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The Effect of Natural Resource Abundance on Income of Local Labor Markets

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Abstract

This master thesis contributes to the literature on the effect of natural resource abundance on regional level outcomes in Norway. We aim to analyze the causal effect of an onshore petroleum facility (OPF) approval on average income of labor markets that were allocated an OPF, and whether labor markets within commuting distance to the OPF experience any spillover effects on their average income. The identification strategy is of a generalized difference-in-difference setup, exploiting the rollout of onshore petroleum facilities between 1965 and 1992. The sample consists of all municipalities in Norway in 2016, and the time period comprises 1957 to 2008.

The results of this thesis show no significant effect of an OPF approval on average income in labor markets where an OPF is established, while spillover effects increase average income of surrounding labor markets by 3.2 per cent. Extending the analysis, we find that an OPF approval led to a rise in average income of 3.4 per cent in labor markets with an OPF during the 2000s. Similarly, spillover effects from OPFs increased average income by 3.9 per cent in surrounding labor markets during the 1980s. We also find that the unemployment rate increases by 0.4 per cent following approval in labor markets where the OPF is located, and insignificant spillover effects onto unemployment in surrounding labor markets.

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1 Introduction

1.1 Motivation and Purpose

Until the early 1980s, the Norwegian gross domestic product (GDP) per capita was consistently below that of its neighbors, Denmark and Sweden. Comparisons by the turn of the millennium provide a completely different picture, where Norway enjoys the largest GDP per capita among the Scandinavian countries. The altered situation is conventionally and plausibly attributed to the Norwegian petroleum discovery of 1969, and the subsequent development of the Norwegian petroleum industry (Larsen, 2006). However, large oil revenues are not synonymous with economic growth and development. On the contrary, empirical macro literature often indicates that resource-abundant countries perform worse than non-abundant countries in terms of GDP growth and living standards (Auty, 2001). This counter-intuitive phenomenon was coined as the natural resource curse by Richard Auty in 1993.

Based on the evidence of a present natural resource curse, Norway and Botswana stand out as they have been seemingly successful in converting their natural resources into sustained economic growth and development (van der Ploeg, 2011). However, studies of resource-abundance in Norway are performed mainly on a national level. A growing literature debates whether the resource curse occurs within countries, also in the context of economies who seemingly have escaped the resource curse on a national level. The question is whether petroleum extraction has benefited persons living in the resource-abundant areas. Such insight is essential for policy-makers who are deciding whether to encourage or restrain introduction of resource extraction.

Supportive information of this kind is highly relevant in the Norwegian setting, as the petroleum industry is steadily advancing in the north. The debate is ongoing about whether we as a nation should develop the petroleum industry in the future, and especially whether the industry should be expanded further in the northern parts of Norway. Drilling in the coastal areas outside Vesterålen and Lofoten, and in the Barents Sea, is an unresolved dispute that continues to be a central conflict in Norwegian politics. Shedding light on the question of whether persons living in resource-abundant areas have benefited from the petroleum extraction is important in the cost-benefit analyses performed in connection to such debates. This is also what motivated us to study the effect of OPFs on local labor markets outcomes.

1.2 Research Question

In this thesis, we will exploit the rollout of OPFs to analyze the effect of natural resource abundance on average income of local labor markets. Our research question is as follows:

"What is the effect of an onshore petroleum facility approval on the average income of local labor markets?"

Several indicators of resource abundance are used in the literature. We will elaborate more on our choice in Section 4. Moreover, the approval of an OPF is likely to affect other labor market outcomes, such as unemployment and immigration. Further, it would be interesting to study potential heterogeneous effects within the labor market, such as effects across sectors or over demographics. The scope of this study is, however, limited to focusing on the average income of the labor markets, and a small investigation of unemployment and net immigration. The remainder of the paper is organized as follows. In Chapter 2, we present background information on the petroleum industry in Norway. Chapter 3 describes previous relevant literature on this subject. The chosen empirical approach is explained in Chapter 4, followed by a description of the exploited data in Chapter 5. Chapter 6 includes results of our analyses, both main findings, sensitivity tests and extended analysis, while Chapter 7 presents a discussion of the findings. Chapter 8 concludes the thesis.

2 Background

Norwegian Oil Exploration and Industry

In 1958, the Geological Survey of Norway (NGO) assured the Ministry of Foreign Affairs that the possibility of petroleum discoveries on the Norwegian continental shelf could be disregarded (see, e.g., Helle, 1984). In general, few people believed Norway's continental shelf was concealing rich oil and gas deposits in the late 1950s. Today, the petroleum industry is by far the largest contributor to the Norwegian economy, both in terms of revenues, investments and total value creation (Norwegian Petroleum Directorate, 2011).

After the findings of gas at Groningen in the Netherlands in 1959, expectations were revised. Phillips Petroleum was the first international company to contact the Norwegian Ministry of Industry. Their offer was seen as an attempt to achieve exclusive rights over the Norwegian continental shelf. The authorities declined the offer, and 31 of May 1963 the Norwegian government proclaimed sovereignty over the Norwegian continental shelf. Licenses were issued to oil companies for carrying out preparatory exploration and performing seismic surveys the same year. The drilling licenses were postponed until border agreements and further regulations for the petroleum industry were reached in 1965 (see, e.g., Helle, 1984). The licensing round contained blocks located south of the 62nd parallel north, issuing 22 production licenses for 78 blocks (see, e.g., Lerøen, 1990). These licenses gave exclusive rights not only for exploring but also for drilling and production in the licensed area (see, e.g., Helle, 1984).

Esso was the first international company to drill for oil in the North Sea, using the oil rig "Ocean Traveler". As the Norwegians lacked knowledge for platform construction in the 1960's, the oil rig was constructed in New Orleans and towed to Norway. The rig drilled its first exploration well in 1966, but it turned out to be dry. It took 3 years, 33 wellbores and 750 million NOK in expenses for the companies before the first economically interesting oil field was discovered (see, e.g., Helle, 1984). Ekofisk, which turned out to be one of the largest offshore oil fields ever found, was discovered in 1969 and marks the start of many major discoveries on the Norwegian continental shelf (Ministry of Petroleum and Energy, 2016). The production at Ekofisk started in 1971 (see, e.g., Helle, 1984).

Optimism towards the oil industry grew after the first significant discoveries were made, and the confidence of politicians and stakeholders increased. State participation in all profitable discoveries was required, either through an additional tax on net profits or though direct ownership, to ensure that the discoveries benefited the Norwegian public. This also allowed the Norwegian oil industry to gain new knowledge and become more independent. In 1971, the parliament issued a white paper stating that all petroleum extracted from the Norwegian continental shelf, if possible, was to be landed in Norway (see, e.g., Helle, 1984). The parliament also voted to ensure economic, political and operative control over the oil industry through a state-owned company and an oil directorate. This resulted in the establishment of Statoil and the Norwegian Petroleum Directorate (NPD) in 1972.[1] Whereas Statoil was to take care of the business, NPD was responsible for government administration, exploration and supervision. Hence, the early 1970s marks a turning point for the petroleum industry in Norway. Due to lack of knowledge, foreign companies initially dominated the industry, but from 1972 and onward the focus was going to be domestic experience and an independent industry (see, e.g., Gjerde, 2014).

Supply Bases

From the first license round in 1965, all companies were required to establish Norwegian subsidiaries and run their operations from Norway (Gjerde, 2014). This eventually led to the creation of offices and onshore supply bases along the coast of Norway. The purpose of a supply base is to compose a supply-package to the offshore oil industry, supplying all essential goods and services during the exploration-, construction- and production phase (NOU 1980:39, 1980). The bases operate supply- and support vessels, loading and unloading of ships, goods- and bulk handling and more administrative tasks such as rental of offices and warehouses and rental of crews and rigs (Gjerde, 2014).

Esso decided in 1965 to locate their onshore supply base to the city of Stavanger. Their decision was based on the proximity to the exploration areas and harbour conditions (Tolås, 2009). Soon the other companies and suppliers followed, and an oil industry cluster quickly built up. Crucial for this development was the engagement and commitment of local politicians and businesses. When both Statoil and NPD eventually located to the city, Stavanger officially became the "oil capital" of Norway (see, e.g., Gjerde, 2014).

When the exploration and development mainly took place in the southern part of the North Sea, Stavanger was an ideal base area. However, the need for establishments farther north became

[1] Statoil changed their name to Equinor 16 of May 2018 (Equinor, 2018). When referring to the historical aspects of the petroleum industry, we use the name Statoil.

apparent as Statfjord was found close to Sognefjorden in 1974. This led to the establishment of Coast Center Base (CCB) at Ågotnes close to Bergen the same year. Furthermore, in 1978 the government decided to make efforts to expand the oil industry farther north, leading to the area north of the 62nd parallel north being opened for exploration drilling from 1980 (see, e.g., Gjerde, 2014). Acquisition of licenses required presentation of a plan regarding the organization of onshore activities. This led to the establishment of supply bases farther north. There were also several expansions below 62nd parallel north in the late 1970s and early 1980s.

Landing- and Processing Plants

Despite the parliament's statement in 1971, petroleum was not landed in Norway before 1985. There were large technological barriers associated with crossing the Norwegian Trench, and petroleum from the first producing fields was therefore piped to other countries (see, e.g., Helle, 1984). In the early 1980s diving tests convinced the NPD that repair of 400 meters deep pipelines was feasible. This led to the construction start of the first gas pipeline to the Norwegian coast in 1983. Statpipe opened in 1985 and led gas from Statfjord to the processing plant built on Kårstø. The first oil pipeline followed a few years later, transporting oil from Oseberg to the Sture terminal, which operated from 1988. After these successful projects, several landing- and processing plants followed farther north, resulting in a large transport network connecting the fields, Norway, the United Kingdom and the continent (Gjerde, 2014).

The steady increase in new petroleum discoveries on the Norwegian continental shelf, in addition to decisions made by politicians in the early 1970s, has given rise to a major and independent Norwegian petroleum industry. The investments in offshore activities, infrastructure, supply bases and landing- and processing plants has given substantial ripple effects onshore (Nilssen et al., 2008). Whereas most parts of the country are affected by the petroleum industry today, the initial shock hit the southwest of Norway, and then the following supply base areas further north.

3 Literature review

There exists a vast amount of literature concerning natural resource abundance and economic growth. Historical observations indicate that natural resource abundance tends to impede rather than enhance economic growth of a country. However, the empirical literature does not agree on whether resource abundance facilitates or impede economic growth. See van der Ploeg (2011) for a thorough overview of the different literature suggestions. The early research on this field focus on the performance of countries, but in later years there has been a growing literature investigating if similar effects can be observed on a regional level. This section will present literature concerning the latter. We first present evidence from regional markets in the U.S. and then turn to studies focusing on Norway. As can be seen below, findings are not concurrent on the regional level either.

To our knowledge, there are no empirical studies investigating the causal effect of the introduction of OPFs on labor market outcomes in Norway.

3.1 International Literature

Basso (2016) exploit cross-sectional variation in oil reserves with time series variation in oil prices between 1969 and 1999 to study the consequences of natural resource shocks on labor market conditions in the U.S. Geological characteristics of the region, combined with the oil price, determine changes in the local value of resources and trigger local labor demand shifts. He argues that his strategy is plausibly exogenous, as the price of oil is determined outside the local labor market. He finds that oil-rich economies adjust by increasing local employment, nominal wages and income from capital during long-term booms, while migration is relatively stable. During busts, he finds negative impacts borne locally through higher non-employment and large reductions in human capital investments.

Michaels (2010) use panel data from 1890 until 1990 to investigate the long-term effects of resource-based specialization on local economic development within southern states in the U.S. The identification strategy exploits geological variation in oil abundance to define treatment and control counties. He argues that the source of variation is plausibly exogenous and that concerns of endogeneity are overcome since the southern counties exhibit small institutional differences, and since all the substantial onshore oilfields in the U.S. are discovered within his time period. Findings show that oil abundance contributed to economic development by increasing education and average income. He also finds that the share of workers employed within the extraction sector increased, which had minor effects on the manufacturing sector.

Allcott and Keniston (2014) estimate the effect of oil and gas booms on local economies in the U.S. They use a "shift-share" approach, exploiting time-series variation in national petroleum employment from 1969-2014 and cross-sectional variation in counties' initial petroleum endowment. They find that local wages, population and revenue productivity are procyclical with petroleum and that booms are canceled out by busts. Even though real wages are higher for oil abundant counties during booms, they find evidence in favor of positive spillovers onto manufacturing; manufacturing in resource-abundant counties grows during resource booms. Thus, the results present overall evidence against the presence of a natural resource curse. This is similar to the findings of Michaels (2010).

Papyrakis and Gerlagh (2006) examine whether a natural resource course can hold across regions within the U.S. They use cross-state regressions and investigate the effect of natural resource abundance on several outcomes. Their data show that resource-scarce counties have a comparative advantage with regards to economic growth and that natural resource abundance is a significant negative determinant of growth through decreasing investment, schooling, openness, R&D investments and increasing corruption.

3.2 Studies concerning Norway

Several studies focus on how Norway has avoided the resource curse on a national level (see, e.g., Bjørnland, 1998, Larsen, 2006, van der Ploeg, 2011). The number of studies investigating regional effects of resource abundance is, however, limited. We present some empirical studies by Dyrstad and Brunstad and some reports published by Norut Northern Research Institute concerning regional ripple effects of the petroleum industry.

Dyrstad (1987) uses variation in the number of people employed within the petroleum sector in Norwegian counties, and the nominal wage level within the industry, from 1973-1982 to estimate the effect of the petroleum industry on county-level nominal wages and unemployment. He finds that increased nominal wages in the petroleum sector unambiguously increase the nominal wage level and the rate of unemployment in the county. He also finds that increased employment within the petroleum sector increases the nominal wage level, while it has an ambiguous effect on unemployment.

Dyrstad and Brunstad (1997) investigate demand and cost-of-living effects of the Norwegian petroleum industry in local labor markets from 1971-1982. Variation in the number of persons employed within the petroleum sector is used to classify labor markets that are regionally close to the petroleum industry.[2] They determine the demand and cost-of-living effects by OLS through investigating wages before and after the boom in these sub-markets across different sectors and occupations. They find a positive demand effect on nominal wages for workers occupationally and regionally close to the petroleum industry. Moreover, cost-of-living increase in labor markets regionally close to the petroleum industry. The net effect in these regions was positive for those affected by the increased demand, whereas those unaffected experienced a decrease in their real wage. From these findings and the findings of Dyrstad (1987), they conclude that the rise in petroleum wages has been transmitted to the manufacturing sector through comparison effects in the Norwegian wage formation system, which has caused weak manufacturing performance.

Arbo et al. (2007) provides an overview of the existing literature concerning regional ripple effects of the petroleum industry in Norway. Most of the literature presented is experience studies and impact assessments concerning the construction of the OPFs. From the observed literature, the authors conclude that the effect of an OPF on regional development depends on several aspects. These include the industry mix where the OPF is located, the type of industry that locates in the market following the establishment of the OPF and time passed since establishment. Lastly, they find that the development of the petroleum industry in Norway is path dependent in the sense that the established clusters in Stavanger and Bergen have influenced operations in other labor markets. This has led to a reinforcement of these clusters also when development is happening in new areas.[3] Nilssen et al. (2008) builds on the report of Arbo et al. (2007) and investigate regional ripple effects from the establishments of OPFs in Harstad, Hammerfest, Kristiansund, Aure and Sandnessjøen. They perform input-output analysis, examine cluster dynamics and value-chain analysis as well as interviews, surveys and present different descriptive statistics for the individual markets. They do not conclude on any general effect but find that the size of the ripple effects in the market mainly depends on the factors put forward by Arbo et al. (2007).

[2]Labor markets, where more than 5 per cent of total employment are within the petroleum sector, are defined as regionally close.

[3]Path dependence is the idea that decisions we are faced with depend on past knowledge trajectory and decisions made, and are thus limited by the current competence base (Financial Times Lexicon, 2018).

4 Empirical Approach

This thesis aims to estimate a causal effect of the approval of an OPF on the average income of local labor markets.[4] To be able to claim causality, the inherent endogeneity between petroleum activity, income and other characteristics of the labor market must be overcome. Our identification strategy is of a generalized difference-in-difference setup, exploiting the rollout of onshore petroleum activity.[5] The variation in exposure is driven by decisions to establish an OPF. We assume that, even though decisions were politically motivated, the timing is independent of factors that affect our outcome variables and thus inflicts an exogenous shock.[6] This assumption will be further discussed in Section 4.2.

We estimate the following model:

$$log\, y_{it} = \alpha + \gamma D_{it} + \phi N_{jit} + \delta X_{it} + \beta_c + \theta_t + \epsilon_{it}, \tag{1}$$

where y_{it} is the outcome of interest for local labor market i in time t.[7] D_{it} is an indicator variable equal to one if labor market i at time t is treated and zero otherwise. γ represents the effect of an OPF approval on average income and is our key coefficient. N_{jit} equals one if a labor market j in close distance to labor market i has been treated in time t. ϕ represents the spillover effects of an OPF approval onto nearby labor markets and is also a coefficient of interest. X_{it} is a set of market specific time variant control variables. These include educational attainment, population density, share of people on social security benefits, share of people working in the health sector and share of women, youth and retired. See Table A2 for an overview of the control variables. β_c is a full set of labor market indicators allowing for time-invariant factors to differ between labor markets. An example is persistent differences in income caused by other natural resources or structural differences in the labor market such as industry composition. Time fixed-effects are included to control for common year specific shocks and are indicated with θ_t. Such events could be tax changes, inflation fluctuation or a financial crisis affecting the whole economy. ϵ_{it} is the error term.

Failing to control for unobservables correlated with both the explanatory variable and the outcome variable would lead to omitted variable bias (OVB), and a causal effect cannot be claimed

[4]Onshore petroleum facilities include supply bases and landing- and processing plants.

[5]Papers utilizing this approach are Akerman et al. (2015) and Bütikofer et al. (2016), amongst others.

[6]See Vatne (2003) for an overview of government petroleum policies.

[7]We use the logarithm of the average income to incorporate the non-linearity between average income and the explanatory variables.

(Angrist and Pischke, 2015). Including fixed effects and control variables helps to avoid OVB by controlling for effects that could cause post-treatment differences between treated labor markets and the control group.

4.1 Choice of Treatment

For our analysis, we use the location of OPFs to define the treated group, whereas the approval year defines the treatment cutoff. Due to the complexity of the offshore petroleum industry, we also extend the analysis by using other treatment cutoffs. See Section 6.4.

Treatment Group

Several papers, such as Allcott and Keniston (2014), exploit geological variation in counties' petroleum endowment to study the effect of natural resource abundance on local economies. The treatment group is defined by initial oil and gas endowment, indicated by discovery and subsequent extraction within the labor market. Such a definition of the treatment group would be our preferred approach. However, determining endowments is more challenging when discoveries are made offshore, outside the geographical area of any labor market. With offshore petroleum activity, it is natural to consider labor markets which are highly influenced by the petroleum industry as endowed with petroleum.

OPFs were established in labor markets along the coast as a direct consequence of the offshore petroleum activity. Through deliverance of supplies and landing of petroleum, the labor markets became directly connected to the industry. This connection created large workplaces, which caused long-term structural changes in the labor market (Gjerde, 2011). Thus, we consider any market with an OPF connected to a petroleum discovery on the Norwegian continental shelf as endowed with petroleum, and thereby treated.[8]

Treatment Year

The most exogenous shock in the petroleum process is the discovery of petroleum fields. However, the previously mentioned challenge with offshore discoveries is also present when assigning treatment year. In addition, the effect of an offshore petroleum discovery on a local labor

[8]Plants are to a large extent located in the same labor markets as earlier established supply bases, causing the treatment group to mainly consist of labor markets where a supply base was established.

market does not necessarily emerge close in time to the specific discovery. The petroleum industry in a given market goes through several stages from the first exploratory expeditions until full petroleum production. Preparatory processes and expectations in the markets might induce an effect before the specific discoveries are made. Further, production start of several fields takes place many years after discovery as they might not be considered economically interesting at the time of discovery. For example, condensate from the Cod field was discovered in 1968, while it took nine years before production started in 1977. Such lags in the petroleum process can result in a lag of the effect on local labor markets and potentially bias the average effects of discovery towards zero. Thus, assigning treatment year to local labor markets is challenging.

Due to the preparatory work, which for many companies started years before the first discoveries, some of the first supply bases were established before any oil was discovered.[9] The drilling rigs and ships required supplies in the exploratory period, leading to activity at the supply bases also in this period. However, it is reasonable to expect that the economic activity in the market began to increase even earlier in the process. When an OPF is approved, expectations in the market increase and the construction process starts. Preparing the site, building facilities and improving infrastructure requires construction workers, supplies and administration. Thus, it is reasonable to expect changes in income as economic activity, caused by an OPF approval, increase in certain labor markets. Therefore, our main analysis uses the date of approval of the OPF as treatment cutoff. If there is more than one OPF located in the labor market, the approval date of the first OPF is applied as treatment year.

4.2 Test of Key Identifying Assumption

Our empirical strategy exploits variation in when and where OPFs were approved to estimate the effect on average income in the local labor markets. The key assumption of this approach is that the timing of approval is uncorrelated with other determinants of average income in the labor market. To provide suggestive evidence of this assumption, we first investigate relevant law and policy changes over the time period. Then, we exploit an event-study specification to investigate whether pre-approval trends in average income influence the treated labor markets. Also, we perform an alternative check of the assumption by including market-specific time trends in Section 6.3.

[9] This is the case for four of our treated labor markets; Stavanger, Kristiansund, Hammerfest and Kårstø.

Norway implemented large tax reforms in 1969, 1987, 1992 and 2006. Generally, tax reforms are both implemented simultaneously in all labor markets and impose equal changes in average income for the labor markets, and are thus controlled for by time fixed effects. However, if the implementation of a reform coincides with approval, it can be difficult to isolate the treatment effect of the OPF approval, and our results might be biased. This is the case for the tax reform in 1992, which coincides with approval of the OPF in Aure. We investigate this further in Section 6.3, where the labor market of Aure is excluded from the regression. Our findings confirm that the baseline results are robust to excluding Aure, suggesting that the tax reform in 1992 pose no threat to our analysis. Moreover, reforms implemented prior to approval can cause differential trends in income for the labor markets. Hence, the reforms of 1969 and 1987 might threaten our strategy as they occur prior to treatment for certain labor markets.[10] Whether this violates our strategy will become apparent in the event-study figures discussed in Section 6.2. Our findings suggest that this is not a problem. Other reforms and policy changes are also investigated, and to our knowledge, there are no further policy changes or reforms threatening our strategy.

Other contemporaneous events in the local labor markets possibly influencing average income may also bias the estimates. The industrial history of all treated labor markets is, therefore, investigated. The OPF approval in Florø occurred in 1979. This coincides with establishment of the largest employer in the region, the central hospital in Førde. As Førde is a neighboring labor market to Florø, it is reasonable to assume that establishment of the hospital created incentives to commute out of Florø. To account for the potential spillover effects from the hospital onto the labor market of Florø, we include a control for persons working in the health sector in our analysis. To our awareness, the rest of the treated labor markets are not affected by such events.

Event-Study

We are not able to observe all factors influencing the decision to establish an OPF in a certain labor market. Thus, a violation of the key assumption of independence in the timing of OPF approvals cannot be excluded. A possible concern is that pre-approval trends in average income drive the estimated effects in Equation 1. For instance, if approvals occur in labor markets with decreasing economic growth, it would bias the effect of approval on outcomes negatively.

[10]The reform in 1969 occurs prior to all treatments except for Sola, and the reform in 1987 occurs prior to treatment in Aure.

To test whether the assumption holds, we use an event-study specification.[11] This approach allows us to examine differences in pre-trends across groups visually. In addition, it provides information on the timing of treatment effects, which in turn can indicate the underlying mechanisms for the effects (Kose et al., 2016). This is further analyzed in Section 6.2.

The model we estimate is the following:

$$log\, y_{it} = \alpha + \sum_{\tau=-8}^{-2} \omega_\tau D_{i,t+\tau} + \sum_{\tau=0}^{m} \nu_\tau D_{i,t+\tau} + \phi N_{jit} + \delta X_{it} + \beta_c + \theta_t + \epsilon_{it}, \tag{2}$$

The binary indicator $D_{i,t+\tau}$ equals one if a facility ever was approved in labor market i and the year of observation is τ years from treatment year in this market. ω_τ are the anticipatory effects and represents income in the years prior to approval, while ν_τ are the subsequent effects and represents income in the years after approval. The other variables are equivalent to those included in Equation 1. The year prior to treatment constitutes a control and is therefore omitted.

Significant anticipatory effects indicate differential pre-trends between control and treatment group. This implies that there are time-varying omitted variables correlated with both the outcome variable and $D_{i,t+\tau}$. Thus, the independence assumption is violated, and the control group does not represent a suitable counterfactual for the treatment group. However, if ω_τ is insignificant for all $\tau < -1$, the hypothesis of no pre-trends cannot be rejected. This allows us to interpret ν_τ as the causal effect of onshore facility approval in year τ after treatment. Results from the event-study figures are discussed in Section 6.2.

4.3 Standard Error Issues

Traditional inference assumes that the data are independent in the sense that there is no correlation between observations. Any research design with a group structure is potentially threatened by dependence due to correlation between individuals within the groups, i.e. the clustering problem, or due to variables within groups being correlated over time, i.e. serial correlation (Angrist and Pischke, 2009). Bertrand et.al. (2004) argues that the issue of serial correlation is especially critical in the difference-in-difference context.

For our model it is likely that income of a labor market in a certain year is correlated to the previous years, representing a serial correlation problem. Income of labor markets within the

[11] Other papers using event-studies to examine pre-trends are Autor(2003) and Bütikofer (2017), amongst others.

same counties can also potentially be correlated, representing a clustering problem. Both issues affect statistical inference. Bertrand et al. (2004) propose different solutions. One includes clustering standard errors at the group level. Standard errors for all specifications are therefore clustered at regional labor market level in our analysis, obtaining 40 clusters in the baseline model.[12] Standard errors are also robust to heteroscedasticity.

[12] Details about the distinction between local and regional labor markets are found in Section 5.1. The number of clusters varies somewhat for the sensitivity analyses, ranging from 39 to 46 clusters.

5 Data Description

We have constructed a panel data set where average income of the labor markets is linked with OPF approval year and control variables. The data are mainly collected from Statistics Norway (SSB) and the NCRD.[13]

The time span of our analysis should cover both the period before and after a labor market is affected by the petroleum industry. Approval of the first OPFs in the different labor markets mainly occured between 1965 and 1992. The time period of our data is therefore from 1957 to 2008. The upper restriction is due to lack of data on income beyond 2008. The time span of our data allows us to investigate both short- and long-term effects.

In this section we will describe the data used in the analysis, as well as the choices we have made when collecting and restricting the data set. We first describe the data on income, then the treatment group data are presented, followed by data on control variables and how the sample is selected. Lastly, descriptive statistics are presented.

5.1 Data on Income

Our measure of income is Ordinary Income, which is gross income minus income deductions of personal taxpayers residing within the municipality.[14] Data on total income per municipality are collected from the Municipal Tax Assessment from 1957 until 2008. However, between 1957 and 1971 we only have data for 1961, 1965 and 1968. Income is corrected for inflation and reported in 2015 kroner.

In our analysis, we are interested in the effect of an OPF approval on average income of the local labor market. Hence, we are only interested in persons participating in the labor force.[15] Our outcome variable is therefore equal to the average income of the working age population.

[13]SSB has overall responsibility for providing statistics on the Norwegian society. The NCRD collects municipality level data for Norway from Statistics Norway.

[14]Municipalities are the lowest administrative level in Norway. Gross income includes earned income, business income, pensions and capital income (Statistics Norway, 2018c). Deduction from income includes deductions associated with work, business or cost of capital (Statistics Norway, 2018d). Between 1970 and 1992 special deductions were also deducted from the gross income (Aukrust and Borgenvik, 1969, Statistics Norway, 2005). Special deductions include deductions associated with disability, large medical expenses and reduced earning capacity (Statistics Norway, 2018e). The special deductions are therefore added to the net income to obtain a variable corresponding to the ordinary income during this period. Similarly, we add the income of seamen acquired on board between 1965 and 1989 since their income was reported separately from other taxpayers during this period (Statistics Norway, 1983, 1994).

[15]The labor force is defined as the sum of employed and unemployed, where the unemployed are people either on temporary layoff or without income-producing work and actively seeking such employment (Bø and Håland, 2015).

Following the Labor Force Survey, we define the working age population as people aged between 15 and 74 and exclude all others (Bø and Håland, 2015). Furthermore, we control for people that are not participating in the labor market. This is discussed in more detail in Section 5.3. Data on the size of the population in each market from 1950-2008 is collected, as well as the number of people under age 15 and over 74 from 1950, 1960 and 1967-2008.

According to NCRD, data collected from the municipal tax assessment are comparable going back to 1948. However, the tax system and the possibility to collect data has changed over the time span of our analysis.[16] Furthermore, several reforms have been implemented during the period. Following these reforms, the amount of deductibles and the tax rate have changed (Statistics Norway, 2005). As stated earlier, this does not pose any threats to our strategy if the changes affect municipalities equally and do not correlate with the timing of approval. Regarding the quality of the data, NCRD states that collection-, dropout- and register errors are present to a small extent, which is reassuring.

Labor Markets

There are 428 municipalities included in our analysis. These are the existing municipalities in Norway in 2016. Municipalities that have merged during the time period have been merged from the outset of the analysis.

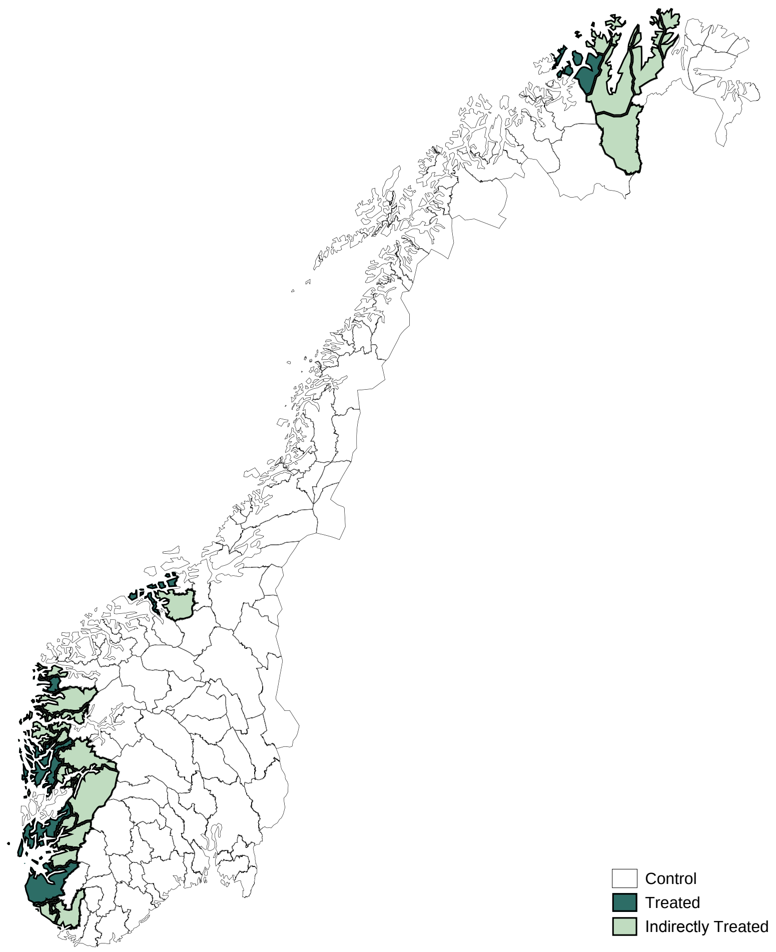
Commuting between municipalities is likely to increase following the establishment of a large workplace such as an OPF. Since commuters income is registered within the municipality of residence, commuting might lead to spillover effects from the municipality where the OPF is located to the surrounding municipalities. To capture the full effect of the petroleum industry we make use of labor market divisions based on commuter statistics.

Bhuller (2009) divides Norway into 46 labor markets (hereby referred to as regional labor markets). We suspect that there might exist some heterogeneous effects within these labor markets as they enclose a large number of municipalities and cover large geographical areas. Gundersen and Juvkam (2013) propose a labor market division based on stricter criteria, resulting in 160 labor markets (hereby referred to as local labor markets). Splitting up the regional labor markets in smaller units, following Gundersen and Juvkam (2013), allow us to differentiate the estimated effect within the regional labor market. The local labor markets in the treatment

[16] Statistics Norway collected only a representative selection of data from the tax assessment from each municipality prior to 1967.

group are considered to be directly affected. In addition to these, we define some indirectly treated markets. These are all the other local labor markets within the regional market that does not have an OPF located within their borders.[17] These are likely to be affected by the OPF through spillover effects. With the use of such divisions, we end up with 7 treated and 26 indirectly treated labor markets, depicted in Figure 1.

Figure 1 – Labor Markets



Treated labor markets are marked in dark green. These are local labor markets with an OPF located within their borders. Indirectly treated markets are the remaining local labor markets within the regional market. These are likely to be affected by the OPF through spillover effects and are marked with light green.

[17] Several of the local labor markets consists of municipalities from different regional labor markets. A local labor market with one or more municipalities within a regional market with an OPF is defined as indirectly treated. Further, Aure and Kristiansund are situated in the same regional labor market. Aure is therefore considered as indirectly treated by the OPF in Kristiansund.

Total income and number of persons within working age are summed up for each local labor market. Total income is divided on the working age population to obtain the average income of the labor market, which constitutes our variable of interest.

5.2 Data on Treatment

We use a variety of data sources to document the rollout of OPF approvals from 1965 to 1992. The treatment data consists of the year of approval for the first OPF in the local labor market.

The first supply bases were established in Stavanger in the mid-1960s. The Norwegian Oil Repair and Supply Company (Norsco) bought property on the west side of Stavanger in 1965, and the Tananger base was operational the year after (Nerheim, 1990). Bergen followed with the approval of CCB base on Ågotnes in 1973. Construction started the same year, and the base was operational from 1974 (Ørgersen, 2004). Florø was approved as the base area for explorations on the blocks in the northern North Sea in 1979, and Fjordbase AS was established in 1985 (INC gruppen, 2018). Further north, the city of Kristiansund established Vestbase in 1981 after a cooperation agreement was signed between the municipality of Kristiansund and Statoil ASA in 1978 (Norsk oljemuseum, 2015). The most northern supply base in Norway, Polarbase, is located in Hammerfest. The permanent base was approved in 1980 and operational from 1984 (Gjerde, 2011). Stordbase is dropped due to high offshore related activity from other industries located in the same market prior to the establishment of the base.[18] Helgelandsbase in Alstahaug is dropped due to missing values.

The processing plants at Kårstø, Tjeldbergodden and Nyhamna are located in labor markets without an earlier established supply base. The localization of the plant at Kårstø in the South West of Norway was approved in 1981, and the first gas reached the facility in 1985 (Førde, 2015). The plant at Tjeldbergodden, further north along the coast, was approved in 1992 and established in 1997 (Tjeldbergodden Utvikling, 2009). Nyhamna was approved in 2004, and operational from 2007 (Innst. 159 S (2003-2004)). As this implies few observations after treatment, Nyhamna is not included.

The treatment group consists of the local labor markets where the supply bases Norsea Tananger, CCB Ågotnes, Fjordbase, Vestbase and Polarbase, and the processing plants at Kårstø and

[18] Stordbase was established in 1981 as a subsidiary of Stord Verft. The yard had experienced a large increase in offshore related activity from the middle of the 1970s, and the base was created with the aim to exploit spillover effects from the existing industry at the yard.

Tjeldbergodden were approved. The labor markets and approval years are described in Table 1, and the geographical location depicted in Figure 1.

Table 1 – Treatment Year

Labor Market	OPF	Approval Year
Stavanger	Norsea Tananger	1965
Bergen	CCB Ågotnes	1973
Kristiansund	Vestbase	1978
Flora	Fjordbase	1979
Hammerfest	Polarbase	1980
Tysvær	Kårstø Processing Plant	1981
Aure	Tjeldbergodden Industrial Facility	1992

As mentioned earlier, the timing of the effect of an OPF in the local labor markets is not clear. To be able to extend the analysis and look at other possible treatment cutoffs, we also collect data on discovery year, when the parliament approved the plan for development and operation (SPUD) and production start of the petroleum fields.[19] The rollout of petroleum discoveries and production starts between 1965 and 2008 are documented by records collected from the Petroleum Register via FactPages, provided by the NPD.

5.3 Data on Control Variables

We have included several variables to control for labor market specific time variant omitted variables. All controls are aggregated to local labor market level. Unless otherwise stated, variables are divided on the working age population of the labor market, and data are collected from the NCRD. Table A2 in Appendix displays an overview of the control variables.

Firstly, we have added a set of variables for educational attainment. The data covers the period from 1970 until 2008, except from 1971 until 1979 where there are no registered data. The variables measure the share of persons over 16 with elementary school, high school or higher education as their highest obtained education level. Data on the number of men and women living in each municipality are also collected. Data are registered for the years 1950, 1960 and from 1966 until 2008. A variable for the share of women in the population is generated.

[19] A PUD is prepared by the licensees holding the production license(s) in which the instance is located. A PUD is supposed to present the overall construction and development concept (Norwegian Petroleum Directorate, 2018).

Those aged between 17 and 24, the retired and those receiving social security achieves the lowest average income in Norway (Epland and Kirkeberg, 2001). It is also reasonable to assume that these groups have a low labor force participation.[20] To account for the fact that the average income is understated in local labor markets where many inhabitants are not part of the labor force, we include the share of retired, share of youth (those aged between 15-24), share of people receiving disability benefits and the share of people receiving economic social aid to the regression.[21] Data on the number of retired people living in the municipality in 1950, 1960 and 1967-2008 are collected from the population censuses. Economic social aid is available from 1967 to 2008 and is partly collected from SSB. Data on the disability benefits are available from 1979 to 2007, except for 1983. The data on the share of youth covers 1950, 1960 and 1967-2008.

Further, cities can for several reasons have a higher income growth than rural areas. See Quigley (1998) for an overview. We control for this by creating a variable for population density. Data on the area of each labor market are collected in the years 1957-2008 and the variable people per square kilometer is calculated. Lastly, we include data on the share of people employed within the health sector in 1970, -80, -90 and 2001 to control for the establishment of the previously mentioned Førde Central Hospital in 1979.

5.4 Sample Selection

As mentioned earlier, we include data for municipalities from 1957 to 2008. However, the sample is restricted using oil-city criteria represented in Gjerde (2011).[22] In addition to Stavanger, Bergen, Kristiansund and Hammerfest also Harstad, Oslo and Trondheim are considered to be oil cities. The regional labor markets of Trondheim, Oslo and Harstad are therefore dropped from the analysis as they do not represent suitable counterfactuals for the treatment group. Harstad will be discussed in greater detail in Section 6.3.

Further, the panel is unbalanced due to differences in when the local tax offices start to register income. The lack of registration is more prominent in the beginning of our time period, and

[20] People receiving social security are either entirely outside of the labor force, or partly unemployed. People aged 15-24 have a higher unemployment rate than the working age population as a whole (Statistics Norway, 2018a). This is mostly due to a high share of graduates and students (Statistics Norway). In addition, students typically work part-time, go in and out or are completely outside of the labor force.

[21] Economic Social Aid is temporary income given as either contribution or debt. People who are not able to make a subsistence through work or other public schemes are eligible for economic social aid (Statistics Norway, 2001).

[22] Gjerde (2011) use criteria based on economy, industry and infrastructure, management and cultural functions to classify cities as oil-cities.

the tax registration coverage rate rapidly increases. In 1957, we have data on income for 42 per cent of the municipalities, in 1965 it increases to 74 per cent and further to 90 per cent in 1984. See Figure A1 in the appendix for a visualization of the tax registration coverage rate.

An unbalanced panel can cause estimates to be inconsistent due to sample selection (Wooldridge, 2010). This is a problem if the unobserved covariates are correlated with selection in a fixed effects model.[23] To test whether this problem is present in our data set, we apply a test proposed by Wooldridge (2010). We create a selection indicator s which is equal to one if a municipality has registered income, and zero otherwise.

We estimate the following model:

$$log\, y_{it} = \alpha + s_{i,t-1} + \gamma D_{it} + \phi N_{jit} + \delta X_{it} + \beta_c + \theta_t + \epsilon_{it}, \tag{3}$$

The test builds on the assumption that unobserved covariates in time t should be uncorrelated with selection in any period. Thus, the lagged indicator variable in Equation 3 should have an insignificant effect on income in period t.[24] Table A3 in the appendix presents the estimated result. The lagged indicator is statistically insignificant. Thus, sample selection bias due to an unbalanced panel should not be a concern for our estimates.

Except the missing observations caused by differences in the start of income registration, there are no missing values for the income variable. When the municipalities begin to register income, we have observations for all subsequent years. For missing observations on background characteristics, we include a dummy variable indicating that the variable is missing to keep the sample constant over time. There are no missing observations on the number of inhabitants per square kilometer for any of the municipalities, whereas for education, data is missing for 26.5 per cent of the sample. For economic social aid and disability benefits, 10.4 per cent and 29 per cent of the data is missing, respectively. For those variables where numbers are assumed to be relatively stable over time and observations are missing for several years, we replace the missing observations with the best possible estimate, which we consider to be values generated by interpolation between two points where data is available. This is the case for the number of retired, kids, youth and women.

[23] Selection is defined as having registered income.

[24] The test is performed before municipalities are collapsed into labor markets. Hence, i represents municipalities in Equation 3 and not local labor markets as in Equation 1. Otherwise, the variables represent the same as in Equation 1.

5.5 Descriptive Statistics

The development in real income for treatment and control group are depicted in Figure 2. Observing the whole period, real income for both the treated labor markets and the control group show a positive trend. The growth is steady from 1960 to 1995, thereafter the growth rate nearly doubles, before it culminates in 2008.[25]

If we look to the development of Norway's real disposable income, gains from trade explain most of the increased growth during the period from 1970 to 1995. The real disposable income increased by 72 per cent from 1998 to 2008, and 41 percentage points were due to advantageous terms of trade (Halvorsen et al., 2015).[26] Most of the advantages followed from increased petroleum prices. However, losses from trade essentially equal out the gains in the long term, and therefore the gains do not explain the steady growth over the whole period. The most important long-term sources of growth have been increased productivity and growth in real capital per worker. 29 per cent of the long-term growth can be attributed to the growth in petroleum production and the gains from petroleum trade (Halvorsen et al., 2015). The main contribution to the real disposable income growth is from productivity growth in other industries than the petroleum industry (Barth and Brasch, 2016).

Since our data is collected from the tax assessments, nationwide tax reforms will necessarily affect the total registered income.[27] Some of the spikes and troughs are therefore attributed to changes in the tax system. As previously mentioned, large reforms were implemented in 1969, 1987, 1992 and 2006. Two of these reforms seem to be observable in Figure 2. Following the tax reform of 1992, the minimum deductible level rose from 10.000 to 27.000. Since our income variable is net income after deductibles, it can explain the drop in average income in 1992. Further, the reform of 2006 implied a rise in the tax rate of capital income. This caused many companies to pay out high dividends prior to implementation. In 2005 a total of 100 billion NOK of dividends were paid out to stockholders, compared to 5 billion the year after (Thoresen et al., 2012). This can explain the volatility in average income around 2006.[28] We

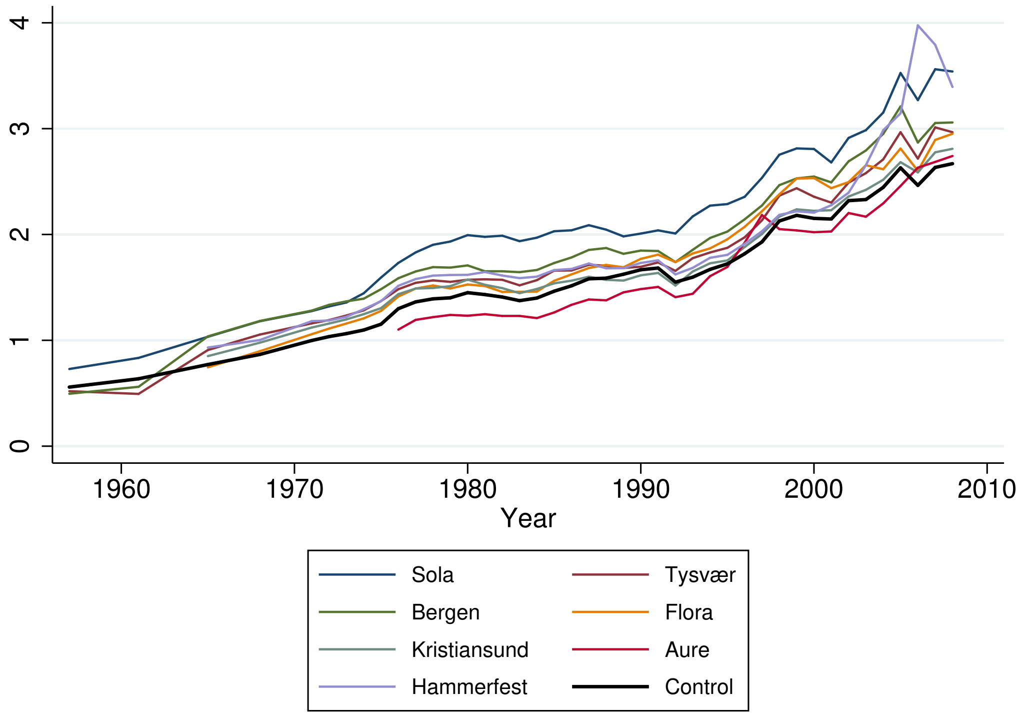
[25] Our data set does not cover the period after 2008, but from Barth and Brasch (2016) we know that even though the growth did not stagnate after 2008, real income was still at a lower level in 2015.

[26] $Disposable\ Income = Gross\ domestic\ product - Consumption\ of\ fixed\ capital - (Primary\ incomes\ payable\ to\ non-residents\ net) - (Current\ transfers\ payable\ to\ non-residents)$.

[27] Note that, as mentioned earlier, the reforms do not threaten our strategy as most can be controlled for with time-fixed effects and that of 1992, coinciding with Aure, does not seem to drive our results.

[28] Following the tax reform, the government allowed the stockholders to inject the previously disbursed dividends back into the companies, which could be paid back without taxation to the stockholders. This caused the capital income to normalize after 2006.

Figure 2 – Income Development Over Time



can also observe a drop in income in 2001. This can be explained by the implementation of double taxation on dividends from September 2000 until the end of 2001, which led companies to postpone distribution of dividends until 2002 (NOU 2003:9, 2001).

Observing the different treated labor markets, trends in real income seem to correspond fairly up until 1990. Thereafter, some of the markets stand out. Especially Aure and Hammerfest differ from the others. Aure grows at a higher rate than all the other markets from 1990 to 1998. Similarly, the income growth of Hammerfest from 2001 to 2006 is twice the size of the other markets. In addition, these two markets do not experience the drop in real income in 2006 as the rest of the markets do. Hammerfest experiences a large drop the year after. The OPF in Aure was approved in 1992, which might explain the increase during the 1990s. As for Hammerfest, we know from Section 6.4 that the SPUD for the petroleum field Snøhvit occurred in 2002. This had major impacts for Hammerfest and is likely to explain the increase in real income from early 2000s (Myrset, 2017). We investigate other treatment cutoffs, such as SPUD, in Section 6.4.

Lastly, we observe that the panel is unbalanced, but as discussed earlier, sample selection bias due to an unbalanced panel is not a concern for our estimates.

Table 2 displays averages for all control variables from 1985 to 2008, for the treated-, indirectly treated- and control group, as well as for the whole sample. Population per square kilometer is higher in the treated group. This is not surprising as Oslo and Trondheim, being the largest and fourth largest city in Norway, are excluded from the control group, and Bergen and Stavanger, being the second and third largest cities, are situated in the treatment group. The indirectly treated labor markets are least densely populated, suggesting that these are mainly rural areas. The treatment group is also considerably larger than the two other groups in terms of municipalities situated within the labor market. In addition, there seem to be slightly less retired persons and persons with primary education as their highest education level in the treatment group. For the remaining characteristics, the different groups can be considered similar. Nonetheless, since we are utilizing a difference-in-difference approach, we are not dependent on balanced treatment and control groups (Angrist and Pischke, 2015). The same table also presents the number of observations. The treatment group has a significantly lower number of observations than the control group, which is due to few treated labor markets. This is further discussed in Section 7.2.

Table 2 – Descriptive Statistics for Labor Market Characteristics

	Treated	Indirectly Treated	Control	Full Sample
Education[a]				
Primary Education	37.69	42.04	43.23	42.72
Higher Education	15.77	12.57	13.02	13.08
High School	43.12	42.74	41.11	41.53
Population per sqrm.	43.24	10.81	13.47	14.51
Retired	8.45	10.15	10.11	10.05
Women	49.68	48.68	49.63	49.46
Youth (Age 15-24)	19.68	19.77	19.12	19.27
Disability Benefits	7.00	7.22	8.86	8.48
Economic Aid	3.79	3.52	4.13	3.99
Health Workers	8.23	8.13	7.74	7.85
Number of Municipalities[b]	6	1.65	2.33	2.39
Observations	168	624	2384	3224

Notes: Statistics are averages from the years 1985 to 2008 and the numbers represents percentages. See Table A2 in the Appendix for further explanation of the control variables. [a] Does not add up to 100 per cent cause of persons without or without registered education (in addition to statistics being averages). [b] The average number of municipalities included in the labor markets in 2008.

Summary statistics for the different groups, as well as the full sample, are shown in Table 3. We notice that the mean average income is highest in the treated markets, followed by the indirectly treated markets. Interestingly, the income gap between the treated and indirectly treated has decreased after the approval of an OPF. Since a higher population density has been shown to increase productivity and subsequent wages, the higher income in the treated labor markets prior to approval can be explained by the higher population density in those markets, as shown in Table 2 (Quigley, 1998). Further, we notice that the gap between maximum and minimum average income is more pronounced in the control group than the other groups.

Table 3 – Summary Statistics Average Income

	Mean	Stand.Dev	Min.	Max.
Treated	1.87	0.62	0.49	3.98
Prior	1.21	0.27	0.49	1.61
Post	2.08	0.55	1.03	3.98
Indirectly Treated	1.74	0.59	0.37	3.68
Prior	1.01	0.32	0.37	1.77
Post	1.91	0.50	0.73	3.67
Control	1.65	0.56	0.27	6.24
Full Sample	1.68	0.57	0.27	6.24

Notes: Statistics are averages over the whole time period. Average income is represented in 100.000 NOK and adjusted for inflation, 2015 level.

6 Empirical Analysis

In the following section, our main findings and sensitivity analysis will be presented. The main findings include results from the roll-out and an analysis of the event-study. In addition, we extend the analysis, investigating different time periods and treatment cutoffs as well as other interesting labor market outcome variables. Unless otherwise specified, labor markets are local.

6.1 Main Findings

We estimate the average effect of an OPF approval on average income in treated and indirectly treated labor markets. All results measure the treatment on the treated (TOT) effect.

Table 4 reports main estimated effects of approval of an OPF on average income in the labor market using Equation 1. Each column represents a separate regression. Column (i) represents our baseline model, where the estimated effect of approval in a treated labor market is presented, as well as the estimated spillover effect onto surrounding labor markets. The specification in column (ii) excludes all control variables, while time- and labor market fixed-effects remain. In column (iii) the indirectly treated labor markets are excluded from the sample, whereas in column (iv), the sample consists of all 160 labor markets.[29] All standard errors are clustered at the regional labor market level.[30]

The first row of Table 4 reports estimates of γ in Equation 1. Observing the baseline model, average income increases by 1.1 per cent on average after an OPF is approved in the market. The estimated coefficients are consistently positive across changes in sample and composition of the control group, but the sign alters when controls are excluded. However, since none of the estimates are statistically significantly different from zero, no conclusions can be drawn. The second row of Table 4 reports estimates of ϕ in Equation 1, which measure the spillover effects onto surrounding labor markets. The estimates are consistently positive, significantly different from zero at a ten percent level and sizable in magnitude over all specifications. Average income increases by 3.2 per cent for the indirectly treated labor markets following the OPF approval in a treated labor market.

[29] The regional labor markets of Stord and Sandnessjøen, Harstad, Oslo and Trondheim which are excluded due to aspects discussed in Section 5 are added back in this specification.

[30] A labor market consisting of municipalities from different regional labor markets is defined as belonging to the regional market where the majority of its municipalities are situated. Thus, a labor market with one municipality within region A and two within region B are said to lay within region B.

Table 4 – Main Results

	(i) Baseline	(ii) No Controls	(iii) Direct	(iv) Full Sample
Approval	0.0108	-0.0088	0.0144	0.0119
	(0.0127)	(0.0156)	(0.0132)	(0.0118)
Spillover	0.0322*	0.0457*		0.0312*
	(0.0166)	(0.0264)		(0.0178)
Controls	Yes	No	Yes	Yes
Observations	5,310	5,310	4,284	6,310

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Robust standard errors adjusted for clustering on the level of the regional labor markets are shown in parenthesis. The following set of control variables are added for all except column (ii): share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview over the control variables is given in Table A2.

As displayed in Table 3, the mean average income in the treated markets is higher than in the indirectly treated markets prior to approval of an OPF. In addition, the same table display that the treated markets are larger in terms of the number of included municipalities. The higher average income and larger size might have caused the shock to be less apparent in the treated markets than in the indirectly treated markets. Section 7.1 provides a further discussion of the findings.

In model (ii), the estimated effect of approval changes from 1.1 to -0.9 per cent, indicating that the baseline results are not robust towards excluding control variables. Further, the estimated spillover effect increases from 3.2 to 4.6 per cent. However, neither of the estimates are significantly different from the baseline estimates. Exclusion of the indirectly treated markets give a slightly higher estimated effect of approval, but the effect remains insignificant. Hence, the insignificant effect of approval on the treated markets is robust to the exclusion of nearby labor markets. When we use the full sample, estimated effects are in line with the baseline regression. This suggests that there are small effects of an OPF approval in the omitted labor markets. However, as we still consider these labor markets to be non-suitable counterfactuals, we continue with the baseline sample.

6.2 Event-Study and Short-Term Analysis

Figure A2 in Appendix plots event-study estimates as well as 95 per cent confidence intervals for average income in the treated labor markets, over a) 30 lags and b) 20 lags, following Equation 2. The results show a significant pre-approval effect on the fifth lead, which indicates that the treatment group has a higher average income growth than the control group five years prior to approval. This makes us critical of a causal interpretation of the lagged effects. However, as the preceding and subsequent leads show insignificant effects, we consider the event-study figures to validate our strategy. We also examine pre-trends for the average income of the indirect markets. Figure A3 in Appendix shows no significant anticipatory effects.

Point estimates for both treated and indirectly treated markets are, however, quite imprecise. The confidence intervals shown in Figure A2 and Figure A3 in Appendix are large and vary from year to year. This is due to the small number of treated labor markets, which increases the standard errors and the confidence intervals (Wooldridge, 2013). In addition, the number of treated labor markets changes during the period. The first OPF was approved in 1965, while the last was approved in 1981. Hence, the number of observations before and after treatment is unbalanced within the treatment group. This causes the confidence intervals to increase at the extremities.

In addition to visualization of pre-trends, the event-study figures provide information on the timing of the treatment effects. We have chosen a long time-horizon for the event-study analyses. This is due to the previously mentioned lags in the petroleum process and the fact that all established OPFs are still operating today, 30-40 years after. It can take several years from a supply base is approved until a connected oil field is fully operational. In addition, the degree of petroleum activity evolves over time, as more discoveries are made and more connected petroleum fields become operational (Nilssen et al., 2008). Thus, it is reasonable to examine the long-term effects of an OPF approval. However, as our panel is rather unbalanced, we also investigate a shorter time-span to eliminate effects due to fewer observations when the absolute value of τ in Equation 2 increases in size. See panel b of both Figure A2 and Figure A3 in Appendix.

Observing the graphs in Figure A2 in Appendix, the treatment effects differ over time. The estimated effect is positive and significantly different from zero two years after approval. Following year two, there seems to be a negative trend culminating in a negative and significant effect in year eleven. After this, the effect flattens out. For the indirectly treated markets, observing the graphs in Figure A3 in Appendix, there are positive and significant effects in year one and twenty-nine. Hence, the event-study figures suggest that there exist some heterogeneous short-term effects of an OPF approval. We investigate this further by limiting the number of time periods before and after treatment included in the regression.[31] Performing such an analysis also allows us to make the panel less unbalanced.

Table A4 in Appendix reports results from the short-term analysis. Column (i) displays the baseline model. In column (ii) and (iii), the time period included in the regression, before and after treatment, are limited to five and eight years, respectively. The first row shows estimated effects on the treated labor markets, which remain insignificant for all models. However, the estimate increases as the treatment period is limited to five years, and decreases as the window widens to eight years. For the indirectly treated markets in row two, the estimated effect decreases but remains significant in the five-year model. More specifically, income increases by 1.8 per cent on average during the first five years after approval, which is 1.4 percentage points lower than the baseline results. For the eight-year model, the estimate decreases even further and turns insignificant. None of the above-mentioned estimates are significantly different from the baseline estimates at a ten percent level.

The coefficients suggest more pronounced effects in the short-term for the treated markets. However, the estimated effects are insignificant, and the hypothesis of no effect of an OPF approval in the short-term cannot be rejected. For the indirectly treated markets, the short-term effects are less pronounced than the baseline model. This suggests that there are positive spillover effects emerging several years after approval, driving an important share of the estimated effect.

6.3 Sensitivity Analysis

We have performed various sensitivity checks to test the robustness of our results and discover potential weaknesses of our analysis. First, we perform an additional test of the key identifying assumption by adding regional labor market specific time trends to the specification. Second, we perform the analysis including a labor market where an OPF was approved but no petroleum discovery followed the establishment. Third, we control for labor markets that are largely influenced by the fishing industry. Then, we test whether the results are robust to the exclusion

[31] We only limit time- periods for the treated and indirectly treated markets. The control group is unaffected.

of extreme observations. Lastly, we investigate whether there are significant changes in the estimated effects as we exclude treated labor markets one at the time. All sensitivity analyses are performed using local labor markets.

Time Trends

An alternative check of the identifying assumption is to add regional labor market specific time trends to Equation 1. In this case, the identification of the effects of an OPF approval comes from whether the approval leads to deviations from pre-existing regional labor market specific trends. Hence, adding such time trends can allow us to find causal effects despite different pre-trends, but this requires a sharp enough deviation from the initial trends (Angrist and Pischke, 2015). We control for the existence of both linear, quadratic and cubic trends, by estimating the following model:

$$log\, y_{it} = \alpha + \gamma D_{it} + \phi N_{jit} + \delta X_{it} + \rho_i t^k + \beta_c + \theta_t + \epsilon_{it}, \tag{4}$$

where $\rho_i t^k$ is the coefficient of a regional labor market specific time trend multiplied by a time trend variable t, which is linear, quadratic or cubic when k is 1,2 or 3, respectively. Apart from the inclusion of regional labor market specific time trends, the specifications are equal to that of Equation 1. If the estimate of the variables of interest, γ and ϕ, are significantly different from the baseline specification, differences in time trends are driving the estimated effect of the OPF approval on average income in the labor markets.

Table A5 in Appendix displays the estimates of γ and ϕ from Equation 4. In column (ii), the model includes linear trends, while in (iii) and (iv), quadratic and cubic trends are included, respectively. The results show altered estimated effects of approval on average income in the treated markets when including time trends. However, the estimates remain insignificant and are not significantly different from the baseline estimates reported in column (i). The estimated spillover effects decrease as time trends are included. Including linear time trends makes the estimated effect turn insignificant. For the quadratic time trends, the estimate increases compared to the inclusion of linear trends, albeit significant at a 12 per cent level. When including the cubic trends, the estimate is significant at a 10 per cent level, but the magnitude decreases compared to that of the baseline regression. More specifically, average income is 2.9 per cent higher on average in the indirect markets following the approval of an OPF. We also notice that the standard errors change. For the treated markets, the standard errors consistently increase as time trends are added. For the estimated spillover effects, standard errors decrease when linear trends are included and remain roughly unchanged for quadratic and cubic trends. Based on the total change in precision our preferred model is the baseline specification.

Our findings are inconclusive in that the spillover effects dissipate as the linear trends are included, but remain significant when we include cubic trends (and quadratic trends, on a 12 per cent level). Although this is not desirable, it is reassuring that all estimates are positive. Angrist and Pischke (2015) argues that it can be hard to distinguish between a linear trend and the treatment effect when the treatment effect is emerging gradually over time. This might cause the estimated treatment effect to be picked up by the time trend. When we observe the event-study figures for the indirect markets, no large or persistent deviations follow treatment. Moreover, it is possible that there exist some short-term secular business cycles that fluctuate around a long-term linear trend. These short-term fluctuations are better captured by flexible trends, such as quadratic or cubic time trends. The models including quadratic and cubic time trends give decreased coefficients, and an estimate from the quadratic trend model is only significant on a 12 per cent level. Nonetheless, these show estimated effects that are more in line with the baseline results. Thus, we conclude that differences in time trends do not seem to drive the effect of the OPF approval on average income in the labor markets.

Note that robust estimation including regional labor market specific trends depends on a clear trend pre-treatment that can be extrapolated into the post-treatment period (Angrist and Pischke, 2009). Thus, the low number of observations prior to treatment might limit the robustness of the analysis.

Harstad

Harstad is excluded from the treatment group because of the discontinuous petroleum activity at the supply base, NorBase. The base was approved and established in 1980, but as the northern offshore activity did not turn out as extensive as expected, the oil activity was shut down from 1985 to 2000 (Gjerde, 2013, Norbase, 2015). However, as several of the major petroleum companies were established in, and continued operating from, Harstad, administrative activity was sustained during the whole period. Therefore, it is interesting to investigate whether the estimated effect alters as a local labor market where the operational activity has been low, but the administrative activity comparatively high is included in the treatment group.

From column (ii) in Table A6 in Appendix we observe that the estimated effect of approval is consistent with the baseline model, both in magnitude and insignificance. For the estimated spillover effects, significance increases to a five per cent level. However, Harstad does indeed differ from the other treated labor markets, and the change is not significantly different from the baseline estimates. Hence, we conclude that our estimates are robust to the inclusion of Harstad.

Fishing Industry

All of the treated labor markets are located on the coast of Norway, as can be seen in Figure 1. The fishing industry has been a large employer and an important source of income for people living in these regions (Hallenstvedt, 2018). Two of the treated labor markets, Tysvær and Hammerfest, are highly influenced by fishery.[32] The fish price is volatile and affects the income level in the industry directly. If such fluctuations are correlated with treatment in these markets, it can bias our results. Tysvær and Hammerfest markets are treated in 1981 and 1980, respectively. Hence, we create an indicator variable equal to one if the market is highly influenced by fishery and the time period being post-treatment for these two markets (after 1980). By controlling for these markets, we allow for shocks in the fishing industry and can observe whether these are driving our results.

Column (iii) in Table A6 displays estimated effects when controlling for the fishery industry. The results are consistent with the baseline estimates, and thus robust to the inclusion of the fishery indicator.[33]

Outliers

Regression estimates can be sensitive to the inclusion of one or several influential observations. Wooldridge (2013) emphasizes this risk especially for data sets with few observations. As our treatment group consists of few labor markets, the risk of such extreme observations to drive the

[32]Our measure of influence is based on the value of landed fish and number of active fishermen. The 15 largest fishing municipalities, measured in the value of landed fish, and the 6 largest measured in active fishermen are considered to be high fishery labor markets (Norsk Fiskerinæring, 2016, Torsvik, 2018).

[33]This does not take into account the possible endogeneity in fishery and the petroleum industry. Persons in the fishing industry likely gained entry into the petroleum industry and achieved a higher wage. The petroleum sector can also affect the stock of fish and fishing opportunities through their activities offshore (Thesen et al., 2013). This means fishery is correlated to both petroleum and the error term, creating an endogenous model.

results are present. To examine the robustness, we perform analyses where different percentiles of the observations of the outcome variable in the baseline specification are excluded.

The results are presented in Table A7 in Appendix. In column (ii) and (iii) we examine the robustness towards excluding the upper and lower 2.5 and 0.5 percentile of the outcome observations, respectively. We also report the number of observations for the treatment group, which falls by a relatively large amount as we exclude outliers. The first row displays consistently positive and insignificant estimated coefficients. However, the estimates decrease as outliers are excluded. As many of the excluded observations stem from the treatment group, the reduced effects suggest that the majority of these observations are above mean average income. Nevertheless, none of the estimates are significantly different from the baseline estimates. Observing the spillover effects, the estimated coefficients are consistent with the baseline estimates both in magnitude and significance. To summarize, the baseline results are robust against excluding outliers, even though the number of observations in the treatment group is reduced. Further implications of a small treatment group will be discussed in Section 7.2.

Excluding Regional Markets

Our treatment group consists of relatively few labor markets. Thus, there is a risk of certain labor markets to drive the effects. Figure 2 indicate some variation in the development of income over time across treated markets. Therefore, we exclude regional labor markets with an OPF one at a time and observe whether the estimated effects are altered. Exclusion of the Aure labor market also allows us to test whether the tax reform of 1992 seems to bias the results.

The results are reported in Table A8 in the Appendix. Column (ii) to (vii) display estimated results when dropping the specified labor market. Observing the effect of approval, estimated coefficients are consistently positive and insignificant for all specifications. This is in line with the baseline model. The coefficient decreases when Bergen or Kristiansund are excluded, indicating some heterogeneity within the treatment group. However, none of the restricted models produce an estimated effect significantly different from the baseline regression. As for the spillover effects, all coefficients, except when excluding the labor market of Florø, are in line with the baseline result. The estimated effect of approval on the average income of the indirect markets decreases from 3.2 per cent to 1.5 per cent and turns insignificant when excluding Florø.

The findings suggest that the baseline regression estimates on treated markets are robust towards reducing the treatment group. The estimated spillover effects are sensitive to the exclusion of Florø, which seem to drive an important share of the estimated effects on indirectly treated markets.

As mentioned in Section 4.2, the tax reform in 1992 coincides with the OPF approval in Aure. Exclusion of the regional labor market of Aure also gives us the opportunity to check whether our results are robust towards this tax reform. Note that since Aure and Kristiansund are situated within the same regional labor market, Kristiansund is also excluded. The estimated effects are not significantly different from the baseline regression, which convince us that the tax reform of 1992 does not impose any problems for our analysis.

6.4 Extended Analysis

We provide three extended analyses to get a deeper understanding of the effects of an OPF on the local labor markets. First, we investigate whether the effect of an OPF on income is heterogeneous over decennials. Thereafter, we present analyses using different treatment cutoffs. Lastly, we take a look at unemployment and net immigration to have an insight into the dynamics of the markets.[34]

Time Periods

The petroleum sector has been in constant development since the first oil was found in 1967. Level of investment, fluctuation in the oil price and the discovery of new fields change the level of economic activity within the treated labor markets (Nilssen et al., 2008). As these elements change over time, we suspect that our estimates experience some heterogeneity across different time periods. To analyze the stability of the effects, we divide the post treatment period into four sub-periods; before 1980, the 1980s, the 1990s and the 2000s, and assign a dummy variable for each period.

We estimate the following model:

$$log\, y_{it} = \alpha + \gamma D_{it} I + \phi N_{jit} I + \delta X_{it} + \beta_c + \theta_t + \epsilon_{it}, \qquad (5)$$

[34]However, this analysis will only give us indications to which mechanisms are at work. More thorough investigations need to be done to connect the effects to income.

In Equation 5, we have included an interaction term between the dummy variables D_{it} and N_{jit} and I, where I is a column vector containing the different time period dummies. The other variables are equivalent to those included in Equation 1.

Table A9 in Appendix reports estimates of γ and ϕ from Equation 5, in the different time periods. Observing column four, the estimate for the years after 1999 is significant at a 10 percent level for the treated labor markets. More specifically, following an OPF approval, average income increased by 3.4 per cent in the treated markets during the 2000s. Spillover effects onto indirectly treated labor markets are significant at a 5 per cent level in the 1980s. During this period, spillover effects increased average income by 3.9 per cent. Estimates for all other time periods are insignificant for both treated and indirectly treated markets. The pronounced effects for indirectly treated markets in the 1980s and treated markets in the 2000s can be explained by the increased activity within the petroleum sector during these periods. The number of people employed within the petroleum sector and related industries roughly doubled during the 1980s and increased by 80 per cent during the 2000s. By comparison, employment increased by roughly 20 per cent during the 1990s (Norsk Petroleum, 2018a).

It is important to note that the number of observations per decade is modest. Hence, the insignificant estimates might be due to low statistical power following from the low number of observations rather than no true effect in the given decade. Thus, it is worth mentioning that the estimated spillover effects during the 1990s and 2000s are positive and significant at a 15 per cent level.

Treatment Year

One can identify several other incidents in the offshore petroleum process being potential treatment cutoffs. We consider the approval of OPFs to introduce a large shock in economic activity in the labor markets, and an incident that increased the optimism towards a sustained petroleum industry in Norway. However, as discussed in Section 4.1, the offshore petroleum industry is complex, and it is hard to predict which events in the process that cause a shock in economic activity. In this section we have extended the analysis using the year of discovery for connected petroleum fields, the SPUD and the year of production start for these fields as treatment cutoffs. Table 5 presents the labor markets and the different implemented treatment years.

Table 5 – Alternative Cutoff Years for each Labor Market

Labor Market	Approval Year	Discovery	SPUD[1]	Production
Stavanger	1965	Ekofisk 1969	1972	1971[2]
Bergen	1973	Statfjord 1974	1976	1979
Kristiansund	1978	Aasgard 1981	1988	1993
Flora	1979	Statfjord 1974	1976	1979
Hammerfest	1980	Snøhvit 1984	2002	2007
Tysvær	1981	Statfjord 1974	1976	1979
Aure	1992	Heidrun 1985	1991	1995

Notes: All cutoffs are based on the first field in the market being discovered, approved by the parliament or starting production. Thus, the SPUD and production year does not necessarily relate to the same field.

[1] The parliament's approval of the plan for development and operation (SPUD).

[2] Test production in 1971, ordinary production starts in 1972 after SPUD.

Use of alternative cutoffs implies exploiting new sources of variation to estimate the effect of an OPF on average income in the labor markets. Hence, the key identifying assumption is altered for each of the new cutoffs. As discussed earlier, a possible concern is that pre-approval trends in average income drive the estimated effects. To examine whether this is the case, we exploit a similar event-study specification as in Equation 2, where the definition of $D_{i,t+\tau}$ follows the respective treatment cutoff. Figure A4 in Appendix shows estimates as well as 95 per cent confidence intervals. Results are insignificant anticipatory effects for all the alternative cutoffs, except for production, which shows significant anticipatory effects on the sixth lead.

Regression results of Equation 1 with different treatment cutoffs are reported in Table A10 in Appendix. Column (i) presents the baseline model with the approval of an OPF as treatment cutoff. Column (ii) to (iv) show estimated results when using discovery, SPUD and production start as treatment cutoff, respectively.

The first row of Table A10 reports the estimated effect of the different treatments on average income for the treated labor markets. Overall, estimates are insignificant. However, coefficients decrease as the discovery of a connected field is defining the cutoff and increases for SPUD and production start. Observing row two, where estimates measure the spillover effects onto surrounding labor markets, both magnitude and significance vary. Spillover effects decrease and turn insignificant for discovery. For SPUD, spillover effects are similar to baseline results. When production start is defining cutoff, spillover effects increase and turn significant at a one per cent level. More specifically, average income for the indirectly treated markets increases by 4.69 per cent after production has started on a field connected to the labor market.

The different treatment cutoffs give different estimated coefficients, both in magnitude and significance levels. Although this is not surprising, it is reassuring that all estimates are positive. The consistently insignificant estimates on the treated markets indicate that the insignificant effects in our main analysis cannot be attributed to a lag of the activity level within the petroleum process. We also find the estimated spillover effects across treatment cutoffs reassuring. The insignificant effect following discovery suggests that discovery in itself does not foster increased activity in the labor markets.

Unemployment and Net Immigration

A higher unemployment rate will, everything else being equal, cause the average income of the labor market to decrease.[35] Hence, investigating how unemployment within the treated and indirectly treated markets is affected by an OPF approval might shed some light on the mechanisms at work within the markets. We estimate the post-treatment effect, as well as examining how the effect evolves compared to that of income.

We make use of the same identification strategy as in Equation 1, but replace the outcome variable with the unemployment rate. We construct the unemployment rate variable by dividing the number of unemployed people in the labor market on the working age population.[36] All of the labor market specific control variables are equal to those included in Equation 1. Results from the regression are found in Table A11 in Appendix. The unemployment rate increase by 0.4 percentage points in the treated labor markets following approval. The estimate is significantly different from zero at a one per cent level. For the indirectly treated markets, estimated spillover effects are negative but insignificant.

Similarly to earlier modified models, we perform an event-study to validate the key identifying assumption of no pre-trends and examine the timing of the treated effects. Figure A5 in Appendix plots event-study estimates, as well as 95 per cent confidence intervals for a) unemployment and b) average income as dependent variables for the treated labor markets, following

[35] Unemployment and net immigration are not included in the baseline model of the main analysis as they are also outcome variables in our study and thus considered to be bad controls (Angrist and Pischke, 2009).

[36] Unemployed persons are defined as those completely unemployed that are actively searching employment which have been without paid work over the last two weeks (Bø and Håland, 2015). These data are collected from NCRD and covers the period 1957-2008.

Equation 2. Firstly, none of the leads in a) are significant. Hence, the assumption of no pre-trends in unemployment for the treated markets holds. Secondly, year ten and eleven after treatment are the only significant lags. These are both positive and sizable. Further, we notice that unemployment is counter-cyclical to income in the treated labor markets.

For net immigration, we find no significant effects. However, the event-study (not reported) unfortunately shows clear pre-trends, which means the results cannot be interpreted causally. Hence, we do not proceed with the investigation of net immigration into the labor markets.

6.5 Summary of Results

In our main analysis, we find no significant results of an OPF approval on the income of the treated labor markets. The estimate remains insignificant throughout all sensitivity checks. For the indirectly treated markets, results show positive and significant spillover effects. This estimate is sensitive to the exclusion of the regional labor market of Florø, indicating that this specific market is driving an important share of the effect. Further, the short-term analysis shows no significant effects for the treated markets, and significant spillover effects when examining five years post treatment. In the extended analysis, we find that an OPF approval leads to income growth in treated labor markets after 1999 and that the spillover effects are pronounced only in the 1980s. Further, we find insignificant effects on average income for the treated markets for all the alternative treatment cutoffs, and significant spillover effects for SPUD and production start. Lastly, our results show that the unemployment rate within the treated labor markets increases significantly after the approval of an OPF, while the spillover effect onto indirectly treated markets is insignificant. We also note that the unemployment rate seems to be counter-cyclical with average income.

7 Discussion

In this section, we will first provide a discussion of the main findings from the analysis in Section 6. Thereafter, some limitations with regards to data and empirical strategy are addressed. Lastly, implications of the study and suggestions for further research are presented.

7.1 Discussion of Results

There is a general belief that the petroleum industry has caused an increase in income for the affected regions on the west coast of Norway. Nonetheless, we find no significant effect of an OPF approval on average income in the treated labor markets. Several explanations can support this finding. Firstly, the introduced petroleum industry might cause heterogeneous effects on income within the labor market, benefiting only a portion of the population. Those working in the non-petroleum sectors do not necessarily achieve the same gain as those directly or indirectly employed by the petroleum industry. There might also be negative effects of the introduced petroleum industry on other labor market outcomes, which are likely to affect income in the long-run. As an example, Papyrakis and Gerlagh (2006) find that natural resource abundance decreases investment, schooling and R&D expenditures. We identify the average income of the total working age population and are unable to pick up such differential effects within the market. For further research, such aspects would be interesting to include.

Secondly, persons working offshore do not necessarily commute from nearby labor markets. The employment practice in the petroleum sector is characterized by shift work.[37] The system justifies a longer commuting distance and allows those working offshore to live outside the labor markets investigated in our analysis. This is confirmed by Johannesen (2009), which find that 413 municipalities in Norway had at least one inhabitant employed within the petroleum industry in 2008. As will be discussed in Section 7.2 below, such spillover effects might cause the estimated effect to be biased towards zero.

In addition, the authorities' degree of regional policy focus will affect the attitude of operators towards local content in contracts and thus the degree of local engagement. The period from 1971 to 1985 was characterized by a seed-bed policy, where domestic experience and an independent Norwegian petroleum industry was the superior goal (Vatne, 2003). From 1985 to 2012 the authorities reduced their regional policy ambition. This turned the focus of op-

[37]The standard shift system applied in Norway implies four weeks leave for every two weeks of work (NOU 2016:1, 2016).

erators more towards an efficient and reasonable extraction of the petroleum resources. Such focus has fostered the use of rotational schemes of labor in the Norwegian offshore industry, which has led to a practice among the main supplier companies where hiring of labor for individual projects is the common strategy. The offshore operators compensate suppliers for the commuting expenses, which creates an incentive to employ experienced workers with more competence from outside of the labor market instead of recruiting workers locally (Nilssen et al., 2008).[38] This is especially common during the construction of landing- and processing plants and submarine pipelines, since the necessary competence more often is found outside of the labor market. Another widespread practice is for suppliers located outside of the region to exclude transportation costs from quotations. The offshore operators cover these transportation costs, which effectively eliminates the comparative advantage of local industries. As an illustration, only 9 per cent of total investments into the Snøhvit gas system accrued to Northern Norway, and only 7 per cent of the investments into the Tjeldbergodden facility accrued to Møre og Romsdal county (Arbo et al., 2007, Nilssen et al., 2008).[39] Labor and supplies were transported from the southwestern part of Norway, around Bergen and Stavanger. Both the procurement practice and the rotating scheme contributes to a form of spillover effect between the treated labor markets. This reduces the development of local competence in treated markets outside of Stavanger and Bergen, which reduces the aggregated number of local employees and further reduces the long-term effects of the OPFs.[40]

Lastly, Dyrstad (2017) find that coordinated wage formation in the petroleum industry was instrumental in decreasing the wage growth within the petroleum sector and preventing a potential Dutch Disease.[41] Norway experienced harmful wage inflation following the petroleum discoveries in the 1970s (Dyrstad, 2017). This led to an extraordinary intervention by the Government in 1981, aiming to bring growth in petroleum wages in line with the rest of the economy. The intervention was successful. Both the wage gap between petroleum and manufacturing and the wage growth within the petroleum sector, shrunk from its implementation (Dyrstad, 2017). The coordinated wage bargaining from 1981 can, therefore, contribute to the explanation of an

[38] Statoil terminated the compensation scheme for commuter expenses effectively from 1 of August 2012 (Nilssen et al., 2008).

[39] Northern Norway comprises Nordland, Troms and Finnmark county.

[40] Measures have been taken to increase local employment and to include local suppliers to a greater extent. However, the measures are introduced in recent years, after the time-period of our analysis (Nilssen et al., 2008).

[41] Dutch Disease refers to the situation where resource booms induce an appreciation of the real exchange rate and make non-resource sectors less competitive (van der Ploeg, 2011). The term was coined by the Economist in 1977 to describe the difficulties of the Dutch economy.

insignificant effect on average income in the treated markets.

The time-period analysis in Section 6.4 shows that there is an effect of approval on average income of the treated markets during the 2000s. This can be explained by the rise in the oil price, and the subsequent boom within the industry during the period.[42] The petroleum industry experienced a real wage rise of 26,7 per cent, compared to a national average of 24,5 per cent (Statistics Norway, 2018b). Moreover, the total petroleum production in Norway reached its peak in 2004, while the peak in total petroleum export, measured in kroner, was reached in 2008 (Norsk Petroleum, 2018b,c). In addition, Nilssen et al. (2008) argues that an OPF market need to pass a critical level of activity before obtaining a complete industrial cluster with self-renewing growth processes. Engineering and technical service providers follow the establishment of a supply base, and as activity increases, the cluster will eventually represent the entire value chain of the petroleum industry (Nilssen et al., 2008). The substantial increase in activity during the 2000's may have caused some of the investigated labor markets to pass the critical level of activity, resulting in both short- and long-term growth.

Further, our results show that the unemployment rate is significantly higher within the treated markets following the approval of an OPF. Okun's law predicts that the unemployment rate is negatively correlated with gross domestic income.[43] Observing the event-studies in Graph 9, this does also seem to be the case for average income in the treated labor markets. This indicates that a positive effect on total income following the approval of an OPF might be absorbed by a higher unemployment rate, possibly leading to an insignificant effect. Findings of Dyrstad and Brunstad (1997) suggest that labor markets located regionally close to the petroleum industry experienced a rise in nominal wages and an increase in cost-of-living. These two effects increase costs for companies located within the treated markets, potentially leading to a local Dutch Disease. If new jobs within the petroleum industry are unable to compensate for the jobs lost due to the crowd-out of other sectors, the unemployment rate increases, all else equal. This would be in line with the findings of Dyrstad (1987).[44] Furthermore, if commuting workers cover the jobs within the petroleum industry, it will enhance the positive effect on unemployment. Commuters might be preferred due to higher competence and experience, as mentioned

[42]From 2000 until 2008 the annual price for Brent crude oil rose from 28.4 to 97 dollars per barrel (Statista, 2018). Similarly, the number of people residing in Norway employed within the petroleum industry rose by 38,6 per cent (Johannesen, 2009).

[43]Okun's law states that a 1 percent increase in unemployment is followed by a 2 percent decrease in gross domestic income (Okun, 1962).

[44]Dyrstad (1987) finds that a rise in petroleum wages unambiguously increases unemployment in counties affected by the petroleum industry.

earlier, or due to lower reservation wages. From Section 5.5 we know that the average income is lower in the indirectly treated labor markets, indicating possibly lower reservation wages for commuters. There are several other possible explanations for the increased unemployment rate. Examples are hysteresis in an insider-outsider framework following the oil-bust in 1986 and longer periods of unemployment for petroleum workers due to better unemployment benefits. Alas, concluding on such matters are beyond the scope of our thesis.

For the indirect markets, we find significant positive spillover effects. Although Florø seems to drive an important share of the effects, it is interesting to look at potential explanations to the differing estimates between the treated and the indirectly treated labor markets. Firstly, the labor markets included in the two samples might differ. From Section 5.5 we know that labor markets included in the treatment group have higher population density and lower education levels, which we allow for in our model. However, labor markets differ along several dimensions, and there are also inequalities beyond what is controlled for in our model. Examples are the size of the labor market, social setting, distance to closest city or abundance in other natural resources. From the Summary Statistics, also in Section 5.5, we know that the treated markets are larger in terms of the number of municipalities included in the market and have a higher mean average income per capita than the indirect markets. Due to these differences, the indirect markets might benefit relatively more from the shock than the treated labor markets, assuming fixed transportation costs.

Whether workers in the indirect markets choose to commute, depends on the obtainable wage premium and the transportation costs (Venables, 2007). In equilibrium, the difference in wages between the treated and indirectly treated markets are equal to the transportation costs, and workers are indifferent to commuting. The transportation costs are not observable, however, the findings in Section 5.5 indicate that wages are higher in the treated markets. Improvements of the infrastructure often follow an OPF approval, which decreases transportation costs. Examples are the Krifast project in 1992 which decreased commuting time from Molde to Kristiansund by more than one hour (Nilssen et al., 2008), and improvements of the road network around Tysvær during the construction of the OPF at Kårstø (Gjerde, 2014). Hence, workers in the indirect markets have an incentive to commute to the treated markets to obtain a higher wage, everything else being equal. This will cause the income level in the indirect markets to converge towards that of the treated markets, as observed in Table 3. These mechanisms possibly explain the significant spillover effects in the indirect markets.

Findings from the time period analysis show pronounced spillover effects on average income only in the indirectly treated labor markets in the 1980s. A possible explanation is the increased activity in the petroleum sector in the late 1970s and during the 1980s (Norsk Petroleum, 2018a). The period was characterized by active employment, and the petroleum companies demanded both low- and high-skilled workers. As an illustration, Phillips Petroleum employed 563 persons in 1978 (Kvendseth, 1988). Additionally, the Norwegian Government strongly signalized a desire to Norwegianize the labor stock within the petroleum industry in 1980. Due to a tight labor market, the transformation process took several years. Nonetheless, the share of Norwegians employed within the industry steadily increased during the 1980s (Kvendseth, 1988). The tight local labor markets, combined with a high demand for Norwegian labor, might have led the industry to recruit more workers from the indirect markets during this period. From Section 5.5, we know that the indirect markets have lower educational attainment on average than the treated labor markets. This indicates a different occupational composition in the indirect markets, with a higher share of low-skilled workers. The demand for low-skilled workers was higher than that for high-skilled in the 1980s, which can also explain why we find a significant effect in the indirectly treated markets and none in the treated markets (Kvendseth, 1988). Furthermore, national infrastructure, such as airports and helicopter bases, might have been less developed during the 1980s.[45] This potentially hampered commuting from outside the regional labor markets. Hence, the operators were more dependent on local labor during the early periods. This would increase employment and income in the indirectly treated markets.

7.2 Limitations

In the following section, we will discuss potential limitations of our study not yet addressed. We start by discussing the limitations of our data, followed by a discussion of potential limitations regarding our empirical strategy.

[45] A helicopter base was first established in Florø in 1994, and the airport was expanded in 2000 (Engerengen, 2018a). A new helicopter base was opened in Kristiansund in 1993, and the airport went through several improvements following the opening of the OPF in 1982 (Engerengen, 2018c). Hammerfest opened a new helicopter base in 1989 (Engerengen, 2018b).

Limitation of the Data

As presented in 5.1, our measure of income is Ordinary Income, which originates from the Municipal Tax Assessment. Using self-assessment tax returns as the data source for our analyses represents potential limitations. The assessment includes all income that is basis for taxation. I.e., the information provided is affected by prevailing tax rules. The potential issue of tax reforms has been addressed earlier. Moreover, income that is not object for taxation, or withheld income, is not registered. Examples are child benefits, housing support, economic social aid, undeclared income and income below the minimum taxable income (Melby and Strøm, 2007). These issues are unfortunate, but unavoidable given the accessible income data. We have taken steps to minimize the impacts on our data, including controls for those on economic social aid and others obtaining no or small amounts of income, but the issue remains.

Limitations of the Empirical Strategy

The first limitation of our empirical strategy is the small number of treated labor markets. Although the total number of observations in our data set is relatively large, the number of observations from the treated group is small. Our identification strategy exploits variation in when and where OPFs were approved to identify the effect on income in the labor markets. Hence, identification arises from changes in the treatment group, which consists of few observations. In contrast, traditional inference assumes that the number of observations is large. A small sample size gives imprecise estimates and test statistics with less power. As discussed in Section 6.2, the event-study estimates suffer from large confidence intervals which is due to this issue. Further, we find relatively large standard errors for many of our results. Low statistical power reduces the chance of discovering effects that are genuinely true, and also the chance of an observed statistically significant effect to be true (Wooldridge, 2013).

The second limitation to our selected empirical strategy regards the key identifying assumption. The timing of approval must be uncorrelated with other determinants of average income in the labor market. This is hard to test, and there might be endogeneity between the approval of an OPF and unobservable determinants of average income. Our research has revealed that committed politicians and stakeholders heavily influenced many of the OPF establishments. This does not necessarily violate our identification strategy single-handedly. An example of violation can be that the desire of the politicians was based on a common trajectory of the labor markets where an OPF was allocated. We aim to check for potential bias created by such situations by the event-study, where figures show few signs of pre-trends, and by the further investigation including time trends, which indicates that time trends are not driving the results. The politicians might also, motivated by for example an economic downturn in the labor market, implement other means to affect the economic development. If such means are not identified and controlled for, it would bias our estimates.

The next limitation is similar to the above but more complex. During the 1970s, the OPEC-crisis caused the oil price to rise distinctively.[46] This had a significantly negative effect on the global shipbuilding industry during the second half of the 1970s. See Table 6 for an overview of people employed within the shipyard industry in different countries.

Table 6 – People Employed within the Shipyard Industry

	1975	1978	1980	1982
Norway	41737	42313	41132	
Shipbuilding	36456	35245	31082	
Offshore	5281	7068	10050	
Sweden	23700	14800		8000
Denmark	16600	12000		11200
Great Britain	78400	72100		6000
Netherlands	49700	39400		34400

Numbers are people employed within the shipyard industry. Source: Nerheim (1996).

In Norway the crisis had a dual effect; it had a positive effect on the oil industry through increased demand for Norwegian oil, and a negative effect on the shipbuilding industry.[47] As a result of the crisis, Norwegian shipyards went through a restructuring towards supplying the offshore industry, which compensated for the drop in shipbuilding. This helped to preserve the employment level within the shipyard industry throughout the crisis and averting a potential crisis (Nerheim, 1996). The estimated effect of the OPFs is therefore likely to be underestimated since two of our treated labor markets also has a shipyard. The counterfactual of having a petroleum sector would have been a crisis within the shipyard industry in these markets. However, controlling for this is outside the scope of this thesis as a suitable counterfactual would imply accessible data for markets solely affected by the crisis, i.e. markets outside of Norway.

[46] The crisis began in October 1973 when the members of OAPEC (consisting of the Arab members of OPEC plus Egypt and Syria) announced an oil embargo against the U.S. and other countries supporting Israel in the October war (Gjerde, 2014).

[47] The international oil crisis increased demand for oil from politically stable countries, such as Norway (Gjerde, 2014).

Lastly, our control group can be subject to critique. For the control group to represent a suitable counterfactual, there should be no spillover effects from the treatment group. As mentioned earlier, Johannesen (2009) find that 413 municipalities in Norway have at least one inhabitant employed within the petroleum sector. It is therefore likely that the effect of an OPF approval is spread across a large part of the country. To reduce the harm of this issue, we exclude all labor markets considered to be highly influenced by petroleum, where the amount of oil workers is likely to be high. However, as a large share of the remaining municipalities also is influenced to a certain degree, the issue remains.

7.3 Implications of Study

The debate is ongoing about whether Norway should continue to develop the petroleum industry in the future, and especially whether the industry should be expanded further in the northern parts of Norway. Despite the opposition from environmental quarters, the petroleum industry is steadily advancing in the north. The parliament recently approved the plan for development and operation for the Johan Castberg field in the Barents Sea (Innst. 368 S (2017-2018)). Barents Base, located in Vardø, is also under development and is planned to supply activity in both the Norwegian and the Russian sector (Norsk oljemuseum, 2018). When policymakers are deciding on whether to encourage or restrain such approvals, the effect on local communities is important information. As an illustration, the recommendation to the parliament proposing approval of the Johan Castberg field includes forecasts of employment consequences and focus on the operator's (Equinor) interest in regional industry and how much of the national value-creation that will accrue to the regional market (Innst. 368 S (2017-2018)).[48] Shedding light on the question of whether persons living in the resource-abundant area does indeed benefit from the petroleum extraction, is therefore important.

Findings in our study seem to contradict that the approval of an OPF results in large benefits for the local labor market. Our results indicate that there is no effect on the average income of the working age population due to the approval of an OPF, while the unemployment rate increases. Instead, the positive effects of an OPF seem to accrue to the surrounding labor markets through positive spillover effects on average income, and no change in unemployment. It is, however,

[48] Bills are first proposed in the Norwegian Parliament (Storting), either by the government or by members of the parliament(MPs), and then sent to one of the standing committees. The committee submits a recommendation with a proposed decision to the Storting (Stortinget, 2018).

hard to conclude on whether the establishment of an OPF has benefited the local labor markets solely on the basis of our research. Firstly, the discussion above purposes some reasons to why we cannot find significant effects on the treated labor markets which are important to bear in mind. Secondly, the approval of an OPF can benefit the local labor market through other channels than measurable changes in average income, which are not investigated due to the scope of this study. For further research, such aspects can be interesting to include. See the following section for more details.

Moreover, the extent to which the results of our study can be generalized is subject to discussion. Firstly, the authorities' concern towards regional policy factors has changed. After 2012 the authorities re-enacted a state intervention policy where they to a larger extent direct activity towards the regional markets by setting requirements for the PUD's. This changed the attitude of operators towards facilitating local development, resulting in more local content in contracts (Nilssen et al., 2008). Thus, the recent focus on achieving regional policy goals might lead to a larger effect of the proceeding advancement of petroleum industry on the regional markets.

Secondly, our analysis mainly concerns a period consisting of steady growth in both production and employment (Norsk Petroleum, 2018a,c). Total extraction of petroleum in Norway reached it's peak in 2004 and is forecast to decline in the future (Norsk Petroleum, 2018c). Our time period analysis indicates that the potential positive effects on average income are dependent on a high activity level within the petroleum industry. As it is reasonable to believe that the most intensive periods within the petroleum industry are behind us, such positive effects are less likely in the future. However, Northern Norway is the region which has achieved the smallest return from the petroleum activity. This is due to a smaller number of discoveries, where the fields considered as economically interesting have proven more challenging to exploit (Vatne, 2003). The northern region might experience a significantly increased activity if new technology allows for extraction from these fields or new discoveries are made. Hence, one cannot disregard future effects for Northern Norway similar to those found in booming periods.

Our findings provide no clear-cut answers, and more research in the field is necessary to obtain a thorough knowledge of how local labor markets are affected by OPFs, which can have implications for policy.

7.4 Further Research

Our thesis is limited to studying the average income of local labor markets. For further studies, it would be interesting to investigate heterogeneous effects in the labor markets, and especially whether effects on average income differ across sectors or over demographics. Dyrstad and Brunstad (1997) does investigate effects over different occupational groups within certain sectors. The study is, however, concerning a limited time period and sectors related to the petroleum industry. Further studies will therefore still be interesting. Studying sectors will also give further indications as to whether there has been crowd-outs of certain sectors following OPF approvals. Analyses performed on an individual level would provide interesting insight into the type of persons affected, and how they are affected.

Expanding the analysis by looking more closely at other outcome variables, such as unemployment, employment, immigration and inequality, will also give a better understanding of the dynamics shocks like the OPF approval cause in the labor markets. Similarly, investigating the effect of an OPF on local governance outcomes would be interesting. Real estate taxation of OPFs can potentially provide a large income source for municipalities. As an example, such taxation has helped raise Tysvær and Øygarden from having among the weakest tax bases nationally to having among the strongest (Vatne, 2003). Further, the time period of our analysis is mainly concerning a semi-permanent boom and does not cover any large busts in the petroleum industry. The boom lasted until the recent oil price drop in 2014, which represents an interesting event for further studies of busts on outcomes of the local labor markets and the municipalities.

Lastly, it would be interesting to investigate effects of policy changes in the petroleum industry, such as the mentioned reduction in commuter compensation implemented by Statoil from 2012 (Nilssen et al., 2008). This would give interesting insights into how practices in the industry are affecting local labor market reactions to OPF approvals and would be highly relevant for policymakers in both the petroleum sector and the government.

8 Conclusion

The aim of this thesis was to answer the following research question:

"What is the effect of an onshore petroleum facility approval on the average income of the labor markets?"

The Norwegian petroleum industry quickly developed from essentially being non-existing in the late 1960s, to being the largest contributor to the Norwegian economy, both in terms of revenues, investments and total value creation (Norwegian Petroleum Directorate, 2011). Norway is also one of the few countries which have been seemingly successful in escaping the natural resource curse (Larsen, 2006). However, this conclusion draws on the basis of national level studies. This thesis contributes to the scarce literature on the effect of natural resource abundance on regional level outcomes. To answer the research question, and have an indication to whether petroleum extraction has benefited persons living in resource-abundant areas, we exploit variation in when and where OPFs were approved to estimate the causal effect on average income in the labor markets. Our analysis follows a generalized difference-in-difference setup, and we also perform event-studies to test internal validity and look at the timing of the effects. To obtain a more thorough understanding of the effects on the labor market, we also extend our analysis to look at average income in different time periods, average income for different treatment cutoffs and unemployment.

Our main results indicate that an OPF approval does not affect average income in markets where the OPF is established, while spillover effects increase average income by 3.2 per cent in the surrounding labor markets. From the extended analysis, we find that an OPF approval led to an increase in average income of 3.4 per cent in labor markets with an OPF during the 2000s. Further, spillover effects from an OPF approval increased average income by 3.9 per cent in surrounding labor markets during the 1980s. Both of these periods are characterized by booms in the petroleum industry, which can explain the enhanced effects. From the sensitivity analysis, we also know that an important share of the spillover effects is driven by the labor markets surrounding Florø, indicating that all of the indirect labor markets do not benefit from the OPF approvals to the same extent. The insignificant effects in labor markets where the OPFs were established are possibly explained by an increase in the unemployment rate of 0.4 percentage points following the OPF approval. We find no spillover unemployment effects onto nearby markets.

Although our findings are inconclusive with regards to whether resources have benefited persons living in resource-abundant areas, this study is limited to investigating the average income of labor markets as well as a limited analysis of unemployment. Thus, many interesting aspects are not covered, such as immigration and potential heterogeneous effects in the labor markets. However, our findings can inspire further interesting research, which will be important for policymakers on all administrative levels in Norway.

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9 Appendix

Table A1 – List of Abbreviations

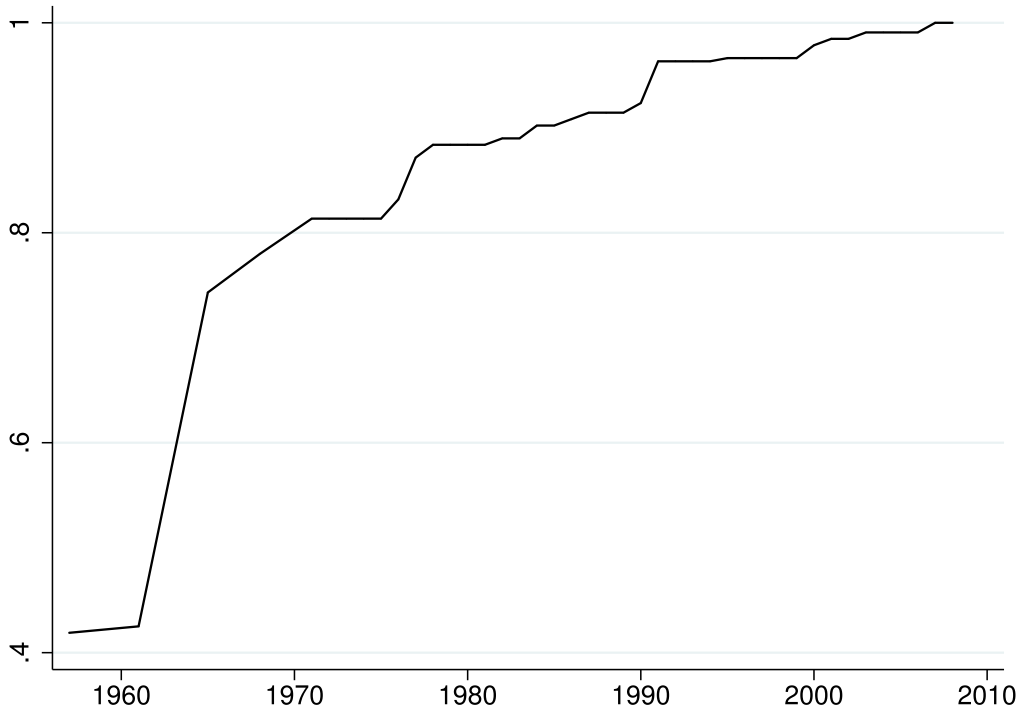
NCRD	Norwegian Center for Research Data
OPF	Onshore Petroleum Facility
NGO	The Geological Survey of Norway
NPD	Norwegian Petroleum Directorate
NOK	Norwegian Kroner
CCB	Coast Center Base
OVB	Omitted Variable Bias
OLS	Ordinary Least Squares
SSB	Statistics Norway
SPUD	Parliament approval of plan for development and operation

Table A2 – List of Control Variables

Labor Market Characteristic	**Time Period**	**Description**
Educational Attainment Elementary School High School Higher Education	1970-2008	Based on the number of people above 15 years with elementary school, high school or higher education as their highest obtained education level living in each municipality, we have constructed a set of variables displaying the share of population over 15 years with the given education level.
Women	1950-2008	Share of women in the population of each labor market.
Retired	1960-2001	Share of retired in the working age population of each labor market.
Population Density	1957-2008	People per square kilometer is calculated by dividing total population on the area of each labor market.
Economic Social Aid	1967-2008	Share of people on economic social aid in the working age population of each labor market.
Disability Benefits	1979-2007	Share of people on disability benefits in the working age population of each labor market.
Share of Youth	1950-2008	Share of people aged between 15 and 24 in the working age population of each labor market.
Health	1970-2001	Share of people working in the health sector in the working age population of each labor market.

Notes: The time period does not necessarily mean that the data are continuous over the given years, see Section 5.3 for details.
Labor markets are local.

Figure A1 – Tax Registration Coverage Rate



Notes: The y-axis shows share of municipalities registering income. The lack of registration is more prominent in the beginning of our time period, and the number of registered municipalities rapidly increases. In 1984 we have data on income 90% of the municipalities.

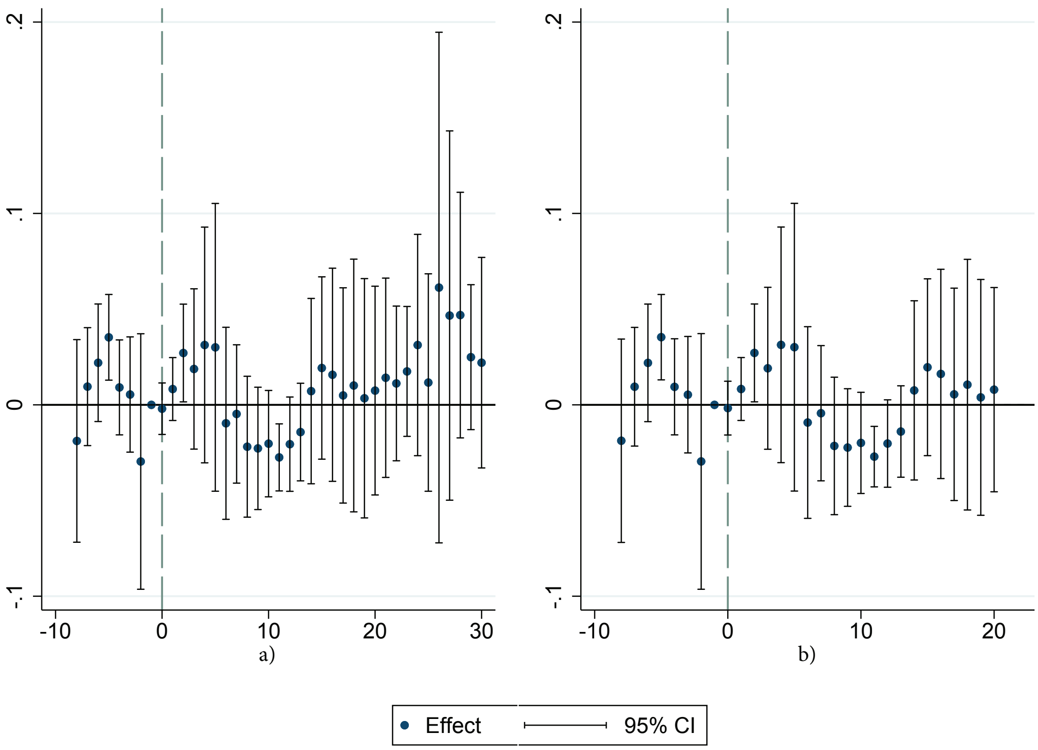
Table A3 – Wooldridge Test for Unbalanced Panels

	(i)
	Baseline
s_{t-1}	-0.0090
	(0.0088)
Controls	Yes
Observations	11973

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

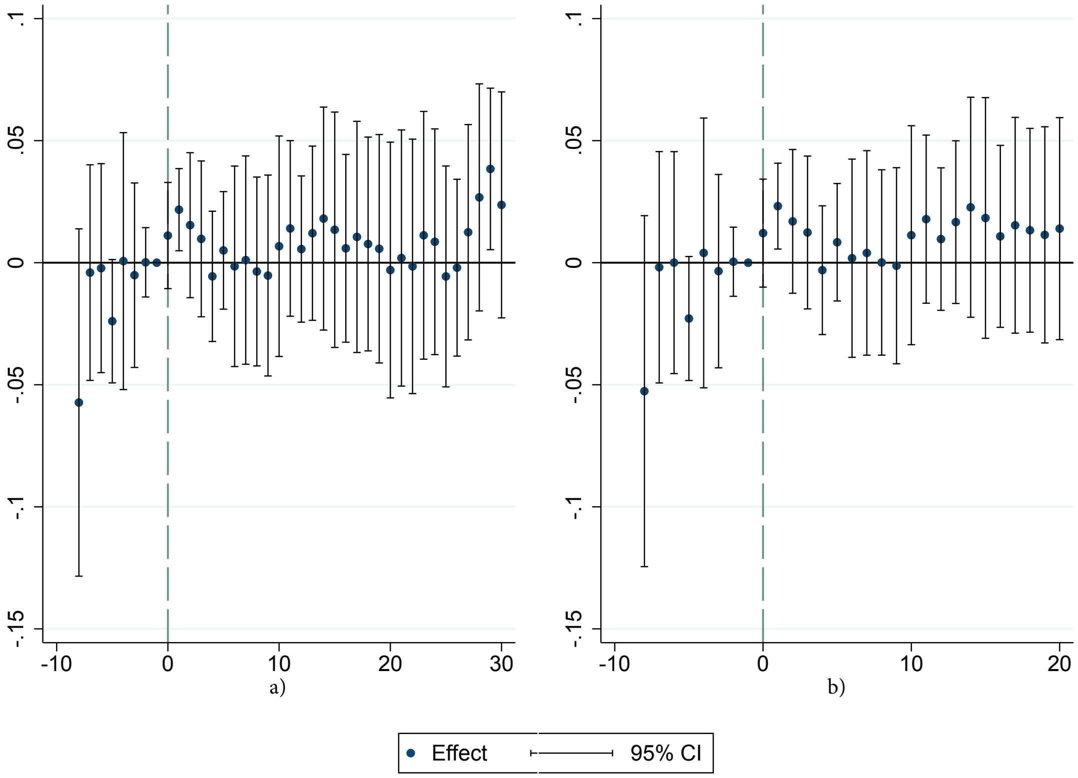
Notes: The table shows the results of running a regression based on the model in Equation 3. The selection indicator s is equal to 1 if a municipality has registered income, and 0 otherwise (selection is defined has having registered income). The test is built on the assumption that unobserved covariates in time t should be uncorrelated with selection in any period. Thus, the lagged indicator variable should have an insignificant effect on income in period t.

Figure A2 – Event-Study for the Treated Labor Markets



Notes: The figures plot the post treatment ν_τ and anticipatory effects ω_τ from the event-study specification, Equation 2, for income in the treated labor markets. Panel a) over 30 years and b) over 20 years. Time- and market fixed effects are included, as well as the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview of the control variables is given in Table A2. Standard errors are robust and adjusted for clustering on the level of the regional labor markets. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.

Figure A3 – Event-Study for the Indirectly Treated Labor Markets



Notes: The figures plot the post treatment ν_τ and anticipatory effects ω_τ from the event-study specification, Equation 2, for income in the indirectly treated labor markets. Panel a) over 30 years and b) over 20 years. Time- and market fixed effects are included, as well as the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview over the control variables is given in Table A2. Standard errors are robust and adjusted for clustering on the level of the regional labor markets. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.

Table A4 – Short-term Analysis

	(i) Baseline	(ii) Five Years	(iii) Eight Years
Approval	0.0108	0.0219	0.0058
	(0.0127)	(0.0145)	(0.0153)
Spillover	0.0322*	0.0178*	0.0140
	(0.0166)	(0.0100)	(0.0124)
Controls	Yes	Yes	Yes
Observations	5310	4308	4468

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Each column is from a separate regression of the outcome variable, which is log average income in the labor market, on the approval of OPF and spillover effects, based on the model in Equation 1. In column (ii) and (iii), the time period included in the regression, before and after treatment, are limited to five and eight years, respectively. Time- and market fixed effects are included in all specifications, and the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview of the control variables is given in Table A2. Robust standard errors adjusted for clustering on the level of the regional labor markets are shown in parenthesis. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.

Table A5 – Including Time Trends

	(i)	(ii)	(iii)	(iv)
	Baseline	Linear Trend	Quadratic Trend	Cubic Trend
Approval	0.0108	-0.0174	-0.0048	-0.0008
	(0.0127)	(0.0169)	(0.0187)	(0.0184)
Spillover	0.0322^{*}	0.0139	0.0255	0.0290^{*}
	(0.0166)	(0.0140)	(0.0161)	(0.0166)
Controls	Yes	Yes	Yes	Yes
Observations	5310	5310	5310	5310

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Each column is from a separate regression of the outcome variable, which is log average income in the labor market, on the approval of OPF and spillover effects, based on the model in Equation 4. Column (ii) to (iv) shows estimated results when including the specified time-trends to the specification. Time- and market fixed effects are included in all specifications, and the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview of the control variables is given in Table A2. Robust standard errors adjusted for clustering on the level of the regional labor markets are shown in parenthesis. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.

Table A6 – Regression Sensitivity Analysis

	(i) Baseline	(ii) Harstad	(iii) Fishmarket
Approval	0.0108	0.0160	0.0109
	(0.0127)	(0.0132)	(0.0124)
Spillover	0.0322*	0.0357**	0.0321*
	(0.0166)	(0.0163)	(0.0168)
Controls	Yes	Yes	Yes
Observations	5310	5392	5310

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Each column is from a separate regression of the outcome variable, which is log average income in the labor market, on the approval of OPF and spillover effects, based on the model in Equation 1. The sample for model (ii) includes Harstad in the treatment group. The model in column (iii) includes an indicator for high fishery labor markets. Time- and market fixed effects are included in all specifications, and the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview of the control variables is given in Table A2. Robust standard errors adjusted for clustering on the level of the regional labor markets are shown in parenthesis. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.

Table A7 – Excluding Outliers from the Sample

	(i) Baseline	(ii) 99% CI	(iii) 95% CI
Approval	0.0108	0.0027	0.0075
	(0.0127)	(0.0153)	(0.0144)
Spillover	0.0322*	0.0349**	0.0322*
	(0.0166)	(0.0168)	(0.0174)
Controls	Yes	Yes	Yes
Observations	5310	5241	5069
Treatment	211	186	173

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Each column is from a separate regression of the outcome variable, which is log average income in the labor market, on the approval of OPF and spillover effects, based on the model in Equation 1. Log of income per capita is approximately normally distributed. We exclude observations lying far away, defined by a certain fence, from the mean. For column (ii) this implies exclusion of observations further away from the mean than the 2.5th percentile / 97.5th percentile. For column (iii) the 0.5th percentile / 99.5th percentile. Time- and market fixed effects are included in all specifications, and the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview of the control variables is given in Table A2. Robust standard errors adjusted for clustering on the level of the regional labor markets are shown in parenthesis. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.

Table A8 – Excluding Treated Labor Markets One at a Time

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
	Baseline	Sola	Tysvær	Bergen	Florø	Kristiansund and Aure	Hammerfest
Approval	0.0108	0.0127	0.0144	0.0039	0.0120	0.0080	0.0173
	(0.0127)	(0.0128)	(0.0136)	(0.0110)	(0.0141)	(0.0185)	(0.0119)
Spillover	0.0322*	0.0326*	0.0380**	0.0372*	0.0151	0.0321*	0.0378*
	(0.0166)	(0.0168)	(0.0170)	(0.0199)	(0.0114)	(0.0185)	(0.0188)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,310	5,147	5,153	4,982	5,066	5,155	5,052

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Each column is from a separate regression of the outcome variable, which is log average income in the labor market, on the approval of OPF and spillover effects, based on the model in Equation 1. Column (ii) to (vii) shows estimated results when dropping the specified labor market. Time- and market fixed effects are included in all specifications, and the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview over the control variables is given in Table A2. Robust standard errors adjusted for clustering on the level of the regional labor markets are shown in parenthesis. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5. Note that since Aure and Kristiansund are situated within the same regional labor market, the exclusion of this regional labor market involves excluding the two treated local labor markets.

Table A9 – Different Time Periods

	(i) 57-79	(ii) 80s	(iii) 90s	(iv) 00-08	Obs.
Approval	-0.0204	0.0177	-0.0029	0.0336*	5310
	(0.0199)	(0.0175)	(0.0223)	(0.0173)	
Spillover	0.0120	0.0389**	0.0347	0.0331	5310
	(0.0163)	(0.0146)	(0.0208)	(0.0223)	

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The two rows contain the estimates of approval and spillover effects from a single regression of the outcome variable, which is log average income of the labor market, for different time periods, based on the model in Equation 5. Column (i) depicts the estimated effect prior to 1979, while column (ii), (iii) and (iv) show the estimates for the 80s, 90s and the years after 1999, respectively. Time- and market fixed effects are included in all specifications, and the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview of the control variables is given in Table A2. Robust standard errors adjusted for clustering on the level of the regional labor markets are shown in parenthesis. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.

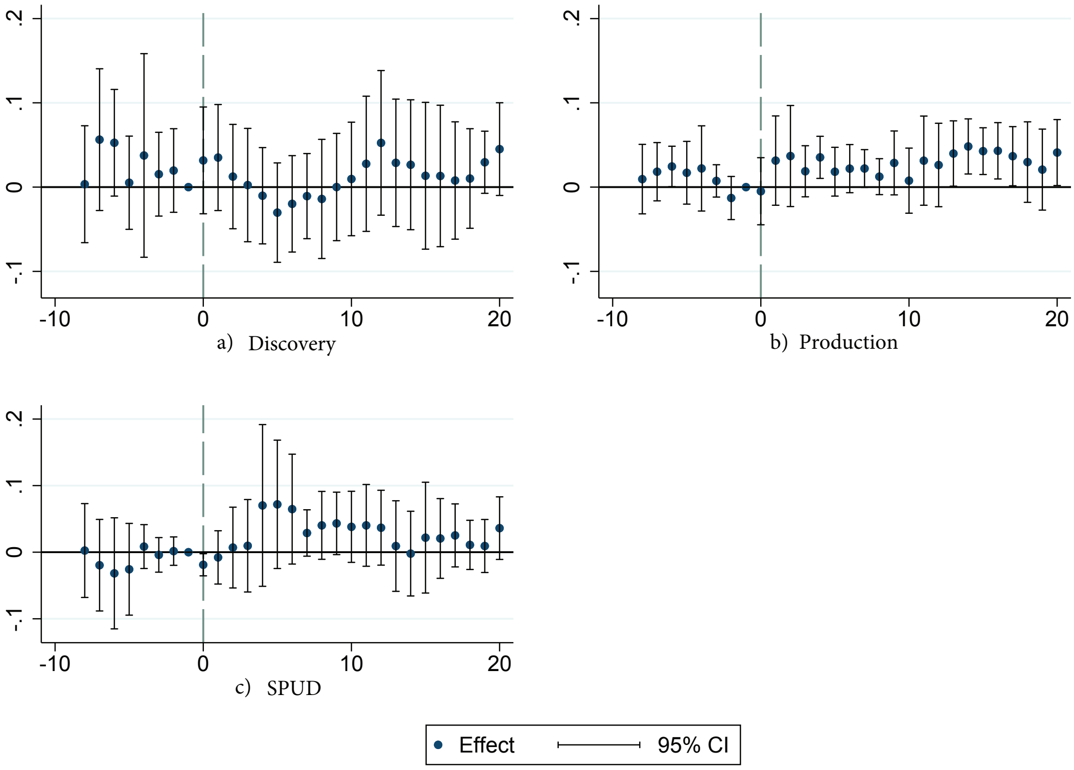
Table A10 – Different Treatment Cutoffs

	(i) Approval	(ii) Discovery	(iii) SPUD	(iv) Production Start
Treatment	0.0108	0.0016	0.0300	0.0181
	(0.0127)	(0.0169)	(0.0244)	(0.0115)
Spillover	0.0322*	0.0283	0.0336*	0.0469***
	(0.0166)	(0.0177)	(0.0174)	(0.0170)
Controls	Yes	Yes	Yes	Yes
Observations	5310	5310	5310	5052

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The two rows contain the estimates of approval and spillover effects from a single regression of the outcome variable, which is log average income of the labor market, for different treatment cutoffs, based on the model in Equation 1. The treatment cutoff equals the specified incident for each column. Robust standard errors adjusted for clustering on the level of the regional labor markets are shown in parenthesis. Time- and market fixed effects are included all specifications, and the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview over the control variables is given in Table A2. The sample for each model includes all local labor markets except those omitted due to aspects discussed in Section 5. In model (iv) Hammerfest is excluded from the sample due to a single observation after treatment.

Figure A4 – Event-Studies for Different Treatment Cutoffs



Notes: The figures plot the post treatment ν_τ and anticipatory effects ω_τ from the event-study specification in Equation 2, as well as 95 per cent confidence intervals. Event-study estimates are plotted for a) Discovery, b) Production and c) SPUD as treatment. Thus $D_{i,t+\tau}$ equals one dependent on the treatment cutoff specified. Time- and market fixed effects are included in all specifications, as well as the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview of the control variables is given in Table A2. Standard errors are robust and adjusted for clustering on the level of the regional labor markets. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.

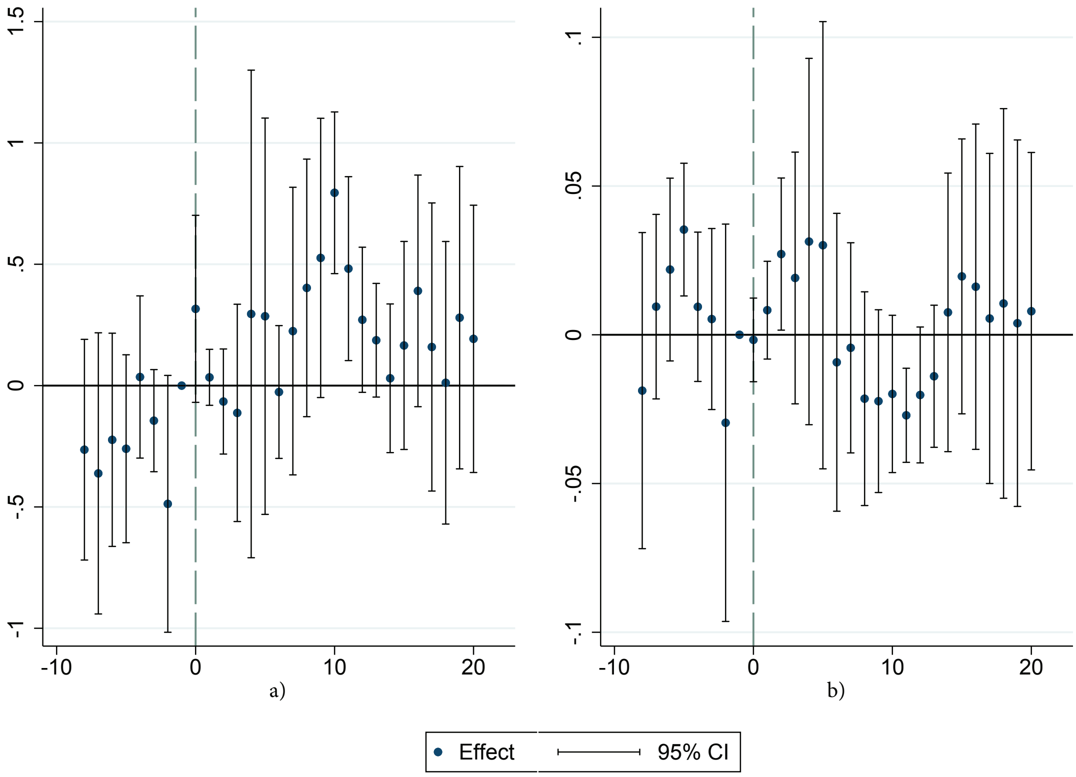
Table A11 – Unemployment and Net Immigration

	(i) Unemployment Rate	(ii) Net Immigration
Approval	0.4394***	-0.0978
	(0.1413)	(0.1077)
Spillover	-0.0516	0.1384
	(0.0851)	(0.2053)
Controls	Yes	Yes
Observations	5310	5310

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Each column is from a separate regression of the outcome variable, which is unemployment rate for model (i) and net immigration for model (ii), on the approval of OPF and spillover effects, based on the model in Equation 1. Time- and market fixed effects are included in both specifications, and the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview of the control variables is given in Table A2. Robust standard errors adjusted for clustering on the level of the regional labor markets are shown in parenthesis. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.

Figure A5 – Event-Studies for Unemployment Rate and Average Income



Notes: The figures plot the post treatment ν_τ and anticipatory effects ω_τ from the event-study specification in Equation 2, as well as 95 per cent confidence intervals. Event-study estimates are plotted for a) unemployment and b) average income. Time- and market fixed effects are included in all specifications, as well as the following set of control variables: share of people with primary, high school and university as their highest obtained educational level, density, share of retired, share of women, share of youth, share of people working in the health sector, share of people on social services. An overview of the control variables is given in Table A2. Standard errors are robust and adjusted for clustering on the level of the regional labor markets. The sample includes all local labor markets except those omitted due to aspects discussed in Section 5.