# Economic Downturns, Adjustment Costs, and External Labor Utilization

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Abstract

Recent evidence shows that firms increasingly rely on external labor, i.e., subcontracting, domestic outsourcing, temp agency hiring, etc. An explanation for firms' use of external labor is that this allows firms to adjust their labor inputs more easily in response to changes in product demand. In this paper, we provide new evidence on firms' adjustments of internal and external labor during an economic downturn. Further, we investigate the role of downturns as a driver of labor restructuring, and how firms' adjustments of internal and external labor depend on unions and organizational structures. We study a local recession following the 2014 oil price shock, which had larger impacts on some regions of Norway than others. We use this in difference-in-differences framework, together with detailed register data on firm performance, internal and external labor costs, and worker outcomes. Our results suggests that firms that relied more on external labor prior to the downturn–arguably facing lower adjustment costs–also adjusted labor inputs more aggressively. The downturn also triggered a restructuring of labor inputs, with an increase in demand for external labor during the aftermath in firms that previously did not rely on external labor. Finally, local unions seem to have an influence on firms' labor adjustments, where firms with higher unionization experience smaller reductions in internal labor inputs, and larger in external labor inputs.

**Keywords:** Labor Demand, Adjustment Costs, External Labor, Subcontracting
**JEL codes:** J23, J81, L24

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# 1 Introduction

Adjustments in the labor market are key to understanding the depth and persistence of aggregate economic fluctuations (Hall, 2005a,b). How firms adjust their labor demand during economic downturns depends crucially on the structure of their labor adjustment costs (Hamermesh, 1989) and whether nominal wages can be cut (Bewley, 1999). Importantly, the increasing reliance of firms on alternative forms of external labor inputs, e.g., subcontractors, temp agency workers, independent contractors, etc. (Katz and Krueger, 2019b,a), has implications for how labor markets are expected to adjust during economic downturns. On the one hand, workers hired through alternative external labor contracts often face adverse work conditions (Goos et al., 2022) and may lack formal employment protection, thus being more prone to earnings losses during economic downturns. This can amplify aggregate fluctuations, causing concerns about the rising use of external labor. At the same time, economic downturns provide firms an opportunity to restructure (Hershbein and Kahn, 2018), and external labor may allow firms to adjust their labor inputs more easily in response to changes in product demand and aide restructuring.[1]

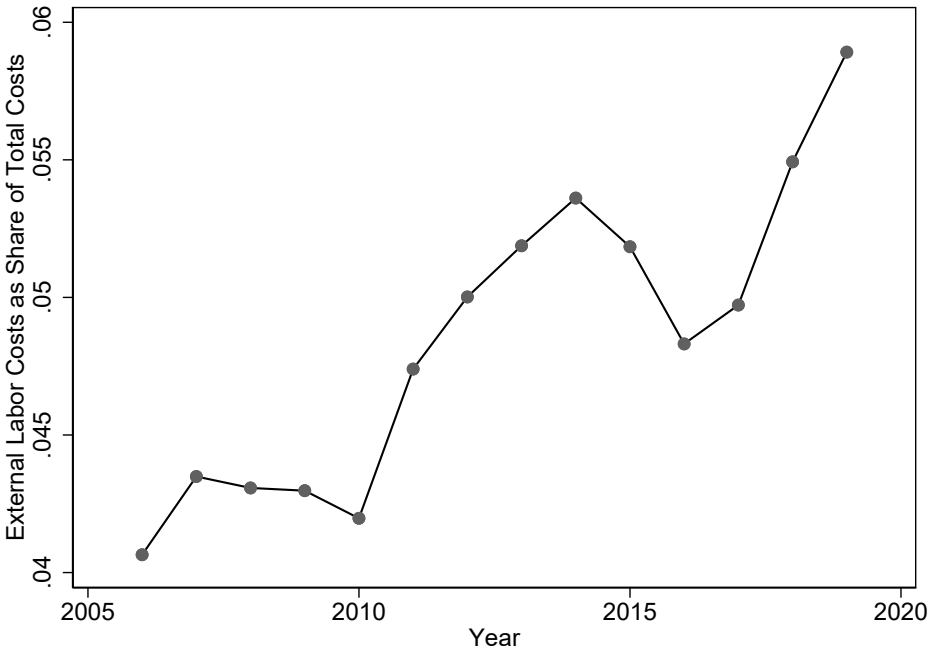
In this paper, we study a local recession following the 2014 Oil Price Crash–a drop in the Brent Crude price from above 100 USD to around 50 USD per barrel–which had larger impacts on some regions of Norway than others. Using detailed firm-level balance sheets and matched employer-employee register, we shed light on firms' labor adjustments during and in the aftermath of the local recession. Importantly, our data provide information on external labor costs for private sector firms. These external labor costs include the total expenses each firm incurs on personnel hired by subcontractors or through temp agencies or independent contractors that assist the firm in its production process. The availability of such information and the potential for linking this to a rich set of additional data sources on firm performance, presence of local unions and worker outcomes allows for a close evaluation of firms' labor adjustments following economic downturns.

Figure 1 shows the evolution of aggregate external labor costs in Norway, calculated as a share of firms' total costs aggregated for the whole economy. Notably, the external labor cost share increased by almost 50% from 2006 to 2019. Moreover, this aggregate evolution also points towards two salient features of firms' external labor use. First, external labor is highly sensitive to business cycle fluctuations, with lower use following both the Financial Crisis of 2007–2008 and the 2014 Oil Price Crash that triggered a local recession in Norway. Second, there also appears to be a tendency that external labor use

[1]Relatedly, Wasmer (1999) and Holmlund and Storrie (2002) find that temporary work is countercyclical. While temporary workers are internally employed and not regarded as external labor, they also represent a similar type of flexibility as external labor, since their employment contracts are short.

picks up sharply during the aftermath of each crisis. While these patterns are arguably consistent with firms facing lower adjustments costs for external labor and possibility of labor restructuring, it is challenging to make causal inference due to concerns about other aggregate changes over time that may correlate with firms' external labor use.

FIGURE 1: Aggregate External Labor Cost Share in Norway from 2006–2019.




**Notes:** Aggregate costs spent on external labor use as the share of aggregate total costs in Norway from 2006 to 2019. The sample consists of the universe of private sector limited liability (AS/ASA) firms in Statistics Norway's accounts data. The external labor costs include the total expenses a firm has incurred on personnel hired externally by subcontractors or through temp agencies assisting the firm in its production process, as reported under account no. 4500 in firms' balance sheets.

To address the identification concerns, we will exploit the fact that the 2014 Oil Price Crash had larger impacts on local economies in some regions of Norway than others. Importantly, oil and oil support industries are geographically concentrated along the Western Coast and partly the Southern Coast of Norway. The aggregate revenues in the most heavily exposed regions ("high-oil") reduced by more than 21% over the five year period following the oil price shock, as compared to the least exposed regions ("low-oil"), with substantial impacts on regional employment rates. Notably, this shock was driven by international events–largely increased oil production in the US and Canada combined with a lack of consensus among the oil-producing OECD countries to cut their production–and unrelated to other domestic factors that may influence labor demand in Norway. We study the impacts of the local recession triggered by the oil price shock on firms' labor demand adjustments in a difference-in-differences strategy, under the assumption that

outcomes of the firms in the high-oil regions would have developed similarly to the firms in the low-oil region if they had not been affected by the oil price shock (or affected to the same extent as the low-oil regions). Consistently, we find no evidence that outcomes in low- and high-oil regions evolved differently prior the five year period prior to the shock, which lends support to this crucial identification assumption.

Our main empirical findings show that firms in high-oil regions responded to the oil price shock swiftly by cutting their overall costs, following the revenue losses. Despite cost reduction, we find that exposed firms' average operating margin–a measure of their profitability–declines by about 40% over the five year period following the shock. Focusing on firms' labor demand adjustments, we find that firms reduce their total labor costs substantially by almost 9%. Exposed firms' costs on internal labor–workers hired and paid by the firm–shrink by about the same magnitude and stay lower during the whole five year period. Interestingly, we find a somewhat different dynamics when we focus on firms' costs on external labor–workers hired through subcontractors or temp agencies–where we find a strong initial decline followed by a recovery during the aftermath of the recession. By comparison, there is no evidence of a recovery in internal labor use. These patterns may indicate that firms face different costs for adjusting internal and external labor, and in the aftermath of a recession may find it easier to recruit workers externally. Such responses may reflect firms' attempts to avoid excessive future labor adjustment costs, but also that workers are more likely to accept external contracts after a recession. Notably, our main findings are robust to alternative treatment definitions (e.g., variable treatment intensity) and the inclusion of firm fixed effects.

To shed more light on the heterogeneity in adjustments of internal and external labor demand, we provide additional findings where we differentiate firms by their pre-crisis characteristics. We first consider whether a firm that had no external labor costs as opposed to having some external labor costs prior the crisis. This distinction allows us to split our main sample in two, almost equal sized samples. This distinction is also economically meaningful, as firms that already use external labor may face overall lower adjustments costs at the onset of the shock, while they are also more likely to have exhausted their potential for further efficiency gains through labor restructuring. Interestingly, we find that firms without external labor only marginally reduce their total labor costs, even though they reduce their overall costs. By contrast, firms with prior external labor aggressively cut down their total labor costs, and in relative terms, we see even sharper reductions in their external labor use. These results thus provide some evidence that firms that use external labor indeed find it easier to lay off workers, consistent with lower adjustment costs associated with having such labor. At the same

time, we find these firms' external labor use recovers faster as opposed to their internal labor, suggesting the face also lower costs on the hiring margin.

Next, we focus on the role of local labor unions, using information on union density at the firm level. During economic downturns, local unions are expected to be particularly salient, as they evidently promise workers insurance against unlawful termination by employers and support in workplace conflicts. Consistent with this view, we document interesting patterns of heterogeneity by local union presence, where less unionized firms cut their labor costs dramatically, at a similar pace as their revenue losses and their overall cost reductions. These labor cost reductions come about mainly through downsizing of internal labor. By contrast, more unionized firms cut their labor costs, in relative terms, less sharply as their revenue losses and overall costs, however, at the same time external labor use reduces significantly and, in relative terms, more than internal labor. One possible interpretation of these findings can be that while local unions are able or willing to shield internal workers during an economic downturn, there may be limited scope for similar insurance against adverse shocks for external workers. Further, among firms that used external labor prior to the crisis, we find even stronger reductions in external labor among more unionized firms. This evidence suggests that while local unions can play an important role in curtailing the transmission of aggregate economic shocks on to internal workers, their presence may even amplify the impacts on external workers.

Our paper contributes to a literature that focuses on the determinants of external labor use (e.g., Abraham and Taylor (1996)), and in particular, external labor use–and labor adjustments more broadly–during recessions. Early papers used firm interview data, e.g., Houseman et al. (2003), who found support for four main reasons for firms' reliance on external labor: i) numerical flexibility (i.e., ability to adjust labor size), ii) worker replacements (e.g., temporarily absent workers), iii) worker screening, and iv) cost saving.[2] The literature on the use of external labor over the business cycle is scarce. de Graaf-Zijl and Berkhout (2007) find that temp agency work leads GDP at the macro level, while Houseman et al. (2003) find more temp agency work in tight labor markets. We contribute

[2]Several studies show lower pay for external workers, indicating that there is indeed a cost-saving motive for the use of external labor (Weil, 2014, 2019). Goldschmidt and Schmieder (2017) study outsourcing events, where a group of workers move employer to a service provider firm within security, cleaning or food. They find that the outsourced workers are paid less than when they were directly employed at the workplace where they perform the work. Drenik et al. (2020) have data on workplace for temp agency workers in Argentina and find that the temp agency workers are paid less than their directly employed coworkers and receive a smaller part of firm rents. Goos et al. (2022) find that workers who continue their work at the same workplace, but switch from being directly employed to a "payrolling" contract with a different employer experience a lower hourly wage growth. Several papers document that workers in alternative work arrangements are paid less than workers with similar characteristics on ordinary contracts (Forde and Slater, 2005; Autor and Houseman, 2010; Jahn and Rosholm, 2014), but there is also some evidence that some groups, like health specialists, are better paid (Kalleberg, 2000).

to this literature by providing firm-level evidence on external and internal labor adjustments following a local recession triggered by a plausibly exogenous shock. Our paper also relates to a literature focusing on restructuring of firms during economic downturns (Hershbein and Kahn, 2018; Hall, 2005b; Koenders et al., 2005). We also contribute to the recent literature by providing new evidence on how the presence of local labor unions influences the transmission of shocks to internal and external labor.

We are not the first to study the economic consequences of the 2014 Oil Price Crash for Norway. Ahn et al. (2023) study local spending responses to the negative income shock, finding that spending shares fall by around 7 percent for the most exposed workers, and that the fall in demand amplifies the shock locally. Relatedly, Aursland et al. (2021) find changes in consumption behavior towards cheaper goods and buying on sale after the oil price shock. Mirroring the fall in consumption demand, Juelsrud and Wold (2019) find that the increased risk of unemployment after 2014 increases savings of more exposed workers (engineers). Lastly, Lorentzen (2023) study how the 2014 oil price shock impacted sectoral reallocation and wages in typical destination sectors of oil workers. These papers are, however, not directly related to our study, as they are not primarily concerned with firm behavior and external labor use. This research provides a backdrop, showing that the shock was deeply felt and had effects on the whole local economy.

The remaining paper is organized as follows. Section 2 provides details on the institutional setting, including the geographic concentration of the oil industry in Norway and the evolution of the 2014 Oil Price Crash. Section 3 presents our data sources, discussions of sample selection and some descriptives. Section 4 describes our empirical strategy, while Section 5 shows the aggregate impacts on local economies. Section 6 provides our main empirical findings on firms' labor adjustments. Finally, Section 7 concludes.

## 2 Institutional Setting

### 2.1 Labor Laws in Norway

As in most other developed countries, employers in Norway face legal constraints related to hiring and dismissal of their employees, i.e., labor adjustment costs are non-negligible. Importantly, most workers in Norway enjoy strong employment protection, which is regulated through the Working Environment Act (WEA). As a general rule, the WEA requires that employment contracts should be permanent (WEA, § 14-9-1). However, several exceptions to this rule exist, which allow firms to hire workers temporarily. As of November

2022, around 12% of workers in Norway were employed on such temporary contracts.[3]

While the employment protection legislation described above generally applies to internal workers, firms may also engage externally employed workers through temp agencies under similar provisions as in the WEA.[4] Further, firms can buy external labor services from sub- or independent contractors subject to provisions in the contract law. A year before the 2014 Oil Price Crash, firms in our study sample spent on average around 15% of their total labor costs on external labor. The reliance on externally hired workers thus appears to be a relatively common feature of firms' production processes in our setting, although most workers do have strong employment protection. Notably, however, the increasing use of subcontracting and temp agency hiring is politically contested, with labor unions expressing concerns about external labor use putting a downward pressure on wages. Another concern is that increase use of external labor may undermine the tight cooperation between employer and employee organisations and the government, which has historically between an important feature of collective bargaining systems in many European countries, including Norway (see, e.g., discussions in Bhuller et al. (2022)).

Employers also face stringent requirements regarding the dismissal of permanent workers. As a general rule, workers may not be dismissed "unless this is objectively justified based on circumstances relating to the undertaking, the employer or the employee" (WEA, § 15-7). An example of a circumstance relating to the undertaking and/or the employer can be a change in economic conditions (e.g., loss of a revenue source), but dismissals based on such criteria are justified only if downsizing is strictly essential in order to maintain the continued operation of the undertaking.[5] Examples of circumstances relating to the employee that may trigger a dismissal can be lack of competence or skill, low efficiency, unsatisfactory results, illegal absence, unwillingness to follow managers' instructions, use of drugs during working hours, financial fraud and disloyalty to the employer. In practice, few dismissals according to circumstances relating to the employee are approved, while dismissals according to circumstances relating to the undertaking or employer are more common. Workers on temporary contracts, however, can be laid off when their contract period expires without further notice (WEA, § 14-9-6), unless they have been hired for a

[3]These exceptions are stated explicitly in the WEA, § 14-9-2, and can be satisfied (a) when the work has a temporary nature (i.e., permanent contract is infeasible), or when a worker is hired (b) as a temporary replacement for other (permanently hired) worker(s), (c) in a trainee position, (d) as participant in an active labor market program, or (e) as an athlete, trainer, referee, or sports leader.

[4]Such external workers hired through temp agencies may have a temporary or a permanent employment contract with the temp agency. From April 1st, 2023, the provision related to use of external temp agency workers for work that "has a temporary nature" as in WEA, § 14-9-2(a), was made stricter.

[5]An economic downturn affecting firm revenues may qualify as a change in economic conditions, allowing firms to downsize according to this legislation. However, collective dismissals (of more than 10 workers) are subject to additional requirements, such as an advanced layoff notificiation (WEA, § 15-2).

three-year period, in which case the same rules as for permanent employers apply (WEA, § 14-9-7). By contrast, the work relationship for externally hired workers ends when the contract between the focal firm and the subcontractor or temp agency expires. The costs of terminating such external labor contracts are expected to be lower than the costs associated with dismissal of internal workers, which is of course one of the stated reasons why firms engage external labor (Abraham and Taylor (1996); Houseman et al. (2003)).

## 2.2 The Oil Industry in Norway and the 2014 Oil Price Crash

The oil and gas sector in Norway is the largest sector measured in terms of value added, government revenue, investments and export value, currently accounting for 24% of GDP, 19% of total investments and 52% of total exports.[6] For the most part, the extraction of oil in Norway is performed on offshore platforms placed outside the Western Coast and partly Southern Coast of Norway.[7] Firms operating in the oil industry and associated oil support industries are also mostly situated in municipalities along these coastlines, such as Equinor (Stavanger), which is the biggest oil company in Norway. Figure 2 shows a map of Norway and the share of revenue in oil and oil support industries in the different labor market regions, using the regional classification of Bhuller (2009). There is a clear geographical concentration of the industry along the Western and Southern Coast. There are some oil-dominated areas even in the Eastern Inland in Norway, e.g the labor market region that covers Kongsberg, which is an important industrial city for many sectors.[8]

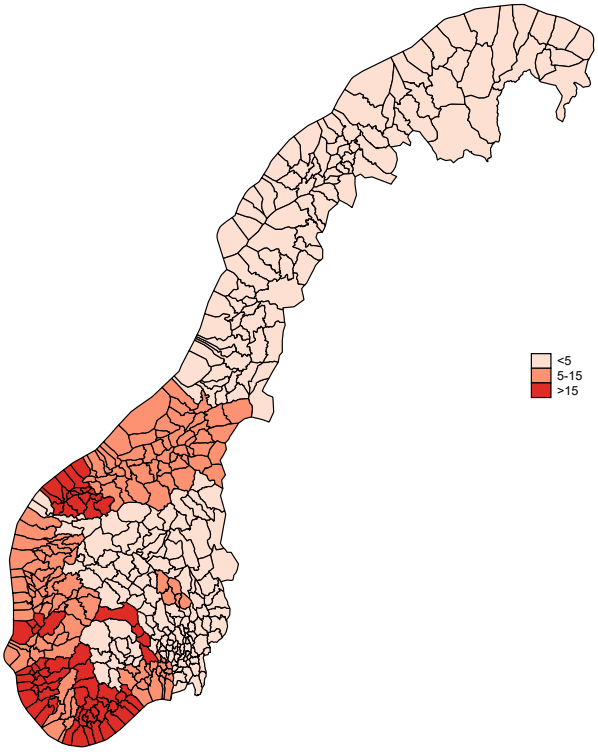
Our research design exploits the geographical concentration of oil industry illustrated above, combined with a major global shock to the oil price driven by international events. Starting in mid-2014, the oil price plummeted worldwide. Figure 3 shows that the price of Brent Crude went down from above 100 dollars to around 50 dollars before it gradually increased from 2016 but not reaching the previous levels in the five year period following the shock. Oil prices are set internationally, and Norwegian production amounts to only around 2% of the total production. The 2014 price fall came after a period when the U.S. and Canada had increased their oil production, while Saudi Arabia continued to produce oil as planned to provoke a fall in the oil price that could in the long run keep their market shares intact. Among factors behind increased U.S. production include advances in hydraulic fracturing and horizontal drilling technologies that ease oil extraction from shale reserves (Mead and Stiger, 2015). Norway's production, however, had vanishingly

[6]Meld. St. 1 (2023–2024) Nasjonalbudsjettet 2024.

[7]https://www.norskpetroleum.no/en/interactive-map-quick-downloads/interactive-map/

[8]For instance, the flagship Kongsberg Gruppen ASA located here is a major supplier of technological equipment to the oil industry, besides serving marine, defence, aerospace, and similar industries. Other examples include TechnipFMC, which is Norway's biggest oil service support company, also located here.

FIGURE 2: Regional Oil Dependence in 2013.



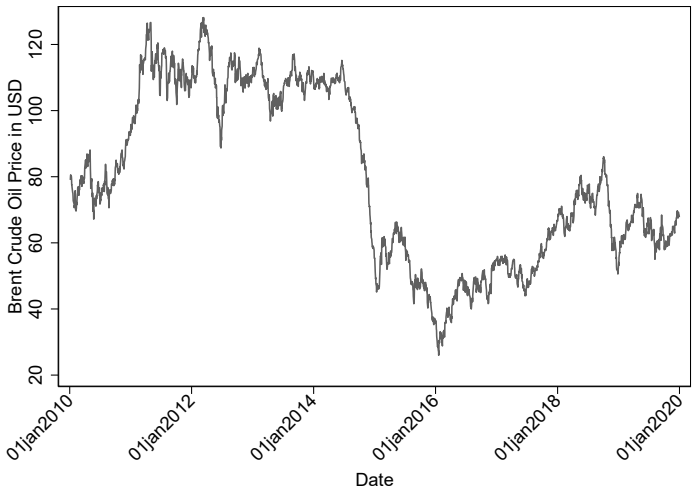

**Notes**: This figure shows the share of aggregate revenue in the oil and oil support industries by labor market regions in 2013. See Table 1 in Statistics Norway (2015) for the definition of oil support industries used in our analysis. The black lines show municipal borders, where each municipality is part of a larger labor market region. Following the classification of Bhuller (2009), there are 46 such regions in Norway. The light shaded municipalities are in regions where less than 5% of aggregate revenues are from oil and oil support industries ("low oil dependence"), while the medium shaded have 5–15% ("medium oil dependence"), and the dark shaded have above 15% ("high oil dependence") oil revenue share. This figure is constructed based on our calculations using firms accounts data from Statistics Norway.

small impact on the oil price, and the 2014 oil price crash can be thus be safely viewed as an external shock to the Norwegian economy not triggered by domestic factors. Since the oil-industry is geographically concentrated, this shock was also felt locally hitting the oil-dominated regions much more severely than other areas, as we document below.

## 3 Data Sources and Sample

We use several administrative data sources provided by Statistics Norway, which can be linked based on unique firm and individual identifiers. Our main source is firm accounting data from 2010 to 2019, which cover the universe of limited liability firms in Norway. This is the most common legal entity type of Norwegian firms, accounting for around 58% of all employed workers and 93% of private sector workers in 2019 (weighted by

FIGURE 3: Daily Brent Crude Oil Prices, in USD, 2010-2019.




**Notes:** Source: Archival Economic Data, St. Louis Fed.

their contractual hours of work), according to our calculations. The accounting data provides information on operating revenues and costs, including components for internal and external labor costs. The external labor costs include the total expenses each firm incurs on personnel hired by subcontractors or through temp agencies or independent contractors that assist the firm in its production process, as reported by firms under entry no. "4500" in their balance sheets. From the firm registry, we have information on the firms' location, industry and firm age. Furthermore, we can link firms to workers using the employer-employee registry, containing information on employment relationships, and we can further add worker characteristics through individual-level data on demographics, such as gender, education, and immigrant status, as well as labor income.

Our main sample consists of firms present in the firm and accounting registries, with at least 20 employees on October 1st, 2013, i.e., nine months prior to when the oil price started to decline.[9] We exclude firms registered as temp agencies. We assign a location to each based on the municipality of operation from the firm registry.[10] As we explain below, our main empirical analysis uses the panel dimension of our firm-level data where we follow firms before and after the 2014 Oil Price Crash. In this analysis, we further restrict the sample of firms in each year to those having registered employees, i.e., firms without any workers as of October 1st in the current year are dropped.

As shown earlier in Figure 2, we next combine information on all firms' locations and

[9]Each employee must earn at least 1 Basic Amount (NOK 85 245 in 2013) in yearly earnings.

[10]For multi-location firms, this definition assigns location based on the firm's business headquarters. As a robustness, we alternatively assigned location based on the establishment where the largest share of a firm's workforce is employed. This had no meaningful impact on our empirical findings.

revenues to construct a measure of the regional oil dependence, defined as the aggregate share of revenues in oil and oil support industries[11] for each of the 46 labor market regions in Norway (Bhuller, 2009). For the purposes of our analysis, we further divide labor market regions into three groups based on this measure of oil dependence. The low-oil group has a revenue share from oil below 5%, while the medium-oil has 5-15%, and for high-oil above 15%. We focus on firms located in either high- or low-oil regions.

Table 1: Aggregate Region Level Characteristics, 2013, Averages

| | Level of Oil Dependence | | | |
|---|---|---|---|---|
| | Low | | High | |
| Population 18-67 | 65.03 | [198.09] | 76.47 | [73.21] |
| Share Employed | 0.59 | [0.03] | 0.63 | [0.03] |
| Share Employed in oil | 0.02 | [0.01] | 0.10 | [0.04] |
| Share of Employment in Oil | 0.03 | [0.02] | 0.15 | [0.06] |
| Wage Costs | 19835.22 | [65252.78] | 25725.42 | [28716.39] |
| Wage Costs in Oil | 727.81 | [2335.03] | 5769.14 | [8339.24] |
| Internal Labor costs | 14022.95 | [57431.54] | 21719.17 | [32821.28] |
| Internal labor costs in oil | 221.03 | [865.14] | 4016.22 | [6034.81] |
| External labor costs | 4483.54 | [18786.35] | 8420.62 | [10558.30] |
| External labor costs in oil | 221.03 | [865.14] | 4016.22 | [6034.81] |
| Aggregate Revenue | 90736.04 | [3.8e+05] | 2.6e+05 | [5.2e+05] |
| Aggregate revenue in oil | 3566.15 | [16139.50] | 1.7e+05 | [4.0e+05] |
| N | 27 | | 7 | |

Notes: This table displays the region level characteristics for labor market regions by level of oil dependence. All variables are regional aggregates, and not subject to the firm sample restrictions in section 3. Population in 1000's. Employment is all individuals aged 18-67 (including public sector) with an active employment on October 1 and at least 1 BA in yearly earnings, in the employer-employee registry. The wage costs are the sum of wages in the employer-employee registry for employment relationships active on October 1 and with at least 1 BA in yearly earnings. Both employment and wage costs are based on the home municipality of the individual. The labor costs and revenue are the sums for all limited liability firms in the region in the accounting data. Monetary variables are CPI adjusted to 2015 and in million NOK.

In addition to the firm-level analysis described above, we also perform an analysis at the regional level to quantify how the aggregate shock hits local labor markets. In this latter analysis, we do not place any restrictions on firms or workers mentioned above, and instead study aggregate quantities, e.g., total regional revenue and employment rate.

Table 1 shows the region level characteristics by level of dependence (low vs. high), as averages by region in 2013. There are 27 low-oil labor market regions, and 7 high-oil regions. The high-oil regions are slightly larger in terms of population, with on average

[11]See Table 1 in Statistics Norway (2015) for definition of the oil support industries.

around 76 000 inhabitants compared to 65 000 in the low-oil regions. The employment share among 18-67-year-olds is slightly higher in the high-oil region, 63 percent, compared to 59 percent in the low-oil regions, on average. As expected, both the share employed in oil in the population, and the share of employment in oil, is higher in the high-oil regions.

Table 2: Firm Level Characteristics, 2013, Averages

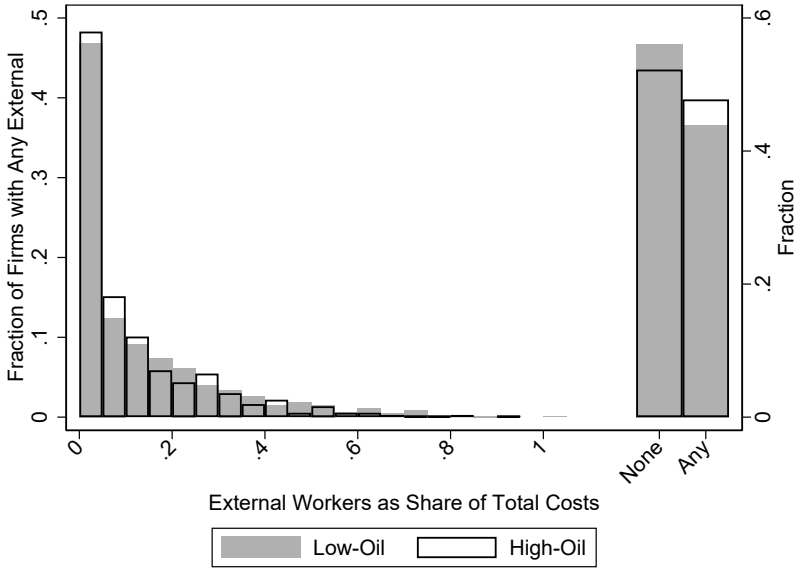
| | Regional Oil Dependence | | | |
|---|---|---|---|---|
| | Low | | High | |
| Number of employees | 101.14 | [333.52] | 106.70 | [563.27] |
| Share female | 0.32 | [0.26] | 0.28 | [0.27] |
| Share immigrant | 0.19 | [0.22] | 0.18 | [0.20] |
| Share union members | 0.33 | [0.25] | 0.33 | [0.27] |
| Share low education | 0.20 | [0.14] | 0.19 | [0.13] |
| Share high school education | 0.46 | [0.20] | 0.52 | [0.19] |
| Share higher education | 0.35 | [0.26] | 0.29 | [0.24] |
| Average age | 40.79 | [5.66] | 40.48 | [5.09] |
| Firm age $\leq$5 | 0.13 | [0.33] | 0.14 | [0.35] |
| Stock-based firm (AS) | 0.99 | [0.08] | 0.99 | [0.10] |
| Share in Oil Industry | 0.00 | [0.06] | 0.04 | [0.20] |
| Share in Oil Support Industry | 0.04 | [0.20] | 0.12 | [0.33] |
| Sum Operating Revenue | 261.65 | [576.41] | 225.41 | [498.67] |
| Sum Operating Costs | 246.24 | [526.23] | 220.90 | [493.68] |
| Operating Result | 11.38 | [38.61] | 11.04 | [36.09] |
| Operating Margin | 0.04 | [0.10] | 0.04 | [0.10] |
| Total Labor Costs | 54.22 | [98.29] | 55.46 | [99.77] |
| Internal Labor Costs | 43.56 | [73.85] | 45.05 | [77.55] |
| External Labor Costs | 7.56 | [26.97] | 9.15 | [32.61] |
| N | 4804 | | 1551 | |

Notes: This table displays the firm level characteristics of the firms in the main analysis sample described in Section 3, in 2013, by regional oil dependence. A region is defined as low-oil if the aggregate share of revenue is below 5 percent, and high-oil if the share is above 15 percent. Monetary variables are CPI adjusted to 2015 and in million NOK.

Table 2 shows the firm level characterics in our main analysis sample, for firms located in low- and high-oil regions for 2013. There are approximately 4800 firms located in low-oil regions, and 1600 firms located in high-oil regions. On average, firms in low- and high-oil regions are relatively similar in regards to most firm-level characteristics. The average number of employees is slightly higher in high-oil regions, while the share of female employees are somewhat lower. Average operating revenue and costs are higher in low-oil region firms, but the operating result and margins are similar. As expected, the share of firms in the oil and oil support industry is higher in high-oil regions.

Figure 4 shows the share of firms in our main sample with no or any costs for external labor in 2013, as well as the distribution of external costs as share of the total costs for firms with any costs, for firms in low- and high-oil regions. Around half of the firms in our sample had no external labor costs in 2013, with a slightly higher share in the low-oil regions. Most firms with external costs have a relatively low share of total costs spent on external labor, though there is a similar dispersion between low- and high oil regions.

FIGURE 4: Costs to External Labor As Share of Total Costs, by Oil Revenue Intensity, 2013




**Notes:** This figure shows the share of firms with no external costs and any external costs on the right axis, and distribution of firms (with any external costs) by share of total costs to external labor ont the left axis, in 2013, by regional oil dependence. The sample of firms includes all limitied liability firms with at least 20 employees, described in detail in section 3. Regions are defined as low-oil if the oil revenue share is below 5 percent, and high-oil if above 15 percent.

## 4 Empirical Strategy

In Section 2.2, we showed that there is a clear geographical concentration of oil revenues in Norway. We now describe a research design that exploits this geographical concentration combined with a major global shock to the oil price driven by international events. We use a difference-in-differences (DiD) approach, comparing the outcomes of firms in high-oil regions, where the oil revenue share is above 15 percent, to firms in low-oil regions, with a revenue share below 5 percent, before and after the 2014 Oil Price Crash.

Our empirical approach can be sketched by the following regression model:

$$Y_{jt} = \sum_{\substack{t=2010,\\ t\neq 2013}}^{t=2019} \beta_t (HighOil_{r(j)} \times Year_t) + Region_{r(j)} + Year_t + \lambda X_j + \epsilon_{jt} \quad (1)$$

where $Y_{jt}$ is the outcome for firm $j$ in year $t$, while $Year_t$ and $Region_{r(j)}$ are fixed effects corresponding to the current calender year and the region of location of firm $j$ in 2013, respectively. Next, $HighOil_{r(j)}$ is an indicator for whether region $r(j)$ was classified as a high-oil region based on its oil revenue share in 2013. Our parameters of interests, $\beta_t$, associated with $HighOil_{r(j)} \times Year_t$, capture the differential year-specific effects of the 2014 Oil Price Crash on the outcomes of firms located in high-oil regions, as compared to firms located in low-oil regions, where we denote 2013 as the base year (i.e., $\beta_{2013} = 0$). In the above regression model, we also add a rich set of firm-level controls $X_j$ measured in 2013, including indicators for firm's industry (NACE-classification), firm size (i.e., number of employees), and indicators for young firm ($\leq$5 years) and stock-based firm, and firm's workforce composition, such as average age, share of females, share of immigrants, shares of workers with different education levels (below high school, high school, and higher education), and share of union members. Throughout, we use robust standard errors.

To capture the dynamic effects of the local recession triggered by the 2014 Oil Price Crash, we will present our results in event-study graphs where we plot the coefficient estimates of $\beta_t$ from equation (1) with 2013 as the base year. We will also provide supplementary results from simpler DiD estimation where we replace $HighOil_{r(j)} \times Year_t$ by $HighOil_{r(j)} \times Post_t$ in equation (1), where $Post_t = 1(t \geq 2014)$ is a post-event indicator, and where we also constrain $\beta_t = \beta$ for $t \geq 2014$ and equal to zero otherwise. Furthermore, to shed light on some possible mechanisms, we also provide heterogeneity results by baseline external labor use and baseline local union density, respectively. In the regional analysis, we use a similar model as in equation (1), replacing firm-level outcomes $Y_{jt}$ by regional outcomes $Y_{rt}$ and accordingly use indicators $HighOil_r$ and $Region_r$.

Our main outcomes of interest are total, internal, and external labor costs, but as a backdrop we also present results on operating results and an indicator for firm being out of business[12], total revenue, total costs, and operating margin. All monetary variables are CPI adjusted to 2015 prices, truncated yearly at the 1st and 99th percentile, and expressed in logs (with the exception of the operating margin). The outcomes are censored when 1) there is no data available, and 2) there are no employees registered on October 1st.

The empirical strategy relies on three important assumptions. First, that firms in high-oil regions were affected by the oil-crisis to a larger extent then firms in low-oil regions, i.e.,

[12]Equal to one if there are no registered employees on October 1st in the employer-employee registry.

differential treatment exposure. Second, we maintain a parallel trends assumption, i.e., that outcomes of the firms in the high-oil regions would have developed similarly to the firms in the low-oil region if they had not been affected by the oil price shock (or affected to the same extent as the low-oil regions). Third, a causal interpretation of our estimates further requires that the composition of firms' doesn't change differentially across high- and low-oil regions, e.g., due to selective exit of firms in the more exposed regions.

To test to the first assumption, we first and foremost provide estimates on the aggregate effects of the oil price shock at the regional level in Section 5, which allows us to construct quantitative measures of local shock exposure. Furthermore, we run a number of robustness checks with different versions of treatment, including different definitions of the location of the firm (e.g., using establishment with most employees instead firm headquarters), the oil dependence of the region (e.g., using employment share in oil or regional gross product in oil), and alternative measures of treatment intensity (rather than the binary treatment $HighOil_{r(j)}$ for high- vs. low-oil). Our estimates are qualitatively robust and quantitatively similar across these alternative treatment definitions. To test the second assumption, we provide pre-trends in all event study graphs. Finally, in order to address potential selection due to the imbalanced sample in our accounting data (due to exits of 2013-firms), we provide results including firm fixed effects for firms that are present in the sample both before and after the shock. While this is not a perfect solution, it provides some assurance that compositional changes are not driving our estimates.

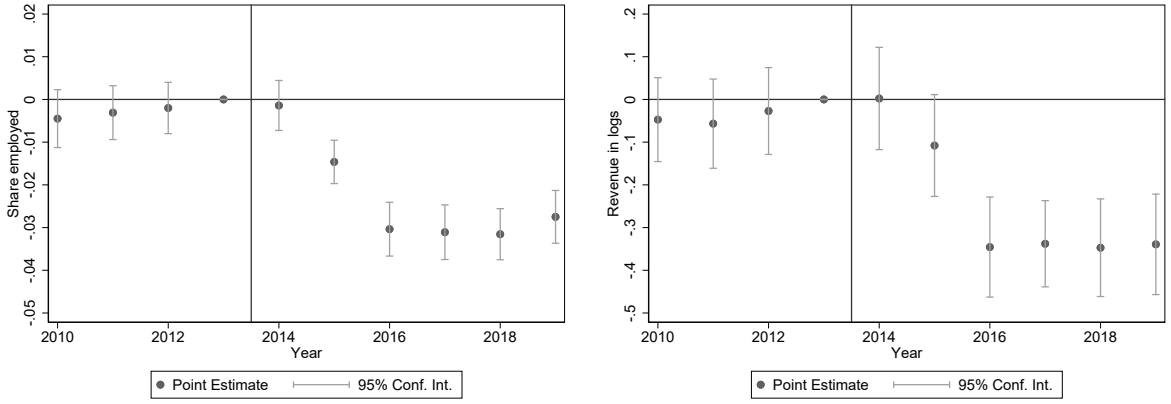
## 5 Quantifying the Shock

We start our empirical findings by describing how the aggregate shock was felt across local labor markets, based on a regional analysis. Figure 5 provides our regional evidence for two important regional outcomes–the regional employment rate in panel (a) and the total regional revenue in panel (b). Notably, the employment rate is calculated across all working-age individuals, and is not restricted to employment in particular industries or sectors (i.e., both private and public sectors employees are included). However, given data availability and measurement problems related to regional revenue measures for the public sector, we calculate total regional revenues by aggregating revenues reported by private-sector limited liability firms (see description in Section 3).

Focusing on Figure 5, panel (a), we find that the 2014 Oil Price Crash had substantial and persistent employment impacts in high-oil regions, as compared to low-oil regions. Notably, employment rates across high- and oil-regions had evolved similarly prior to the oil price crash, as confirmed by the absence of differential pre-trends. In 2016–two

calendar years after the oil price shock–the employment rate in high-oil regions was around 3 percentage points lower, which compared to the mean employment rate of 63% in 2013 amounts to a staggering almost 5% reduction. Consistent with the oil price remaining relatively low over several years (see Figure 3), we see that the negative employment impacts in high-oil regions persisted. Over the post-event period as a whole, we find a reduction in the employment rate of 2 percentage points (see Appendix Table A.1). It is worth emphasizing that while the aggregate economy at the national level did recover a few years later, the employment growth in high-oil remained for an extended period. Our regional estimates capture this differential impact felt in high-oil regions.

FIGURE 5: Quantifying the Shock: Regional Effects.



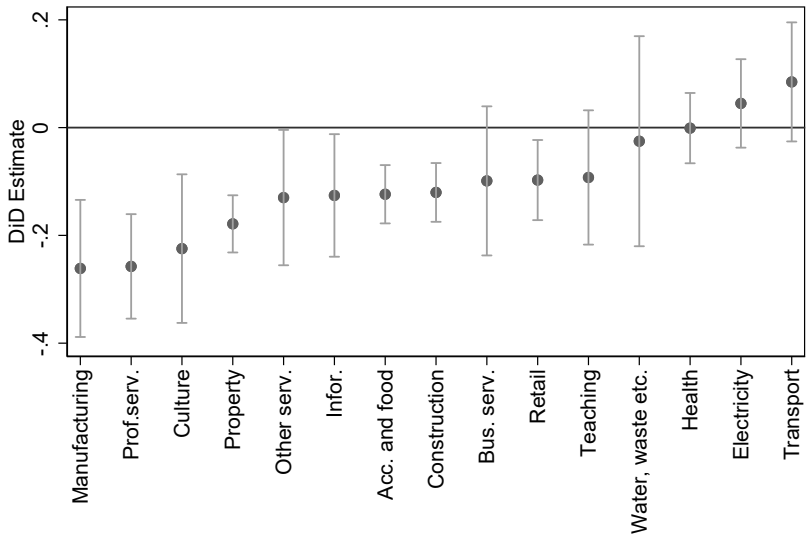

(A) Regional Employment Rate (B) Total Regional Revenue (in logs)

**Notes:** This figure displays the difference-in-difference point estimates and 95 % confidence intervals from Equation 1 in Section 4, with outcomes aggregate on the labor market region level, and without controls. The employment rate is the share of individuals ages 18–67 with their home municipality in the region that have an active employment relationship on October 1 with at least 1 BA in yearly earnings. The total regional revenue is the sum of revenue from all limited liability firms in the accounting data in each year (not subject to the sample restrictions in Section 3.) Revenue is CPI adjusted to 2015 NOK, in millions, and presented in logs. Standard errors are robust.

Next, we consider the total regional revenue in Figure 5, panel (b). Similar to the evolution of regional employment rates, we find regional revenues were on similar trajectories prior to the oil price crash across high- and oil-regions. Following the oil price crash, the total regional revenue in high-oil regions fell sharply, with an aggregate loss in log total revenues above 0.3-points. Over the post-event period as a whole, we find a reduction in the total regional revenue around 20% (see Appendix Table A.1). While the revenue impacts illustrated in Figure 5 are an order of magnitude stronger than the employment impacts, it is worth noting that by construction we only capture changes in revenues for private-sector limited liability firms. The employment impacts depend in turn on labor demand responses and firms' ability to pass-through revenues loss on to workers. Further,

countercyclical public sector fiscal policies may also the overall employment impacts.

FIGURE 6: Quantifying the Shock: Aggregate Regional Revenue by Industry.




**Notes:** This figure displays the difference-in-differences point estimates and 95 % confidence intervals from Equation 1 in Section 4, with outcomes aggregate on the industry-labor market region level, without controls, and pooled for the pre and post period. The aggregate regional revenue by is the sum of revenue from all limited liability firms in each industry in the accounting data in each year (not subject to the sample restrictions in Section 3.) The following industries are not included in the figure: Agriculture, Mining (including Oil), Finance, Public Administration, Paid Work in Private Houseoulds, International Organizations and Missing. This restriction is due to either the small number of firms in the industry, or the unique nature of the industry (Agriculture and Mining). Revenue is CPI adjusted to 2015 NOK, in millions, and presented in logs. Standard errors are robust.

Although the 2014 Oil Price Crash had a direct impact on revenues in oil and oil-supporting industries, the evidence provided above underscores that it is meaningful to view this event as a deeply felt persistent negative shock to the local labor markets in high-oil regions as a whole, affecting overall employment and private sector revenues. To further shed light on the widespread impacts of the oil price crash, we consider industry-wise revenue impacts of this event in Figure 6. For the analysis, we estimate a simpler DiD based equation (1), considering the post-event period as a whole, separately for some major non-oil industries in the private sector. We thus compare the changes in aggregate revenues in selected industries in high-oil regions, as opposed to the changes

in revenues for the same industries in low-oil regions.[13] We find statistically significant and economically large negative impacts on total revenues for nine out of the 15 major industries considered in Figure 6. Among private sector industries where we are unable to reject null estimates, include health, teaching, transport, water and wastewater industries, which are expected to be less sensitive to local business cycle movements. This evidence serves as a motivation for our design studying not only the direct impacts on the oil industry, but rather viewing the 2014 Oil Price Crash as a widespread local recession.

# 6 Results

Having documented that the 2014 Oil Price Crash triggered a local recession in certain oil-dominated local labor markets in Norway in Section 5, we now move on to present our main evidence related to firms' labor adjustments. We consider changes in firms' demand for internal and external labor, both during and in the aftermath of the oil price crisis. Next, we provide heterogeneity by pre-shock external labor use. Finally, we investigate the role of local union as a factor explaining heterogeneous responses across firms.

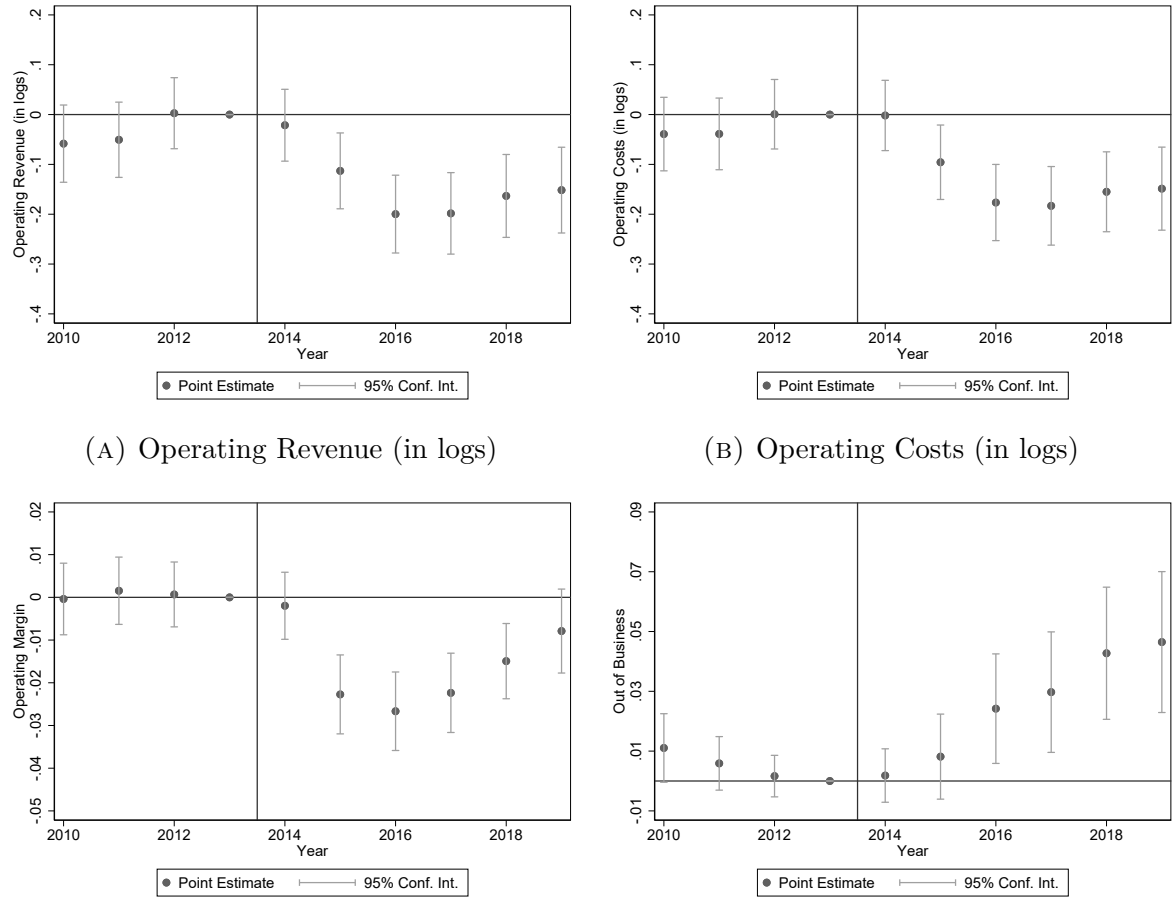
## 6.1 How do Firms Adjust Demand for Internal and External Labor?

Our evidence in Figure 5 showed that the 2014 Oil Price Crash had substantial impacts on total regional revenues. As a backdrop to our evidence on firms' labor adjustments, we now provide firm-level evidence on firms' economic conditions. Consistent with the regional evidence, we find that firms in high-oil regions experienced substantial declines in their revenues in Figure 7, panel (a), with operating revenues being 20% lower two to five years after the shock. Notably, panel (b) shows that firms also cut costs aggregative, with total operating costs lowered by a similar magnitude. Taken together, we nonetheless find that the operating margins drop by 3 percentage points over the first couple of years after the shock. Over the post-event period as a whole, the operating margins drop by 1.65 percentage points from a pre-event mean of 4 percent in 2013 (see Appendix Table A.3, panel (a), column (4)). It is also worth emphasizing that firms in high-oil regions are more likely to run out of business, as shown in Figure 7, panel (d). As more firms disappear

[13]Note that we do not consider the direct impacts on revenues in oil and oil-supporting industries here. By construction, there is a limited share of oil-intensive firms in low-oil regions and these firms would be directly affected by the oil price crash. A possible strategy to quantify the direct impacts on oil-industry could be to compare the evolution of the oil revenues in high-oil regions to non-oil private sector revenues in low-oil regions. Given the evidence in Figure 6 that suggests significant impacts on the local economy beyond the oil industry, one would have severely underestimated the direct impacts on oil revenues if one had instead used non-oil industries in high-oil regions as the control group.

over the post-event period, we also find that operating margins appear to recover with five years, likely as the most devastated firms are out of business.

FIGURE 7: Firm Performance: Revenues, Costs, Margins and Exits.




(A) Operating Revenue (in logs)

(B) Operating Costs (in logs)

(C) Operating Margin

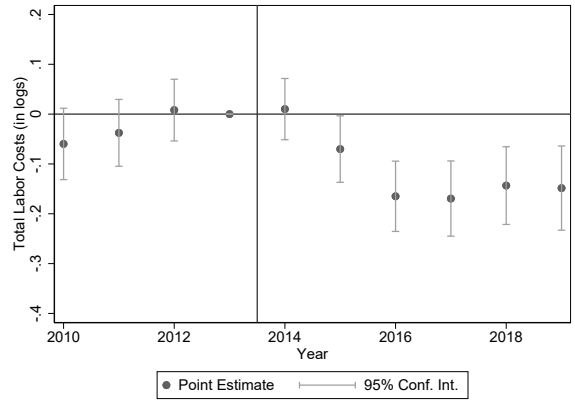
(D) Out of Business

**Notes:** This figure displays the difference-in-differences point estimates and 95 % confindence intervals for firms performance measures with the estimation in Equation 1 in Section 4. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). For operating results (Panel A-C), firm-year observations are dropped if there are no employees in the current year. Furthermore, these outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). The indicator for Out of Business (Panel D) is one if the firm has no employees. Standard errors are robust.

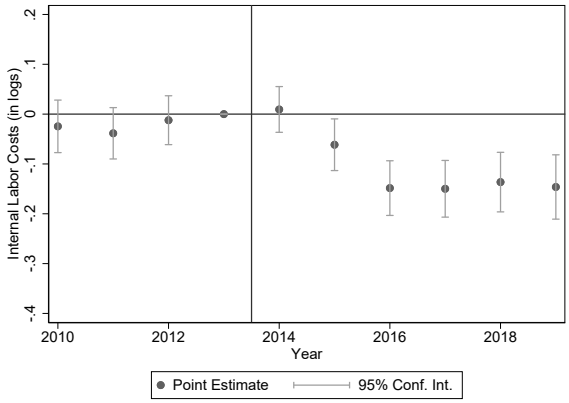
Next, we delve into the patterns of firms' labor adjustments in Figure 8. Consistent with the earlier evidence that firms cut their total operating costs swiftly, we find in panel (a) that firms reduce their total labor costs substantially. Over the post-event period as a whole, total labor costs decline by almost 9% (see Appendix Table A.4, panel (a), column (1)). In 2013, firms in our sample spent on average around 15% of their total labor costs on external labor. While the impacts on firms' internal labor costs shown in

Figure 8, panel (b), are similar to the overall labor adjustments, we find more interesting dynamics once we focus on firms' external labor costs in Figure 8, panel (c). Although we do find significant reductions in external labor costs two-three years after the shock, firms' demand for such labor appears to bounce back in latter years, while we find no recovery in internal labor costs. These patterns may indicate that firms face different costs for adjusting internal and external labor, and in the aftermath of a recession may find it easier to recruit workers externally. Such responses may reflect firms' attempts to avoid excessive future labor adjustment costs, but also that workers are more likely to accept external contracts after facing a recession (Holmlund and Storrie, 2002).

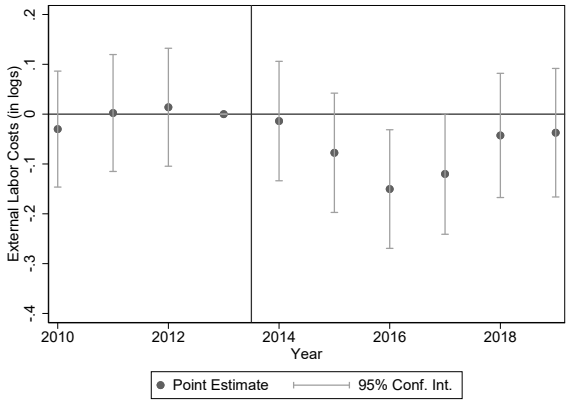
FIGURE 8: Labor Adjustments: Total, Internal and External Labor Costs.




(A) Total Labor Costs (in logs)




(B) Internal Labor Costs (in logs)




(C) External Labor Costs (in logs)

**Notes:** This figure displays the difference-in-differences point estimates and 95 % confindence intervals for labor costs with the estimation in Equation 1 in Section 4. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

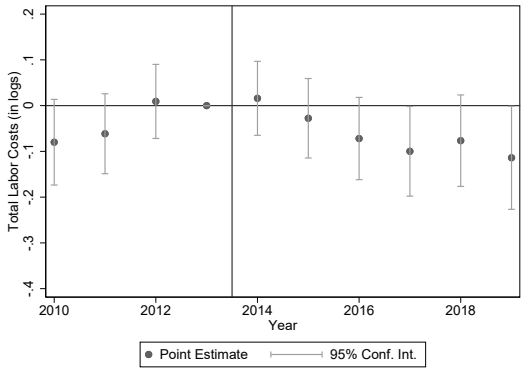
To shed more light on the heterogeneity in firms' adjustments of internal and external labor, we now differentiate firms by their pre-crisis external labor use. In particular, we distinguish between firms that had no external labor costs and firms had did have some external labor costs already in 2013. As we showed in Figure 4, around 55% of firms in our sample had no external labor use pre-crisis, while the remaining had use some external labor. Relying on this distinction, we provide sub-sample estimates for both types of firms using the same empirical design. This distinction is also economically meaningful, as firms that already use external labor may face overall lower adjustments costs at the onset of the shock, while they are also more likely to have exhausted their potential for further efficiency gains through restructuring of their labor force. The two firms might of course also differ along several other dimensions, importantly for us their exposure to the oil price shock. In Appendix Figure A.4, panels (a)-(b), and Appendix Table A.3, panels (b)-(c), we show the revenue impacts felt across both firms types, finding larger reductions for firms that already had external labor use. At the same time, we find no differences in the likelihood of firm exit. In relative terms, we also do not find clear differences in overall cost reductions or in operating margins.

When we consider the labor adjustments across the two firm types in Figure 9, we find interesting heterogeneity. Despite facing a revenue loss of about 6% (see Appendix Table A.3, panels (b), column (2)), firms without external labor only marginally reduce their total labor costs, even though they reduce their overall costs. By contrast, firms that earlier relied on external labor cut down their total labor costs quite aggressively, and in relative terms, we see even sharper reductions in their external labor use. These results thus provide some evidence that firms that use external labor indeed find it easier to lay off workers, consistent with lower adjustment costs associated with having such labor. At the same time, in Figure 9, panel (f), we also find these firms' external labor use recovers faster as opposed to their internal labor, suggesting lower costs on the hiring margin.

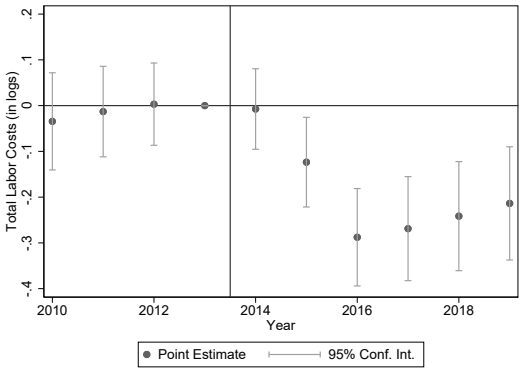
Interestingly, however, if we consider external labor use among firms that pre-crisis did not rely on external labor in Figure 9, panel (e), we actually find evidence suggesting that these firms increase their external labor use during the aftermath of the crisis. Over the post-event period as a whole, we indeed find that such firms located in high-oil regions increase their external labor use by 2.8%, as compared to similar firms in low-oil regions (see Appendix Table A.4, panels (b), column (3)). While the short-run impacts found in Figure 9, panel (f), for crisis-exposed firms having pre-crisis external labor contrast these findings, the longer-run impacts for both types of firms suggest an overall recovery in external labor use and increased external labor use among firms that previously did not rely on external labor. As pointed out earlier, such responses may reflect firms' attempts

to restructure, and their attempt to avoid excessive labor adjustment costs in the future.

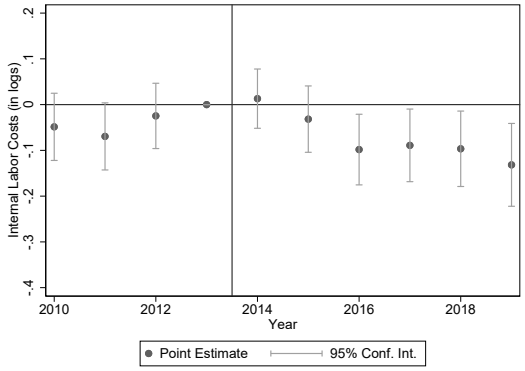
FIGURE 9: Labor Adjustments By Pre-Crisis External Labor Use.



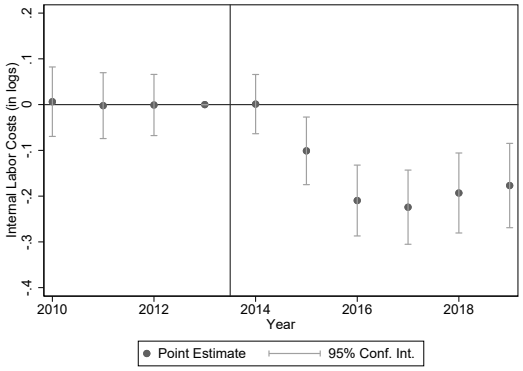

(A) No External: Total Labor Costs



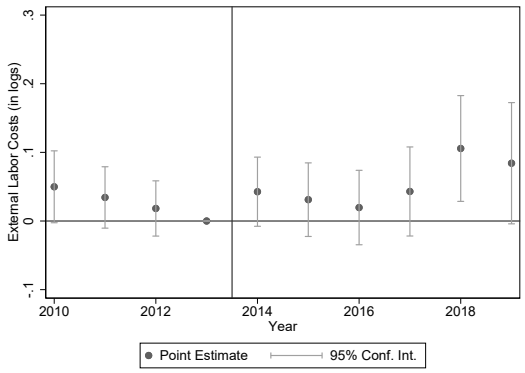

(B) Any External: Total Labor Costs



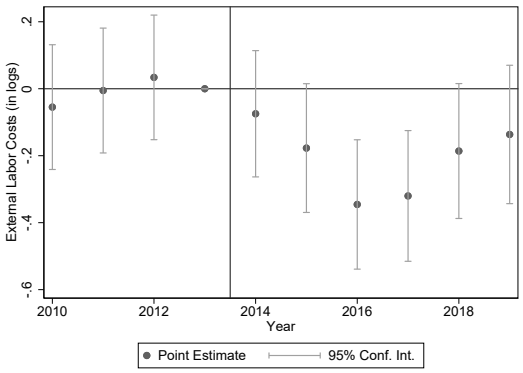

(C) No External: Internal Labor Costs




(D) Any External: Internal Labor Costs




(E) No External: External Labor Costs




(F) Any External: External Labor Costs

**Notes:** This figure displays the difference-in-differences point estimates and 95 % confindence intervals for labor costs with the estimation in Equation 1 in Section 4, separately by pre-crisis (2013) external use. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

### 6.2 What is the Role of Local Unions?

To further delve into the heterogeneity in firms' labor adjustments, we now focus on the role of local unions at the firm level. Specifically, we use information on the share of workers in each firm that were members of a labor union in 2013, and differentiate between firms with above and below median local union density. In our study sample of firms, the pre-crisis average local union density was 33% in both high-oil and low-oil regions, although bigger firms in both areas tend to have higher union density.

As in several other European countries, Norway has a two-tier collective bargaining system, where local unions participate in annual wage negotiations at the firm level once the central negotiations have concluded, i.e., there is local rent sharing (see, e.g., discussions in Bhuller et al. (2022); Barth et al. (2014)). Local unions also provide workers insurance against unlawful termination by employers and support workers in workplace conflicts. Consistent with this, one may expect events such as the 2014 Oil Price Crash to trigger increased union mobilization. Indeed, we do find a modest increase 0.5 percentage points in local union density among firms located in high-oil regions after the oil price shock (see Appendix Table A.2). Despite this increase, there remain meaningful differences in unionization across above and below median pre-crisis union density firms. To the extent that local unions are able to shield workers during economic downturns, we do expect to find differences in labor adjustments across firms with high vs. low union density.

Firms with different levels of pre-crisis union density are diverse along several dimensions– firm size and industry being the most important. Our evidence nonetheless suggests that both high and low union density firms located in high-oil regions pre-crisis were in relative terms similarly affected by the 2014 Oil Price Crash, with revenues losses at 9% and 12.7%, as compared to similar firms in low-oil regions (see Appendix Table A.5). Both types of firms cut overall costs aggressively, but also saw similar reductions in their operating margins. Turning to these firms' labor adjustments in Table 3, however, we find interesting patterns of heterogeneity. In panel (a), we see that the below median union density firms cut their labor costs dramatically, at a similar pace as their revenue losses and their overall cost reductions. These labor cost reductions come about mainly through downsizing of their internal labor (column (2)), while we also find a smaller negative coefficient on external labor (column (3)), although statistically insignificant. Next, in panel (b), we see that the above median union density firms also cut their labor costs, but not at the same pace as their revenues and overall costs. Interestingly, for these firms, we find significant reductions in external labor costs (column (3)), where the relative impacts appear to be larger than on internal labor. It is worth emphasizing

that we find no evidence of differential pre-trends in any of the outcomes we considered, neither for above nor below median union density firms (see Appendix Figures A.5-A.6).

TABLE 3: Labor Adjustments by Pre-Crisis Union Density.

| | Total Labor Costs (in logs) | Internal Labor Costs (in logs) | External Labor Costs (in logs) |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Panel A: Under Median Union Density** | | | |
| DiD Estimate | -0.1135*** | -0.1131*** | -0.0525 |
| | (0.0224) | (0.0174) | (0.0352) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 33.92 | 26.40 | 6.03 |
| Observations | 29185 | 28534 | 28261 |
| **Panel B: Over Median Union Density** | | | |
| DiD Estimate | -0.0590** | -0.0491** | -0.0860** |
| | (0.0271) | (0.0203) | (0.0438) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 77.62 | 64.16 | 12.34 |
| Observations | 29058 | 28402 | 28248 |

Notes: This table displays the difference-in-differences estimates for labor costs with the estimation in Equation 1 in Section 4, by pre-crisis (2013) union density. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil region firms respectively. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Local union density is defined as the share of the firm's employees who are union members, and is defined as low (high) if below (above) median. Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

One possible interpretation of the evidence above can be while local unions are able or willing to shield internal workers during an economic downturn, there may be limited scope for similar insurance against adverse shocks for external workers. Given that external workers typically would not be organized as members of local unions and are only loosely attached to the core organizational structures of firms, this might not come as a surprise. A caveat here is that we do lack statistical precision to draw firm conclusions about the relative importance of labor unions for internal vs. external labor based on the estimates in Table 3. To further shed light on how the presence of local unions affects firms' external labor use during downturns, we now focus on high vs. low union density firms that already relied on external labor pre-crisis. Notably, both types of firms located in high-oil regions were fairly similarly affected by the 2014 Oil Price Crash, with revenue losses at 15-17% (see Appendix Table A.6, panels (c)-(d)). Interestingly, while overall

costs are cut at a similar pace, high union firms end up cutting external labor costs much more dramatically by 26.5% (see Appendix Table A.7, panels (c)-(d)). Having a sizeable stock of external workers might thus have allowed these firms to avoid cutting other costs. By contrast, low union firms without pre-crisis external labor use located in high-oil regions actually increased their external labor use by 4.6%, as compared to similar firms in low-oil region (see Appendix Table A.7, panel (a)), even though they were adversely affected by the shock (see Appendix Table A.6, panel (a)).

## 7 Conclusion

Recent evidence shows that firms increasingly rely on external labor, i.e., subcontracting, domestic outsourcing, temp agency hiring, etc. An explanation for firms' use of external labor is that this allows firms to adjust their labor inputs more easily in response to changes in product demand. In this paper, we provided new evidence on firms' adjustments of internal and external labor during an economic downturn. Further, we investigated the role of downturns as a driver of labor restructuring, and how firms' adjustments of internal and external labor depend on unions and organizational structures. We studied a local recession following the 2014 oil price shock, which had larger impacts on some regions of Norway than others. We used this in difference-in-differences framework, together with detailed register data on firm performance, internal and external labor costs, and worker outcomes. Our results suggested that firms that relied more on external labor prior to the downturn–arguably facing lower adjustment costs–also adjusted labor inputs more aggressively. The downturn also triggered a restructuring of labor inputs, with an increase in demand for external labor during the aftermath in firms that previously did not rely on external labor. Finally, local unions seemed to have an influence on firms' labor adjustments, where firms with higher unionization experienced smaller reductions in internal labor inputs, and larger in external labor inputs.

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# Appendix

## A Additional Tables and Figures

Table A.1: Quantifying the Shock: Regional Impacts.

| | Regional Employment Rate (in % points) | Total Regional Revenue (in logs) |
|---|---|---|
| | (1) | (2) |
| DiD Estimate | -0.0204*** | -0.2132*** |
| | (0.0021) | (0.0320) |
| Region FE | Yes | Yes |
| 2013 Mean Treated | 0.63 | 258271.86 |
| Observations | 340 | 340 |

Notes: This table displays the difference-in-difference estimates from Equation 1 in Section 4, with outcomes aggregate on the labor market region level, and without controls. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil regions respectively. The employment rate is the share of individuals ages 18–67 with their home municipality in the region that have an active employment relationship on October 1 with at least 1 BA in yearly earnings. The total regional revenue is the sum of revenue from all limited liability firms in the accounting data in each year (not subject to the sample restrictions in Section 3.) Revenue is CPI adjusted to 2015 NOK, in millions, and presented in logs. Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

TABLE A.2: Impacts on Local Union Density.

| | Union Density |
|---|---|
| | (1) |
| DiD Estimate | 0.0052*** |
| | (0.0019) |
| Controls | Yes |
| 2013 Mean Treated | 0.33 |
| Observations | 58256 |

Notes: This table displays the difference-in-differences estimates for local union with the estimation in Equation 1 in Section 4. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil region firms respectively. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Local union density is defined as the share of the firm's employees who are union members. Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

TABLE A.3: Firm Performance By Pre-Crisis External Labor Use.

| | Out of Business | Revenues (in logs) | Costs (in logs) | Operating Margin |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Panel A: Full Sample** | | | | |
| DiD Estimate | 0.0210*** | -0.1126*** | -0.1048*** | -0.0165*** |
| | (0.0043) | (0.0190) | (0.0182) | (0.0021) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 225.41 | 220.90 | 0.04 |
| Observations | 63012 | 56906 | 56893 | 57199 |
| **Panel B: No External** | | | | |
| DiD Estimate | 0.0187*** | -0.0621** | -0.0587** | -0.0125*** |
| | (0.0059) | (0.0265) | (0.0252) | (0.0030) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 237.54 | 230.22 | 0.04 |
| Observations | 34487 | 31113 | 31107 | 31269 |
| **Panel C: Any External** | | | | |
| DiD Estimate | 0.0209*** | -0.1610*** | -0.1483*** | -0.0206*** |
| | (0.0064) | (0.0271) | (0.0261) | (0.0029) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 213.12 | 211.72 | 0.04 |
| Observations | 28020 | 25358 | 25352 | 25488 |

Notes: This table displays the difference-in-differences estimates for firms performance measures with the estimation in Equation 1 in Section 4, in the full sample and by pre-crisis (2013) external use. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil region firms respectively. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). The indicator for Out of Business (Column 1) is one if the firm has no employees. For operating results (Columns 2-4), firm-year observations are dropped if there are no employees in the current year. Furthermore, these outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

Table A.4: Labor Adjustments By Pre-Crisis External Labor Use.

| | Total Labor Costs (in logs) | Internal Labor Costs (in logs) | External Labor Costs (in logs) |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Panel A: Full Sample** | | | |
| DiD Estimate | -0.0894*** | -0.0834*** | -0.0705** |
| | (0.0178) | (0.0136) | (0.0282) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 55.46 | 45.05 | 9.15 |
| Observations | 58243 | 56936 | 56509 |
| **Panel B: No External** | | | |
| DiD Estimate | -0.0275 | -0.0340* | 0.0278* |
| | (0.0233) | (0.0191) | (0.0164) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 42.85 | 43.56 | 0.00 |
| Observations | 32158 | 31301 | 31419 |
| **Panel C: Any External** | | | |
| DiD Estimate | -0.1751*** | -0.1470*** | -0.1995*** |
| | (0.0266) | (0.0191) | (0.0460) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 69.69 | 46.75 | 19.44 |
| Observations | 25620 | 25201 | 24783 |

Notes: This table displays the difference-in-differences estimates for labor costs with the estimation in Equation 1 in Section 4, in the full sample and by pre-crisis (2013) external use.. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil region firms respectively. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

TABLE A.5: Firm Performance By Pre-Crisis Local Union Density.

| | Out of Business | Revenues (in logs) | Costs (in logs) | Operating Margin |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Panel A: Under Median** | | | | |
| DiD Estimate | 0.0313*** | -0.1272*** | -0.1212*** | -0.0145*** |
| | (0.0062) | (0.0245) | (0.0236) | (0.0027) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 132.68 | 129.54 | 0.04 |
| Observations | 31400 | 28505 | 28506 | 28501 |
| **Panel B: Over Median** | | | | |
| DiD Estimate | 0.0105* | -0.0913*** | -0.0815*** | -0.0188*** |
| | (0.0061) | (0.0285) | (0.0271) | (0.0032) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 320.88 | 315.21 | 0.04 |
| Observations | 31612 | 28401 | 28387 | 28698 |

Notes: This table displays the difference-in-differences estimates for firms performance measures with the estimation in Equation 1 in Section 4, by pre-crisis (2013) union density. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil region firms respectively. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Local union density is defined as the share of the firm's employees who are union members. The indicator for Out of Business (Column 1) is one if the firm has no employees. For operating results (Columns 2-4), firm-year observations are dropped if there are no employees in the current year. Furthermore, these outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

TABLE A.6: Firm Performance by Pre-Crisis Local Union Density and External Labor Use.

| | Out of Business | Revenues (in logs) | Costs (in logs) | Operating Margin |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Panel A: Under Median No External** | | | | |
| DiD Estimate | 0.0245*** | -0.1051*** | -0.1021*** | -0.0159*** |
| | (0.0085) | (0.0353) | (0.0334) | (0.0039) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 147.04 | 139.43 | 0.04 |
| Observations | 16923 | 15385 | 15388 | 15345 |
| **Panel B: Over Median No External** | | | | |
| DiD Estimate | 0.0134 | -0.0155 | -0.0122 | -0.0088** |
| | (0.0082) | (0.0388) | (0.0367) | (0.0045) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 324.15 | 317.78 | 0.04 |
| Observations | 17564 | 15728 | 15719 | 15924 |
| **Panel C: Under Median Any External** | | | | |
| DiD Estimate | 0.0377*** | -0.1529*** | -0.1435*** | -0.0136*** |
| | (0.0090) | (0.0341) | (0.0334) | (0.0037) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 118.14 | 119.46 | 0.04 |
| Observations | 14222 | 12898 | 12896 | 12931 |
| **Panel D: Over Median Any External** | | | | |
| DiD Estimate | 0.0027 | -0.1733*** | -0.1562*** | -0.0296*** |
| | (0.0092) | (0.0427) | (0.0406) | (0.0045) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 320.18 | 315.38 | 0.04 |
| Observations | 13798 | 12460 | 12456 | 12557 |

Notes: This table displays the difference-in-differences estimates for firms performance measures with the estimation in Equation 1 in Section 4, by pre-crisis (2013) union density and external use. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil region firms respectively. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Local union density is defined as the share of the firm's employees who are union members. The indicator for Out of Business (Column 1) is one if the firm has no employees. For operating results (Columns 2-4), firm-year observations are dropped if there are no employees in the current year. Furthermore, these outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

TABLE A.7: Labor Adjustments by Pre-Crisis Union Density and External Labor Use.

| | Total Labor Costs (in logs) | Internal Labor Costs (in logs) | External Labor Costs (in logs) |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Panel A: Under Median Union No External** | | | |
| DiD Estimate | -0.0577* | -0.0906*** | 0.0462** |
| | (0.0299) | (0.0254) | (0.0195) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 23.64 | 24.11 | 0.00 |
| Observations | 15821 | 15449 | 15393 |
| **Panel B: Over Median Union No External** | | | |
| DiD Estimate | 0.0028 | 0.0224 | 0.0099 |
| | (0.0357) | (0.0286) | (0.0259) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 61.20 | 61.94 | 0.00 |
| Observations | 16337 | 15852 | 16026 |
| **Panel C: Under Median Union Any External** | | | |
| DiD Estimate | -0.1877*** | -0.1505*** | -0.1392** |
| | (0.0332) | (0.0237) | (0.0582) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 44.47 | 28.68 | 12.21 |
| Observations | 13126 | 12862 | 12709 |
| **Panel D: Over Median Union Any External** | | | |
| DiD Estimate | -0.1575*** | -0.1442*** | -0.2654*** |
| | (0.0415) | (0.0292) | (0.0721) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 98.28 | 67.16 | 27.60 |
| Observations | 12494 | 12339 | 12074 |

Notes: This table displays the difference-in-differences estimates for labor costs with the estimation in Equation 1 in Section 4, by pre-crisis (2013) union density- and external use. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil region firms respectively. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Local union density is defined as the share of the firm's employees who are union members, and is defined as low (high) if below (above) median. Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

TABLE A.8: Firm Performance Using Alternative Treatment Definitions.

| | Out of Business | Revenues (in logs) | Costs (in logs) | Operating Margin |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Panel A: Treatment Intensity** | | | | |
| DiD Estimate | 0.0365*** | -0.1898*** | -0.1722*** | -0.0328*** |
| | (0.0082) | (0.0329) | (0.0310) | (0.0037) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean | 0.00 | 218.49 | 208.11 | 0.04 |
| Observations | 89620 | 80139 | 80117 | 80548 |
| **Panel B: Establishment Location** | | | | |
| DiD Estimate | 0.0218*** | -0.0956*** | -0.0837*** | -0.0146*** |
| | (0.0041) | (0.0175) | (0.0167) | (0.0019) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 212.08 | 203.89 | 0.04 |
| Observations | 68421 | 61748 | 61730 | 62067 |
| **Panel C: Oil Employment Share** | | | | |
| DiD Estimate | 0.0230*** | -0.1207*** | -0.1094*** | -0.0222*** |
| | (0.0056) | (0.0224) | (0.0211) | (0.0026) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 239.47 | 238.10 | 0.05 |
| Observations | 69290 | 62195 | 62181 | 62541 |
| **Panel D: County Oil Gross Product Share** | | | | |
| DiD Estimate | 0.0255*** | -0.0955*** | -0.0840*** | -0.0163*** |
| | (0.0054) | (0.0209) | (0.0196) | (0.0023) |
| Controls | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 209.78 | 205.11 | 0.05 |
| Observations | 89620 | 80139 | 80117 | 80548 |

Notes: This table displays the difference-in-differences estimates for firms performance measures with the estimation in Equation 1 in Section 4, for different treatment definitions. In panel A, we use a continuous treatment intensity measure for oil dependence: the aggregate share of revenue from the oil and oil support industries. Note that the interpretation for this coefficient is different, as it is not a dicotomous treatment. In Panel B, the location of the firms (and hence, calculation of regional oil dependence) is based on the labor market region where the firms has the largest share of its employees. In Panel C, we use share of employees in the oil and oil support sector to define low- (below 5 percent) and high-oil (above 15 percent) labor market regions. In panel D, we use the share of the county's gross product from the oil industry to define low- and high-oil counties. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013). The sample consists of limited liability firms (excluding temp agencies) in regions with at least 20 employees in 2013 (further described in Section 3.). Panel A and D includes all firms in the sample, while Panel B and C only includes firms in low- and high-oil regions. The indicator for Out of Business (Column 1) is one if the firm has no employees. For operating results (Columns 2-4), firm-year observations are dropped if there are no employees in the current year. Furthermore, these outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

TABLE A.9: Labor Adjustments Using Alternative Treatment Definitions.

| | Total Labor Costs (in logs) | Internal Labor Costs (in logs) | External Labor Costs (in logs) |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Panel A: Treatment Intensity** | | | |
| DiD Estimate | -0.1607*** | -0.1555*** | -0.1282** |
| | (0.0324) | (0.0243) | (0.0527) |
| Controls | Yes | Yes | Yes |
| 2013 Mean | 49.98 | 39.60 | 7.84 |
| Observations | 81966 | 80189 | 79547 |
| **Panel B: Establishment Location** | | | |
| DiD Estimate | -0.0731*** | -0.0788*** | -0.0736*** |
| | (0.0169) | (0.0128) | (0.0263) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 53.50 | 42.39 | 9.21 |
| Observations | 63196 | 61768 | 61307 |
| **Panel C: Oil Employment Share** | | | |
| DiD Estimate | -0.1035*** | -0.0983*** | -0.0598* |
| | (0.0217) | (0.0160) | (0.0353) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 64.71 | 52.25 | 9.59 |
| Observations | 63640 | 62213 | 61761 |
| **Panel D: County Oil Gross Product Share** | | | |
| DiD Estimate | -0.0781*** | -0.0838*** | -0.0501 |
| | (0.0213) | (0.0165) | (0.0341) |
| Controls | Yes | Yes | Yes |
| 2013 Mean Treated | 59.89 | 46.15 | 9.40 |
| Observations | 81966 | 80189 | 79547 |

Notes: This table displays the difference-in-differences estimates for labor costs with the estimation in Equation 1 in Section 4, for different treatment definitions. In panel A, we use a continuous treatment intensity measure for oil dependence: the aggregate share of revenue from the oil and oil support industries. Note that the interpretation for this coefficient is different, as it is not a dicotomous treatment. In Panel B, the location of the firms (and hence, calculation of regional oil dependence) is based on the labor market region where the firms has the largest share of its employees. In Panel C, we use share of employees in the oil and oil support sector to define low- (below 5 percent) and high-oil (above 15 percent) labor market regions. In panel D, we use the share of the county's gross product from the oil industry to define low- and high-oil counties. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013). The sample consists of limited liability firms (excluding temp agencies) in regions with at least 20 employees in 2013 (further described in Section 3.). Panel A and D includes all firms in the sample, while Panel B and C only includes firms in low- and high-oil regions. Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

TABLE A.10: Firm Performance By Pre-Crisis External Labor Use, Using Firm Fixed Effects.

| | Out of Business | Revenues (in logs) | Costs (in logs) | Operating Margin |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Panel A: Full Sample** | | | | |
| DiD Estimate | 0.0220** | -0.0912*** | -0.0807*** | -0.0153*** |
| | (0.0085) | (0.0156) | (0.0141) | (0.0025) |
| Firm FE | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 225.41 | 220.90 | 0.04 |
| Observations | 63550 | 56886 | 56874 | 57189 |
| **Panel B: No External** | | | | |
| DiD Estimate | 0.0197* | -0.0396* | -0.0362* | -0.0105*** |
| | (0.0113) | (0.0227) | (0.0201) | (0.0034) |
| Firm FE | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 237.54 | 230.22 | 0.04 |
| Observations | 34780 | 31121 | 31115 | 31280 |
| **Panel C: Any External** | | | | |
| DiD Estimate | 0.0224* | -0.1590*** | -0.1402*** | -0.0208*** |
| | (0.0130) | (0.0212) | (0.0197) | (0.0036) |
| Firm FE | Yes | Yes | Yes | Yes |
| 2013 Mean Treated | 0.00 | 213.12 | 211.72 | 0.04 |
| Observations | 28260 | 25330 | 25325 | 25467 |

Notes: This table displays the difference-in-differences estimates for firms performance measures with the estimation in Equation 1 in Section 4, in the full sample and by pre-crisis (2013) external use, including firm fixed effects.. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil region firms respectively. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). The indicator for Out of Business (Column 1) is one if the firm has no employees. For operating results (Columns 2-4), firm-year observations are dropped if there are no employees in the current year. Furthermore, these outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

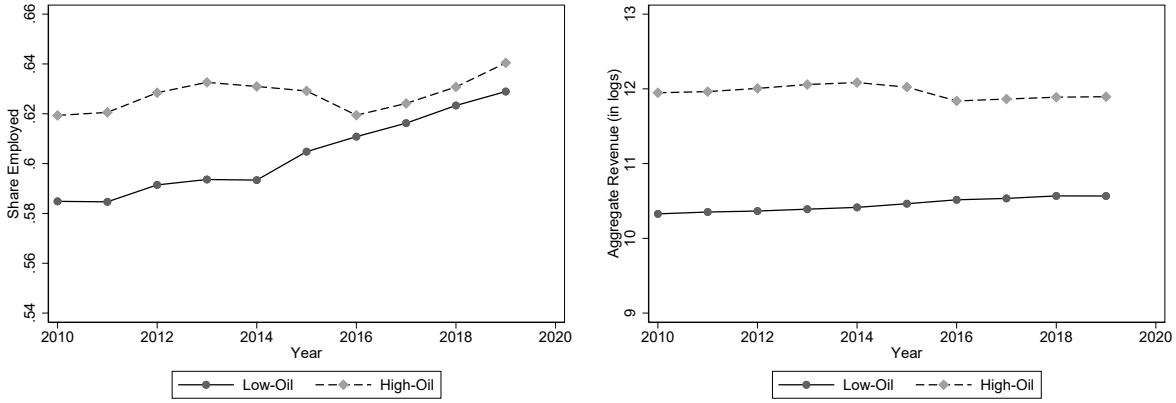
TABLE A.11: Labor Adjustments By Pre-Crisis External Labor Use, Using Firm Fixed Effects.

| | Total Labor Costs (in logs) | Internal Labor Costs (in logs) | External Labor Costs (in logs) |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Panel A: Full Sample** | | | |
| DiD Estimate | -0.0764*** | -0.0703*** | -0.0830*** |
| | (0.0221) | (0.0146) | (0.0239) |
| Firm FE | Yes | Yes | Yes |
| 2013 Mean Treated | 55.46 | 45.05 | 9.15 |
| Observations | 58236 | 56915 | 56488 |
| **Panel B: No External** | | | |
| DiD Estimate | -0.0104 | -0.0223 | 0.0311 |
| | (0.0301) | (0.0211) | (0.0256) |
| Firm FE | Yes | Yes | Yes |
| 2013 Mean Treated | 42.85 | 43.56 | 0.00 |
| Observations | 32168 | 31308 | 31426 |
| **Panel C: Any External** | | | |
| DiD Estimate | -0.1690*** | -0.1340*** | -0.2155*** |
| | (0.0326) | (0.0202) | (0.0425) |
| Firm FE | Yes | Yes | Yes |
| 2013 Mean Treated | 69.69 | 46.75 | 19.44 |
| Observations | 25603 | 25173 | 24755 |

Notes: This table displays the difference-in-differences estimates for labor costs with the estimation in Equation 1 in Section 4, in the full sample and by pre-crisis (2013) external use, including firm fixed effects. In contrast to Equation 1, the DiD esimate compares the average outcomes for post-crisis years (2014-2019) to pre-crisis years (2010-2013) for low- and high-oil region firms respectively. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

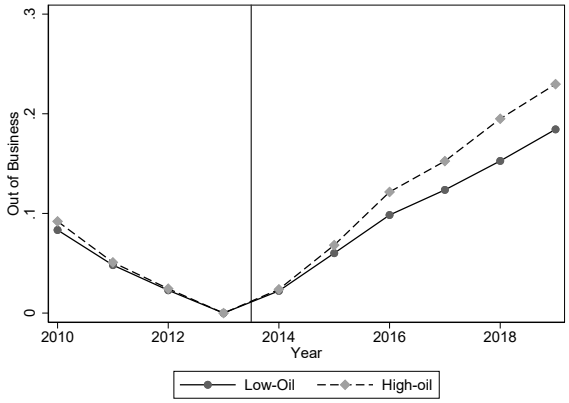
FIGURE A.1: Regional Employment and Aggregate Revenue, Averages



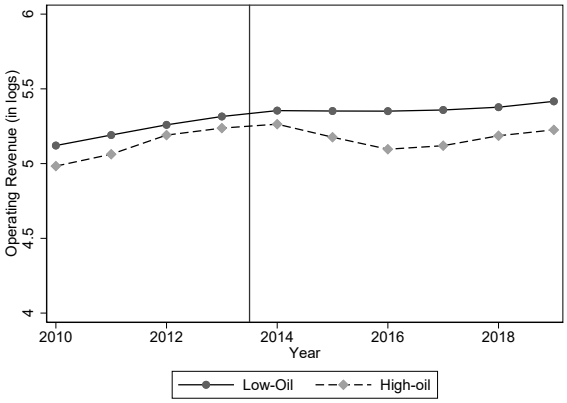

(A) Regional Employment Rate (B) Total Regional Revenue (in logs)

**Notes:** This figure displays the average regional employment rate and total regional revenue, by labor market oil dependence. A labor market region is defined as low-oil (high-oil) if the aggregate share of revenue in oil and oil supporting industries is below 5 percent (above 15 percent). The employment rate is the share of individuals age 18–67 with their home municipality in the region that have an active employment relationship on October 1 with at least 1 BA in yearly earnings. The total regional revenue is the sum of revenue from all limited liability firms in the accounting data in each year (not subject to the sample restrictions in Section 3). Revenue is CPI adjusted to 2015 NOK, in millions, and presented in logs.

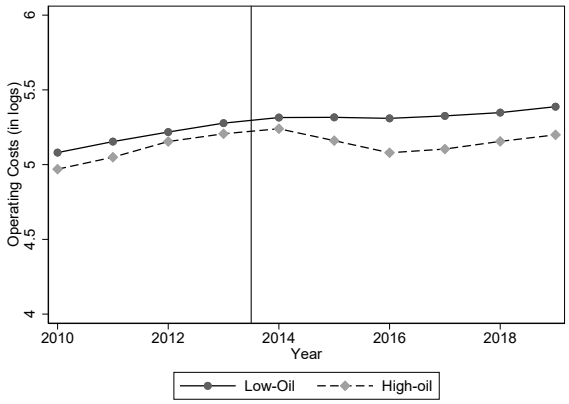
FIGURE A.2: Firm Performance, Full Sample, Averages by Oil Dependence



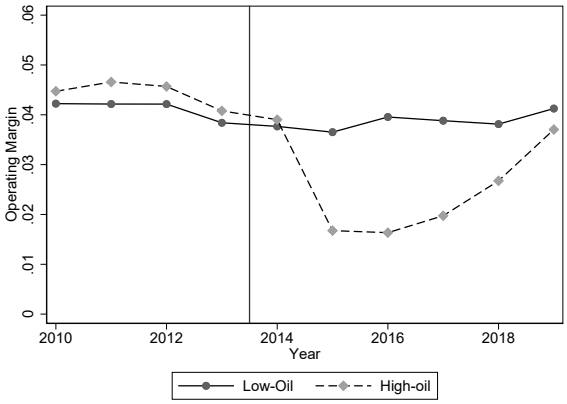

(A) Out of Business




(B) Operating Revenue (in logs)



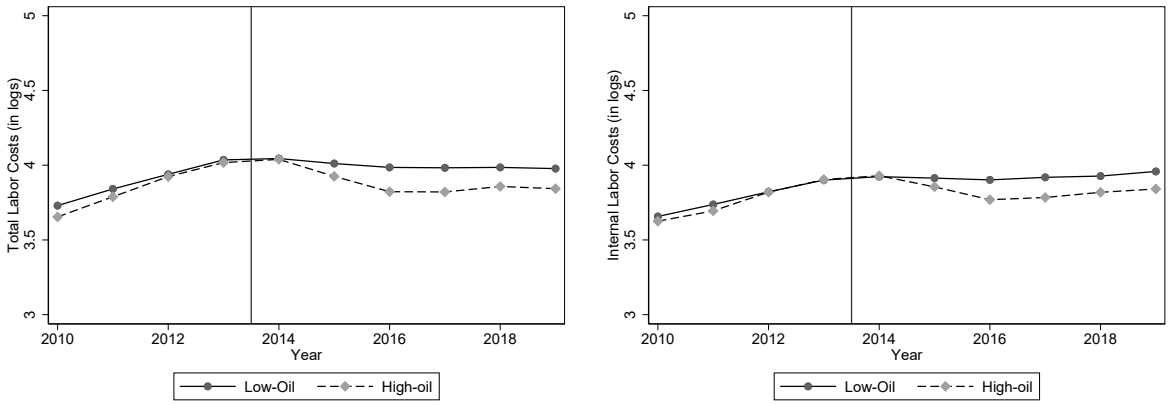

(C) Operating Costs (in logs)




(D) Operating Margin

**Notes:** This figure displays the average firm perfomance, by regional oil dependence. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). For operating results (Panel A-C), firm-year observations are dropped if there are no employees in the current year. Furthermore, these outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). The indicator for Out of Business (Panel D) is one if the firm has no employees.

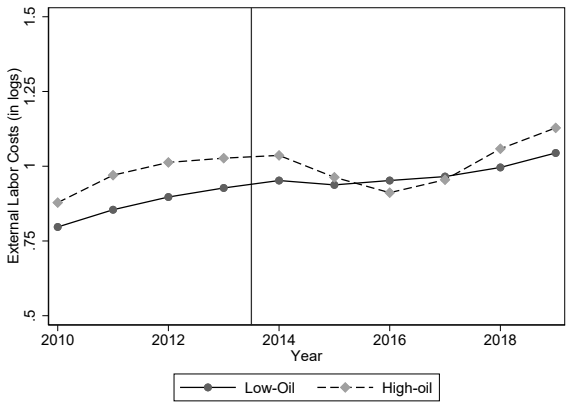
FIGURE A.3: Labor Costs, Full Sample, Averages by Oil Dependence




(A) Total Labor Costs (in logs)



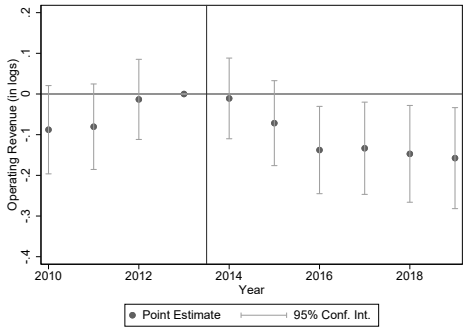

(B) Internal Labor Costs (in logs)



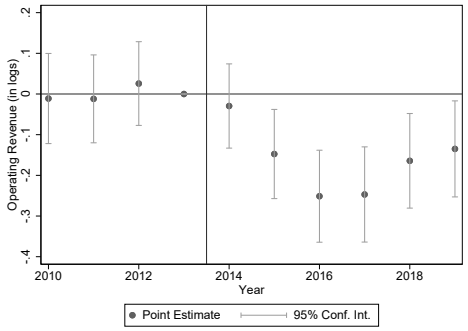

(C) External Labor Costs (in logs)

**Notes:** This figure displays the average labor costs, by regional oil dependence. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly).

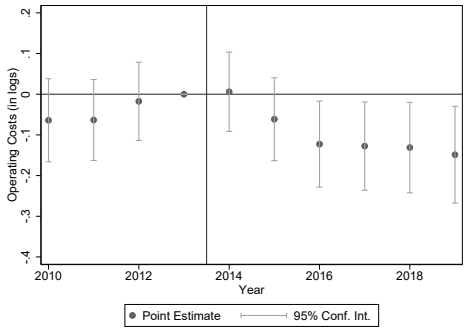
FIGURE A.4: Firm Performance by Pre-Crisis External Labor Use.



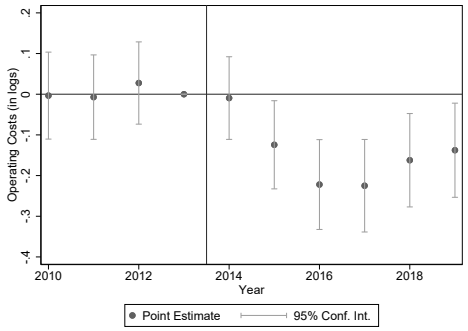

(A) No External: Operating Revenue



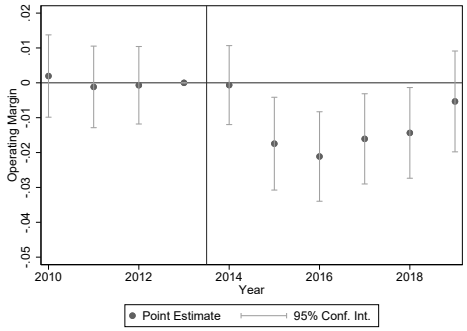

(B) Any External: Operating Revenue



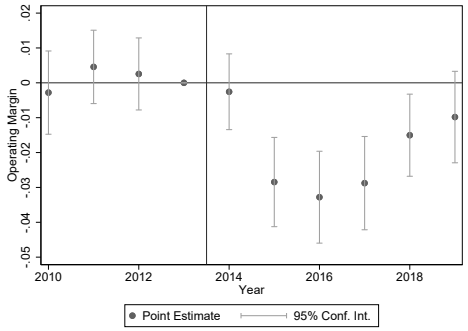

(C) No External: Operating Costs



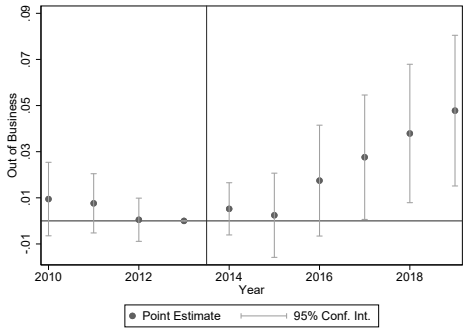

(D) Any External: Operating Costs)



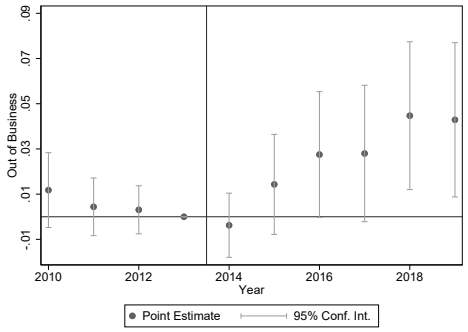

(E) No External: Operating Margin




(F) Any External Operating Margin



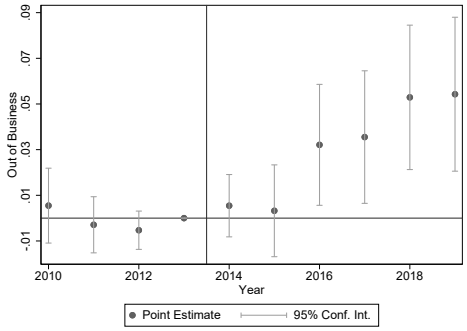

(G) No External: Out of Business



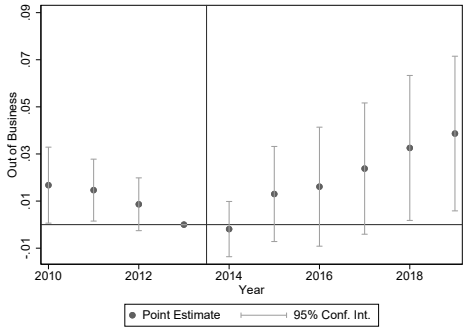

(H) Any External: Out of Business

**Notes:** This figure displays the difference-in-differences point estimates and 95 % confindence intervals for firms performance measures with the estimation in Equation 1 in Section 4, by pre-crisis (2013) external use. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). For operating results (Panel A-C), firm-year observations are dropped if there are no employees in the current year. Furthermore, these outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). The indicator for Out of Business (Panel D) is one if the firm has no employees. Standard errors are robust.

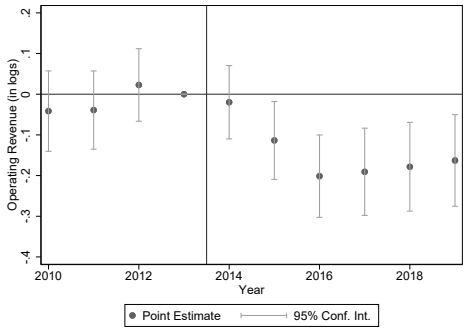
FIGURE A.5: Firm Performance by Pre-Crisis Local Union Density.



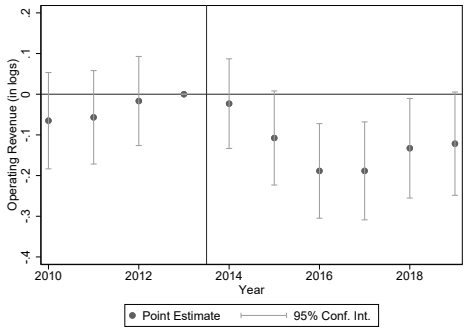

(A) Low: Out of Business



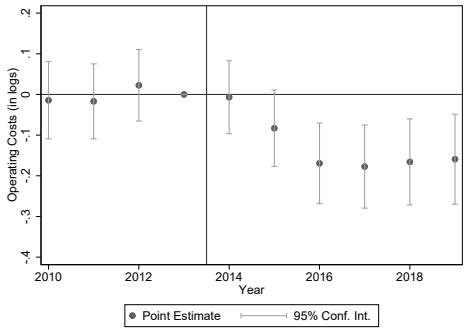

(B) High: Out of Business



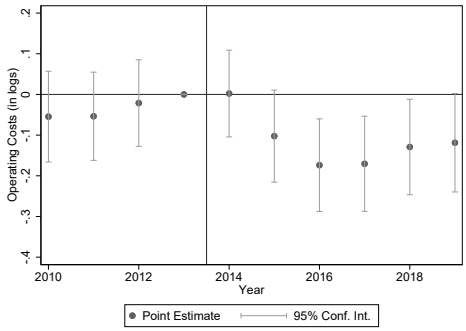

(C) Low: Operating Revenue



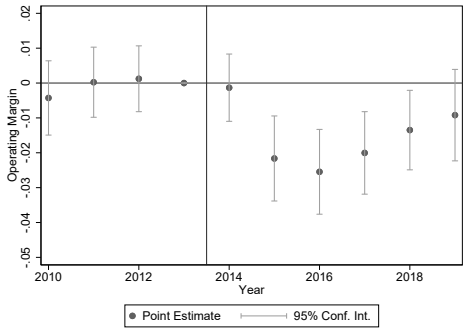

(D) High: Operating Revenue



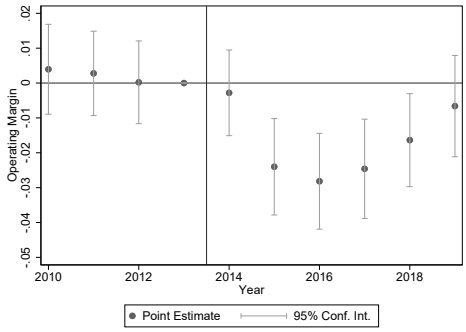

(E) Low: Operating Costs)




(F) High: Operating Costs



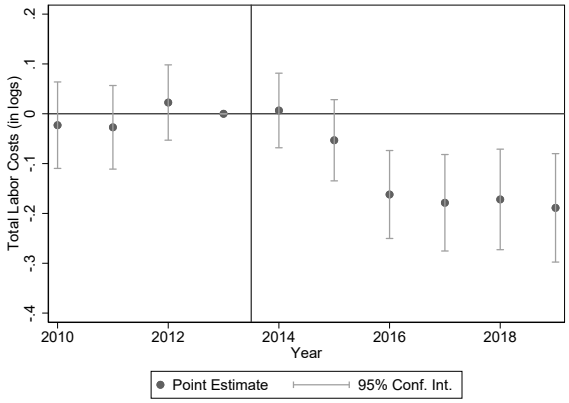

(G) Low: Operating Margin



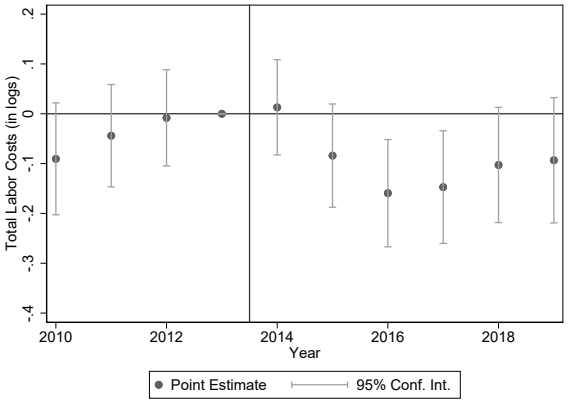

(H) High Operating Margin

**Notes:** This figure displays the difference-in-differences point estimates and 95 % confindence intervals for firms performance measures with the estimation in Equation 1 in Section 4, by pre-crisis (2013) union density. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Local union density is defined as the share of the firm's employees who are union members, and is defined as low (high) if below (above) median. For operating results (Panel A-C), firm-year observations are dropped if there are no employees in the current year. Furthermore, these outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). The indicator for Out of Business (Panel D) is one if the firm has no employees. Standard errors are robust.

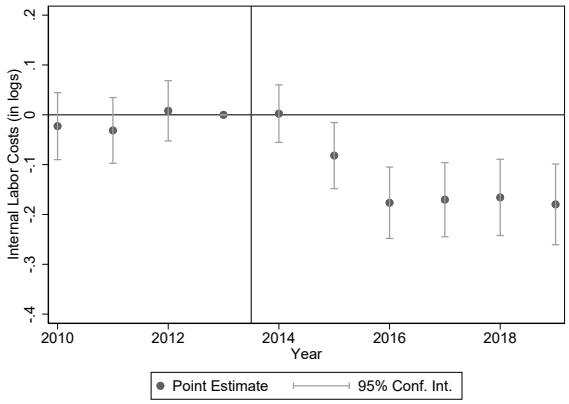
FIGURE A.6: Labor Adjustments By Pre-Crisis Local Union Density.



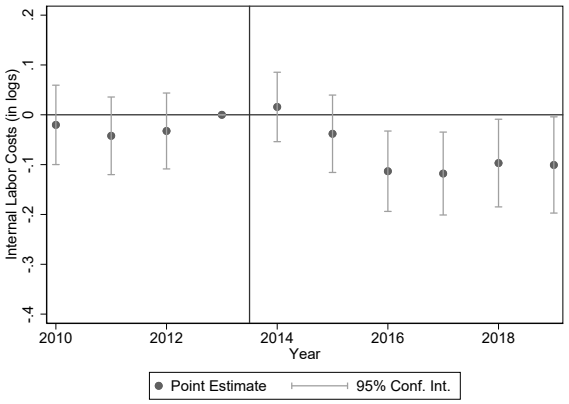

(A) Low: Total Labor Costs



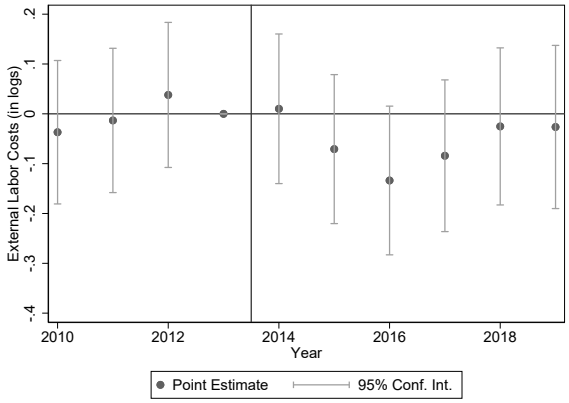

(B) High: Total Labor Costs



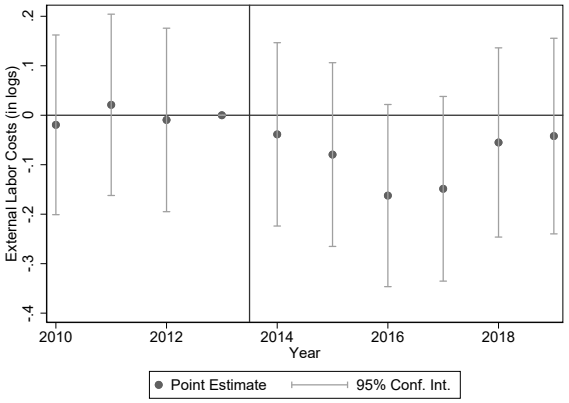

(C) Low: Internal Labor Costs




(D) High: Internal Labor Costs




(E) Low: External Labor Costs)




(F) High: External Labor Costs

**Notes:** This figure displays the difference-in-differences point estimates and 95 % confindence intervals for labor costs with the estimation in Equation 1 in Section 4, by pre-crisis (2013) union density. The sample consists of limited liability firms (excluding temp agencies) in low- and high-oil regions with at least 20 employees in 2013 (further described in Section 3.). Local union density is defined as the share of the firm's employees who are union members, and is defined as low (high) if below (above) median. Firm-year observations are dropped if there are no employees in the current year. The outcomes are CPI adjusted to 2015 and truncated at the 1st and 99th percentile (yearly). Standard errors are robust.