How do oil prices influence Alaska and other energy-dependent states?

Prepared with support from Northrim Bank

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September 26th, 2018

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Abstract

We analyze monthly data from the Bureau of Labor and Statistics to evaluate how fluctuations in oil prices affect economic activity in Alaska and other energy-dependent states. For this most recent recession, we find that only 6 of the traditional oil states experienced a recession. Four of those have already recovered, leaving Alaska and North Dakota as the only two to continue losing jobs. Using monthly employment data between 1991 and 2018 we estimate that, on average, the long run effect of a 10% change in oil prices results in a 1.7% change in employment across the five most important oil states. When analyzed individually, we find that some of them experience symmetric responses to oil price increases and decreases while others are much more sensitive to price declines.

Keywords: Recession; Oil prices; Energy states.

JEL Classification: R10; R12; E 37

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1 Summary

1.1 Main findings

We examine how the recent decline in oil prices has affected the overall Alaska economy and its individual sectors. We also compare the Alaska recession to that of other oil dependent states. We find that Alaska has experienced 34 straight months of negative growth making it by far Alaska's longest recession. Only North Dakota with 37 straight months of negative growth has had a longer period of employment decline. In fact, of all the energy states, only these two remain in a recession while the others have experienced a rather robust recovery since the initial declines. Between July 2015 and July 2018, Alaska lost a total 12,500 jobs or about 3.42% of its total employment. Sectoral analysis indicates that Oil and Gas, and Construction employment have shown small improvements in the most recent months. The gains in these sectors are not consistent or large enough to offset the significant declines in the household spending sectors. Using monthly employment data between 1991 and 2018 we estimate that, on average, the long run effect of a 10% change in oil prices results in a 1.7% change in employment across the five most important oil states. When we evaluate the states individually, we find that Alaska, Louisiana, and Oklahoma have symmetric responses to positive and negative oil shocks while North Dakota and Wyoming are much more sensitive to declines in prices than increases. Below, we summarize the findings for Alaska, the other energy states, and the findings regarding our econometric analysis:

- Alaska has experienced 34 straight months of negative growth. Overall, Alaska's employment as of June 2018 was 96.6% of what it was in June 2014:
  - Oil and Gas, Alaska's most important economic base, has shrunk in size. As of June 2018, it was 75.5% of its size in June 2014. April and May 2018 showed the first job gains in the sector in three years but the June employment numbers were slightly lower than 2017.

- Construction as of June 2018 was 86.4% of what it was in June 2014.
- Professional and Business services as of June 2018 was 91.6% of what it was in June 2014.
- The retail sector as of June 2018 was 95% of what it was in June 2014.
- Between July 2015 and July 2018, the total job losses were 12,500 which amounts to about 3.42% of the state's labor force.

- We examine the evolution of employment in the states historically considered oil states. Across these 13 energy states, we find the following:
  - All the states we evaluate shed upward of 60% of their rigs between 2014 and 2016; Alaska is the exception as it only lost 20% of its rigs during that same period.
  - The oil dependence, as measured by the share of GDP coming from Oil and Gas and Mining varies greatly across these 13 states. Alaska, Wyoming, Oklahoma, and North Dakota are the three states most dependent on the oil sector. In 2014, they had 28.63%, 26.9%, 19.62%, and 18.35% of the value produced coming from the sector.
  - Only six of the 13 states experienced jobs losses amongst the group of energy states.
  - Of those six states, only North Dakota and Alaska continue to be in a recession.[1] Oklahoma, Louisiana, and Wyoming have all lost jobs but have had robust recoveries. Louisiana has already had 10 straight months of positive growth, Wyoming 12 months, and Oklahoma 15 months.

- Using monthly data from 1991 to 2018, our econometric analysis shows that on average, a 10% change in oil prices results in a 1.7% change in employment in the long run.[2] Using Alaska numbers, it translates to about 4,515 jobs.

[1] North Dakota has had positive growth in June 2018 but it is too early to determine if the state is out of the recession.

[2] We define the long run as one year after an oil shock.

- Our state-by-state analysis shows that positive and negative oil shocks affect North Dakota and Wyoming differently. Those two states are more sensitive to negative shocks than they are to positive ones. Alaska, Louisiana, and Oklahoma have symmetric responses to positive and negative shocks. The length of time these shocks are felt in the respective states, however, varies.

1.2 Report Funding

This work is generously funded by a grant from Northrim Bank.

1.3 Study independence

As with all ISER research, this report and its conclusions are solely the work of the individual authors and should be attributed to them, not to ISER, the University of Alaska Anchorage, or the research sponsors.

1.4 Upcoming reports

Below, we describe the two reports we will be producing over the next few months.

- We will be publishing a forecast of the statewide economy. We will also provide forecasts for Anchorage, Fairbanks, Juneau, and the Mat-su. The report will provide medium term employment forecasts at the sector level. We intend to release the analysis at the end of November, 2018.
- The second report will focus on the permanent fund, its sensitivity to different withdrawal amounts, rates of return, and inflation proofing mechanisms. We intend to release the analysis in the middle of January, 2019.

2 Basic information

The Alaska economy is heavily dependent on the oil sector both in terms of private sector jobs and government funding. Since the rapid decline in oil prices, it has experienced a prolonged recession with declines in employment across most sectors. Before the end of 2014, oil prices were elevated for a long period of time when the price exceeded 100 dollars for multiple months. However, starting June 2014, oil prices experienced a deep drop averaging only $54.26 in the 4 years since. This is much lower than the $84.47 they averaged between 2006 and July 2014. While oil prices started declining in June of 2014, the first month of negative employment growth did not occur until October 2015. The state has essentially lost jobs in every month since that initial decline. This has also resulted in a precipitous drop in government revenues, which has forced the state to use savings to fill the fiscal gap. To gain perspective on the depth and severity of the Alaska experience, we attempt to compare the recessions across states and understand the features of the states which fared best and worst. We start by focusing on the evolution of employment and hours worked in Alaska before moving on to the comparative exercise. Lastly, using monthly data from the Bureau of Labor Statistics (BLS) between 1990 and 2018 we examine how employment growth responds to oil shocks across the energy states. Particularly, we evaluate how an oil shock reverberates through the economies of the different oil dependent states.

Table 1 shows that employment declined by 2.2% from June 2015 to June 2016, 0.82% from June 2016 to June 2017, and 0.60% from June 2017 to June 2018. The cumulative declines in private sector employment from June 2015 to June 2018 amounted to 9,900 jobs. We also report average number of weekly hours worked in columns 2 and 3. We can see that the average number of hours worked fluctuates a considerable amount. Interestingly, we see that hours worked started declining in 2014. We can also see that they rebounded in 2017 before declining again in the fist portion of 2018.[3] The aggregate yearly data only tells us

[3]We only have reliable data until June 2018.

Table 1: Employment and hours workers in the private sector in Alaska between 2007 to 2018 for the month of June

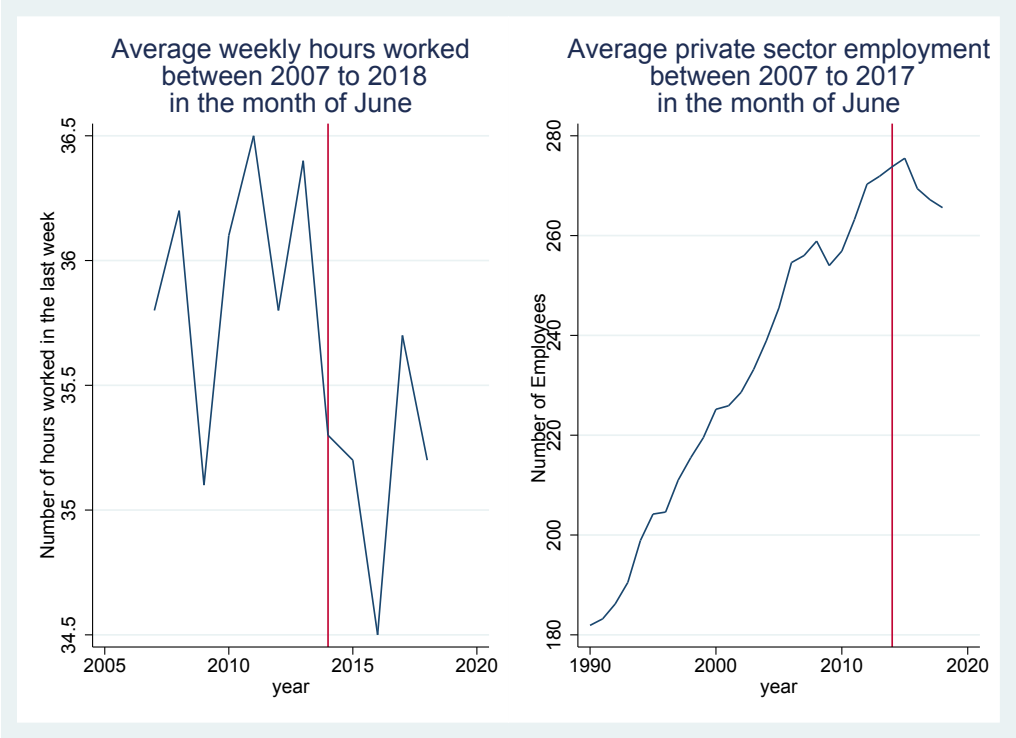
Year	Number of hours worked	Percent change	Employment in thousands	Percent change
2007	35.8	—	256	—
2008	36.2	-1.12%	258.9	1.13%
2009	35.1	-3.04%	254	-1.89%
2010	36.1	2.85%	256.9	1.14%
2011	36.5	1.11%	263.2	2.45%
2012	35.8	-1.92%	270.3	2.70%
2013	36.4	1.68%	271.9	0.59%
2014	35.3	-3.02%	273.8	0.70%
2015	35.2	-0.28%	275.5	0.62%
2016	34.5	-1.99%	269.4	-2.21%
2017	35.7	3.48%	267.2	-0.82%
2018	35.2(P)	-1.40%	265.6(P)	-0.60%

so much about the dynamics of job changes across the months and sectors. To better grasp these changes, we turn our attention to the monthly evolution of employment. Specifically, we focus on the period between 2014 and 2018 at the sectoral level.

3 Monthly employment in Alaska between 2014 and 2018

We begin by showing all non-farm employment and private employment in Figure 2(a-d) in both seasonally adjusted and non-adjusted form. We show the seasonally adjusted figures because Alaska has considerable seasonality -particularly in construction, fishing, and tourism- which makes drawing conclusions about monthly fluctuations challenging. Figures (b) and (d) show the unadjusted employment numbers for all and private only employment, respectively. From these figures, we can see that the decline in employment between between 2015 and 2016 was the largest. We can also see that the losses tapered in 2017 but the levels of employment were still below those of 2016. In the first 6 months of 2018, the job losses continued to shrink but growth is still elusive. With the exception of January, there were

Figure 1: Hours worked and employment

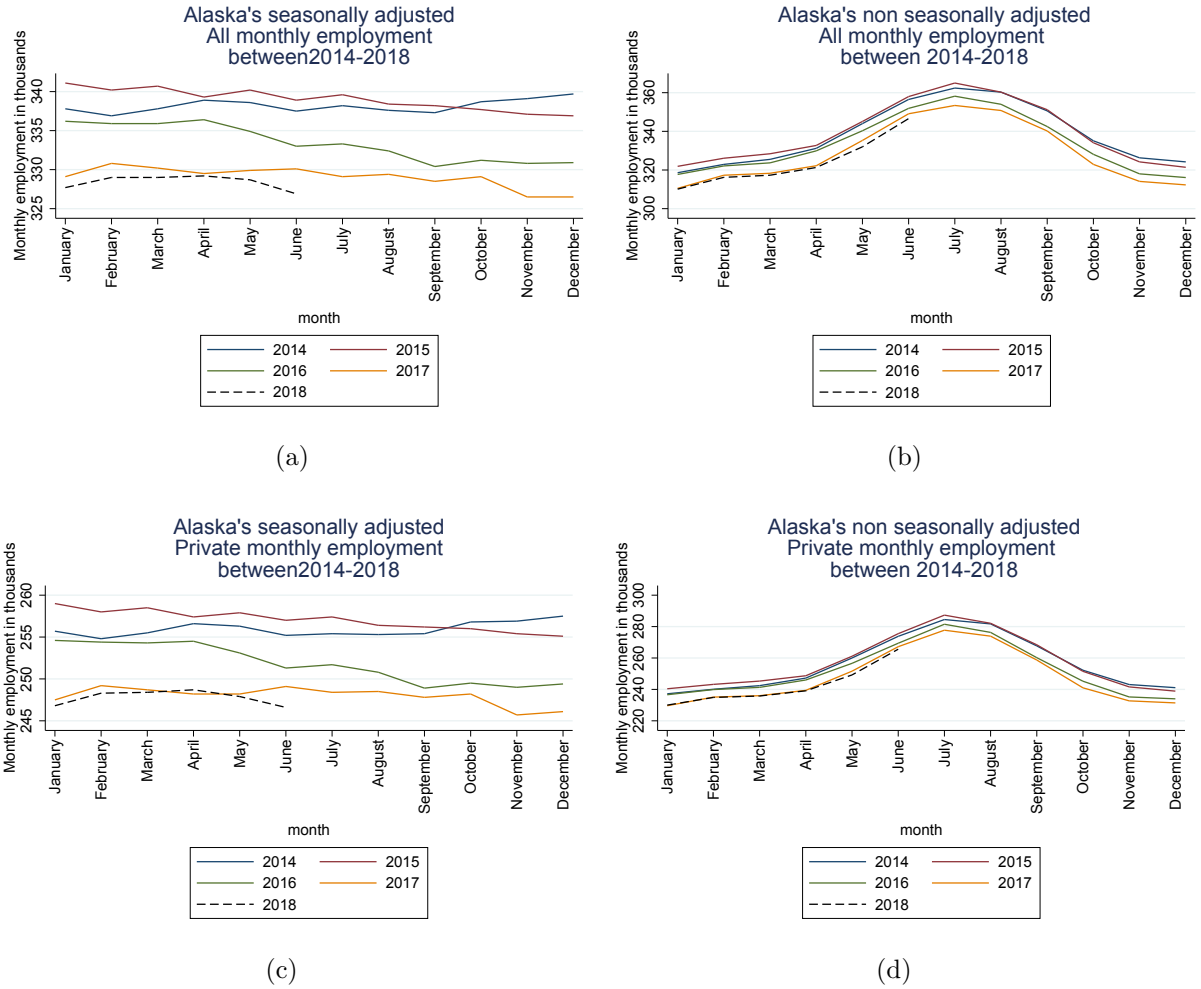


losses in private employment in 5 of the first 6 months. From these aggregate numbers, the state appears to be toward the tail end of the job declines but there are few macroeconomic signs of growth. As we will show in the next few pages, some important sectors have started gaining jobs but those gains are not large or consistent enough to offset the drops in the household spending dependent sectors which are experiencing the deepest losses. We evaluate each sector's evolution in the next section to better understand the recession's path.

4 Sectoral decomposition

We start our sectoral decomposition by showing how the sector -Mining/Oil and Gas- most sensitive to oil prices has fared in the last four years in Figure 3. We can see that the losses started slowly in the latter part of 2015 and accelerated in 2016. Since July 2017, the year over year losses have dampened and in both April and May of 2018 employment growth turned

Figure 2: Monthly employment in Alaska



positive. Employment in June 2018, however, was a little bit lower than that of June 2017. At a minimum, this indicates that employment in Alaska's most important economic base seems to have stabilized. The sector as of June of 2018 was, however, considerably smaller as it had 4,300 fewer jobs than it did in June 2014. This means that while a slowdown in losses or small gains are undoubtedly a good sign, the sector was still markedly smaller than it was 4 years ago. In Figure 4(a-b), we show how the other two sectors that have lost a considerable number of jobs -Construction and Professional and Business services- have evolved in the last four years. They both show a similar pattern to Oil and Gas in that the most significant declines occurred between 2015 and 2016. Also, they recorded positive employment growth in the first part of 2018 for the first time in close to 4 years but the May and June numbers are slightly weaker. Similar to Oil and Gas, the recent signs are largely positive even with the most recent monthly numbers. However, both sectors are still much smaller than what their respective sizes were in 2014. When the recession first began, these three sectors led the way in terms of the losses of fairly high paying jobs. They now are slowly turning the corner or at least appear to have found a new smaller level of activity. The question going forward for these three sectors is if and when they can recover the jobs shed from 2015 onwards. All of these losses had downstream ramifications which resulted in lower spending and therefore fewer jobs in household spending sectors. To investigate these downstream effects, we turn our attention to sectors typically associated with households' finances.

Figure 3: Mining employment

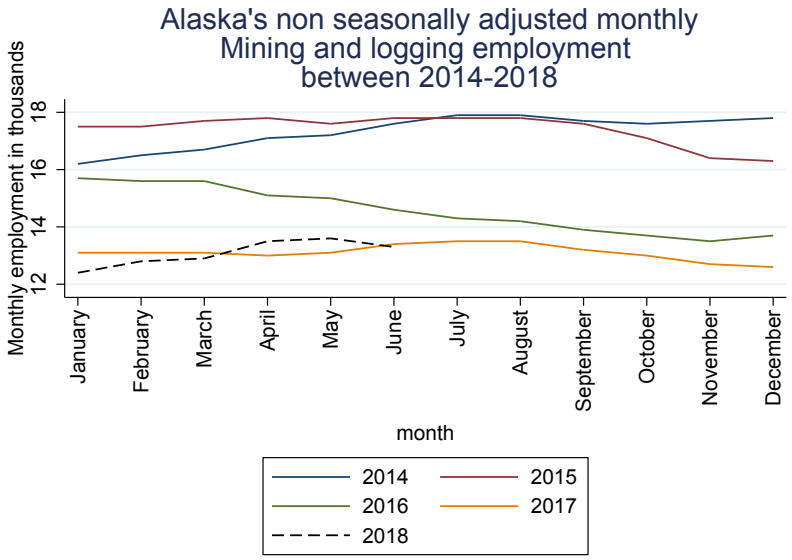
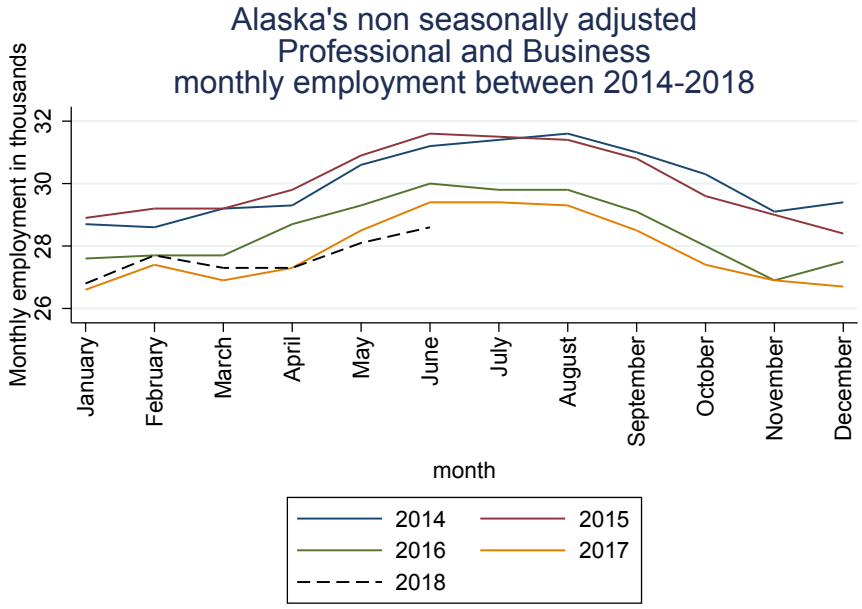


Table 2: Employment in thousands in the Mining/Oil and Gas Sector

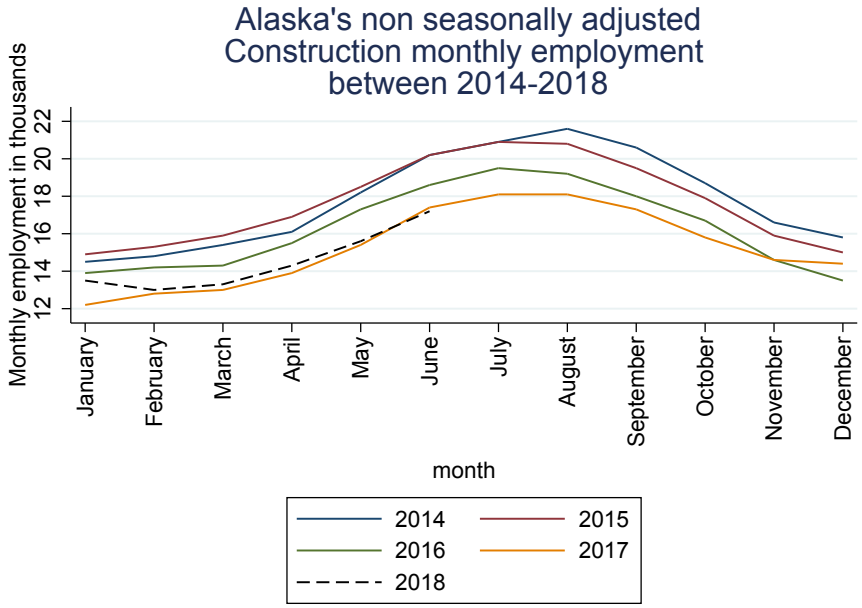
Month	2014	2015	2016	2017	2018
January	16.2	17.5	15.7	13.1	**12.4**
February	16.2	17.5	15.6	13.1	**12.8**
March	16.7	17.7	15.6	13.1	**12.9**
April	17.1	17.8	15.1	13	**13.5**
May	17.2	17.6	15	13.1	**13.6**
June	17.6	17.8	14.6	13.4	**13.3**
July	17.9	17.8	14.3	13.5	
August	17.9	17.8	14.2	13.5	
September	17.7	17.6	13.9	13.2	
October	17.6	17.1	13.7	13	
November	17.7	16.4	13.5	12.7	
December	17.8	16.3	13.7	12.6	

We can see from Figure 5a that the retail sector had a delayed reaction to the recession as it only started losing jobs in the middle of 2017 with the losses accelerating since then. In the first six months of 2018, the average level of employment was 34,200, which is 2,450 jobs less than the average employment level in the first six months of 2016. Leisure and Hospitality in Figure 5b has unsurprisingly held up well as it is more sensitive to tourism than it is to local spending. Figure 6(a-c) show government employment, manufacturing,

Figure 4: Monthly employment in Alaska for the hardest hit sectors

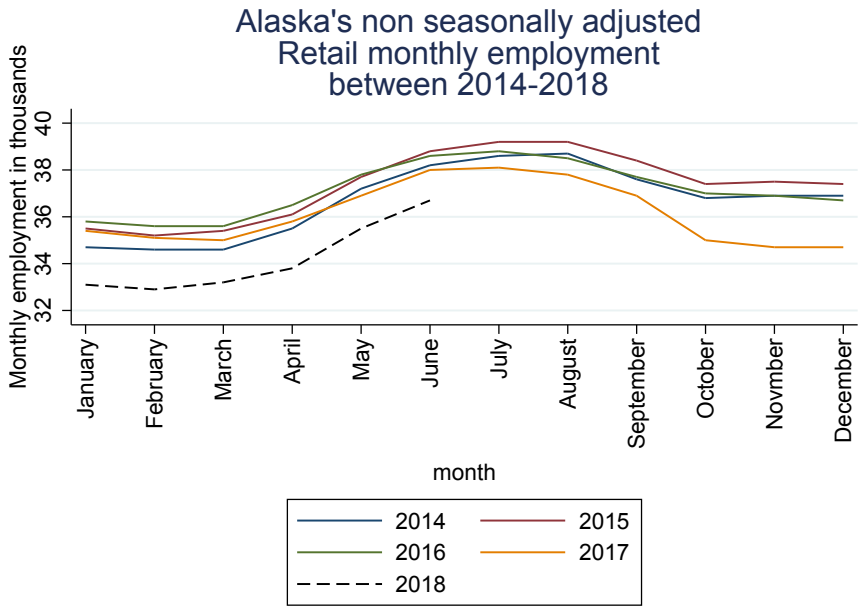


(a)

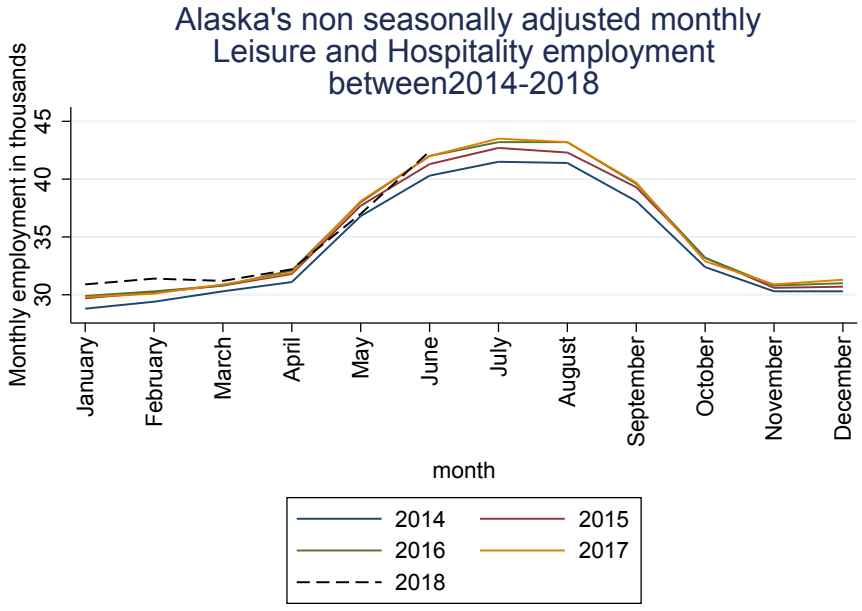


(b)

Figure 5: Monthly employment in Alaska for household spending sectors



(a)

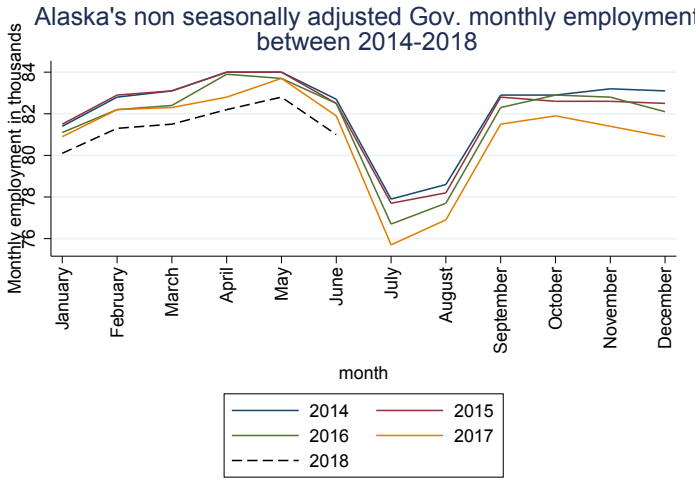


(b)

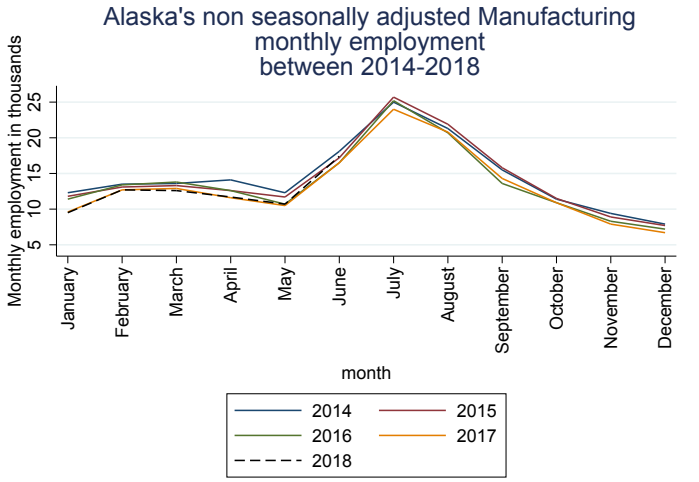
and Education and Health services, respectively. We can see that government employment in Figure 6a has declined for three straight years and was still considerably lower in the first 6 months of 2018 relative to 2017. Manufacturing employment in Figure 6b seems to have been largely unaffected by the current recession as employment in that sector is driven largely by world markets. The last figure in this series is Figure 6c that shows that the Education and Health Care services, which is largely comprised of health care has continued growing over the last four years and has been a source of strength during a time statewide economic decline.

After examining all these sectors, it appears that the Alaska economy is still weak and while the losses have slowed in the initially affected sectors (Oil and Gas, Professional and Business services, and Construction), there is still significant weakness in the retail sector. It would be a mistake to characterize the small improvements we are observing in Oil and Gas, Professional and Business services, and Construction as signs of a recovery because those sectors are still considerably smaller than they were in 2014. To be exact, as of June 2018 Oil and Gas employment was 75.5% of its level in 2014, Professional and Business services was 91.6% of what it was in 2014, and construction was 86.4% of what it was in 2014. In general, it would be safe to think about the economy entering the end phase of the recession with the losses now concentrated in the household dependent sectors which are typically lower paying but are indicative of household spending behavior and general confidence. It is unlikely that we will see significant growth or a recovery of the jobs lost as the government still has around a non negligible deficit and oil prices remain too low to spur a significant improvement in hiring in Oil and Gas. These two sectors are typically the catalysts of Alaska recovery and with both of them weakened, it is best to think about the state re-entering a period of low to no growth. In the next section, we compare Alaska's experience during this recession to that of other states that are also energy-dependent to gain some perspective on how the decline in oil prices affected their respective economies.

Figure 6: Monthly employment in Alaska for Government, Manufacturing, and Education and Healthcare



(a)



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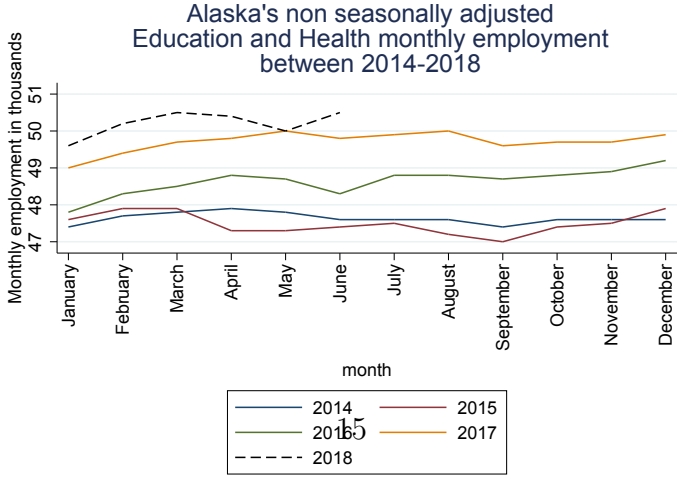


(c)

5 Examining oil dependence and the recession across states

We rely on Snead (2009)[1] as a starting point to identify the other states whose economies are oil dependent. We first evaluate how the dependence on oil varies across them, then we assess how each of these states have fared since the decline in oil prices, and examine which of them have recovered and what it can potentially tell us about the Alaska economy. Table 3 shows the share of each of the economies' GDP coming from Mining and Oil and Gas. It is clear that while many states have a reliance on oil, Alaska's Gross Domestic Product has a much higher dependence with Wyoming being a close second. Additionally, we can see that the share of the value produced in Alaska that comes from Oil and Gas has decreased since 2015 when prices dropped. One common measure of assessing how the changes in prices has affected activity across the country is to look at rig counts. Table 4 shows the number of rig counts across the states of interest between 2010 and 2016 and calculates the percentage change in rig counts between 2014 and 2016. All the states we evaluate shed upward of 60% of their rigs in those states with the exception of Alaska which lost 20% of its rigs.

It is important to note that oil production differs from state to state in terms of both resource endowment and cost of production which largely determine the variation of rigs across the country. There is, however, no doubt that the drop in oil prices resulted in deep rig count reductions across the country. To examine how this decline in rigs affected economic variables, we turn our attention to employment losses in Table 5.

We present June employment in 2015, 2016, 2017, and 2018 relative to 2014 in Figure 7 and Table 5. We see that among the energy states, only six of the thirteen experienced economy-wide job losses.

Table 3: Share of GDP coming from Mining, quarrying, and Oil and Gas Extraction

State	2010	2011	2012	2013	2014	2015	2016	2017
Alaska	31.8%	35.2%	35.19%	32.61%	28.63%	18.63%	15.28%	18.59%
Arkansas	3.03%	3.64%	3.14%	3.35%	3.47%	2.12%	1.43%	1.40%
Colorado	5.08%	5.73%	5.21%	5.60%	6.32%	4.26%	3.17%	3.79%
Kansas	1.65%	1.78%	1.86%	1.91%	1.79%	0.97%	0.63%	0.71%
Louisiana	9.31%	9.78%	8.97%	8.13%	7.43%	4.92%	3.90%	4.66%
Montana	6.54%	7.42%	7.37%	7.13%	6.36%	4.89%	4.06%	4.03%
New Mexico	10.45%	12.11%	11.90%	13.20%	13.85%	10.06%	8.07%	9.96%
North Dakota	8.36%	12.64%	16.33%	17.95%	18.35%	12.29%	9.03%	11.72%
Oklahoma	13.16%	15.95%	14.51%	18.12%	19.62%	13.82%	10.22%	12.09%
Texas	10.71%	12.12%	12.61%	13.96%	14.55%	9.34%	6.95%	8.46%
Utah	3.67%	4.07%	3.66%	3.47%	3.55%	2.09%	1.64%	1.75%
West Virginia	14.5%	16.59%	13.4%	14.0%	14.11%	11.58%	10.24%	12.87%
Wyoming	34.6%	35.18%	29.27%	28.86%	26.9%	21.25%	19.85%	23.33%

Table 4: Rig count by state 2010-2016

State	2010	2011	2012	2013	2014	2015	2016	% change from 2016 to 2014
Alaska	8	7	7	9	**10**	11	8	-20%
Arkansas	39	35	21	14	**12**	6	0	No rings in 2016
Colorado	58	72	65	63	**68**	38	19	-72.05%%
Kansas	20	28	30	27	**29**	13	3	-89.65%
Louisiana	192	165	124	108	**111**	77	46	-58.55%
Montana	7	9	20	12	**8**	2	0	No rigs in 2016
New Mexico	62	79	84	77	**92**	53	25	-72.82%
North Dakota	114	168	188	173	**176**	84	31	-82.38%
Oklahoma	128	180	196	179	**199**	117	69	-65.32%
Texas	659	838	899	835	**882**	430	236	-73.24%
Utah	27	28	37	29	**25**	7	3	-88%
West Virginia	23	21	26	28	**29**	19	10	-65.51%

Figure 7: June Employment by year relative to 2014

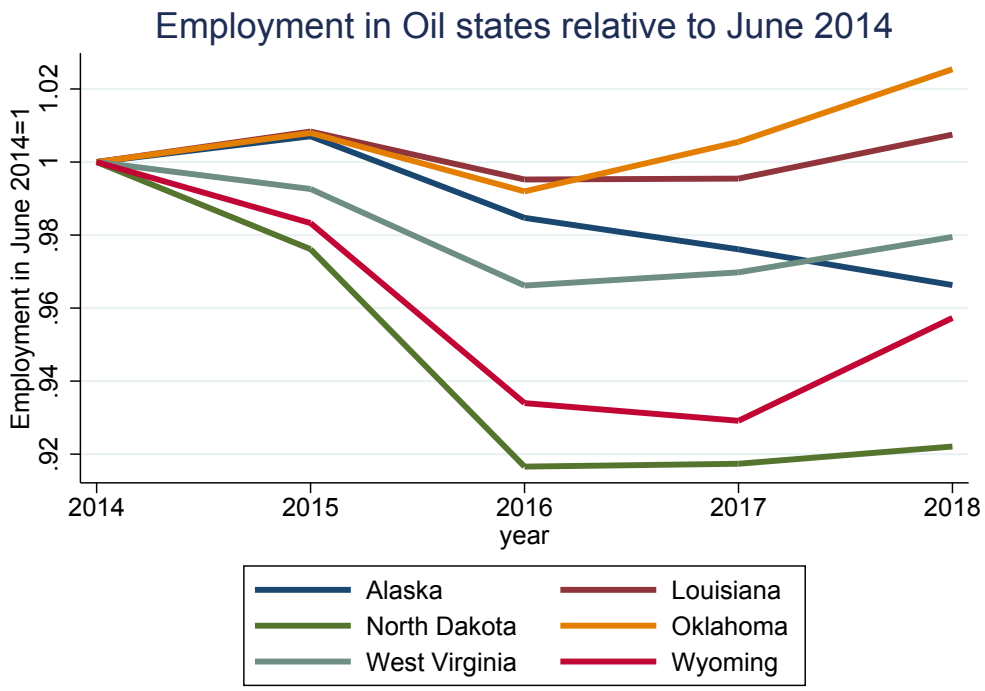


Table 5: Employment evolution in the private sector across traditional oil states

State	2014	2015	2016	2017	2018
Alaska	1	**1.007**	**.984**	**.976**	**.966**
Arkansas	1	1.023	1.041	1.057	1.065
Colorado	1	1.033	1.057	1.083	1.114
Kansas	1	1.008	1.01	1.008	1.027
Louisiana	1	**1.008**	**.995**	**.995**	**1.007**
Montana	1	1.020	1.033	1.050	1.059
New Mexico	1	1.015	1.015	1.028	1.044
North Dakota	1	**.976**	**.916**	**.917**	**.922**
Oklahoma	1	**1.007**	**.991**	**1.005**	**1.025**
Texas	1	1.025	1.033	1.057	1.093
Utah	1	1.045	1.084	1.122	1.158
West Virginia	1	.992	.966	.969	.979
Wyoming	1	**.983**	**.933**	**.929**	**.957**

Those states are Alaska, Louisiana, North Dakota, Oklahoma, and Wyoming, and West Virginia. West Virginia's situation is slightly different as it had been undergoing economic decline well before this most recent recession. Figure 7 shows the path of decline for each of the six states. We see that North Dakota and Wyoming both experienced employment declines in 2015 while the rest were still experiencing growth. Of interest is that every state in this group experienced the most severe decline between 2015 and 2016. Also, Louisiana and Oklahoma are the only two states whose employment levels in 2018 exceeds those of 2014. Wyoming seems to be on the rebound as it has had a strong first portion of 2018. Alaska, on the other hand was still shedding jobs as of June, 2018. Table 6 shows that the cumulative declines across the hardest hit five states are substantial.[4] We show the job losses at their worst in each of the states. In terms of share of employment, Wyoming and North Dakota lead the way with Alaska being third.

Table 6: How many jobs did each state lose when the recession was at its worst?

State	Cumulative declines	Share of overall employment decline
Alaska (Oct 2015 to Oct 2017)	11,200	3.46%
Louisiana (Oct 2015 to Oct 2017)	25,900	1.30%
North Dakota(May 2015 to May 2018)	25,200	5.79%
Oklahoma(January 2016 to January 2017)	17,900	1.11%
Wyoming (May 2015 to May 2017)	14,000	4.94%

In Table 7, we identify the first month of negative growth for each state to determine when the recession started and then we add up the total number of months of negative growth for each of the energy states. Alaska has now had 34 months of negative growth, Wyoming experienced 27 months of decline before turning the corner, and North Dakota had 37 months of negative before June when it had it first month of growth.[6] In Table 8, we identify the states where the recession has ended and the first month of positive growth they experienced. The table shows that Alaska and North Dakota are lagging behind the other energy states

[4]We only count job losses after the beginning of the recession in each of the states.

[6]We are omitting West Virginia from this conversation as the reasons behind the decline in economic activity stem from multiple reasons and is not solely attributable to oil.

Table 7: Length of the recession across oil states

State	Consecutive months of year over year declines	First month of negative growth
Alaska	34	October 2015
Arkansas	0	N.A
Colorado	0	N.A
Kansas	2	December 2015
Louisiana	21	September 2015
Montana	0	N.A
New Mexico	2	October 2016
North Dakota[5]	37	May 2015
Oklahoma	18	November 2015
Texas	0	N.A
Utah	0	N.A
Wyoming	27	May 2015

who have had fairly robust recoveries with multiple months of growth. Another important dimension of recessions is their effect on population. The next section evaluates the population responsiveness to economic decline by examining basic net migration.

Table 8: Has the recession ended everywhere?

State	Recession has ended?	First month of positive growth	N. of positive months
Alaska	No	N.A	
Louisiana	Yes	October 2017	10
North Dakota	Maybe	June 2018	
Oklahoma	Yes	May 2017	15
Wyoming	Yes	August 2017	12

5.1 Migration from the hardest hit states

Energy states typically attract migrants during times of high oil prices. Traditionally, those same workers tend to leave when prices decline. To evaluate the extent to which this most recent price decline has influenced migration, we show net migration -In-migration minus out-migration- from 2012 to 2017. Net migration has been negative in Alaska for 6 straight years. Wyoming had four years of negative migration, Louisiana and North Dakota had fewer people moving into the state than leaving it in both 2016 and 2017 and Oklahoma only had

negative migration in 2017. It is important to note that migration decisions are driven by both economic opportunities in the individual's state of residence and those outside of it.

Table 9: Net migration

State	2011	2012	2013	2014	2015	2016	2017
Alaska	702	**-434**	**-2,178**	**-8,022**	**-5,077**	**-2,557**	**-8,381**
Louisiana	6,119	5,498	4,203	1,434	915	**-5,020**	**-19,819**
North Dakota	6,174	11,654	18,051	10,264	11,733	**-4,684**	**-5,164**
Oklahoma	12,103	14,661	19,024	10,068	15,466	2,894	**-3,148**
Wyoming	485	5,964	2,941	**-2,187**	**-1,224**	**-3,823**	**-8,285**

5.2 Sectoral analysis

It is clear from the above that many states experienced prolonged recessions with thousands of jobs lost. To understand the nature of the losses better, we provide sectoral breakdowns below. Given that this is an oil driven recession, we begin our sectoral analysis by examining the Mining and logging sector which includes Oil and Gas in Figure 8 and Table 10. We present yearly June employment in the sector of interest relative to its 2014 employment level for each state. We find that the losses were large in every state. As of June 2018, the Oil and Gas sector was 75.5% of its size in 2014 in Alaska, while it was at 69.3% and 62.7% in North Dakota and Louisiana, respectively. North Dakota stands out as it experienced the most precipitous and deepest losses and was half of its 2014 size in 2016. None of the states we analyze reached the 2014 levels even if the majority of them have started experiencing growth in the sector.

The construction sector which is typically quite sensitive to oil and gas in oil states has also shrunk considerably in some of the hardest hit areas as we can see in Figure 9 and Table 11. Oklahoma and Louisiana both have, however, had resilient employment in the sector. This resilience in those two states is one reason for their rebound. Once again, North Dakota, Wyoming, and Alaska are found to be the states that were most affected.

Figure 8: June Employment in the mining sector by year relative to 2014

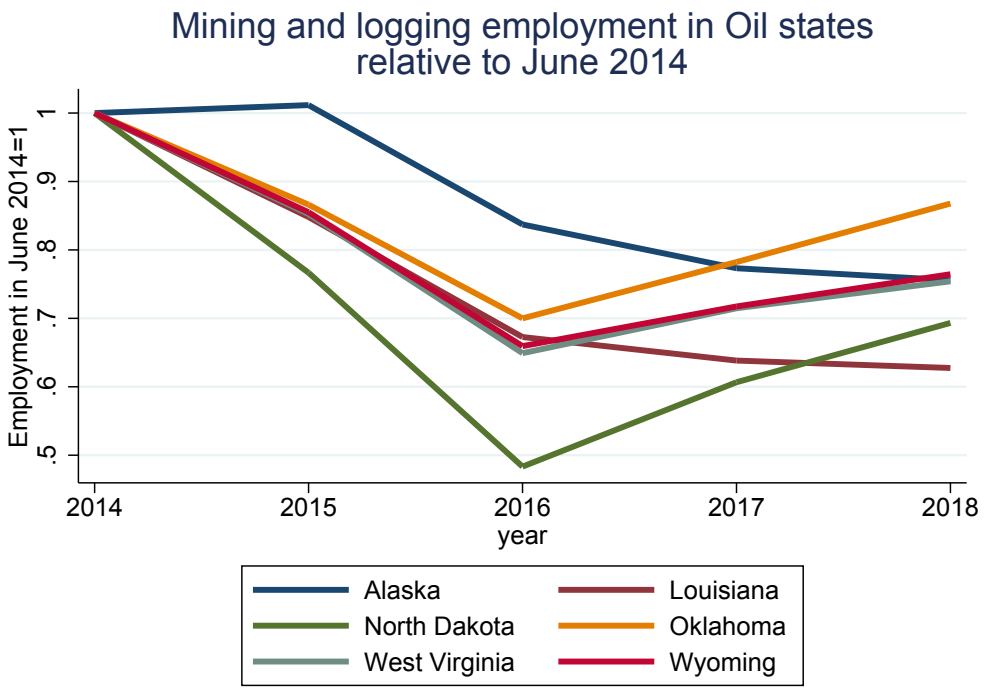
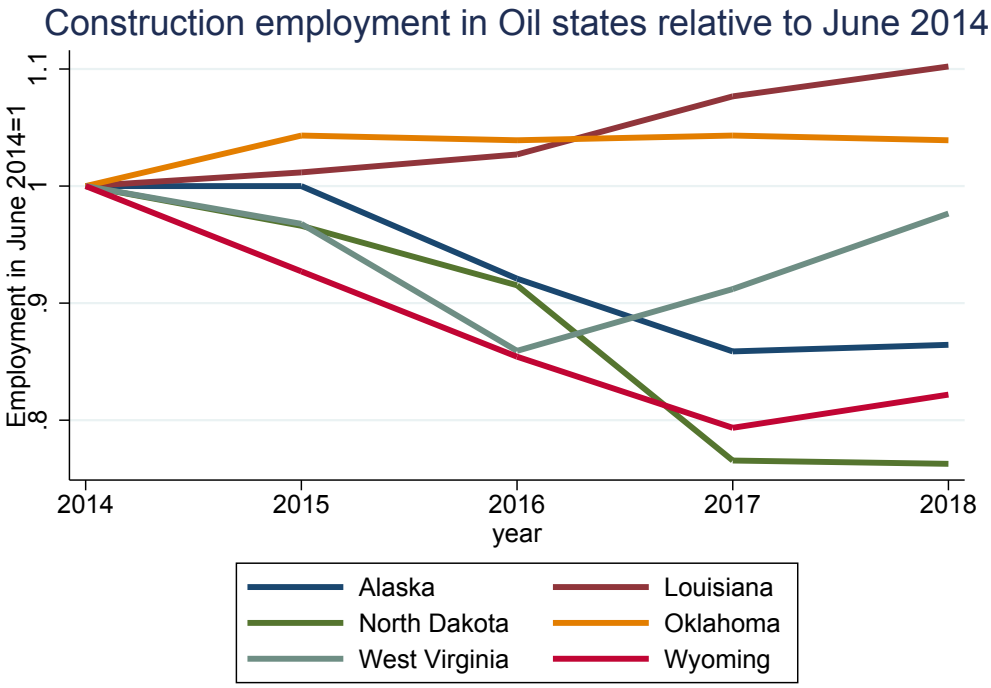


Table 10: Employment evolution in the mining sector across traditional oil states

State	2014	2015	2016	2017	2018
Alaska	1	**1.011**	**.837**	**.773**	**.755**
Arkansas	1	.898	.696	.674	.617
Colorado	1	.911	.686	.769	.869
Kansas	1	.811	.641	.641	.669
Louisiana	1	**.848**	**.672**	**.638**	**.627**
Montana	1	.912	.769	.758	.780
New Mexico	1	.9107	.7	.75	.732
North Dakota	1	**.766**	**.483**	**.606**	**.693**
Oklahoma	1	**.866**	**.7**	**.782**	**.867**
Texas	1	.874	.675	.719	.826
Utah	1	.845	.682	.707	.682
West Virginia	1	.852	.649	.714	.754
Wyoming	1	**.855**	**.659**	**.717**	**.764**

Figure 9: June Employment in the construction sector by year relative to 2014



The professional and business sector, typically a leading indicator of recessions held up well in most states as we can see in Figure 10 and Table 12 after the sharp decline in oil prices. The two states where employment levels in the sector as of June 2018 were not back to their June 2014 levels were Alaska and North Dakota. The last private sector we highlight is Retail which reflects household behaviors. Once again, there is considerable heterogeneity in both how quickly after the oil price decline, the retail sector was affected and how severe were the job losses. As Figure 11 and Table 13 show, North Dakota saw first saw retail declines in 2015, Alaska in 2016, and Wyoming in 2017.

Lastly, we turn our attention in Figure 12 and Table 14 to government employment as these states not only have their private sector jobs dependent on the health of the oil sector but they all rely on severance and other oil related tax revenues to fund government activities. North Dakota's government employment grew in both 2015 and 2016 and only started declining in 2017. Wyoming also saw growth in both 2015 and 2016 before experiencing a decline. As of

Table 11: Employment evolution in the construction sector across traditional oil states

State	2014	2015	2016	2017	2018
Alaska	1	**1**	**.920**	**.858**	**.864**
Arkansas	1	1.067	1.103	1.125	1.155
Colorado	1	1.040	1.080	1.146	1.205
Kansas	1	1.006	1.019	.993	1.006
Louisiana	1	**1.011**	**1.027**	**1.076**	**1.102**
Montana	1	1.031	1.055	1.098	1.134
New Mexico	1	1.023	1.007	1.070	1.136
North Dakota	1	**.966**	**.915**	**.765**	**.762**
Oklahoma	1	**1.043**	**1.039**	**1.043**	**1.039**
Texas	1	1.051	1.075	1.10	1.166
Utah	1	1.074	1.164	1.244	1.320
West Virginia	1	.967	.859	.912	.976
Wyoming	1	**.927**	**.854**	**.793**	**.821**

Figure 10: June Employment in the professional and business sector by year relative to 2014

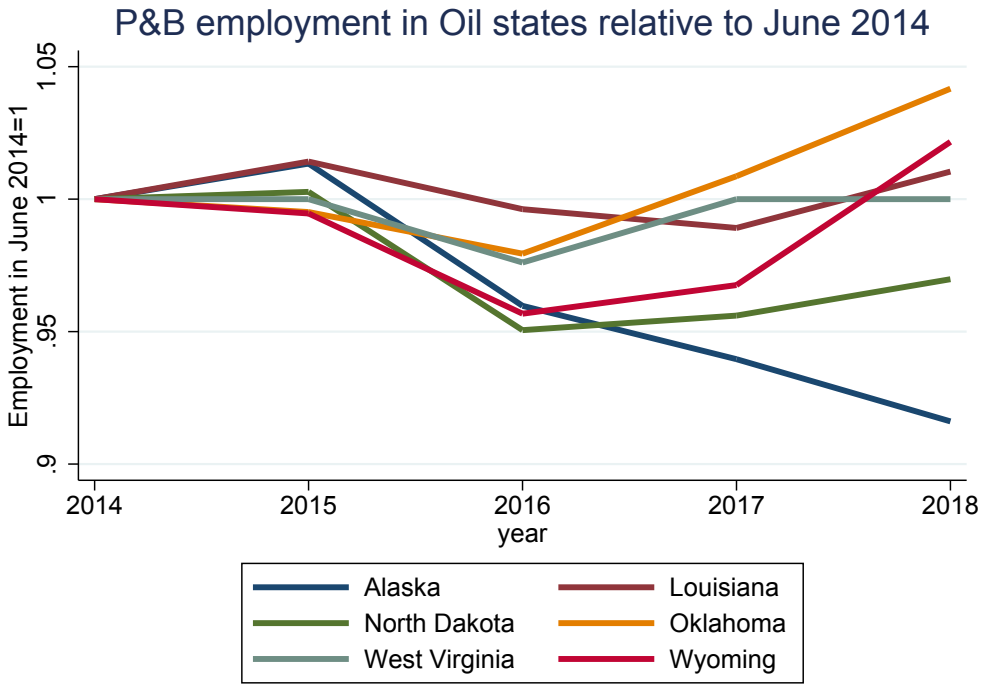


Table 12: Employment evolution in the professional and business sector across traditional oil states

State	2014	2015	2016	2017	2018
Alaska	1	**1.013**	**.959**	**.939**	**.916**
Arkansas	1	1.041	1.069	1.085	1.131
Colorado	1	1.030	1.051	1.073	1.117
Kansas	1	1.001	.991	.989	1.027
Louisiana	1	**1.014**	**.996**	**.989**	**1.010**
Montana	1	1.022	1.022	1.045	1.08
New Mexico	1	1.007	1.024	1.056	1.090
North Dakota	1	**1.002**	**.9505**	**.956**	**.969**
Oklahoma	1	**.995**	**.979**	**1.008**	**1.041**
Texas	1	1.029	1.048	1.076	1.127
Utah	1	1.060	1.100	1.124	1.163
West Virginia	1	1	.976	1	1
Wyoming	1	**.994**	**.956**	**.967**	**1.021**

Figure 11: June Employment in the retail sector by year relative to 2014

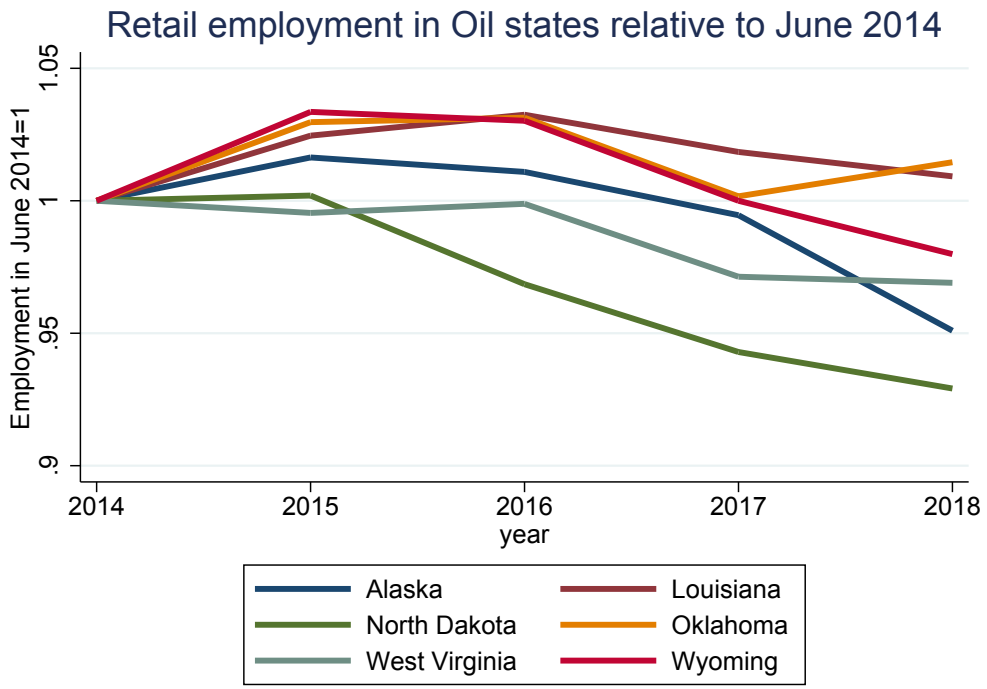


Table 13: Employment evolution in the retail sector across traditional oil states

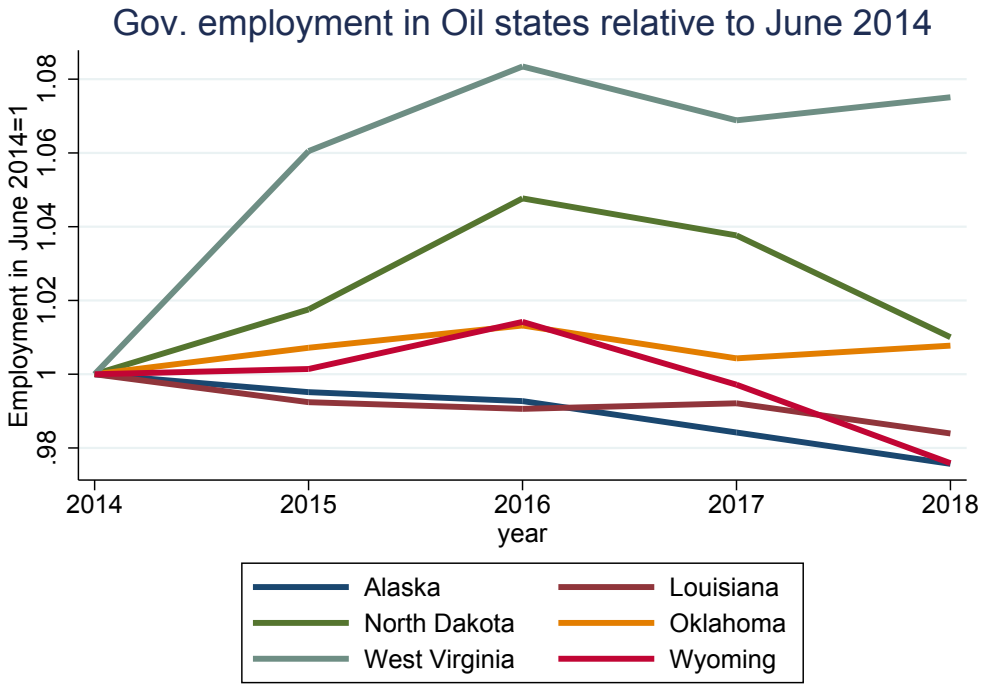
State	2014	2015	2016	2017	2018
Alaska	1	**1.016**	**1.010**	**.994**	**.950**
Arkansas	1	1.035	1.044	1.031	1.027
Colorado	1	1.028	1.052	1.064	1.080
Kansas	1	1.024	1.032	1.018	1.009
Louisiana	1	**1.024**	**1.032**	**1.018**	**1.009**
Montana	1	1.024	1.038	1.029	1.017
New Mexico	1	1.0097	1.004	.985	.983
North Dakota	1	**1.001**	**.968**	**.942**	**.929**
Oklahoma	1	**1.029**	**1.031**	**1.00**	**1.014**
Texas	1	1.036	1.052	1.057	1.068
Utah	1	1.041	1.088	1.10	1.16
West Virginia	1	.995	.998	.971	.969
Wyoming	1	**1.033**	**1.030**	**1**	**.979**

June, 2018, Alaska, Louisiana, and Wyoming were the three states where employment levels well below those of 2014. Alaska's government employment went from 83,100 in June 2014 to 80,300 in June, 2018.

Table 14: Employment evolution in the government sector across traditional oil states

State	2014	2015	2016	2017	2018
Alaska	1	**.995**	**.992**	**.984**	**.975**
Arkansas	1	.994	.996	.992	.990
Colorado	1	1.018	1.042	1.056	1.084
Kansas	1	1.004	1.001	.997	1.007
Louisiana	1	**.992**	**.990**	**.992**	**.983**
Montana	1	.998	1.023	1.012	1.011
New Mexico	1	.995	.989	.970	.981
North Dakota	1	1.017	1.047	1.037	1.01
Oklahoma	1	1.007	1.013	1.004	1.007
Texas	1	1.013	1.032	1.043	1.048
Utah	1	1.003	1.024	1.050	1.068
West Virginia	1	1.06	1.083	1.068	1.075
Wyoming	1	1.001	1.014	.997	.975

Figure 12: June Employment in the government sector by year relative to 2014



6 Why have some states recovered?

The previous section shows that 3 out of the five hardest hit states have already recovered while Alaska is still experiencing a slowdown. These three states that have recovered share a few characteristics in common. They, unlike Alaska have a GDP that is less reliant on the oil sector. Additionally, they experienced minimal if any declines in construction and professional business services after the initial oil price drop. They also seem to have reacted faster to the oil price recovery which has resulted in small but sustained growth in the oil sector and other downstream industries. Below, we summarize the characteristics and experiences of those three states.

- **Oklahoma**
  - Oklahoma's GDP is considerably less reliant on oil and gas than Alaska.

- Construction employment continued growing even when the Oil and Gas sector was experiencing significant losses.
- Retail employment held up well and never dropped below its 2014 level.
- Government revenues coming from the severance tax are only 3.75%

- **Louisiana**
  - Louisiana's tax revenues are considerably less reliant on oil and gas than Alaska as only 4.80% come from the severance tax.
  - Its economy is also less reliant on oil as only 7.43% of the state's GDP comes from the sector.
  - Overall employment is higher in 2018 than it was in 2014.
  - Oil and Gas employment is still losing jobs as of 2018. It is 62.7% of its size in 2014.
  - Construction employment has grown substantially between 2014 and 2018.
  - Professional and Business services lost jobs but was back to its 2014 level.

- **Wyoming**
  - Of all government revenues, 31.4% come from the severance tax.
  - Employment is still below 2014 levels but the state has experienced 10 months of growth.
  - Oil and Gas growth occurred in the last two years.
  - Retail and Government are still weak.

Alaska's vulnerability has stemmed from both a private and public sector dependence. The most recent decision to rely on non-oil revenues to fund a portion of the government

expenditures bodes well for future economic resilience to oil shocks. To more formally evaluate how oil shocks affect each of these economies, we model both the average effect of oil changes on employment across the states, and then we assess how each of them responds to large oil shocks.

7 Modeling how fluctuations in oil prices influence employment

In the previous sections, we described how each of the energy states reacted to the most recent recession. Below, we assess how fluctuations in oil prices over the period from 1991 to 2018 affect monthly employment changes. This analysis estimates a variant of Brown(2014)[2] which allows us to capture the average effect of changes in oil prices on employment changes in the five states most dependent on oil prices using equation 1:

$$\Delta emp_{it} = \sum_{n=1}^{12} \alpha_m \Delta emp_{it-m} + \sum_{n=0}^{6} \beta_k \Delta oilprices_{it-k} + \gamma_i + \tau_t + \epsilon_{it} \tag{1}$$

where Δemp_{it} is the percentage change in employment in state i at time t, $\Delta oilprices$ is the percentage change in monthly oil prices, γ is a state fixed effect which captures constant factors in each of the states, τ is a time-year- fixed effect to control for seasonal factors, and ϵ_{it} is an error term. We use six lags for the oil price and 12 lags for employment. This specification allows us to understand the general or economy wide effects of price fluctuations in a long window of time. The immediate employment response from a change in oil prices is estimated by β_0, which is the % change in employment for a 10% change in oil prices. The other coefficients, β_1, β_2,..., β_6 , estimate the employment response in months one to six following a change in prices. Table 14 shows that a 10% change in oil prices results in a 0.22% change in the first month after the increase, a 0.25% change the second month, a 0.21% change in the third month, a 0.25% change in the fourth month, a 0.28% change in the fifth

Table 14: Average effect of oil price changes across oil dependent states

Month	Coefficient of a 10% change in oil prices
One	0.0022
Two	0.025*
Three	0.021
Four	0.025*
Five	0.028**
Six	0.023*

month, and a 0.23% increase in the sixth month. We can also estimate a long-run multiplier (LRM) which measures the long-run effect of a change in oil prices on employment. The LRM is estimated by:

$$LRM = \frac{\sum_{k=0}^{6} \beta_k}{1 - \sum_{n=1}^{12} \alpha_m} \tag{2}$$

Using Equation 2, we calculate that a 10% change in oil prices results in a 1.7% change in employment across these oil dependent states in the long run. For Alaska, using 2018 employment numbers that would amount to about 4,515 increase in jobs as a result of a 10% increase in oil prices. This average response to oil prices across the states makes clear that fluctuations in prices lead to substantial changes in number of jobs across the full period (1991-2018). In the next section, we estimate each state's responsiveness to large oil shocks and determine whether the states have symmetric responses. In other words, we ask if the economy of each of these states responds the same way to a positive and a negative oil shock. This is important because it unveils how quickly a shock to prices makes its way into employment and how long it remains for both price increases and decreases.

7.1 State by state analysis

We model the employment growth rate in each of the oil states as a function of lagged values of its own employment $\Delta emp_{i,t-j}$, positive oil shocks as $\Delta x^{+}{}_{i,t-j}$, and negative oil shocks as $\Delta x^{-}{}_{i,t-j}$. By defining positive and negative oil shocks separately, we are able to to test how employment responds to both increases and decreases separately. The variable $\mathcal{D}_{t-j}$ which takes on a value of one for the post-Hurricane-Katrina period accounts for the possibility of employment growth outliers following the hurricane.

$$\Delta emp_{it} = \alpha_{i,t} + \sum_{j=1}^{12} \alpha_m \Delta emp_{i,t-j} + \sum_{j=1}^{12} \gamma_{ij} \Delta x^{+}{}_{i,t-j} + \sum_{j=1}^{12} \delta_{ij} \Delta x^{-}{}_{i,t-j} + \sum_{j=1}^{12} \theta_{ij} \mathcal{D}_{t-j} + \epsilon_{it} \quad (3)$$

Among the states we analyze, this is particularly relevant for Louisiana. Given that economic activity is much more likely to respond to large shocks as opposed to small fluctuations, we follow Engemman et. al (2014) [3] and define the positive and negative shocks as follows:

$$\Delta x^{+}{}_{i,t-j} = max \left\{ 0, 100 \times ln \frac{x_t}{max \left\{ x_{t-1}, ..., x_{t-12} \right\}} \right\} \quad (4)$$

$$\Delta x^{-}{}_{i,t-j} = max \left\{ 0, 100 \times ln \frac{x_t}{min \left\{ x_{t-1}, ..., x_{t-12} \right\}} \right\} \quad (5)$$

Equations 4 and 5 allow us to capture the effect of large fluctuations in oil prices. That is because, for example, $\Delta x^{+}{}_{i,t-j}$ takes a non zero value equal to $\left\{ ln \frac{x_t}{max\{x_{t-1},...,x_{t-12}\}} \right\}$ only if this month's price is higher than the prices of the last twelve months. The negative shocks are defined in a similar manner.

The equation is estimated separately for each of the main 5 oil states we identified earlier.

This allows us to examine how a rather large oil shock reverberates through each of the states and test whether the effects of a positive and negative oil shocks are symmetric.

Table 15: How does each respond to a large oil shock?

State	Number of positive months	Number of negative months	Symmetric relationship?
Alaska	10	14	Yes
Louisiana	6	16	Yes
North Dakota	14	20	No
Oklahoma	9	20	Yes
Wyoming	12	20	No

From Table 15, we can see that a negative oil shock lasts longer and is stickier than a positive shock in all the states. However, the size of the effects are symmetric in three out of the five states. This means that the economies in these three states do not respond differently to positive and negative shocks. In the other two -North Dakota and Wyoming- a negative shock has more negative consequences on employment than a positive shock contributes to growth in employment.

To visually inspect how an oil shock reverberates through each state's economy, we present impulse response functions of both the positive and negative oil shocks for each state. An impulse-response function describes the evolution of the variable of interest (employment growth) along a specified time horizon (20 months) after a one standard deviation oil shock. The left panel in Figure 13 shows how Alaska employment growth responds to a positive oil price shock as defined in equation 4, while the right panel of Figure 13 shows how employment growth responds to a negative shock as defined in equation 5. Figure 14 to Figure 17 show how each of the other four states respond to those same oil shocks. Figure 14 and Figure 15 show that both North Dakota and Wyoming are considerably more sensitive to drops in oil price than increases. Oklahoma and Louisiana presented in Figure 16 and Figure 17 both have symmetric responses to oil shocks. Louisiana is difficult to assess as it had significant out-migration and an extended period of economic decline after Hurricane Katrina.

Discussions about the role of oil prices on the national economy have received considerable

attention. There has, however, not been as much focus on the effect of oil price fluctuations on regional economies. Our focus is on the states whose economies are heavily dependent on the resource and are therefore typically countercyclical to the rest of the country. Specifically, we model how oil shocks or fluctuations - defined in a few different ways- affect monthly employment growth. We also evaluate the effects of rising and declining oil prices separately to parse out whether states have symmetric responses and whether these responses are homogeneous across states.

Figure 13: Employment growth in Alaska as a response to oil shocks

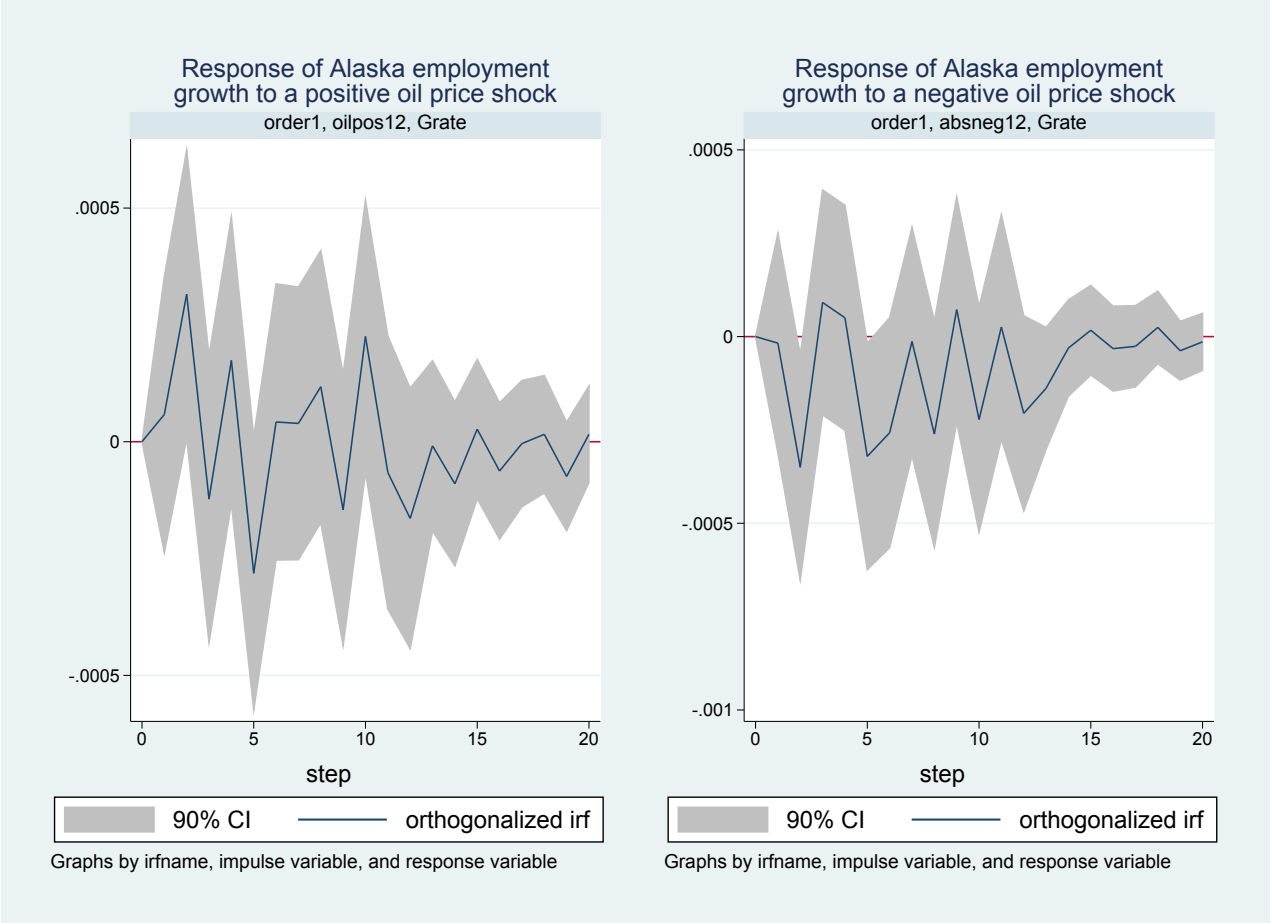


Figure 14: Employment growth in Wyoming as a response to oil shocks

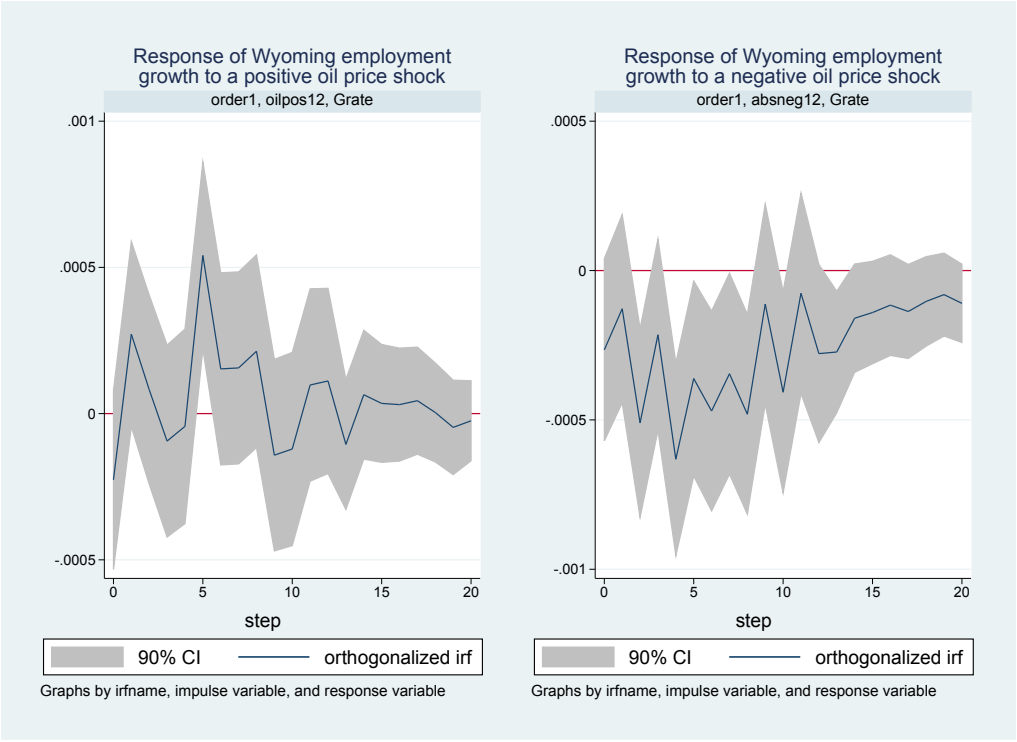


Figure 15: Employment growth in North Dakota as a response to oil shocks

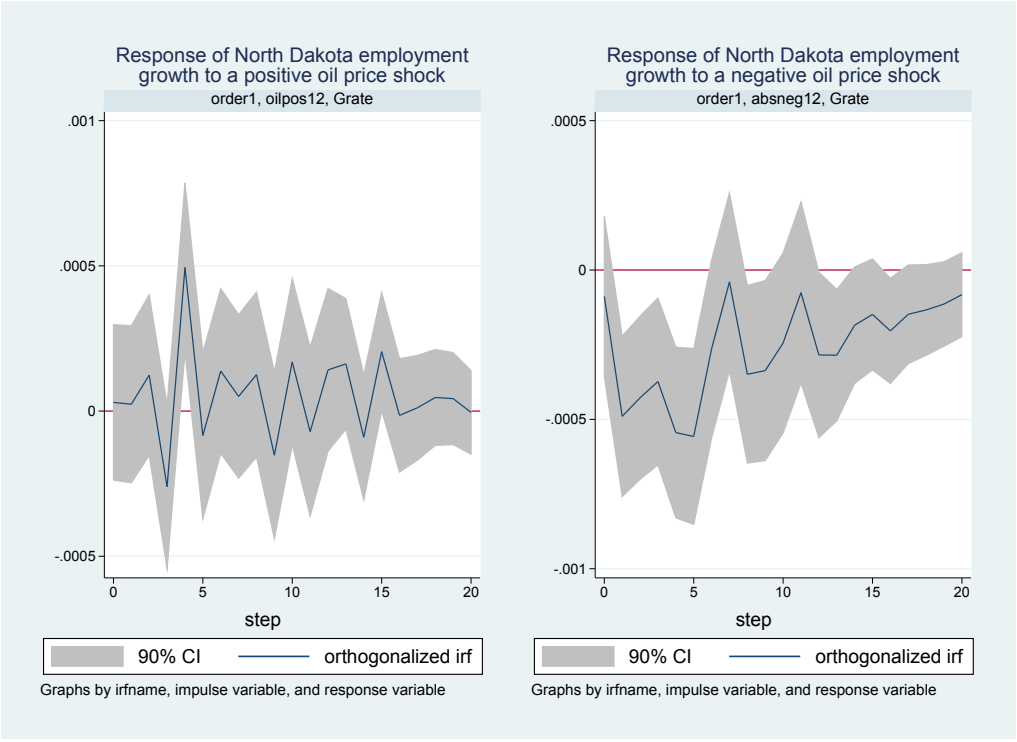


Figure 16: Employment growth in Oklahoma as a response to oil shocks

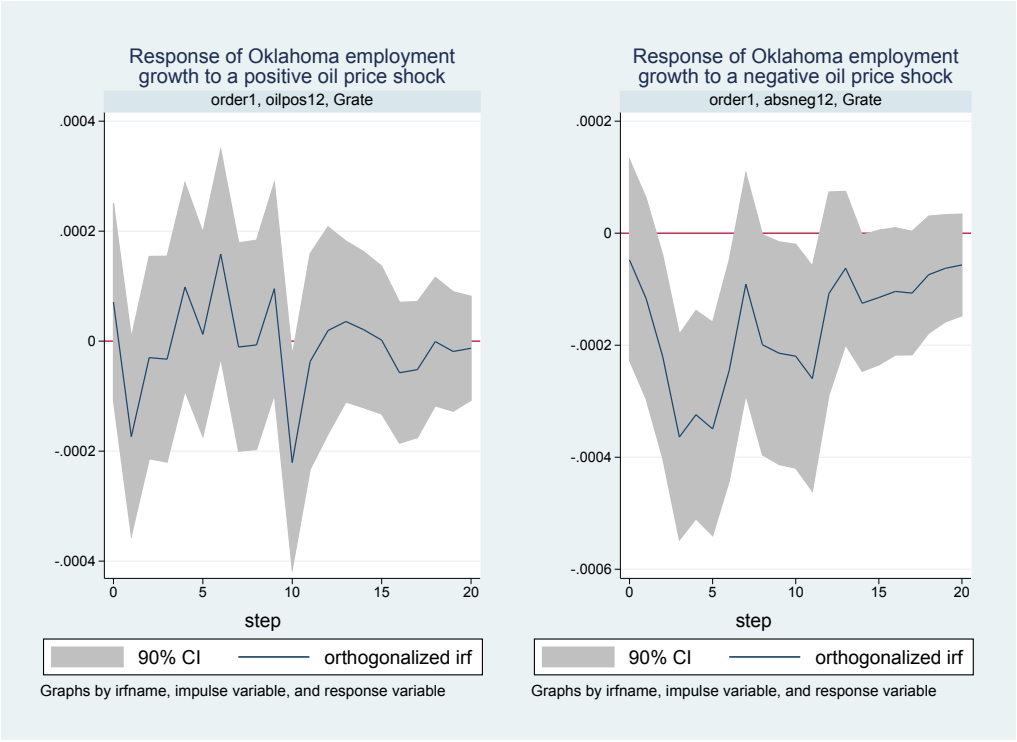
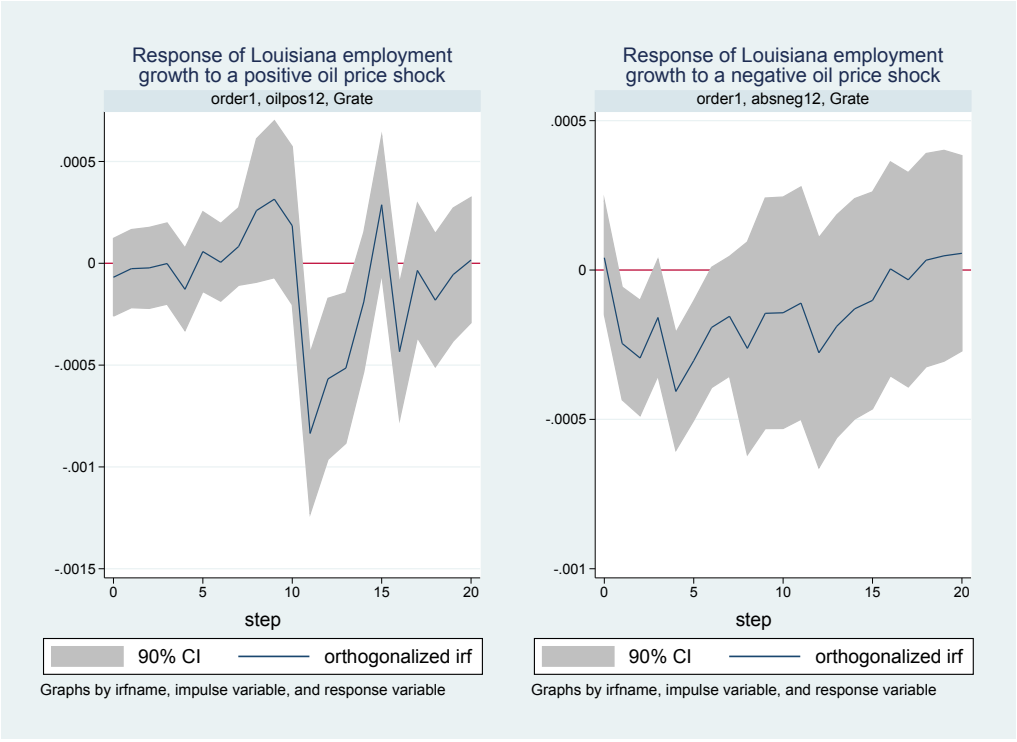


Figure 17: Employment growth as a response to oil shocks



8 Conclusion

In this paper, we evaluate the Alaska economy and how it is influenced by oil prices. First, we simply present the monthly employment by sector for the state and show that the current recession has slowed but we are far from a full recovery as employment levels are considerably below where they were four years ago. It does, however, appear that Oil and Gas, Professional and Business services, and Construction have stabilized. Oklahoma and Louisiana had short bouts of negative growth but recovered fairly quickly while North Dakota, Wyoming and Alaska have had the longest and deepest recessions. In a way, this is unsurprising given that Alaska and Wyoming have historically had a high dependence to oil while North Dakota had a very large boom due to the shale revolution which was followed by a bust. Across all these states, we find that large oil shocks affect employment for significant periods but there are differences in how quickly employment responds to the oil shock and how persistent are the effects. In general, our analysis shows that the states most dependent on oil revenues both through the private sector and government revenues are the ones to have had the longest recessions. The decision in Alaska to fund a portion of government services from non-oil revenues should partially shelter the economy from future oil price drops.

All the indicator variables we evaluate point to Alaska being in the tail end of the recession but the recovery of the jobs lost will be elusive as both the oil sector and the government sector are considerably smaller than they were four years ago. The future of Alaska economic development will rest on the success of the traditional basic sectors, the pursuit of new opportunities, and on whether the state can address its leaky bucket by ensuring that more of the value generated in Alaska stays in state. That will require evaluating opportunities where import substitution is possible and ensuring there is a qualified workforce that can take advantage of employment opportunities.

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