions and organizations examining how the oil patch workers react to the low oil prices and whether there are spillovers to the other industries.

The thesis is organized as follows: Section 1 consists of introduction, where I describe development of the oil prices and overview consequences on the petroleum sector after the price drop. Section 2 is dedicated to the description of the relevant literature review. In Section 3 I describe the data. It has three sub-parts. In the first one I define employment and introduce the workers in 2013. In the second sub-part regional variation of the worker observables are presented, I overview characteristics of the workers in different counties, such as education, age, gender. Third sub-part of the data description is dedicated to the methodology of choosing Treatment and Control groups. In Section 4, the empirical strategy is further elaborated. I explain independent and control variables that I use in the regression part and present the results, the empirical outcome consist of employment and wage dynamics and job mobility across counties and industries, as well as wage differences inside the sector. In order to verify that the results of the study are credible and valid I carry out several robustness checks in Section 5. I consider that the sharp price decline could leave its “marks” on the other industry workers, thus I carry out similar analysis where I re-define the control group as the comparable non-oil workers in the whole country instead of restricting them to Rogaland and Hordaland. I include information technology workers and carry out the regression analysis separately in order to see if the non-oil workers also suffered from similar
trends. Final Section 6 of the research paper includes discussion and conclusion, as well as brief recommendations.

1.1 Development of the Crude Oil Prices

Oil prices are determined by the supply and demand developments of petroleum. The supply and demand mismatch is essential for examining reasons behind the fluctuant oil prices. For example, during financial crisis in 2008 oil demand fell substantially while supply increased. The drop was a consequence of the mismatched demand and supply. According to the World Bank (2018) from mid-2011 until mid-2014 petroleum prices are smooth, describing the stable market over the period. From June-July 2014 and January 2015 they fell by approximately 50%. (See Figure 1)

Figure 1: Monthly Crude Oil Prices. Source: World Bank, Trading Economics (2018).

The drop consists of several phases. Initial gradual shift started in July 2014 when prices decreased by 0.4% compared to the previous month, followed by the drop of 4.4% in August. The second phase is extended to January 2015 when the prices become 363 NOK per barrel (18% decline relative to December 2014). Thereafter the radical decline below 250 NOK is noticeable in January 2016 which is equivalent to less than $35 downward jump.

The degree of the drop in oil prices is hardly predictable. Forecasters were surprised when the prices suddenly jumped down since it was not predicted by any institution in August 2014.
This fact indicates that forecasting oil prices accurately is associated with particular difficulties, taking into account low price elasticities of supply and demand and the complexity of evaluating key oil market players’ strategies.

There are two critical aspects related to the consequences of the oil price fall that need to be taken into account:

- **Underlying drivers that caused the price decline** – Lower oil prices can become a cause for changes in the global economic activities or it can be caused by the other shocks that drive the global economic growth. In the former, the decline is not a consequence of the global economic conditions; the decline could be driven by external changes in the environment e.g. technologic changes and thus, changes in the oil supply. In the latter, oil price decline is caused by changes in the global economic activities such as demand shock and the drop can have significant spillover impact on the other countries. Identifying the source of the price decline is, thus, of great importance for evaluating the impact on each country.

- **Time span of the oil price decline** – The consequences also depend on whether the price decline is persistent over the long-run or occurs temporarily. If the economy faces the short-run oil price drop, advanced oil-importing countries will lend and oil-exporter countries will increase borrowing. If permanent, production and consumption will need to adjust. The duration of the oil price decline depends on the underlying drivers, as well as flexibility of the oil market to adjust to the unexpected decline. E.g., changes in technology, shifting oil supply are followed by the permanent oil price changes. Feedback effects can partly offset the long-run persistence of the oil price drop.

Norges Bank (2016) study discusses that the price drop is not temporary but permanent which means that the firms will have to adjust to the lower activity level, especially in the petroleum industry. Permanently surged activities will cause group of workers to leave the jobs or accommodate lower income as well as change county or industry of occupation, unemployment is expected to spike up sharply. Brander, Brekke (2013) etc. estimate the effect of a fall in oil prices on the turnover of Norwegian enterprises based on the regional network of the Central Bank of Norway. The recent years are characterized with the increased deliveries to the petroleum industry. According to the study, out of 563 enterprises 40% are engaged in the petroleum–related sales. Due to the large concentration enterprises become more vulnerable towards the price changes. Specifically, the industrial and service provision
sector showed higher concentration compared to the building and construction sectors. Overall, the majority of companies noted that there would not be any impact in the activities if petroleum prices stayed not less than $100 per Barrel. The results show that if oil prices drop below $70 per Barrel Norwegian economy will face severe adverse impacts in the petroleum-related sales. The most responded that up to three-four quarters are needed in order for price decline to have an impact on sales in petroleum sector. Among those, only a limited amount of loss was possible to replace by shifting to sales in the non-oil industries within 1-2 years. 85% of pure oil suppliers state that they could only cover 20% of petroleum sales by increasing activities in the other markets which are not related to the oil.

Based on the above study, Norwegian enterprises show more concentration to the petroleum industry activities and less flexibility to recover from the losses by increasing shares of sales in the other industries. The results indicate that the oil patch workers are threatened considerably when the economy faces permanent contraction in the oil & gas industry.

1.2 Petroleum Sector after the Crude Oil Price Slump in Norway

In order to have rather broad understanding of the subject I review the development of the petroleum exports, investments and production activities after the 2014 downward spike of the oil prices that gradually continued during the consequent months.

Overviewing geographic location of petroleum activities gives a clear idea about the most sharply exposed group of workers to the changes caused by the unstable prices. Petroleum production has commenced gradually last fifty years on the Norwegian continental shelf. Many of the early fields are still producing. Petroleum industry has its roots in Rogaland County; first drilling activities started in the North Sea and then through time moved up to the northern part as the knowledge increased. The Map below shows the active areas which are currently open for production. The fields are starting to open in Jan Mayen and Svalbard. Territories locating on the North-Western part of the Norwegian Sea, continuing up to the Arctic Ocean are expected to contain petroleum reserves which might not be fully uncovered yet.
Gradually mainland’s activities have led to the increased export and large profit to the economy. Substantial part of the State’s revenues is taken up by the petroleum sector gains. These gains are transferred to the Government Pension Fund-Global. According to the Norwegian Petroleum Directorate (2014) the Fund’s values correspond to one million Kroner per Norwegian citizen.

Figure 2: Active Fields of Petroleum Activities. Source: Norwegian Petroleum Directorate (2014)

Figure 3: Share of the Petroleum Sector. Source: Statistics Norway, Ministry of Finance (2013)
Figure 3 shows that the exports of petroleum cover half of the total exported goods in Norway which makes the country third largest oil and gas exporter in the world. Approximately one third of the total revenues stems from the sector. These numbers indicate that the considerable part of the companies and workers are involved in the production and service deliveries related to the industry. Approximately 250,000 people are employed and more than fifty companies are operating on the Norwegian continental shelf where Statoil has the largest share followed by ExxonMobil and Total according to the Ministry of Finance (2013). The government and the private companies initiate vast amount of projects in exploration, field development, transport infrastructure, as well as in the open fields in order to accelerate recovery and expand lifetime of the existing fields.

For having a deeper insight of the oil price drop and its impact on micro-level it is vital to overview what happened to the above mentioned macroeconomic variables in Norway and whether the price drop in 2014 caused significant downsize in the economy afterwards.

Figure 4: Petroleum Production. Source: Statistics Norway (2013-2016).

Note: Thousands of Barrels per Day on the vertical axis

On Figure 4, petroleum production has been experiencing jumps over 2013-2014 years, but the consequent years have been marked with the stable production. One of the explanations is that even though the amount of the new projects reduced, it was still profitable to carry out the exploration activities that had already been started before the crisis occurred. Marginal cost of the production could be lower than the marginal profit, thus it was still profitable to continue producing petroleum without changes. Another explanation bases on the fact that the time span is not long enough to observe the radical changes in the production activities.

Investment dynamics in the sector is another crucial indicator for the economic growth. Figure 5 illustrates that the investments in the oil and natural gas extraction has been
noticeably decreasing after the reduction in the oil prices. This is an expected consequence since the low prices lead to the reduced revenues both for the private and public institutions, thus they vastly contract the new projects in the industry. Fewer projects have been approved and fewer fields have been developed after the price cut. Low investments indicate that the industry size is shrinking and a lot of workers are expected to lose jobs or change the occupation, which I plan to observe later in the thesis.

Figure 5: Extraction in Oil and Gas Investments. Source: Statistics Norway (2013-2016)

![Extraction in oil and natural gas Investments](image)

*Note: Actual investments NOK million on the Vertical –Axis*

Contracted investments could be the result of the decreased demand among the major oil-importer countries. Therefore, it is interesting to look at how petroleum exports develop after the price drop.

From Figure 6 we observe substantial decline in the crude oil exports starting in August 2014, lower global demand contributes to the price drops and as a result Norwegian companies face lower revenues and higher costs. If the price drop causes permanent structural changes, the impact would be severe not only for petroleum workers but for the whole economy. Fewer activities in the oil industry might cause spillovers to the other sectors and thus, non-oil workers can be negatively impacted as well.
Macroeconomic overview of the main industry drivers shows that the sector as a whole has been shrinking to large extent after the price slump. Evaluating the size of the diminishing phase and the consequences for workers has been a subject of interest by the vast amount of researchers, thus I dedicate the next section to the core literature review for in-depth understanding of the topic.

2. Relevant Literature

Over the recent years the number of handful empirical literature on the implications of the low oil prices has had a growing importance; though I present the ones I consider the most relevant for my study. Important statistical inference is published by NAV (2016). They find that after the reduced 2014 oil prices the need of the employees within the petroleum sector has decreased. Approximately 30% of the oil engineers and 40% of the civil engineers have changed the municipality of work following the 2014 sudden oil price drop. 30% and 34% respectively, have switched to the other industries. Petroleum engineers and civil engineers tend to be less flexible and stay longer period as jobseekers compared to the other workers, though they become more stable on the job market after being employed. The amount of civil engineers who kept being unemployed after the crisis vary across regions, Rogaland and Hordaland civil engineers have been more vulnerable to the job loss because of the regions’ intense concentration on oil-related activities.
The paper mentioned above illustrates the degree of exposure of oil engineers and civil engineers and the mobility to different sectors and municipalities. My thesis is different from the NAV paper in several aspects, I focus on oil producers and service workers in Rogaland and Hordaland regions rather than the whole country, and I support the analysis with individual fixed effects model in order to reduce the impact of the other events that took place during 2014 and onwards.

Useful statistical inference is found in the study of Lima (2016) at NAV. They show that the unemployment has increased in the south and west parts of Norway but has been pretty stable in the other regions of the mainland. Job loss was higher in the counties that are characterized by the larger dependence on oil-related activities. Despite the crisis they find that the employment increased in 8 counties from 19 in Norway in 2015 compared to 2014 and Østfold, Hedmark and Oppland did not suffer from the increased unemployment because of the less engagement in petroleum-concentrated occupation. Using difference-in-difference method they find that 24% of the unemployed in Rogaland started using sickness benefits. The same amount of unemployed sent applications for receiving unemployment benefits.

Statistics Norway (2018) finds that the oil workers, who changed the industry after the price decline, have faced 14.4% lower wages compared to the ones who kept the same industry. The reduction in wages is the least among the workers who switched to professional, scientific and technical service support. The observed fact has a logical explanation since petroleum industry workers earn higher than they would in the other sectors; changing the industry of work leads to the lower earnings.

The working paper of Huttunen, Møen et.al (2015) shows, that the job displacement is one of the major causes of the re-allocation of workers to different counties. The workers who move to the other regions suffer larger wage losses than the ones staying in same location. They look at the long-run family income dynamics between movers and stayers and find that there are no significant wage differences between them.

Similar study has been carried out by Facker & Rippe (2016) on German example. Their results indicate that the job loss has particularly positive effect on the regional mobility. Differences between movers’ and stayers’ income are not statistically significant in the short-run. The results coincide with the analogous paper published for Norway.

Even though the thesis does not conjecture causal relationship between regional mobility and the wages, conclusions are interesting for explaining re-allocation of oil workers across
regions and industries since the wages is one of the biggest motivators for decision-making process in the job market.

The paper “Where do jobs go when oil prices drop?” suggests that in the first year after the price drop oil and gas extraction and support activities for mining is characterized by the reduction in job creation and an increase in the job destruction in the USA. The reduction in private jobs is mainly caused by the closing firms in services and manufacturing. In this sector, especially in wood manufacturing, plastics and rubber products job destruction tends to be more responsive to the oil price decline than the job creation (Herrera, Karaki, et. Al. 2016).

Implications of the above mentioned paper are clearly related to the study in several aspects. In the US the oil price decline has excessive impact on non-oil workers in manufacturing sector. Based on the chosen control and treatment groups I am going to check whether there are spillovers to the other sectors in Norway and compare with the trends found in the USA.

Since I focus on employment, wages and job mobility it is useful to mention the study at the California State University by Dr. Nyakundi (2017). Correlations between oil prices, employment and wages are discussed for the five most oil-abundant counties in the US from 2011 to 2015. They find that the correlation coefficient between the total employment and the oil prices are positive in four counties. Weak relationship is captured between mining employment and the oil prices in the four oil-abundant counties. Though, wages are positively related to the oil prices, thus when the crude oil prices increase, total average wages tend to increase as well in the USA.

Job destruction in the petroleum sector has been a major consequence of the low oil prices in the mainland Norway. The Central Bank of Norway (2016) discusses the labor market frictions and the mismatch after the 2014 oil price decline. In the oil and gas extraction 22 000 jobs have been eliminated and the unemployment radically increased for oil workers in concentrated counties which are Rogaland, Hordaland, Møre og Romsdal and Vest Agder. The increased employment was noted in the regions with the lowest share of the oil jobs: Hedmark, Oppland and Østfold. The difference between the actual unemployment and the unemployment that would have been realized without mobility is labeled as a mismatch in the labor market. Another way, employers have difficulties in recruiting staff during the high unemployment. The paper investigates whether the high unemployment is a consequence of
the labor market mismatch in Norway. They find out that there has not been any significant evidence that the mismatch is present in the mainland. Based on the core findings of the Central bank of Norway we can assume in the rest of the study that the labor market mismatch is absent in Norway.

Looking at the labor mobility in 1997 in Norway, Statistics Norway (SSB, 2005) finds that the job exit rates are higher for low educated labor force compared with the ones having higher education. Middle and high educated people are more flexible to enter from the academic institutions and from unemployed to the job market compared to the ones having only compulsory education level. The middle educated workforce is the most mobile group of workers in the regional labor markets. High educated labor force is characterized with immense job mobility.

Another relevant paper published by Statistics Norway (2005) illustrates that the job mobility is particularly pronounced in Oslo and Akershus regions compared to the rest of the country. Internal migration tends to be higher in the capital regions and in the regional metropolises. The participation rate of the youngest age group of workers grows gradually in the capital regions. When it comes to the nationality, Norwegian citizens tend to be less mobile than all the other citizens residing in Norway, especially non-Western citizens are more flexible to switching jobs, though they tend to be less stable in the labor market.

The results are of particular interest for the research since the comparison can be made after separating people by their education level and discussing how mobile they become across sectors and counties.

### 3. Description of the Data

The thesis takes advantage of the encrypted longitudinal administrative data of employment made available for the research by Statistics Norway. The detailed micro-level data contains information regarding income, origin, age, education background, birth date, employment status and the conditions, corresponding municipality and the sector of occupation. Information is available for several decades. The dates of interest are from 2013 until 2016, combining the above mentioned characteristics for the individuals. I choose 2013 as a pre date before the oil price started to decline since it is the closest date before the price shock, assuming fewer changes took place between 2013 and the first petroleum price decline. The
primary objective of the study is to observe the employed petroleum workers in 2013 and their responses to the lower oil prices, thus I adapt several handful restrictions in the data.

There is one potential issue with the data source that needs to be taken into account before describing the core assumptions and restrictions. From January 2015 Statistics Norway changed the source of the employment statistics. The main source until this date has been Norwegian Welfare and Labor Administration (NAV) Employee Registry (The Aa-Registry), while after January 2015 the data is based on the A-order. A-scheme is a digital coordinated collection of employment and income data. It is impossible to measure the exact downsize caused by the data source change, though I identify below that it does not prevent the analysis.

Table 1 shows the workers who were present in one year in the petroleum sector and kept being present in the industry a year after. We can see that the workers switching to the other industries are increasing each year started from 2013. It is under question how much change from the given variables is associated to the data source changes. For example, unemployment could have hiked up but it could be caused by the changed job codes of the workers and not by the price drop. Unemployment could suddenly increase as they would automatically be assigned different industry code from January 2015.

Table 1: Transition from Petroleum Sector. Source: Statistics Norway (2017)

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Construction</th>
<th>Other Industries</th>
<th>Not Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008 Nov</td>
<td>59,7</td>
<td>27,7</td>
<td>6,7</td>
<td>5,9</td>
</tr>
<tr>
<td>2009 Nov</td>
<td>66,7</td>
<td>18,7</td>
<td>9</td>
<td>5,6</td>
</tr>
<tr>
<td>2010 Nov</td>
<td>71,3</td>
<td>17,2</td>
<td>6,8</td>
<td>4,8</td>
</tr>
<tr>
<td>2011 Nov</td>
<td>71,8</td>
<td>17,9</td>
<td>6,6</td>
<td>3,7</td>
</tr>
<tr>
<td>2012 Nov</td>
<td>72</td>
<td>17,8</td>
<td>6</td>
<td>4,2</td>
</tr>
<tr>
<td>2013 Nov</td>
<td>71</td>
<td>18</td>
<td>6,2</td>
<td>4,7</td>
</tr>
<tr>
<td>2014 Nov</td>
<td>65,8</td>
<td>15,1</td>
<td>7,8</td>
<td>11,3</td>
</tr>
<tr>
<td>2015 Nov</td>
<td>65,9</td>
<td>14,4</td>
<td>8,6</td>
<td>11,1</td>
</tr>
</tbody>
</table>

**Observed Changes**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2014 Nov-2015 Jan</td>
<td>74,8</td>
<td>18,8</td>
<td>1,4</td>
<td>5,1</td>
</tr>
<tr>
<td>2015 Nov-2016 Jan</td>
<td>76,5</td>
<td>17,6</td>
<td>1,3</td>
<td>4,6</td>
</tr>
<tr>
<td>2016 Nov-2017 Jan</td>
<td>77,2</td>
<td>17,8</td>
<td>1,2</td>
<td>3,8</td>
</tr>
</tbody>
</table>

*Note: All the numbers are evaluated in percentage points.*

Table 1 illustrates that the transition to the other industries from 2008 to 2009 has increased by 2.3 %, which probably happened because of the financial crisis in 2008. After that the oil price kept being stable over time until 2014 July, when it started to decrease. With the same
argument people switched to the other industries from 2014 to 2015 by 0.8% (8.6 – 7.8). Both of the periods are marked with the low oil prices and the increased amount of people who switched to the other industries, though as in January 2015 the data processing changed, we can expect that some parts of the estimation will be caused by changes in the data rather than the oil price drop.

In order to find out whether the transition to the new source of data-gathering prevents the analysis, I look at the months from November 2014 until January 2015. This period gives the shortest distance between the last measurement point with the old data and the first measurement point with the new data. The goal is to compare the transition from the petroleum sector to the other industries between 2014 Nov-2015 Jan and 2015 Nov-2016 Jan. If the change is caused by the oil price shock, then the same numbers should be present in both of the dates and to the contrary, if the data source makes radical differences, the change in unemployment and switching to the other industries should be remarkably higher among 2014-2015 compared to 2015-2016. For simplicity I assume that the downsizing in the petroleum sector is a continuous process where each month workers switch to the other industries by the same amount. The change between November and January includes two months. Under our assumption that the transition is continuous, the shift in 2014-2015 should have been $\frac{2}{12} \times 7.8\% = 1.3\%$. The observed change is 1.4%. Unemployment change is 11.3% in 2014, thus proportionally 2% should have been unemployed between November and January, while in the Table 1 we can see that the observed unemployment has been 5.1%.

Applying the calculations under the same continuity assumption to 2015-2016 years, 1.4% ($\frac{2}{12} \times 8.6\%$) workers should have changed their industries and 2% ($\frac{2}{12} \times 11.6\%$) of them become unemployed, though the actual numbers are 1.3% and 4.6%.

The numbers calculated above show that 2014-2015 and 2015-2016 years have approximately the same magnitude of transition despite of the new data source. This fact can be seen as an indication that the changes in the data do not provide big rashes during the estimation. The numbers to large extent reflect the actual downsize in the economy caused by the oil price drop, thus we can safely ignore the renewed data source and continue the analysis assuming that it will not impact the outcome variables.
3.1 The total Amount of the Employed in 2013

In order to make the oil-workers more tractable I define employment and it is different from the official definition of an employed person in Norway. There are several assumptions I use for identifying a worker in 2013.

The primary exogenous change of interest is the crude oil price drop, thus the logical assumption is to include workers most affiliated to the oil price fluctuations and restrict wages and age. I am interested in the outcome for more stable workers and their responses to the price decline, thus I restrict attention to the middle age group of workers in order to rule out the cases where young job participants would drive the employment pattern, wage changes or job mobility. For this purpose I focus on 25-60 year old individuals since this group is expected to be the representative age group in the petroleum industry and hence, the most impacted when the sector shrinks or expands.

Another restriction in the data that I make is on the job type. A single person can work in several different companies either part-time or full-time. I identify the main job for each employed according to their highest income and disregard the firms where they earn less, this way a lot of part-time workers are ruled out. For measuring income I observe wages before tax, bonuses and grants. The analysis becomes more compelling when the changes are not driven by the part-time workers but instead a rather established group of workforce in the industry.

The handful restriction is to assume that the employed earn more than three times Base Payment. This restriction reduces the amount of outliers from the data, since the oil workers earning less than the given amount are not the majority in Norway; they are rather exception on the job market.

Overall, the employed person in Norway in 2013 is defined as a 25-60 year old full-time worker earning three times more than the Base Payment.
3.2 Regional Variations of the Worker Observables

Taking into account the restrictions and assumptions, we can see on Table 2 that the total amount of workers in 2013 is more than one million. Among those approximately 44% are female.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1,124,185</td>
<td>42,638</td>
<td>9,219</td>
<td>25</td>
<td>60</td>
</tr>
<tr>
<td>Female</td>
<td>1,124,186</td>
<td>0,443</td>
<td>0,497</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Native</td>
<td>1,124,187</td>
<td>0,837</td>
<td>0,46</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Wage 2013</td>
<td>1,124,188</td>
<td>524074</td>
<td>294880,3</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Education

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compulsory</td>
<td>1,124,190</td>
<td>0,158</td>
<td>0,368</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1,124,191</td>
<td>0,407</td>
<td>0,491</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Higher</td>
<td>1,124,192</td>
<td>0,434</td>
<td>0,495</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Production</td>
<td>1,124,194</td>
<td>0,013</td>
<td>0,115</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Oil Services</td>
<td>1,124,195</td>
<td>0,016</td>
<td>0,124</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

I divide the employed in the data by the three categories based on their acquired education level using Norwegian Standard Classification of Education (2016). I separate the employed by education the following way:

<table>
<thead>
<tr>
<th>Compulsory</th>
<th>Intermediate</th>
<th>Higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Childhood (0)</td>
<td>Upper Secondary (3)</td>
<td>Bachelor’s or equivalent (6)</td>
</tr>
<tr>
<td>Primary (1)</td>
<td>Post-secondary non-tertiary (4)</td>
<td>Master’s or equivalent (7)</td>
</tr>
<tr>
<td>Lower Secondary (2)</td>
<td>Short-cycle tertiary (5)</td>
<td>Doctoral or equivalent (8)</td>
</tr>
<tr>
<td>Unspecified Values (9)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

41% and 43% of the total workers in the country have intermediate and higher education correspondingly. High educated employed dominate the other two categories, this trend in education makes fairly good sense due to our assumptions on age and wages. Middle age workers with three times more than the base payment wages are expected to be average and highly educated. In the data we can observe that approximately 84% of the job participants are native.
Around 1.3% of the employed are involved in the oil production activities and 1.6% are occupied by the oil-related service delivery. Average wages is above 500 000 NOK. Since I am going to identify petroleum production and service workers as well as non-oil workers, it is worth paying attention to the above mentioned characteristics in different counties.

Table 4 suggests that the top five counties composed of the highest educated workers are Oslo, Akershus, Sør-Trøndelag, Troms, Hordaland and then Rogaland follows. Oslo and Akershus are the “capital counties” with the majority of workers and higher amount of the open job positions. Sør-Trøndelag has been engaged in agricultural activities involving high-tech business, healthcare and education, thus micro-specialization of workers is required to take over the announced positions. Rogaland and Hordaland have noticeable amount of the employed with high degrees and the reason is its large concentration on oil-related activities. Petroleum sector requires specific skills and knowledge, thus it is more common for these two regions to hire high/intermediate educated workers.

### Table 4: Education Level by County

<table>
<thead>
<tr>
<th>County</th>
<th>Compulsory (%)</th>
<th>Intermediate (%)</th>
<th>Higher (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Østfold</td>
<td>19,5</td>
<td>44,5</td>
<td>36</td>
</tr>
<tr>
<td>Akershus</td>
<td>17,3</td>
<td>36</td>
<td>46,7</td>
</tr>
<tr>
<td>Oslo</td>
<td>15,2</td>
<td>30,9</td>
<td>53,9</td>
</tr>
<tr>
<td>Hedmark</td>
<td>17,2</td>
<td>45,9</td>
<td>36,9</td>
</tr>
<tr>
<td>Oppland</td>
<td>15,1</td>
<td>48,3</td>
<td>36,5</td>
</tr>
<tr>
<td>Buskerud</td>
<td>18,2</td>
<td>43,4</td>
<td>38,4</td>
</tr>
<tr>
<td>Vestfold</td>
<td>16,1</td>
<td>44,4</td>
<td>39,5</td>
</tr>
<tr>
<td>Telemark</td>
<td>14,7</td>
<td>48</td>
<td>37,3</td>
</tr>
<tr>
<td>Aust-Agd.</td>
<td>14,2</td>
<td>45</td>
<td>40,8</td>
</tr>
<tr>
<td>Vest-Agd</td>
<td>14,9</td>
<td>46,9</td>
<td>40,3</td>
</tr>
<tr>
<td>Rogaland</td>
<td>16,1</td>
<td>42,9</td>
<td>41</td>
</tr>
<tr>
<td>Hordaland</td>
<td>14,9</td>
<td>41,1</td>
<td>44,1</td>
</tr>
<tr>
<td>Sogn og Fj.</td>
<td>15</td>
<td>47,9</td>
<td>37,2</td>
</tr>
<tr>
<td>Møre og Roms.</td>
<td>16,9</td>
<td>45,5</td>
<td>37,6</td>
</tr>
<tr>
<td>Sør-Trønd.</td>
<td>13,2</td>
<td>41,7</td>
<td>45,2</td>
</tr>
<tr>
<td>Nord-Trønd.</td>
<td>12,3</td>
<td>47,5</td>
<td>40,2</td>
</tr>
<tr>
<td>Nordland</td>
<td>16,9</td>
<td>44,9</td>
<td>38,3</td>
</tr>
<tr>
<td>Troms</td>
<td>15,9</td>
<td>39,3</td>
<td>44,9</td>
</tr>
<tr>
<td>Finnmark</td>
<td>20,2</td>
<td>39,7</td>
<td>40,1</td>
</tr>
</tbody>
</table>

Intermediate and higher education are almost evenly distributed across counties, though Intermediate degree is as seen most spread among the regions.
Having discussed education level it is meaningful to see whether the top highly educated counties pay out the highest wages. The following figure shows the wage dispersion in the nineteen counties.

Figure 7: Earnings by County (NOK)

Note: Yearly Earnings on the Vertical-axis. Grey color – top five counties with the highest earnings.

As seen in Figure 7 Rogaland workers earn the highest salary on average (approximately 600 000), followed by Oslo, Akershus, Hordaland, Vest-Agder. Average wages in these counties are higher than 500 000 NOK. It is noticeable that wages and education are somewhat related, though education by no means is the sole factor explaining wage differences. We can observe that Rogaland County pays out top wages while the majority of the high-educated workers are concentrated in Oslo region. Explanation lies in the occupation, Rogaland is oil-abundant, thus the most skilled workers are focused specifically in the region in order to deal with the complex petroleum production activities. The employed with specific skills are paid better, thus petroleum workers earn on average higher gross wages than the ones in the other industries.

I examine the background of workers based on their nationality and gender since controlling for those factors could explain variation in unemployment and wages, as well as the job mobility. According to Statistics Norway (2016) gender gap between private and public sector varies, more amount of female workers are present in private sector in Rogaland, Oslo, Sør-Trøndelag and Møre og Romsdal while public sector is characterized by the opposite tendency. The least concentration of women in Rogaland and Hordaland counties can be explained by the main occupation, petroleum sector tends to be male-dominating.
Figure 8 shows that the least amount of female workers are employed in Rogaland (40%), followed by Vest-Agder (41%), while the most diversified group of workers on the job market is present in Oslo (77% of native workers) followed by Akershus (79% of native workers).

3.3 The Least and the Most Exposed Industrial Groups

In the thesis I focus on the dynamics of wages, employment and the job mobility. Job mobility includes changing the county or the industry of occupation. Since the decline in prices was the major source for the Norwegian enterprises to adjust to lower activities in the petroleum sector, some of the employed in the oil and gas industry are expected to subsequently drop out of the labor market. For this purpose I identify the most impacted group of the oil-sector participants and for the comparison I choose the workers that are not directly suffered by the oil price fluctuations.
In general, there are several industries the most severely impacted after the price spikes down:

1) *Production of crude oil and natural gas and pipeline transportation* – According to Norges Bank (2013) 30% of investment in Norway accounted for this sector. Employment in this sector was 1% of the total employment in the same year.

2) *Services linked to production of crude oil and natural gas* – This sector covers exploration, production drilling and other services on the continental shelf. The employment is almost equally high in this sector as in the first one.

3) *Other products that are specially adapted to the needs of petroleum industry* – Such enterprises are spread all over the country.

4) *Non-petroleum- specific goods and services supplied to the petroleum industry* – This sector includes e.g. Banking and financial services, transportation and hotel services, audit services which are specifically supplied to the petroleum industry.

For the sake of in depth understanding of the outcome trends, I divide industries by the two categories. I focus on the above mentioned first two industries which I later on call “Oil workers”, thus, one group consists of oil producers and oil suppliers, while the second category is represented by non-oil industries that are not directly impacted when the price drops. I choose the least impacted industries according to the Input-Output tables at Statistics Norway (2013). The tables give the picture of the total supply and the use of all the goods and services in Norwegian economy, thus I identify the least and the most affected industries based on the companies’ supply-usage. I combine them in order to compare the gap between the two different groups of workers.

In order to identify directly impacted workers I check the regions that are mostly represented by the oil production and service related workers. On Figure 9 we see that Rogaland and Hordaland are more actively involved regions in petroleum-related occupation than the other counties as expected. Around 7% of the oil producers and 8% of the petroleum service related workers are present in Rogaland, while 2% and 3% are accordingly in Hordaland.
We call Oil producers and Oil service suppliers in Rogaland and Hordaland a Treatment group (T-group -21,620 workers), while the industries which are the least engaged in petroleum –related activities represent a Control Group in the same counties (C-group – 33,609 workers). \(^1\)

The above mentioned T and C groups could be different by covariates (characteristics such as age, income, nationality, education etc.). If I do the regression simply including the treatment and control group as they are defined above I will get wrong estimated coefficients (biased coefficients). For example if we find that unemployment increased more in the T group than in the C group we cannot argue that this fact is a consequence of the oil price drop and not of the differences in the covariates, T group can be consisting of more amount of young workers than Control, thus they would show higher flexibility to changing jobs or getting unemployed, and the coefficients will be negatively biased. Mobility decreases with age and increases with education attainment.

\(^1\) Treatment Group: Oil Producers, Oil service suppliers in Rogaland and Hordaland;

Control Group: Electricity, Gas, Stream and Air-conditioning; Natural Water, Water treatment and supply services; Sewerage; Waste collection, treatment and disposal activities; Information services, Financial services except insurance and pension funding; Insurance, reinsurance and pension funding services except compulsory social security; services auxiliary to financial services and insurance services; Real estate services; Legal and accounting services; Education Services; Human health services; Social work services.
In order to reduce bias caused by differences in covariates and make the two groups similar and comparable, I decide to find the matches of petroleum workers in the non-oil industries. According to Stuart (2010) one of the advantages of the matching method is that the similar covariate distribution of treatment and control groups guarantees that the two groups are randomly different on all background covariates that I decide for. In order to implement matching I first choose the covariates that I am going to match workers with. Some papers use more than 50 covariates (Rubin, 2001), though when the sample is small the priority should be given to the ones which are thought to be most related to the outcome variable. I consider age could impact employment level as well as the job mobility since younger workers appear to be more flexible to moving and less stable on the job market. Education could impact the final results as well. High educated workers will find it easier to keep the job than their counterparts with lower degree. Earnings interval, gender, County and Working hours per week are the rest covariates that I include in matching since they will be highly correlated to employment, wage dynamics and job mobility in the regression analysis.

Brookhart et. al. (2006) mentions that there is a sufficiently large tradeoff between the increased variance and the decreased bias of the coefficients when we use matching and then carry out the regression analysis. If we include covariates most related to the treatment assignment but unrelated to the outcome we face higher variance even though bias of the coefficients decreases. Several authors note that it is recommended not to include variables that might be impacted by the treatment of interest (Rosenbaum, 1984). Treatment of Interest is oil price fall in the paper. Age, education, gender and working hours per week are not impacted by the oil price drop but highly related to the unemployment and job mobility, thus after using these characteristics it is guaranteed that the regression output will not suffer from highly increased variance in the regression equation. County and Earnings Interval could be impacted by the price fluctuations, yet not clear that the variance would be increased since they are also correlated with employment and wages, as well as job mobility.

Exact matching is ideal in the analysis, though not always applicable in practice and usually creates larger bias than in case of approximate matching. Instead of exact matching I use Ration Matching. One of the issues with the method is that it requires trade-off between lower variance and increased bias. Since multiple controls are selected for each individual every 2nd, 3rd etc. closest matches are further away from the treated group than the 1st individual, though since the sample size of the workers is large the variance is not expected to be high.
4. Empirical Strategy

The reduced prices could lead to the contracted jobs in Rogaland and Hordaland, thus after time petroleum workers would drop out of the job market. Shortage of investments could reduce earnings of the employed further over the long-run. In order to have a deeper insight of the subject I draw attention to the unemployed and see whether they change the location or the industry. Some of them might consider job offers from the other counties or expect that the price drop has permanent downward impact on the development of the industry and decide to change the work environment. In order to see the outcome over time first I compare the variables of interest for T and C groups for better visual illustration, then present description and the econometric analysis in order to validate the results. The analysis will be carried out for treatment group workers relative to the control group.

I use individual fixed effects model for precisely estimating the difference between T and C group outcomes.

4.1 Explanatory Variables

*Employment* is one of the independent variables that I am going to include in the regression analysis. In order to study dynamics of the employment I first define the workers who would fit under this category through time. Employed in this study as mentioned above is a 25-60 year old person who earns more than $3 \times \text{Base Payment}$. Starting out from the full employment in 2013, I follow the petroleum workers over time and identify how many of them fit in the category; the variable is measured in percentage points for all months.

*Wage* is an independent variable for another regression equation. It is convenient to use wages relative to the Base Payment, thus \( Wages = \frac{\text{Total Amount of Wages per Month}}{\text{Base Payment}} \). This formulation lets us ignore measurement units during interpreting the results. Alternative would be to use log of wages instead.

*Same County* is one of the variables of primary interest in this analysis. It describes workers who keep living in the same county of occupation as in 2013. I generate a binary variable for each month.
Same Industry is defined similar way as Same County variable. Those are the workers who keep the same industry of occupation as in 2013. It can be represented as a binary variable, which equals to 1 if the worker stays in the same industry, and equals to 0 if the worker switches to another industry. The variable is generated over 33 months from January 2014 until September 2016.

Including independent variables in the analysis adds a clear insight for the causal inference. One of the possibilities would be to find instrument for the regression analysis, though I was not able to find a good instrument, thus I restrict attention to the individual fixed effects model for introducing the dynamics of the above mentioned variables.

4.2 Control Variables

The essential reason of using the Individual Fixed Effects model is that there are no unobservable factors which influence the outcome. Unobservable factors that I control for are:

1) State fixed effects – These are omitted variables that do not depend on time but vary among individuals. For example, Rogaland workers could be motivated to move to another county for non-economic reasons; they might like the climate of the other parts of Norway better and change the environment of work. Their preferences are not observed in the data, thus the results would be false if I instead used OLS regression; preferences across workers would be an omitted variable impacting the results and creating downward bias in the coefficients. 2) Time Fixed Effects – The factors that change over time but stay the same across individuals. For example, gradual development of the automated jobs could impact the employment and wages, as well as the job mobility and the coefficients would be more negatively biased. For time fixed effects I use binary variable taking value of 0 and 1 for each month. I allow n-specific intercepts; one for each individual. 3) In the end I generate interaction variable of time and treatment group. I include time as a continuous variable, while individuals are discrete.

The advantage of the model is the absence of the omitted variable bias created by unobservable factors. Since we control for time and state fixed effects, and match petroleum workers with their counterparts in non-oil industries, the analysis does not suffer from highly biased coefficients.

The model can be described by the following equation:
\[ Y_{it} = Individual_i + \sum_t \beta_t Time_t + \sum_t \beta_t \times Time \times Treated_t + u_{it} \]

*Individual* \(_i\) is a binary variable for each individual (24,544), another way individual intercept. *Time* \(_t\) is a dummy variable for each month (33). Coefficient of *Time *\(Treated_t\) measures the difference between treatment and control group’s independent variable each month compared to the base month. \(u_{it}\) is the error term varying over time and through entities.

There are several main assumptions that need to be taken into consideration in order to avoid bias in the results and inconsistency. The mean of the error term is equal to zero in the sample by definition. Observations are independently and identically distributed, matching guarantees that the oil and non-oil workers are different from each other on the random basis. Since I rule out older and younger age groups, as well as restricted earnings, I exclude outliers that create imprecise results. Considerably important assumption is that the error terms need to be uncorrelated. (Stock & Watson, 2012)

### 4.3 Results

#### 4.3.1 Employment and Wage Dynamics

Empirical analysis is the core of the thesis, thus I address the outcomes and implications thoroughly in this section. Employment rate for T and C groups is depicted on the left-hand side of Figure 10. The oil and non-oil workers follow the same decreasing trend before September 2014. We can see that the control group becomes more volatile after September. Employment rate for the workers in C group does not reduce below 90%, while less than 85% of oil workers are employed at the end of 2016. The gap between the industries becomes larger through time. On average, more than one fourth of the oil-related workers in Rogaland and Hordaland regions drop out of the job market in September 2016.

Illustrated trends could suffer from omitted variable bias since over time other important events could take place and impact the direction of the movement. In order to disregard the effect of unobservable factors I validate the results with individual fixed effects regression. \(^2\)

\(^2\) All the Regression Outputs illustrate coefficients on interaction term *time*treated. Confidence intervals are plotted with the dashed lines. Coefficient is significant at 5% level if 0 is out of the interval, and is non-significant when zero is included in the confidence interval. Regression Output contains cluster-robust standard errors. Base Month is January 2014 for all the regression outputs.
Note: Employment Dynamics measures the amount of workers who keep having wages more than three times Base Payment each month compared to 2013 year.

On the right hand-side of Figure 10 we can see that the difference between T and C groups’ employment rate compared to the base month January 2014 is not statistically significant before June 2015 and after that the change becomes negative and significant. Regression output in Table A in Appendix shows that the oil workers are characterized with lower employment rate but the difference is negligible in the start. Gradually the gap between T and C group compared to the base month increases and in the end 8% more oil-workers drop out of the job market compared to the C group. The difference is significant at 0.1% level.

The results are in line with the Central Bank of Norway (2016) predictions as well as NAV (2016) papers. They observe reduced petroleum activity during 2014-2016 years and less announced job positions. Low employment rate among oil-workers could be a consequence of the contracted economic activities after the crude oil price decline.

Negative relationship is captured between the expected rate of change of the real wage and unemployment (Blanchard & Katz, 1999). If unemployment increases, wages over the long-run is expected to decrease. Therefore, it is particularly interesting to look at the wage dynamics.
Figure 11: Wage Dynamics and Regression Output

Note: Dropped months on Wage Dynamics for illustrative purposes: March 2014, March 2015 on the left-hand side. Wage Dynamics plots monthly relative wages for T and C groups.

The left part of Figure 11 illustrates that the monthly wages for Treatment and Control groups move simultaneously until January 2015 and thereafter they fluctuate in summer June-July each year. There are several possible explanations of the jump. Every employed is entitled to the holiday pays and the employment benefits in Norway. Even though official dates of transferring the amount varies among the institutions, the payment is usually carried out in June-July, thus we can see the spike up in monthly relative wages. The private and public institutions have salary negotiations every year, even though the date of the negotiation varies, many of them set the fixed date in March, April or May. Wage is normally negotiated at the higher level, thus we could notice high jump in wages in these months.

Even though T group starts to earn slightly less than C group after 2014 summer, regression output on Figure 11 confirms that the wage differences between the two groups are not statistically significant after correcting for time and state fixed effects. The reason lies behind collective-wage bargaining process in Norway which is fixed in the short-run and therefore, monthly wages are not deviating a lot from the stable amount. The agreements follow the strictly hierarchical procedure, where the most important of these agreements are set between the largest union confederation LO and the national employers association NHO in the private
sector. There are additional negotiation agreements within the local companies. The basic principles and rules are set every fourth year. (United Federation of Trade Unions, 2016-2018). As a result monthly wages are fixed in the short-term and radical changes are not announced during the short time interval.

4.3.2 Job Mobility across sectors and counties

It is hard to cope with being jobless for several consequent years, thus there are most likely people who do not want to stay being unemployed and move to another county or change the industry of occupation in order to seek for the better solution. Figure 12 presents the workers who live in the same county as in 2013 each month. The right hand side shows the regression output in order to acknowledge whether the change between T and C groups becomes significantly large after time.

More than 85% of the petroleum workers have been living in the same county as previous year in January 2014, gradually the number is increasing and at the end of 2016 the number of workers who move to the other counties becomes higher than 30%.

If we look at the regression output, we can see that the change before September 2015 is not significant, afterwards more oil workers move out to the other counties, thus the change becomes negative. The results are significant at 0.1% level (see Appendix, Table A). At the end of the 2016 year the workers who change counties are 9% more in T group compared to the C group after the base month. The results are in line with Statistics Norway (2016) paper; they found that in the start of 2016 4% of the petroleum workers moved out to the other regions. In Figure 12 we observe the same trend for Rogaland and Hordaland counties, and the number increases to 9% at the end of the period.
Figure 12: Workers Staying in the Same County and Regression Output

Note: January 2015 is characterized by the same amount of drop in control and treatment groups because of the new data source, though as shown in the section of Data description above it does not change the results, thus for illustrative purposes I add the change to the both groups to plot the Same County dynamics.

Even though the re-allocation is not high, the results are significant. As Huttunen et al (2015) suggest job loss strongly increases regional mobility. Figure 12 and 13 illustrate that the amount of workers who move to the other counties is higher than the total unemployment rate; this result could also be a consequence of the mobility across regions that is not related to the job loss. Some of the employed from the sector might be getting more profitable offers in the other regions and re-allocate. It is hard to define exactly the amount of workers who move due to the lost jobs after reduction in oil prices, though the regression output illustrates that the petroleum workers are characterized by higher re-allocation rate compared to the workers in least impacted sectors and the difference between the two groups becomes particularly large after the petroleum price slump.

The downward price shock could cause oil producers and service workers to change the industry after realizing that the sector is expected to shrink permanently and it is profitable to switch to the non-petroleum institutions. In Figure 13 we observe that every month less amount of the petroleum workers are present in the oil sector compared to 2013 year, some of the employed do switch to the other industries, though the regression output verifies that the
change between T and C groups is negligible at 0.1% significance level. Oil price drop did not significantly induce workers to switch to the other industries.

Figure 13: Workers keeping the Same Industry and Regression Output

Note: January 2015 is characterized by the same amount of drop in control and treatment groups because of the new data source, though as shown in the section of Data description it does not change the results, thus for illustrative purposes I add the change to the both groups to plot the same county dynamics.

As we illustrate, industrial changes across petroleum workers are not immense and even though some of them re-allocate to the other counties, the number is small. There are several reasons that induce the low flexibility towards job mobility. One of the primary arguments is that petroleum workers are paid the highest wages, thus they prefer to become unemployed temporarily rather than permanently change the occupation since they expect that the sector will recover from the downturn after several months and they will get back to their positions.

The workers who lose jobs prefer to increase the usage of the unemployment benefits, to go on sickness leave or apply for the temporary disability programs because they believe that they will actively get back to their jobs after time.

Another important reason could be family ties. Fairly often the employed tend to have family connections in the same counties where they live or work, thus they find it costly to move to
another region. Changing the industry as well as county could be associated with higher costs rather than staying and waiting for stepping back to the job market.

### 4.3.3 How do wages start varying? – Petroleum Employed vs Unemployed

The above two paragraphs illustrated how the oil workers acted upon the unexpected price shock comparing them to the workers not involved in the oil production or service jobs, though it is rather thought-provoking to contemplate the different wage levels that would be pronounced within the sector. I divide petroleum sector participants by the two categories: 1. *Unemployed petroleum workers* are the ones who earn less than 3 times Base Payment consequently 3 months after the first price drop in July 2014 until January 2015. 2. *Employed petroleum workers* are the participants in the job market during the rest of the period. I decide to make such division since I assume that the unemployment during consequent three months immediately is most related to the drop of the oil price.

Figure 14 illustrates that the group of oil sector participants who became unemployed directly after the first reduction in prices earn higher amount in the start of the period compared to the rest of the petroleum workers. The difference is continuously decreasing and after July 2014 they start earning lower wages compared to the employed; wages of the unemployed oil workers become noticeably lower.

There are several reasons behind the trend. The workers who change occupation or re-allocate can be more intensely concentrated in the Petroleum Employed group. The empirical analysis at Statistics Norway (2015) shows that the oil workers, who change the industry or the county earn considerably lower wages. Alternative explanation is that the unemployed within the oil production and services decide to become a member of the short-term unemployment benefit schemes or disability insurance programs; in this case they will earn lower wages as well.
In order to see the significance of the difference between the employed and the unemployed, I illustrate the regression outcome. As Figure 15 depicts the difference between the two groups is not so large in the start, though over time the unemployed earn substantially lower wages compared to the employed. The difference becomes -4% in March 2016 compared to the change in the base month.

Figure 15: Regression Output, coefficient on interaction term unemployed*time
5. Robustness tests

In order to strengthen and verify the results in chapter 4, I conduct several robustness tests. One of the drivers of the outcome could be workers of foreign origin. Treatment group might consist of more amounts of foreign workers who are relatively flexible to moving to the other counties and changing jobs. In this case coefficients of the regression equation would be biased downwards. In order to identify whether the foreign workers change the significance of the results I evaluate the regression equation for each four outcomes:

\[ Y_i = Individual_i + \sum_t \beta_t Time_t + \sum_t \beta_t \times Time \times Treated_t + \sum_t \beta_t \times Time \times Foreign_t + u_{it} \]

Next I observe the difference between T and C groups which is given by the coefficient of the interaction term \( Time \times Treated_t \). Figure A.1 in Appendix shows the regression output for all four equations. The results are similar to the regression output analyzed above in the Results section; the difference between oil and non-oil workers’ employment rates is still substantial; there are not particularly big changes between wages and industry changes. More amount of oil workers start re-allocating to the other counties compared to their counterparts in the non-oil related sectors.

Even though I matched workers by education, the changes in employment and the job mobility can be caused by more amount of the low educated employed in the T group. For this purpose I include interaction term between compulsory education and time:

\[ Y_i = Individual_i + \sum_t \beta_t Time_t + \sum_t \beta_t \times Time \times Treated_t + \sum_t \beta_t \times Time \times Foreign_t + \sum_t \beta_t \times Time \times Compulsory_t + u_{it} \]

If the low-educated workers move to the other counties which is not related to the oil-price changes then the results will be different from the previous observations, though in Figure A.2 in Appendix regression output verifies that the results are similar for all the variables, the difference between Treatment and Control groups becomes significantly negative gradually for the employment and same county.

Another issue with my empirical findings above could be the measurement error when I estimate the relative wages. Instead of dividing wages to the Base Payment I estimate log-linear equation:

\[ \log (Wages)_i = Individual_i + \sum_t \beta_t Time_t + \sum_t \beta_t \times Time \times Treated_t + u_{it} \]
Figure 16 plots the difference between T and C groups compared to the base month. Wages are less volatile, though the results are similar to the regression analysis carried out using relative wages to the base payment, the coefficient of the interaction term Time * Treated is not significant and wage dynamics does not incorporate any particular trend over time.

5.1 Spillovers to the other industries

The low oil prices reduce investments in the petroleum sector as discussed in chapter 2 because the contracted profitability from the exploration activities in the North Sea. Low investments in turn negatively impact public and private sector spending. Public sector will face cuts in the oil tax revenues, thus they adjust to lower savings rate. Private sector in Norway is triggered several ways by the decline in oil prices. Upstream and downstream petroleum producers are most sensitive and vulnerable when the price changes, though the drop can have crucial effects on the other industries when the extensive part of the companies is occupied by the deliveries to the petroleum industry. For example, even though financial sector is mostly well diversified and hedged in their loans, their investments extend well to the energy sector since it is considered one of the most stable income sources when the prices are not diverging a lot. The external shock to the oil prices was unexpected in 2014 as discussed in the introduction; in this case financial sector can be subject to the lost profits depending on the size of their investments in the energy sector. The low prices will reduce
profit from the investments and induce less pronounced activities in the sector, thus non-oil industry workers might have to cope with lost jobs or become more mobile across sectors and counties.

Another problem could be that the aggregate demand for acquiring new workers might reduce in other industries since the economy overall tends to slow down because of the increased input costs and low profitability. Reduction in the total demand will cause most sectors to announce fewer job positions, thus higher unemployment is inevitable.

Control group in the thesis by definition consists of financial and insurance service workers in addition to the other sectors. In order to estimate whether the employed in the Control group have different trends I loosen the requirement of the region, instead of finding matches of oil workers in Rogaland and Hordaland I look at the matches in the C group over the whole country.

Regression output in Figure A.3 in Appendix illustrates that the employment is not changed for the C group workers as well as wages and job mobility. Financial and insurance service workers in addition to the rest sectors included in the C group do not seem to be importantly impacted by the petroleum price drop in the whole country. One of the explanations is that financial service sector workers are not directly involved providing services to the energy industry, thus they are not suffering from the crucial income losses. Another reason for the fewer changes is that the time span is very short for evaluating the size of the price decline; longer period is needed in order to observe changes in the indirectly exposed industries.

Even though C group defined above is not subject to changes we cannot disregard the severe impact on the economy as a whole. Manufacturing industry is expected to adjust responses corresponding to the announced petroleum prices. Steel producers, machinery and shipbuilding workers are expected to vary their activities depending on the sector’s activities since their occupation is directly related to the availability of projects. In addition to the workers mentioned above, some companies specializing in information technology services might be effected by the price drop. As an example I consider Services attached to Information technologies (62) and Technical consulting business (71) using Standard Industrial Classification (2007) and compare to the oil workers in the T group.

Figure A.4 in Appendix verifies that the above mentioned sectors suffer with higher announced unemployment rate. The workers in IT services tend to change industry more extensively than the oil-workers. Intuitive explanation is that the above mentioned industries
are giving out technology maintenance services to the oil industry intensively, thus contracted investments are most likely to have its spillovers on occupations relating to the maintenance of the petroleum appliance.

6. Discussion and Conclusion

Vast inter-dependence of the economy on the petroleum sector has become fundamental reason to investigate how oil workers respond to the low oil prices. In the thesis I addressed the exposure of petroleum workers in the two most intensively involved counties, Rogaland and Hordaland during 2013-2016 years. The effects cannot be ignored by the central institutions and authorities since I found that the oil employed suffer dramatically more than the workers in the other industries. Petroleum employment rate at the end of 2016 became 8% lower than the non-oil employment rate. 9% of the Rogaland and Hordaland oil sector participants moved out to the other counties and the results are significant at 0.1% level. Individual fixed effects regression output verified that the wage differences are negligible between the oil and non-oil sector workers, while wage differences appeared particularly high within the petroleum unemployed and employed, the oil unemployed earned approximately 4% lower wages at the end of 2016 compared to their employed counterparts. Spillovers to the other counties need to be paid attention since Information Technologies and technical consulting services were found to be largely exposed to the reduced oil prices. Even though individual fixed effects combined with matching method absorbs much of the bias it is impossible to be certain that there is no omitted variable bias left, due to this issue I cannot make conclusions about causal relationship, though the thesis clearly illustrates important downward drifts in the petroleum sector following the dramatic price decline.

I began the analysis with the dynamics of the employment rate. The study illustrates that the employment rate among petroleum workers decreased substantially. The number of employed who kept being present in the job market gradually reduced. The reduction of the employment rate became more disclosed after May 2015 and the difference between petroleum and the other industry workers spiked up to 8% compared to the base month January 2014. Low rate of employment is caused by the conjecture of several factors. Because of the low oil prices investments for the new projects reduced, some of the existing ongoing projects were cancelled due to the negative profitability of the petroleum companies. Investors started to gradually invest in the other sectors, in addition negative expectations have further prolonged
the process of contracting activities. Altogether, workers who were involved in the production and service delivery had to cope with fewer announced job positions.

I observed wages that the workers earn in the industry; the study showed that there are non-significant changes in monthly relative wages between oil and non-oil sector employed. In order to estimate impact of the oil price shock on relative wages, a longer time span is needed for the analysis. The short interval is not enough to see the particular trends in wages, besides somewhat fixed regulations protect workers from radical earnings fluctuations. As expected, wages are fixed during short-term for the most industries, thus I do not observe significant differences over time.

Furthermore, I found that the re-allocation to the other counties increased up to 8% at the end of the period, though the number of workers who changed the industry is not significant. The explanation lies in family ties and preferences. The ones who live with families find it costly to move to another county, in addition since the sector pays off the highest wages, the unemployed expect that the sector will recover from the temporary crisis, thus they prefer to accept short-term unemployment and sickness benefits over permanently changing the workplace. The employed who lost jobs might have hoped that gradually they would get back to the sector after the price recovery.

Similar trends are noticed for the workers who move to the other industries. The number of people changing the industry is minor and the difference between T and C groups is not significant due to similar reasoning, by shifting to the other industry workers agree to earn lower wages permanently, instead of long-lasting changes they prefer to wait and see until they get their jobs back.

In the thesis I also looked at the petroleum workers who stayed unemployed during the consequent three months after the crisis until January 2015. I observed that they earn higher monthly wages but after July 2014 when the price drop started the trend changes and they start earning lower monthly wages compared to the other workers. Possible explanation is that the unemployed people changed expectations about returning to the job they lost and started to re-allocate and switch to the other industries; as a result, they ended up with lower earnings.

In addition, I described consequences of the price drop on the other industries in the whole country; the results indicate that the negative spillovers to the other industries were not
successfully avoided. I showed that the sectors which are involved in construction and maintenance of petroleum technologies were impacted rather immensely.

It is difficult to estimate the amplitude of the effect of the low oil prices beforehand due to its unpredictable nature. The size of the crisis and the amount of workers who suffer from the lost jobs is largely a reflection of the dependence of the Norwegian economy on the petroleum sector. Even though efficient management of resources has helped Norway to build up the strong model, pro-cyclic nature of the economy with the oil prices cannot be denied. High dependence on the petroleum revenues causes the sector to become less flexible towards changes in prices and as a result, substantial part of the employed is not able to remain in the job market. If the decline has a permanent nature oil patch workers have to cope with either changing the region or the industry of work.

The results are not only qualitatively significant but quantitatively important and in line with the similar empirical working papers. The thesis does not cover causal inference, though the methodology verifies that the results are valid within the boundaries of my setup. The negative effects of the low oil prices are inevitable for the petroleum industry participants. Even though Norway succeeded in managing the resources efficiently, the downturn of the economy after the oil price drop is drastically high. Since the degree of the exposure depends on the size of the price decline and the latter can hardly be predicted precisely, a profitable strategy would be to create a particular system for encouraging job mobility across counties and industries. Even though oil workers are highly skilled, we saw that they do not re-allocate and the number of them switching to the other industries is negligible. The workers during the downturn after the low oil prices should be able to find the job easily in the other industries or regions. In order to promote job mobility the responsible institutions could increase particular campaigns oriented on the petroleum workers in Rogaland and Hordaland in order to reduce their dependence on the geographic location of the job and the sector. Their skills can be subsidized by the state as well for incentivizing and increasing motivation for higher job mobility.
7. References


https://tradingeconomics.com/norway/crude-oil-production Last Access : 02/04/2018


8. Appendix

Table A: Regression Output for T and C groups, monthly coefficients

<table>
<thead>
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<th></th>
<th>Employment</th>
<th>Wages</th>
<th>Same County</th>
<th>Same Industry</th>
</tr>
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<tr>
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<td>0.02</td>
<td>0.005</td>
<td>0.06</td>
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<td>0.005</td>
<td>0.06</td>
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<td>0.003</td>
<td>0.005</td>
<td>0.06</td>
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<td>0.005</td>
<td>0.08</td>
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<td>0.011</td>
<td>0.005</td>
<td>0.01*</td>
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<tr>
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<td>0.003</td>
<td>0.004</td>
<td>0.011*</td>
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<tr>
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<td>0.002</td>
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<td>-0.005</td>
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<td>-0.013**</td>
<td>-0.02</td>
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<td>0.01</td>
<td>-0.013**</td>
<td>-0.04</td>
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<td>0.007</td>
<td>-0.014**</td>
<td>-0.02</td>
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<tr>
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<td>-0.012</td>
<td>0.014</td>
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<td>0.002</td>
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<td>-0.04</td>
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<tr>
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<td>-0.037***</td>
<td>0.01</td>
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<tr>
<td>Time*Treat = 16</td>
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<td>0.035</td>
<td>-0.046***</td>
<td>-0.09</td>
</tr>
<tr>
<td>Time*Treat = 17</td>
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<td>0.137***</td>
<td>-0.03**</td>
<td>0.016</td>
</tr>
<tr>
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<td>-0.007</td>
<td>-0.041***</td>
<td>0</td>
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<tr>
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<td>0.017</td>
<td>-0.016</td>
<td>-0.037***</td>
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<td>0.028</td>
<td>-0.047***</td>
<td>-0.02</td>
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<td>-0.053***</td>
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<td>0.061**</td>
<td>-0.058***</td>
<td>-0.024*</td>
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<td>0.023</td>
<td>0.048***</td>
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<td>-0.003</td>
<td>-0.068***</td>
<td>-0.006</td>
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<td>0.241***</td>
<td>-0.069***</td>
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<tr>
<td>Time*Treat = 28</td>
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<td>-0.069***</td>
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<tr>
<td>Time*Treat = 29</td>
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<td>0.113***</td>
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<td>-0.019</td>
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<td>Time*Treat = 30</td>
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<td>-0.069***</td>
<td>-0.019</td>
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<tr>
<td>Time*Treat = 31</td>
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<td>-0.078***</td>
<td>-0.017</td>
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<td>-0.087***</td>
<td>-0.021</td>
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<tr>
<td>Constant</td>
<td>0.960***</td>
<td>0.917***</td>
<td>0.91***</td>
<td>0.94***</td>
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</table>

| R-squared | 0.492 | 0.718 | 0.727 | 0.69 |
| Observations| 1 129 458 | 1 040 532 | 1 129 458 | 1 129 458 |

Note: *= 5%  **= 1%  ***= 0.1% Significance Level. Monthly coefficient enumerated from 1-33 during 2014-2016 years. Using Cluster-Robust Standard Errors omitted in the output for illustrative purposes. Time fixed effects are included, though I do not present them in the table since it is not primary interest of the analysis. Absorbed on individual basis. R-sq. close to 1 indicates a high explanatory power of the model.
Figure A.1: Regression Output including interaction term foreign *time

Note: Coefficient on interaction term $time*treated$ is plotted. Dashed lines are confidence intervals at 5% significance level.
Figure A.2: Regression Output including interaction terms foreign *time and compulsory education*time

Note: Coefficient on interaction term time*treated is plotted. Dashed lines are confidence intervals at 5% significance level.
Figure A.3: Regression Output, Petroleum workers are matched with non-petroleum workers in the whole country.
Figure A.4: Trend Between T and C group.

Note: Control Group includes: Services attached to Information technologies (62) and Technical consulting business (71). Dashed Line = Control Group. Solid Line = Treatment group.