College of Business and Public Policy
UNIVERSITY of ALASKA ANCHORAGE

Department of Economics & Public Policy Working Paper Series

WP 2017-04

Who Benefits From an Oil Boom? Evidence From a Unique Alaskan Data Set

MOUHCINE GUETTABI
University of Alaska Anchorage

ALEXANDER JAMES
University of Alaska Anchorage

UAA DEPARTMENT OF ECONOMICS & PUBLIC POLICY
3211 Providence Drive
Rasmuson Hall 302
Anchorage, AK 99508

http://econpapers.uaa.alaska.edu/

JEL Codes: Q3, Q4

Who Benefits From an Oil Boom? Evidence From a Unique Alaskan Data Set

Mouhcine Guettabi* Alexander James†

September 24, 2017

Abstract

Oil booms have been shown to enhance local employment and wages. But such conclusions reflect the aggregated experience of residents, commuters, and recent migrants alike. But from a local policy perspective, understanding how such economic booms affect existing resident populations is clearly important. This paper takes advantage of a unique data set that identifies labor market outcomes based off of an individual's place of residence, rather than their place of work. Exploiting this feature of the data, we examine the effect of a major oil boom on employment and wage outcomes in the oil-rich North Slope Borough of Alaska. This analysis is juxtaposed with a more conventional one that relies on the use of Bureau of Economic Analysis (BEA) data, which is based off of where individuals work, regardless of where they live. Using a difference-in-difference estimation strategy, we find that the oil boom of the late 2000s generated significant economic gains. While the majority of the gains appear to have gone to temporary migrant workers, residents did experience some gains in the form of enhanced wages and employment. We conclude that the residential impact of resource booms may not be accurately reflected in BEA data.

Keywords: Oil Boom; Alaska; Regional Development; Employment Effects

JEL Classification: Q3; Q4

*Corresponding Author. Institute of Social and Economic Research and Department of Economics, University of Alaska Anchorage. Anchorage, AK. 99508. *Email:* mguettabi@alaska.edu

†Department of Economics & Public Policy, University of Alaska, Anchorage. Anchorage, AK. 99508. *Email:* alex.james@uaa.alaska.edu

1 Introduction

Natural resources play an important role in the short and long run development process of poor and rich economies. This is clearly the case in countries like Saudi Arabia, Venezuela, and Kuwait, but as the recent shale-energy boom demonstrated, it is also true in the United States, especially at the local level.

Motivated in part by the recent shale-energy boom, there is now a large literature that examines the regional economic impacts of natural-resource booms. This literature (discussed in more detail later on) rather consistently shows that energy booms generate significant economic gains, at least in the short run. For example, examining counties in the mountain west, Jeremy Weber (2012) finds that the recent shale-energy boom generated "modest increases in employment, wage and salary income, and median household income".

There are three main sources of state and local-level employment and wage data this literature relies on: 1) the Census Bureau's employment and payroll data in the County Business Patterns (CBP), 2) the Bureau of Labor Statistics' (BLS) employment and wage tabulations derived from various unemployment insurance programs, and 3) the Bureau of Economic Analysis' (BEA) estimates of total wage and salary disbursements and employment. The CBP data reflects surveys of business establishments, the BLS data are collected from state or federal unemployment insurance programs, and the BEA data are derived from the BLS data, but various adjustments are made to account for people that do not have unemployment insurance (such as elected officials or interns employed by hospitals for example). Importantly, all of these data are defined by where people work, and not where they live. This is important given that resource booms attract labor from neighboring economies (see for example James, 2016). Using this "place of work" data to discern the effects of a resource boom on pre-existing local residents is therefore challenging.

We make use of a unique Alaskan data set that defines economic outcomes based off of individuals' place of residents (POR), rather than their place of work (POW). This allows us to examine how local residents are affected by a major oil boom. Specifically, we study how residents of the oil-rich North Slope borough in Alaska were affected during the surge in oil prices that occurred in the mid 2000s. We juxtapose these findings with a more conventional analysis of BEA data. Using POW (BEA) data, we find that the oil boom significantly increased employment and wages, a finding that is consistent with a now large body of research that documents the short run economic effects of resource booms. While we find similar results for the POR data, the estimates are roughly half as large in magnitude. More generally, our results suggest that it may be inappropriate to estimate the residential impact of resource booms using POW data.

2 Background

The discovery of the Prudhoe Bay oil field in 1968 proved to be one of the most important events in the economic development of the North Slope and the State of Alaska. Construction of the Trans-Alaska Pipeline System (TAPS), the only means to move crude oil from Alaska's North Slope fields to tankers in Valdez, began in 1974 and was completed in 1977. At peak production, the Prudhoe Bay oil field supplied 3 percent of the world's oil. The state government, which owns the Prudhoe Bay oil field, has collected more than $70 billion in petroleum revenues through 2004 (AOGA, 2005). These revenues have paid almost all state general expenses since 1978. The North Slope Borough's (NSB) revenues from taxes levied on oil and gas properties have also been substantial.

The North Slope Borough was incorporated as a first class borough on July 2, 1972 under the laws of the State of Alaska. The borough is a regional local government, similar to the county form of government in most of the lower 48. Incorporation of the Borough allowed local residents a chance to overcome the influence of the federal government with respect to education and health care (Harcharek, 2004).

The discovery of oil in Prudhoe Bay, the inception of the NSB in 1972, and the formation of the regional and village Alaska Native corporations changed the structure of the North Slope economy. Prior to these developments, both public and private employment opportunities on the North Slope were limited. The North Slope villages could only afford limited local government, and the year-round jobs were mostly associated with federal and state agencies.[1] Major economic changes occurred with the formation of the NSB and its ability to tax oil development at Prudhoe Bay and related industrial facilities. Between 1978 and 1983, the NSB collected more than 350 million dollars from property taxes and another 107 million from federal and state monies (Knapp and Nebesky, 1983). As a result, the Borough took over from the state and federal entities many public services in the villages. The Borough also implemented major infrastructure projects (i.e. schools, houses, utility systems, airports, roads, etc.); and the Borough soon after became the largest employer of North Slope residents with jobs created for government administration and construction projects.

The oil industrial complex on the North Slope has limited direct linkages to the rest of the region's economy. Some of the oilfield service companies operating in the Prudhoe Bay and Alpine areas are subsidiaries (or joint ventures) of village corporations. These service companies have provided jobs to a number of local residents. However, few North Slope

[1] The U.S. Naval Arctic Research Laboratory and the U.S. Air Force Distant Early Warning (DEW) Program, established in 1947 and 1954, respectively, provided the majority of the steady paying jobs in the region at that time.

residents have been employed by the large, multinational corporations that produce the oil. Although the oil producing companies are the largest employers in the region, nearly all their employees are non-residents, and virtually all of the income earned by these employees is spent outside of the North Slope communities. The oil producers do, however, indirectly support jobs in the communities through property tax payments, the main source of capital and operating revenue for the NSB.

In 2015, the NSB had 9,887 permanent residents with 4,685 of them above the age of 16 years old. Of those 3,358 are employed with local government representing almost 60% of all employment in the region. The three largest sectors in the private sector are Education and Health Services, Trade, and Professional services. These three account for 66% of all private sector employment. While the Borough is incredibly rich with oil, it has a fairly limited economy with a heavy dependence on local government.

3 Literature Review

The magnitude of local multipliers is important for regional economic development policies (Moretti, 2010). State and local governments spend considerable amounts of taxpayer money on incentives to attract new businesses to their jurisdictions. Such location-based incentives are pervasive in manufacturing. However, the efficiency of these policies and their actual effects on employment are not fully understood because there is little systematic evidence on the effects of successfully attracting a new firm on other parts of the local economy. The export base model seems most relevant to rural areas which, by virtue of their low population densities, are relatively abundant in the land and natural resources used intensively by traditional export sectors (Kilkenny and Partridge, 2009). Rural areas have comparative advantages in agriculture, mining, or factory-space-intensive manufacturing. Rural economies are also small and open, which is hypothetically consistent with the model's assumptions of perfectly elastic supplies of labor and capital.

Much of the research that examines mining within developing nations concludes that few economic benefits are retained in the local economy because of the ownership structure of mining firms and lax environmental or labor safety standards. In a review of the resource curse literature, Bridge (2008) concludes that resource development typically fails to produce significant economic gains. However, this literature has been heavily scrutinized over the passed decade (see Van der Ploeg, 2011) for a nice review of this literature). Recent studies that have utilized more sophisticated identification strategies document significant gains stemming from resource booms. Utilizing the synthetic control method, Smith (2015) for example, finds that oil booms significantly increase income per capita at the country level—in the short and long run.

Examining the experience of a subset of shale-rich U.S. counties, Weber (2012, 2014) finds that the shale boom increased local wages and employment. Similar results are documented by Munasib and Rickman (2015) who examine the regional economic impact of the shale boom using a synthetic control analysis. Similarly, Brown (2014) focuses on the effects of natural gas production during 2001 to 2011 on 647 non-metropolitan counties in a nine state region, mostly comprising the 10th Federal Reserve District. He finds faster growth in employment, population, real personal income and wages in counties with increased natural gas production relative to those with declining production and with no production. Komarek (2016) finds that the shale boom increased wages and employment in Pennsylvania, Ohio, and West Virginia relative to New York in which a variety of moratorium had been placed on hydraulic fracturing. Paredes, Komarek, and Loveridge (2015) however document minimal wage and employment effects of fracking in the Marcellus region.

These aforementioned studies however measure employment and wages using BEA data, which reflects where people work, and not where they live. We are aware of only a couple of papers that are focused on the experience of residence in the wake of a resource boom. Caselli and Michaels (2013) find that local, municipal level windfalls from offshore oil revenues within Brazil have minimal effects on living standards, so the windfalls appear to be neither a blessing nor a curse. By contrast, Aragon and Rud (2013) find that the expansion of a mine in a Peruvian city generated significant economic benefits to residents in the surrounding areas.

4 Data

We rely on data that describes economic outcomes by place of employment (BEA data) and by place of residence. The use of the BEA data allows us to examine whether the increase in oil prices resulted in an overall increase in employment and the average wage. The place of residence data allows us to consider whether residents of the North Slope Borough were affected by the oil boom.

4.1 Employment by place of work (BEA)

Employment and wage outcomes defined by place of work are collected from the BEA. As previously discussed, this data is quite similar to that provided by the BLS, though some modifications are made to account for individuals not covered by state or federal unemployment insurance. The BEA also makes adjustments to account for misreporting in state and federal unemployment insurance programs.

The BEA gives equal weight to full-time and part time jobs in its estimates of employment. Wage and salary jobs and proprietors' jobs are counted, but unpaid family workers and volunteers are not. Proprietors' employment consists of the number of sole proprietors and the number of general partners.

4.2 Employment by place of residence (ALARI)

Employment by place of residence comes from the Alaska Department of Labor and is established by matching wage record file data with Permanent Fund Dividend (PFD) information. The wage record file is derived from ADOLWD's Occupational Database (ODB) and contains quarterly earnings, occupation and industry information on workers covered by unemployment insurance within Alaska. The PFD file is a list of Alaskans who either applied for or received a PFD.[2] Workers included in the ODB were considered Alaska residents if they applied for a PFD in at least one of the two most recent years. Most of the data in Alaska Local and Regional Information (ALARI) is for Alaska residents only; non-residents are not included in this data. We acknowledge that an oil boom has the potential to permanently attract new residents. However, to the extent that this occurred during the oil boom in the North Slope borough, our estimates are upper bounds as some fraction of the employment gains may have gone to recent migrants to the area.

In 2001, the share of total employment held by residents was almost 38%, but declined to 21% by 2013. All local government employment is held by residents and about 1/3 of the state's workforce resides in the borough. Of interest in our analysis is how shocks to the borough's most valuable resource reverberate through the economy and the extent to which they improve the employment prospects of residents and non-residents. This shock we refer to stems from the fact that the average price of oil between 2001 and 2005 was only 36.28 dollars but 80.28 between 2006 and 2015 (see Figure 1). The borough is immensely dependent on oil revenues as 75% of all revenues come from the property tax. Most of this tax is the oil and gas property tax as only 3% of it comes from local property tax revenues.

5 Econometric Specification

To estimate the regional economic effects of the oil boom, we estimate two separate equations, both of which offer unique advantages. Following extant literature (see for example Jacobsen and Parker, 2012; Michaels, 2011; James and Smith, 2017), we first generate an indicator vari-

[2] The Permanent Fund Dividend is a dividend paid to Alaska residents that have lived within the state for a full calendar year (January 1 - December 31), and intended to remain an Alaskan resident indefinitely.

able equal to unity if the borough is the North Slope. The first estimation equation interacts this indicator variable with another indicator that defines the boom period. Specifically, we estimate equation (1) below

$$\ln(Y_{i,t}) = \alpha + \beta(D_i \times \text{Post}_{i,t}) + Z_t + C_i + \epsilon_{i,t}, \tag{1}$$

where $Y_{i,t}$ is the outcome of interest for county i in year t, D_i is the indicator variable identifying the North Slope borough, and $Post_t$ is an indicator variable equal to unity for boom years (2006-2013). Any meaningful temporal shocks that are not specific to a single county are captured by time fixed effects Z_t, while any county-specific, time-invariant disturbances are captured by county fixed effects, C_i. The error term, $\epsilon_{i,t}$ is clustered at the county level. Note that the direct effect of $Post_t$ and D_i are both captured by the time and state fixed effects, respectively. Hence, β measures the average effect of being the North Slope borough from 2006-2013, relative to the average effect from 2001-2005. This model is specifically well suited to test whether the average treatment effect (the effect of being the North Slope borough) during the 2006-2013 period is statistically different than that during the 2001-2005 period. However, a clear concern is that any observed treatment effect is due to pre-existing trend. For example, suppose that, relative to other boroughs (or counties), the North Slope borough gained employment throughout the entire sample period. In this case, β would be positive and significant, but not because of the oil boom. To address this concern, we estimate an additional model that allows the treatment effect to vary from one year to another. We specifically estimate equation (2) below:

$$\ln(Y_{i,t}) = \gamma + \sum_{2002}^{2013} \beta_t(Z_t \times D_i) + Z_t + C_i + \epsilon_{i,t}, \tag{2}$$

where all variables are defined as before. Note that now the indicator variable, D_i, is interacted with year fixed effects and the reference year is 2001. The interpretation of β_t is similar to before, but now it reveals the treatment effect in year t, relative to the treatment effect in the year 2001. Estimating equation (2) allows us to not only test whether the treatment effect was relatively high at the end of the sample period, but whether the treatment effect indeed rises in tandem with the timing of the oil boom.

6 Results

Table 1 describes the results from the estimation of equation (1) for total employment and the average wage rate. The first two columns under the heading, "Place of Work" correspond to BEA data that describes outcomes of employees regardless of where people live. A person that, for example, works temporarily in the North Slope borough but lives in neighboring Northwest Arctic borough would be counted as an employee of the North Slope borough. The last two columns correspond to the ALARI data which describes employment outcomes by place of residence, regardless of employment location.

Starting with the BEA data (the first two columns of Table 1), and defining the outcome variable, $Y_{i,t}$ as total employment, the coefficient on the interaction $D_i \times \text{Post}_t$ is 0.310 and significant at the 1% confidence level. This suggests that, relative to the pre-treatment period (2001-2005), the North Slope borough had 31% more employees than the average control borough. Put differently, the oil price boom generated a 31% increase in total employment in the North Slope borough. While the treatment effect for the average wage rate is positive (0.008), it is imprecisely estimated, and is ultimately insignificantly different from zero. These findings are broadly consistent with a now sizable literature that finds that population, employment, and wages rise in response to positive natural-resource shocks.

Of course these results alone provide little evidence that the residents of the North Slope Borough necessarily benefited from enhanced employment opportunities. It may very well be the case that the observed increase in employment reflects inward migration. To start to answer this question, we turn our attention to the last two columns of Table 1. The treatment effect for both total employment and the average wage are negative and significant at the 1% confidence level. Considered in isolation, this suggests that the oil boom resulted in fewer employment opportunities and lower wages for residents of the North Slope. Further analysis discussed below however suggests that this reflects a negative pre-existing trend, and is not a result of the oil-price shock.

To better understand the effect of the oil boom on local residents, we additionally define $Y_{i,t}$ from equation (1) as: 1) the percent of income earners making more than \$50,000 per year, 2) total unemployment claimants, and 3) total new hires. These additional results are provided in Table 2. The treatment effect for unemployment claimants is negative (-0.271) and highly significant, suggesting that the oil boom decreased unemployment for local residents. Similarly, the treatment effect for new hires is positive (0.116) and significant. Because the outcome variables are log-normalized, these results imply that, averaged from 2006-2013, the oil-price shock resulted in a 27.1% decrease in unemployment claimants and an 11.6% increase in new hires of local residents. In contrast though, the treatment effect for the percent of income earners making more than \$50,000 per year is negative and significant. Though as with the "Place of Residence" results descried Table 1, and as discussed below, this result is largely due to pre-existing trend.

For greater insight and detail, and to reveal any preexisting trends, we turn our attention towards Figure 2 which describes the results from various estimations of equation (2). Starting with panel (a), there does not appear to be significant preexisting trend for total employment by place of work. The treatment effect is approximately zero up until 2005, at which time it begins to rise. The treatment effect is maximized around 2007 at approximately 0.35, suggesting the oil price boom resulted in a 35% increase in employment in the North Slope by the mid 2000s. Interestingly, the treatment effect remains close to 35% for the remainder of the sample period, suggesting the oil price boom may have enhanced employment even in the medium to long run. Panel (b) of Figure 2 describes the results for employment by place of residence. While the treatment effect indeed rises from 2005-2010, there was pre-existing negative trend, rendering the treatment effect negative and significant for all years. Similar results are found for average wages of both residents and workers (panels c and d). This explains the seemingly confounding results from Table 1; the positive oil-price shock did not depress labor market outcomes for local residents. Rather, the oil boom reversed a trend in the North Slope borough towards less employment and lower wages for residents and migrants.

We also estimate equation (2) for the three additional outcomes for local residents: the percent of the labor force earning at least $50,000 per year, unemployment claimants, and the number of new hires. Referencing panel (a) of Figure 3, and similar to the previous results, there was significant negative pre-existing trend for the percent of income earners earning at least $50,000 per year. However, this trend was reversed as the price of oil boomed. We also document a significant reduction in unemployment claimants, and an increase in new hires that both occur from 2005-2008.

Preexisting trend makes it difficult to determine whether the observed effects (e.g., those from Figure 3) of the oil-price boom were statistically significant. The relevant counterfactual is no longer an outcome measured in the year 2001. Rather, the appropriate counterfactual is the outcome that would have existed at time t, if preexisting trends had continued unadulterated. To gauge whether the observed changes in trend were significant, we estimate a final model in which the dependent variable is the year on year change in an outcome. More specifically, we estimate equation 3 below:

$$\Delta Y_{i,t} = \lambda + \sum_{2003}^{2013} \lambda_t (Z_t \times D_i) + Z_t + C_i + \epsilon_{i,t}, \tag{3}$$

where all variables are defined as before and $\Delta Y_{i,t}$ refers to the percent change in outcome variable Y from time period $t-1$ to t. As such, λ_t, the coefficient on the interaction term, is estimated for the years 2003-2013, rather than from 2002-2013. The estimated treatment effects are given in Figures 4 and 5. Panel (a) of Figure 4 reveals a clear increase in the growth rate of employment by place of work that coincides with the timing of the oil-price shock. Similar results are documented for total employment by place of residence (panel b).

The treatment effects for the average wage rate (defined both by place of work and place of residence) clearly increase over the sample period. However, the treatment effects rise over the entire sample period (even before the oil-price shock). This makes it difficult to assign all of the variation in the treatment effects to the oil-price shock.

Recall that from panel (a) of Figure 3, there was preexisting negative trend in the percent of income earners earning at least $50,000 per year. But there is clear evidence that the oil-price shock reversed this trend. From panel (a) of Figure 5, we show that this change in trend was statistically significant. In fact, the oil-price boom increased the growth rate of the percent of income earners earning at least $50,000 per year, by more than 10% by the late 2000s. From panel (c) of Figure 5, we also find that the growth rate of new hires was roughly constant over the sample period with the exception of 2006 at which point there was a 10% increase in the rate at which new hires were being made.

In general, a newly created job will be filled by either a new entrant to the labor force, a previously unemployed person, a commuter, or a migrant. Ignoring general equilibrium effects, policy makers may be most interested in creating jobs for existing residents (the first two categories) given that those groups are constituents and are most likely to spend their income locally. Our employment by place of residence data set allows us to generate estimates net of the jobs flowing to commuters (two week shift workers). However, given that residence is established after a year in the state, we may be counting some newly arrived individuals as residents which means that our POR estimates are upper bounds. However, the remoteness and climate of the area make the scale of in-migration very small. In most of the lower 48 communities that have benefited from the recent shale-oil boom, greater labor mobility implies that the local benefits are even smaller than the ones we document in this paper.

7 Concluding Remarks

There is now a large literature documenting the short run economic effects of various types of resource booms. But this existing research has primarily focused on the overall effects of resource booms and does not distinguish between the experience of local residents, and that of temporary workers. From a policy perspective, understanding how the residents of a community will be affected by a resource boom is clearly important.

To estimate how residents are affected by an energy boom, we make use of a unique Alaskan data set that defines economic outcomes based off of individuals' place of residents (POR), rather than their place of work (POW). Specifically, we study how residents of the oil-rich North Slope borough in Alaska were affected during the surge in oil prices that occured in the mid 2000s. We juxtapose these findings with a more conventional analysis of POW (BEA) data. Using BEA data, we find that the oil boom increased employmenet and wages. While we find similar results for the POR data, these estimates are roughly half as large in magnitude. We therefore conclude that estimating the economic impact of resource booms on residents using BEA or BLS data may be invalid.

The policy implications of are findings are clear, though we acknowledge that any Alaskan experience may be unique and that concerns of external validity may be warranted. We hope that this paper will motivate additional research that will help policy makers better understand how regional resource booms affect the residents of impacted areas.

8 References

Alaska Oil and Gas Association (AOGA). "Get the facts, Oil and Gas is Alaska's Future". Information material distributed during the Anchorage Chamber of Commerce, Make it Monday Forum. June 27, 2005.

Aragón, F.M., and Rud, J.P. (2013). Natural resources and local communities: evidence from a Peruvian gold mine. *American Economic Journal: Economic Policy*, 5(2), 1-25.

Bridge, G. (2008). Global production networks and the extractive sector: Governing resource-based development. *Journal of Economic Geography*, 8, 389-419.

Caselli, F. and Michaels, G. (2013). Do oil windfalls improve living standards? Evidence from a Brazil. *American Economic Journal: Applied Economics*, 5(1), 208-238.

Harcharek, B. Critique of North Slope Economy: 1965 to the Present (Draft), Northern Economics, Inc., Anchorage, AK. Prepared for MMS, Alaska OCS Region. January 2004.

Jacobsen, G.D., and Dominic Parker. (2016). The economic aftermath of resource booms: evidence from boomtowns in the American West. *The Economic Journal*, 126(593), 1092-1128.

James, Alexander. (2016). The long run vanity of Prudhoe Bay. *Resources Policy*, 50, 270-275.

James, Alexander, and Brock Smith. (2017). There will be blood: crime rates in shale-rich U.S. counties. *Journal of Environmental Economics and Management*, 84, 125-152.

Kilkenny, M., Partridge, M.D. (2009). Export sectors and rural development. *American Journal of Agricultural Economics*, 91(4), 910-927.

Knapp, G. and Will Knebesky. (1983). Economic and Demographic Systems Analysis, North Slope Borough, Sale 85. Institute for Social and Economic Research, Anchorage, Alaska.

Komarek, T. (2016). Labor market dynamics and the unconventional natural gas boom: Evidence from the marcellus region. *Resource and Energy Economics*, 45, 1-17.

Michaels, Guy. (2011). The long term consequences of resource-based specialisation. *The Economic Journal*, 121(551), 31-57.

Moretti, E. (2010). Local Multipliers. *American Economic Reivew*, 100(2), 373-377.

Munasib, A., and Rickman, D. (2015). Regional economic impacts of the shale gas and tight oil boom: A synthetic control analysis. *Regional Science and Urban Economics*, 50, 1-17.

Paredes D., Komarek, T. and Loveridge, S. (2015). Income and employment effects of shale gas extraction windfalls: Evidence from the Marcellus region. *Energy Economics*, 47, 112-120.

Smith, Brock. (2015). The resource curse exorcised: Evidence from a panel of countries. *Journal of Development Economics*, 116, 57-73.

Van der Ploeg, F. (2011). Natural resources: Curse or blessing? *Journal of Economic Literature*, 49(2), 366-420.

Weber, Jeremy G. (2014). A decade of natural gas development: The makings of a resource curse? *Resource and Energy Economics*, 37, 168-183.

Weber, Jeremy G. (2012). The effects of a natural gas boom on employment and income in Colorado, Texas, and Wyoming. *Energy Economics*, 34(5), 1580-1588.

9 Appendix

Table 1: Employment and Average Wage: Equation (1)

	Place of Work		Place of Residence	
	Employment	Wage	Employment	Wage
$D_i \times \text{Post}_t$	0.310***	0.008	-0.037**	-0.093***
	(0.037)	(0.015)	(0.017)	(0.009)
R^2	.993	.963	0.99	.982
N	299	299	299	299

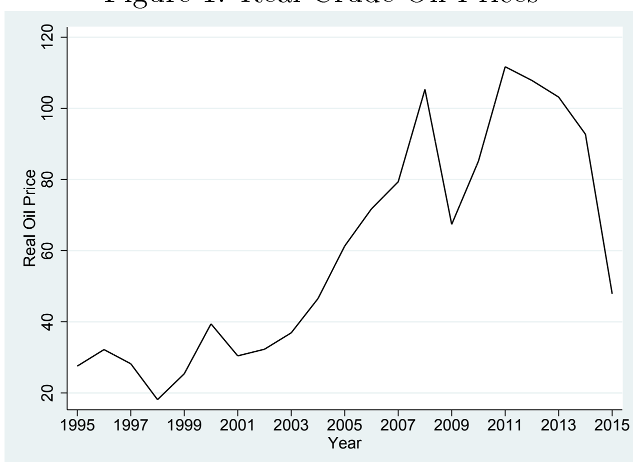
Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. The dependent variables are shown in the column headers. Standard errors (clustered at the county level) are given in parenthesis below the estimated coefficients. Year and state fixed effects are included in all regressions.

Table 2: Additional Outcomes by Place of Residence: Equation (1)

	Wage 50k +	Unemp. Claimants	New Hires
$D_i \times \text{Post}_t$	-0.279***	-0.271***	0.116***
	(0.037)	(0.033)	(0.022)
R^2	.997	.994	.998
N	299	299	276

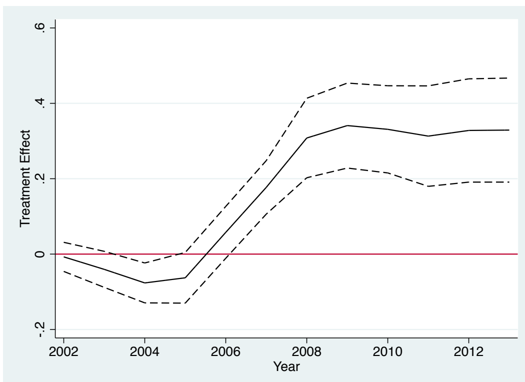
Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. The dependent variables are shown in the column headers. Standard errors (clustered at the county level) are given in parenthesis below the estimated coefficients. Year and state fixed effects are included in all regressions.

Figure 1: Real Crude Oil Prices

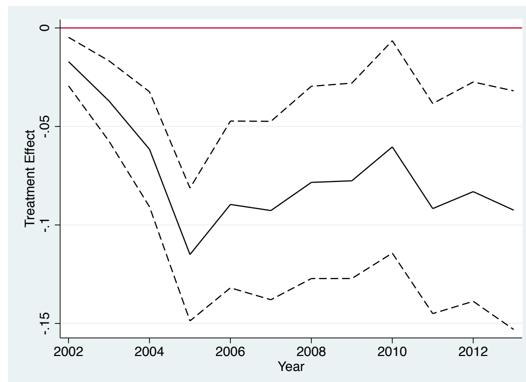


Note: Prices are real and 2017 is the base year.

Figure 2: Employment and Average Wage: Equation (2)

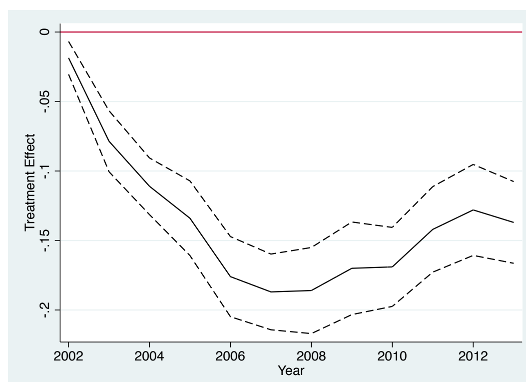


(a) Employment By Place of Work



(b) Employment by Place of Res.

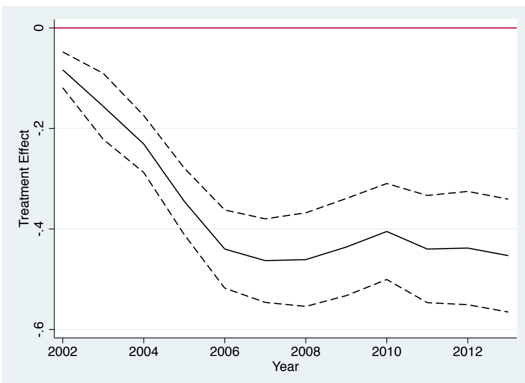
(c) Wage by Place of Work



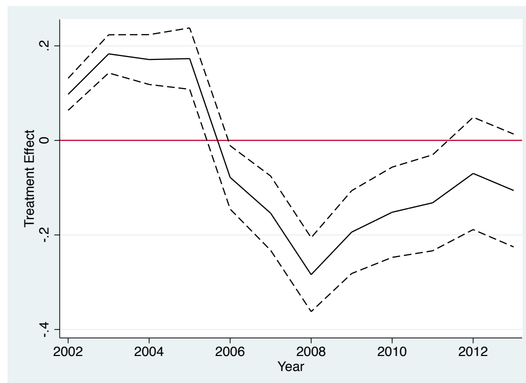
(d) Wage by Place of Res.

Note: 95% confidence intervals are given. The solid line in each diagram describes the annual treatment effect estimated from equation (2).

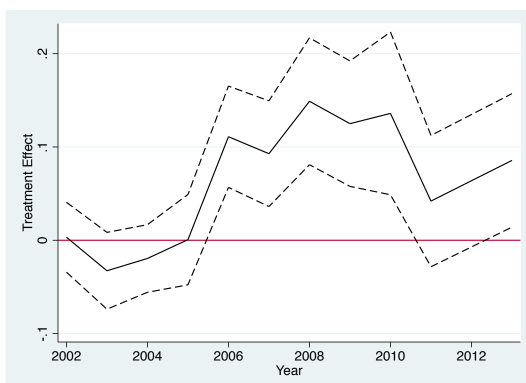
Figure 3: Additional Outcomes by Place of Residence: Equation (2)



(a) % of Labor Earning >50k Per Year?



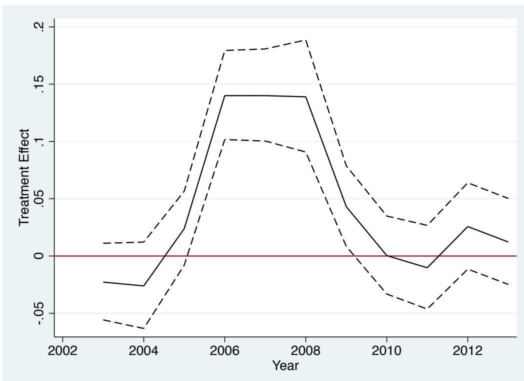
(b) Unemployment Claimants



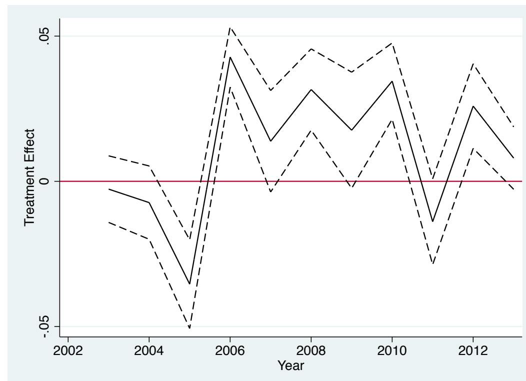
(c) New Hires

Note: 95% confidence intervals are given. The solid line in each diagram describes the annual treatment effect estimated from equation (2).

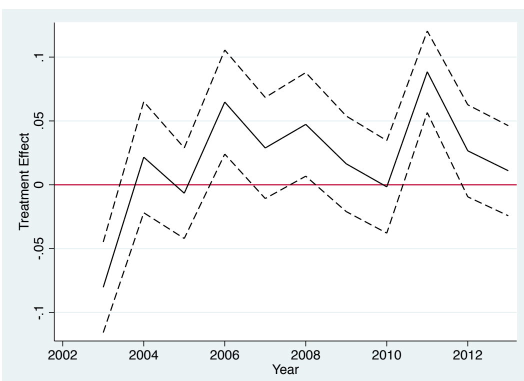
Figure 4: Employment and Average Wage: Equation (3)



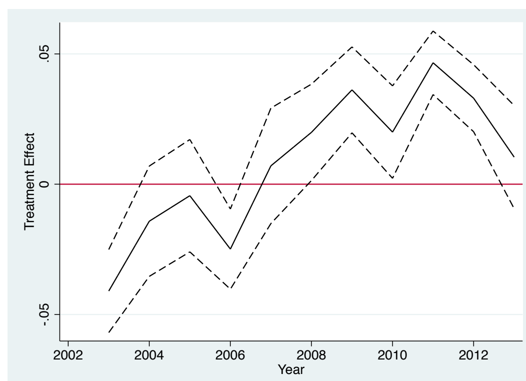
(a) Employment By Place of Work



(b) Employment by Place of Res.



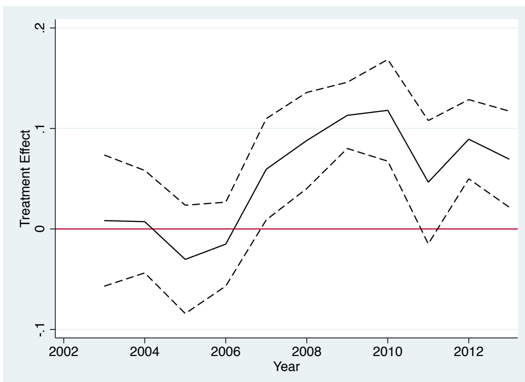
(c) Wage by Place of Work



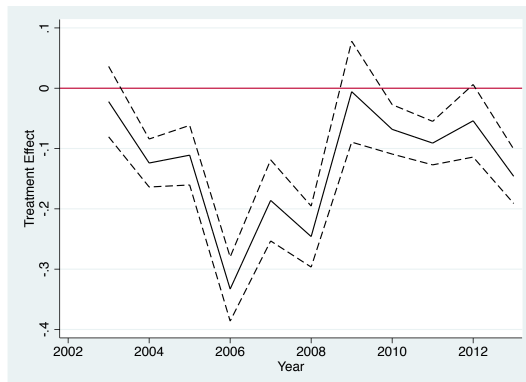
(d) Wage by Place of Res.

Note: 95% confidence intervals are given. The solid line in each diagram describes the annual treatment effect estimated from equation (3). All dependent variables are first differenced. For example, the outcome variable in panel (a) in the year 2003 is the percent change in employment by place of work from 2002 to 2003.

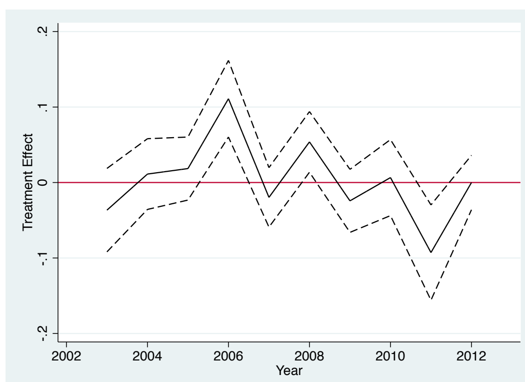
Figure 5: Additional Outcomes by Place of Residence: Equation (3)



(a) % of Labor Earning >50k Per Year?



(b) Unemployment Claimants



(c) New Hires

Note: 95% confidence intervals are given. The solid line in each diagram describes the annual treatment effect estimated from equation (3). All dependent variables are first differenced. For example, the outcome variable in panel (c) in the year 2003 is the percent change in new hires by place of residence from 2002 to 2003.