College or the Oil Boom?

By
Axel S. Urie
Department of Economics, University of Colorado at Boulder

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Thesis Advisor:
Jonathan Hughes, Department of Economics

Committee Members:
Jonathan Hughes, Department of Economics
Martin Boileau, Department of Economics
Paul Strom, Honors Program

Abstract

In this paper I examine the impact of the current boom in oil and gas production on the labor markets within Arkansas, Colorado, Kansas, Louisiana, Maryland, Montana, North Dakota, Nebraska, New Mexico, New York, Ohio, Pennsylvania, Texas, West Virginia, and Wyoming. I am primarily interested in two main questions throughout the study. What has been the overall economic effect of the shocks by the oil and gas sector? How did these effects differ between industries mainly requiring a degree and non-degree industries? I have found evidence of an overall increase of employment and wages, with the difference in earnings per worker between non-degree and degree sectors decreasing during the oil boom.

1. Introduction

This paper examines the effect of the most recent boom in oil production in the United States on the wage differential between university degree jobs and non-university degree jobs. The shale revolution, caused by the new viability of hydraulic fracturing, along with the high price of oil in from 2010 to 2013 has allowed for massive development in oil production in places such as North Dakota. The Great Recession, low oil price period immediately before the boom, and the clear advance in hydraulic fracturing technology allow for a natural experiment comparing counties before and during the boom.

The oil boom effected most counties containing oil and gas formations in the United States but the hallmark of this most recent boom has been the opening of new frontiers in previously untapped areas such as western North Dakota and the return of production to states like Pennsylvania. By comparing counties with large oil and gas production to counties nearby without the presence of oil and gas I am able to measure the effect of the boom on a variety of economic indicators. Further, by narrowing my focus in the difference in earnings between non-degree and degree industries I can distinguish if the boom had any effect on the returns to a college degree. In doing so I am addressing two questions: How did the oil boom affect the economies of a county? If there was an effect, did the return to non-degree jobs increase relative to that of degree jobs? The lack of workers in an area coupled with a strong labor demand will inevitably push up wages. Generally this effect is countered by migration: high wages attract more workers and everything equals out in the end. However, the past decade has also seen a large decline in the willingness of the American worker to migrate. If the demand for workers in the non-degree sector of the labor force increases at a faster rate than for the degree sector this could decrease the incentive to enter university.

My results indicate there is an effect of the boom on the difference in earnings per worker between degree and non-degree industries. Before the boom, the difference in earnings per worker in degree and non-degree industries was relatively the same between boom and non-boom counties. During the boom, the difference in oil counties increased 5.6 % less than in the control group.

The magnitude of this difference in large part depends on employment keeping up with wages. As we see large increase in both the demand for is probably not being met, even by migration into the area. I find evidence that the total earnings of a county and the total employment of a county did not increase in a proportional fashion as wages per worker increased as well.

In section 2 I review the current literature on the subject. Section 3 describes the oil boom and Section 4 presents the methodology for my study with associated findings. In section 5 I present a brief summary and concluding remarks.

2. Literature Review

I. Natural Resource Booms

A rough guide for my study is the research done by Black, McKinnish, and Sanders (2005) in "The Economic Impact of the Coal Boom and Bust." The authors quantify and contrast the effects of the coal boom in the 1970s to the bust in the 1980s. The study carefully establishes a group of treatment counties containing large deposits of coal to be compared with otherwise similar control counties without coal deposits. The main relevance of the study is the analysis of the change in the labor markets which showed a large net migration to the area during the boom. Their concern is with the effect on industrial production, but the regression they develop (admittedly a common regression) is adapted to compare the difference in wages across education levels across counties.

Connected to my question is the movement of labor across the United States in response to an exogenous shock. Carrington (1996), in his analysis of the effect of the Alaskan pipeline, found that the local climate could potentially have a large effect on migration to the area in question. He posits that the extreme weather in Alaska effectively hampered individuals' will to move there even when facing a very high wage premium compared to the rest of the country. Along these lines are some of the observations of labor movement in the Black *et al* (2005). study on the effect of the coal boom. This is relevant because many of the shale boom areas currently are located where the climate is not very hospitable. Accordingly, in my examination I keep the effects of climate in mind when comparing wage differentials between the oil boom counties in North Dakota, a bitterly cold place in the winter, and Texas, a relatively warm place year round.

Additionally, Carrington (1996) found that Alaskan wages are very flexible and that labor supply during the building of the Alaskan pipeline was relatively elastic both in number of hours worked and in overall supply of workers. These effects, according to Carrington (1996), could be a function of the overall make-up of the Alaskan economy which is accustomed to large seasonal shifts in the supply of labor. In their study on the effect of exogenous shocks to spending on welfare; Black, McKinnish, and Sanders (2005) found similar results in the steel and coal industries. A large exogenous shock related to coal and steel booms translated into an increase in wages of about 10% and an overall decrease in those seeking welfare. The opposite was true during the bust for coal mining areas. However, this lack of wage stickiness is important to consider because it may effect a person's considerations of future earnings. Bean (1988), examining the North Sea development in England, found evidence of real wage rigidity due to an oil boom in the short term even during a recession if the oil revenue is distributed in a way to

alleviate pressures on wages elsewhere. With no guarantee of wages staying high in the long run, laborers may be more likely to discount work in the oilfield compared to perceived stable wages associated with a college degree.

II. The Returns to a College Degree

Card (1999) provides a comprehensive survey of the current literature as well as the basic framework for studying the returns to a college degree. The driving question throughout most studies revolves around whether a college degree leads to higher earnings or people who would earn higher earnings self-select to go to university. Card (1999) also provides a useful explanation of the tools used to examine this relationship, primarily Mincer's human capital earnings function and a model of the return to years of schooling derived from there.

Two factors brought forth in the literature applicable to my study are the effects of quality of school as well as the value of a degree. Card and Krueger (1992) examine the quality of education among a cohort and then examine their earnings as adults and found better school quality increased earning potential. Angrist and Krueger's (1990) research on compulsory school attendance also extends this increase of returns to years of mandatory schooling finding that more compulsory years of education leads to higher expected earning later in life. Kane and Rouse (1993) examined the effect of each year of education from college and found that for both two and four year institutions each additional year of education increased earnings by an average of 5% compared to people with only a high school degree. This is in stark contrast to a study conducted by Belman and Heywood (1991) found little effect on earnings from years of college and instead found evidence of a sheepskin effect or that the signal of productivity provided by a college degree is much more valuable than the actual amount of time spent in university.

III. Oil Booms and the Returns to Education

As mentioned above little research has been published on the interaction between oil booms and the returns to a college degree. A highly related study on the effects of the Norwegian oil boom in the 70s compared counties affected by the boom to those which were not. Løken (2010) tests whether the causal mechanisms studied in this paper are reversed. Namely, did the increased income from the oil boom increase the education of children in the oil area? The study found little evidence for this after controlling for parent education and ability. In the United States Cruz, Smith, and Stanley (2014) from the Bureau of Labor Statistics consider the differences in employment and wages across the United States between oil, oil-related workers and workers unaffiliated with the oil and gas industry. They found a large increase in pay for the oil and gas related workers as well as large increases in employment for the period 2007-2012. In addition, while employment in the oil and gas related industries is generally larger, employment in the oil industry is generally more stable.

The cause of oil shocks is also important because it could be correlated with increased demand for college educated workers elsewhere. For the most part the literature by Friedman (1992), Hamilton (2009), Kilian (2009), Gronwald (2008), and Singleton (2013) all confirm that shocks to oil prices are factors of both crude oil supply side changes and changes in demand from consumers. Hamilton (2009), Gronwald (2008), and Kilian (2009) all separately point towards demand as the main long run driver of the price of oil and oil products. The Friedman (1992) study focuses on the change in productivity of oil and gas production in the United States, finding a rather sharp decline from 1972-1982. It is important to note the study was published before the recent gains in productivity from the shale gas revolution. The Kilian (2009) study also notes that a long run driver of price could be speculation on the future price of oil. All of these studies help frame the consideration an actor needs to make about future wage growth

when deciding whether to enter the oil workforce or university. For example, if actors know the price of oil has been propped up by speculators, they may be less willing to take the risk of losing future wages to a bust and instead enter university.

Hefner (2014) and Fetzer (2014) examine the current shale boom in America and also explain why a similar boom has not occurred on a global scale. Hefner (2014) is quick to note that a relatively large amount of smaller oil and gas extraction companies in the United States has increased the incentive to innovate. Further, he describes a friendly combination of unrestricting legislation and widespread private land rights as a large driver of the recent upswings in production. Fetzer (2014), on an attached website, provides an interactive map that charts the areas where shale oil and gas production occurs. Unsurprisingly this follows closely the underlying shale formations but the map proved invaluable when choosing treatment and control areas.

3. The Oil Boom

This section will describe the most recent oil boom, defined here as occurring between 2010 and 2015. My analysis will focus on the states of Arkansas, Colorado, Kansas, Louisiana, Maryland, Montana, North Dakota, Nebraska, New Mexico, New York, Ohio, Pennsylvania, Texas, West Virginia, and Wyoming, all of which contain counties which accounted for a large proportion of the recent growth in oil and gas production. The real price of oil experienced a steady rise from 2000 to about 2009 at which point a large, sudden decrease in real price created a mini-depression[1]; This is largely attributed to the recession. The real price quickly rebounded,

[1] US Energy and Information Administration Calculations. Real Petroleum Prices are computed by dividing the nominal price in a given month by the ratio of the Consumer Price Index (CPI) in that month to the CPI in some "base" period.

however, with a real increase in the prices of oil of about 60% between 2009 and 2011. Figure 1 plots the nominal and real price of coal to demonstrate this shock.

In Figure 2, I present a plot of rig count in the United States. Using the rig count to define the boom is advantageous because an increase in rig count generally indicates new production in both oil and gas[2]. The graph shows a steady number of wells in the United States between 2005 and 2008, with a slight increase going into 2008 followed by a decrease mainly attributed to the recession. In 2009 a large increase in the number of U.S. oil rigs occurred as the advance in shale fracturing technology opened up previously untenable fields of production. Between 2009 and 2013 the number of operating oil rigs increased by more than one hundred fold. Of this new production, the majority took place in the states under analysis here. Figure 3 presents the counties contributing to this growth, while figure 4 presents the large shale gas fields in the United States. Fitting intuition, the producing counties mostly line up with areas of large shale oil and gas reserves.

The strategy is to use the growth in oil rigs during the 2010 to 2013 period as a 'boom' period with the 2006 to 2009 as the pre-boom period. Presumably, at the time of writing the oil boom has ended. It would be beneficial to analyze the post-boom period, but as no data is available for the current period-- in fact the REIS data is only available up to 2013-- this research will need to be conducted at a future date. If the growth in wages and employment in the oil producing counties is larger than in the non-producing counties during the oil boom I interpret this as evidence of the positive effects on growth of the oil boom. Furthermore, if the growth in the difference between non-degree industries and degree industries in counties with oil during the boom is larger than in the non-oil counties, I take this as evidence of a change in the wage

[2] As opposed to a level number of rigs which could be new production or servicing of old wells.

incentive; effectively, the wage incentive becomes more favorable to forgo the opportunity cost of college compared to non-oil counties.

4. Methodology

4.1 Testing for the Associated Effects of the Boom

This section highlights the associated effects of the oil boom. The counties used will be those which made up 95% of the growth in oil and gas production between 2011 and 2013. The sample includes 286 counties in 15 states: Two in Arkansas, 21 in Colorado, 2 in Kansas, 10 in Louisiana, 2 in Maryland, 5 in Montana, 4 in Nebraska, 4 in New Mexico, 10 in New York, 15 in North Dakota, 20 in Ohio, 36 in Pennsylvania, 92 counties in Texas, 52 in West Virginia, and 11 in Wyoming. The appendix lists the counties used. Throughout the study I refer to these counties as treatment counties because they experienced a large shock during the boom period.

Using data from the Regional Economic Information System (REIS) provided by the Bureau of Economic Analysis (BEA) I measure the direct effect of the boom on the treatment counties. This data incorporates earnings and employment by industry sector and county. The BEA computes these measures using employer reports of wage and salary disbursement on tax forms. I do not weight the data to account for the differential size of counties in order to treat each county as a separate observation for the purposes of the experiment.

In Table 1, I measure the size of the boom in the treatment counties by calculating the average annual change in the logarithm of overall employment and real per-capita income for the pre-boom (2006-2009) and boom (2010-2013) periods. During the pre-boom, total employment grew an average of 0.93 % per year and real per capita income grew 2.12 % a year on average.[3] During the boom, total employment grew on average 2.1 % and real per capita income grew by

[3] The difference in logarithms interpreted here as percentage change. Additionally, all dollar figures are in 2013 USD.

3.12 %. The increase in both employment and income is large. In this instance, at 3.12 % the real per capita income would almost grow by half in 11 years.

To conduct this experiment correctly and be able to attribute the observed changes in the oil counties to the actual oil boom I developed a set of comparison or "control" counties. The control group requires a similar set of counties by population. The treatment counties range in population from 75 to almost 530,000 people with an average population of 52,000[4]. Many of these counties have low levels of earnings from oil and gas production. Ideally any county with any kind of production in oil and gas would be excluded from the study. This would leave a very small control group. This will, in the end, bias the results of the study but by a smaller margin then one might expect for two reasons. First, the boom under consideration is largely being driven by a change in the supply side capabilities. Unlike an exogenous demand shock which would affect all counties with the ability to produce oil, this boom mainly applies to those counties where the advance in technology is most applicable. Second, as mentioned previously, 95% of the growth in oil and gas production between 2011 and 2013 occurred in the treatment counties. It should follow that boom by and large mostly affected the treatment counties. The resulting comparison group is made up of 786 counties: 73 in Arkansas, 40 in Colorado, 102 in Kansas, 53 in Louisiana, 17 in Maryland, 50 in Montana, 89 in Nebraska, 27 in New Mexico, 43 in New York, 37 in North Dakota, 63 in Ohio, 21 in Pennsylvania, 157 in Texas, 2 in West Virginia, and 12 in Wyoming. These counties are within the same states as the treatment counties and are presumably under the same state, regional, and country-wide influences and laws. Figure 5 compares mean population, total earnings, and total employment between treatment and control counties during the pre-boom period. Both sets of counties are approximately the same on all levels. Since the area of observation is so widespread across the United States special care

[4] This is after removing the two large outliers with a population of almost 1 million in Allegheny, PA, and Erie, NY.

will be taken in controlling for state effects. A list of the control counties can also be found in Appendix A.

Figure 6 maps the treatment and control counties on a map of the United States. The majority of the control counties are in states with fewer "boom" counties such as Arkansas, Kansas, and Nebraska. Gaps between the control and treatment counties are generally counties containing large cities.

In Tables 2 and 3 I estimate the difference in annual growth in total employment, and earnings per worker between comparison and treatment counties. The regression is as follows:

$$\Delta \ln(Y_{ist}) = \sum_{j=1}^{2} \beta (T_i * P_j) + (State_s * Year_t)\phi + \epsilon_{ist} \quad (1)$$

Where $\Delta \ln(Y_{ist}) = \ln(Y_{ist}) - \ln(Y_{ist-1})$ and Y_{it} is employment, real earnings or earnings per worker. for county *i* in state *s* at time *t*. T_i indicates treatment county. P_j indicates the time period (ie boom or pre-boom).β_1 and β_2 measure the difference in average earnings between treatment and control counties during pre-boom and boom. State and Year are state and year indicator variables which allow control for variances over time and at the state level.

The main benefit of using changes in growth rates is that counties can be compared regardless of size. Large counties will not be weighted more than small counties. Emphasizing growth rates also allows for recognition of trends over time which is easily comparable. In the case of a boom analyzing growth rates also gives a sense of an overall effect on large, widespread areas.

Unlike the earlier calculations, I use earnings per worker here instead of income per capita. Using the REIS data, earnings per worker is calculated by dividing the total number earnings by the total number of workers in a county. This may mask some differences within an industry, especially if a job within an industry experiences particularly high growth or there is

certain sector of worker prone to working longer hours. Though earnings per worker may be an imperfect measure of wages it will prove useful later when I analyze the differences between educated and non-educated industries.

On average the treatment counties experienced higher growth during the boom than the control counties. On average employment grew approximately .89% faster during the boom. Earnings experienced much more rapid growth, increasing approximately 2.5% faster on average during the boom. Earnings per worker also increased approximately 2.9 % faster on average during the boom which matches intuition as earnings grew faster than employment. As hypothesized, the demand for workers exceeded the supply. Another important factor to note here is differences from the pre-boom period. In the pre-boom period there is no statistically significant difference between treatment and control counties using any measure.

In order to test for robustness the treatment counties were limited to the 14 counties, 1 in Colorado, 10 in North Dakota, 2 in New Mexico, 7 in Texas, which produced almost half the oil produced in the United States in 2013[5]. After dropping all other counties considered treatment counties in the previous regression a set of 252 control counties were developed, mapped in Figure 6. These control counties were limited to the population range of the treatment counties, between 699 and 248,193 people. Both treatment and control counties are listed in Appendix A. Figure 5 shows the pre-boom means of population, total earnings, and total employment to slightly larger for treatment counties. Since the treatment counties are presumed to have been highly affected by the boom a stronger result should be expected.

In Table 4 I estimate the difference in annual growth in total employment, and earnings per worker using equation 1 and the new set of treatment and control counties. Before the boom the difference between the growth rates of employment, county total earnings, and earnings per

[5] Oil production information obtained from drillinginfo.com

worker is statistically insignificant. During the boom employment grew approximately 25.7% faster on average in treatment counties. County total earnings grew approximately 43.8% faster on average in treatment counties. Earnings per worker grew approximately 12.5% faster on average in the treatment counties. For the treatment counties the effects of the boom were quite large but behave as expected given the sample.

The different growth rates between the treatment and control counties could be solely from the growth in oil and gas production, an industry mainly comprised of non-degree jobs. The findings by Black *et. al.* (2003) suggest that during a boom the effects spread outwards to other industries. It is not implausible that the effects spread across many sectors, both those which mainly require a degree and those which do not. In the next section I examine how the oil boom affected the difference between degree and non-degree industries of the treatment counties and compare this to the difference in the control counties.

4.2 Testing for Differential Effects on Degree and Non-degree Industries

To further examine the effects of the oil boom I develop a set of industry indices which can roughly be classified as "degree" and "non-degree." Both are comprised of sets of industries as classified by the North American Industry Classification System (NAICS) and relevant data reported by the BEA in the REIS. Using the definitions of the NAICS code the set of non-degree industries contains "wholesale trade," "retail trade," "transportation and warehousing," "real estate, rental and insurance," "arts, entertainment, and recreation," "mining," "construction," "accommodation and food services." The degree industry set contains "finance and insurance," "information," "professional, scientific, and technological services," "management of companies," and "educational services." The definition of each industry is recorded in Appendix B.

The industry groups were developed from a combination of intuition and availability of data. From the definitions presented by the BEA of each industry clearly comprised of mostly skilled labor (degree) and unskilled labor (non-degree) were grouped together, respectively. Those with the most available observations were kept in each index. The result is a measure of the average composite change within the industry indices. Furthermore, using the industry indices will be an imperfect measure of the wage return to a college degree. Ideally, wages by job qualification would be examined but this data is not readily available.

Table 3 estimates the differences between treatment and control industries, between pre-boom and boom time periods, between boom counties and non-boom counties. This produces the following model:

$$\Delta \ln(Y_{ikst}) = \sum_{j=1}^{2} \beta(T_i * P_j * D_k) + (State_s * Year_t)\phi + \epsilon_{ist} \quad (2)$$

Where $\Delta \ln(Y_{ist}) = \ln(Y_{ist}) - \ln(Y_{ist\text{-}1})$ and Y_{it} is employment, real earnings or earnings per worker for industry index k in county i in state s at time t. T_i indicates treatment county. P_j indicates the time period (ie boom or pre-boom). D_k is a dummy variable indicating degree industry index. β_1 and β_2 measure the difference in average earnings between sector indices between treatment and control counties during pre-boom and boom. State and Year are state and year indicator variables which allow control for mean effects over time and at the state level. β_3 measures the difference in the average growth of the difference between degree and non-degree sectors, between control and treatment counties, during the pre-boom and boom periods.

Before the boom there is no statistical difference between treatment and control counties in the difference in growth in employment between degree industries and non-degree industries between counties. The same can be said for earnings per worker. Counterintuitively, the difference in the growth of total earnings between degree and non-degree industries grew

approximately 16.1% slower on average in treatment counties before the boom than in control counties during the boom. This suggests the underlying wages and employment combination in treatment and control counties was about the same before the boom but the earnings by industry were quite different. Conversely, during the boom there was little significance in the difference in earnings. The difference in employment between the degree index and non-degree index grew by approximately 5.9% less on average in the treatment counties than in the boom counties. Earnings per worker between degree and non-degree indices grew by approximately 8.7% less on average in the treatment counties than in the control counties. To be clear, these measurements only inform of the relative differences and not about overall growth rates. Of particular concern to this study is the figure on earnings per worker as this measure is the most closely related to the return to a college degree. Effectively, the oil boom brought degree and non-degree earnings per worker closer together relative to non-boom counties.

It is possible including the Mining sector in the non-degree industry index could overstate the effects of the oil boom. Many of the treatment counties, especially in West Virginia, Pennsylvania, Ohio, and Wyoming have large coal mining sectors. The effects of the oil boom could either be enhanced or biased downwards with the respective rise or fall in the price of coal. Because most of the jobs related to oil and gas extraction are included in the mining industry excluding mining from the "non-degree" index should decrease the magnitude of the results.

Table 7 reports the results of equation 2 without Mining included in the non-degree index. Excluding mining results in no statistically significant difference between the growth rates between industry indices between treatment and control counties before and after the boom. This could indicate the largest gains in the non-degree industry index were made in the mining industry during the boom.

5. Conclusion

This study analyzes the effects of the most recent oil boom across 15 states between 2010 and 2013. The effects of the boom on earnings per worker, employment, and total earnings in a county are positive and significant. In fact given the change in demand for workers during the oil boom, and specifically the demand for unskilled workers without a college degree, there is an expectation for the tightening of the gap between earnings per worker with a college degree and earnings per worker without a college degree. Indeed there is weak evidence for a tightening of the wage gap between degree and non-degree industries.

However tightening wage gaps may and probably does not change the overall incentive to go to college. College degree requiring jobs still pay a higher wage. Instead I can only speak to the relative strength of the incentive to obtain a university degree which decreases during an oil boom. Considering the opportunity cost of attending college, especially if a prospective student must go into debt, the appeal of the oil field becomes stronger. For many it may be worth the wait to earn oilfield wages after graduating high school and then to enter university without the specter of student debt over their head.

The main limitations of this study lay in the data and the selection of controls. Ideally no oil producing counties would be included in the control group. Some oil production in the control counties probably has a negative bias on the results. I would expect to see stronger effects of the boom in a sample where none of the control counties had earnings from oil and gas. Additionally, earnings per actual job would be much more informative than per worker earnings per industry. Future research would ideally be able to use such measures, especially as services such as payscale.com[6] grow their data sets.

[6] Payscale.com collects self reported information on job requirements, earnings, and employment. Data not used here as it is a relatively new service with few observations in the counties of interest.

The major contribution of my analysis to the literature is the added consideration of how a natural resource boom affects the relative earnings between industries. The overall effects of a boom on the economy of a county match the effects seen in the literature by Black *et. al* (2003) and Carrington (1996). An advantage to my study is the broad area under analysis. The effect of the boom is first analyzed at a very large and national scale bringing generalizability to the results. Refining the model to include a small number of the highest producing counties also shows the potential for very large effects to accrue to earnings, employment and earnings per worker during an oil boom. The results for the difference between degree and non-degree industries, though weak and dependent on the mining sector, also indicate the boom has differential effects on industry at a loosely defined educational level but is in line with the findings by Cruz, Smith, and Stanley (2014).

For the policy maker this study should highlight the drive to push students into college in the masses as well as the importance of affordable education. Especially pertinent may be the support of trade schools which would allow students to enter high paying oilfield jobs. These schools are generally low cost, much lower than a traditional four year university. Moreover, policies designed to encourage students to enter college at a later date, perhaps after saving for a couple of years at an oilfield wage, would be broadly beneficial. More workers entering the oilfield would eventually bring down wages and production costs. Those entering the oilfield near the start will be able to save money as a down-payment towards their degree. In a way such a plan would help the market reach equilibrium while also allowing students to be less reliant on debt to finance their education. Many young people are opting to start a family later in life which makes entering college at a later date a more realistic prospect as well. After the boom, providing

incentives for oilfield workers to attend university should also be a priority as oilfield workers generally only have oilfield skills.

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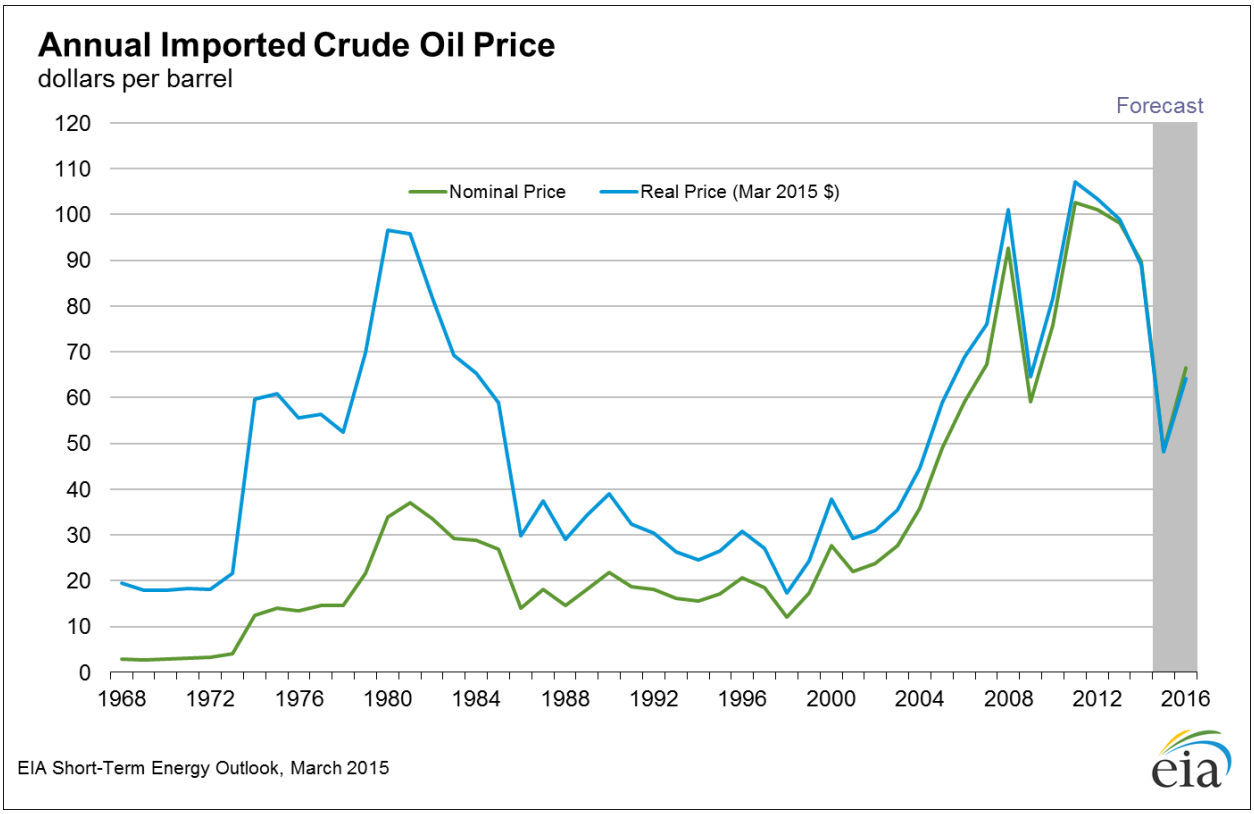
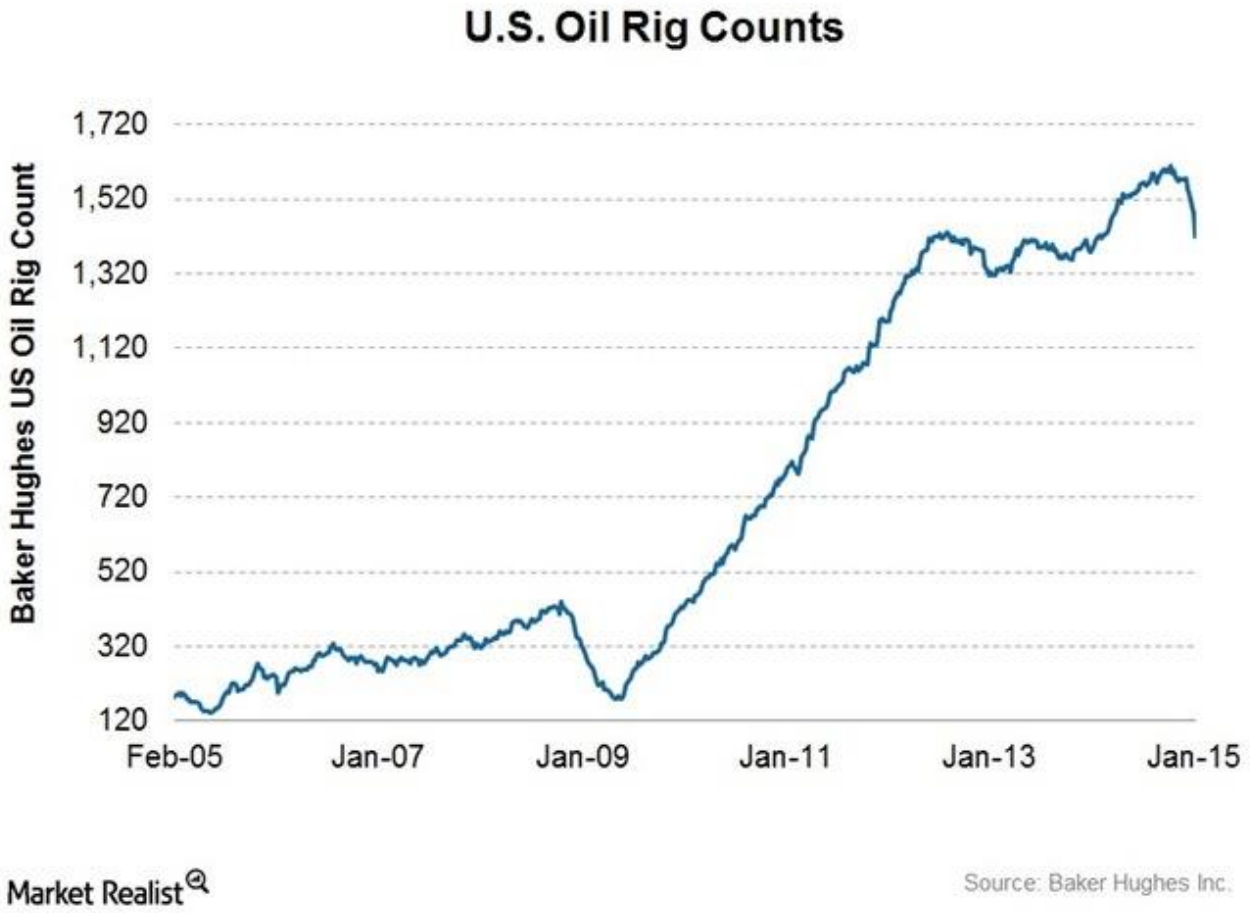
Figure 1: Real Price of Crude Oil

Dollars per barrel



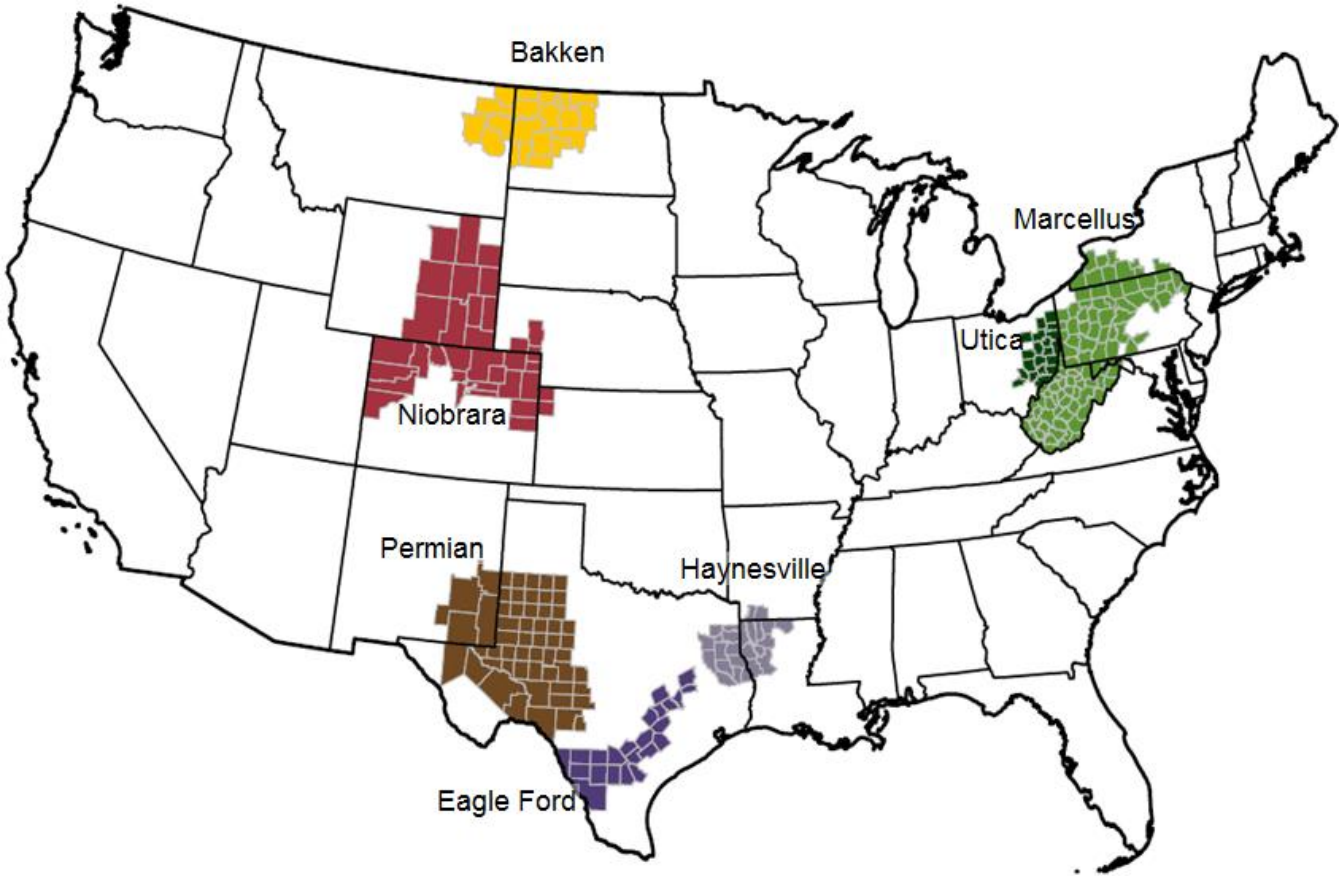
Notes: US Energy and Information Administration Calculations. Real Petroleum Prices are computed by dividing the nominal price in a given month by the ratio of the Consumer Price Index (CPI) in that month to the CPI in some "base" period.

Figure 2: U.S. Oil Rig Counts, 2005-2015



Notes: Calculated by Baker Hughes, an oilfield service company. Oil Rig count is actual.

Figure 3: Treatment Counties



Notes: Graph calculated and reported by the United States Energy Information Administration. Shaded counties comprised 95% of the growth in oil and natural gas production between 2011 and January 2013.

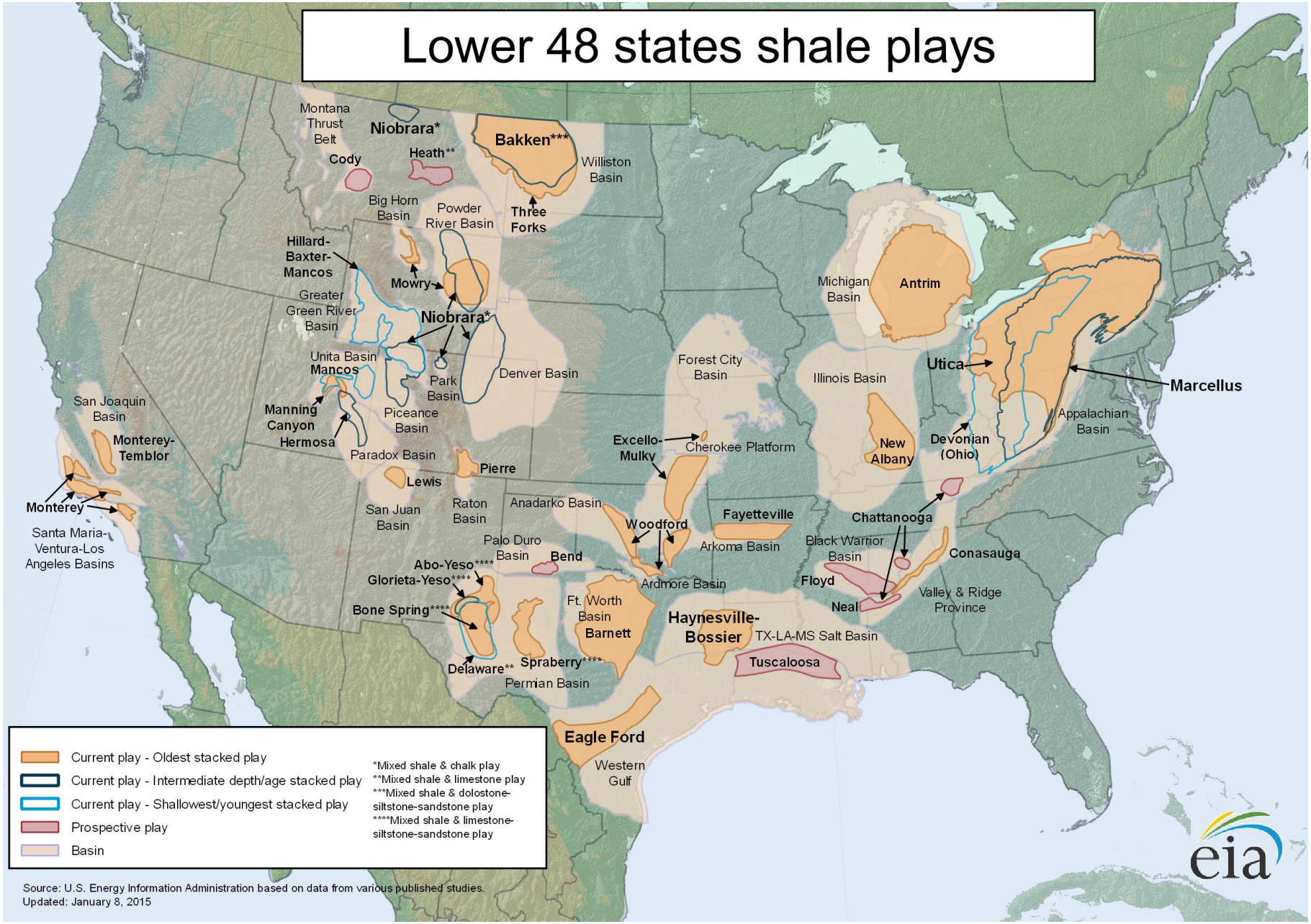


Figure 4: Major US Shale Plays, USEIA 2015

Figure 5: Observations of Treatment and Control Counties in the Pre-boom Period

Pre-boom Comparison of Treatment and Control Counties, 2006-2009

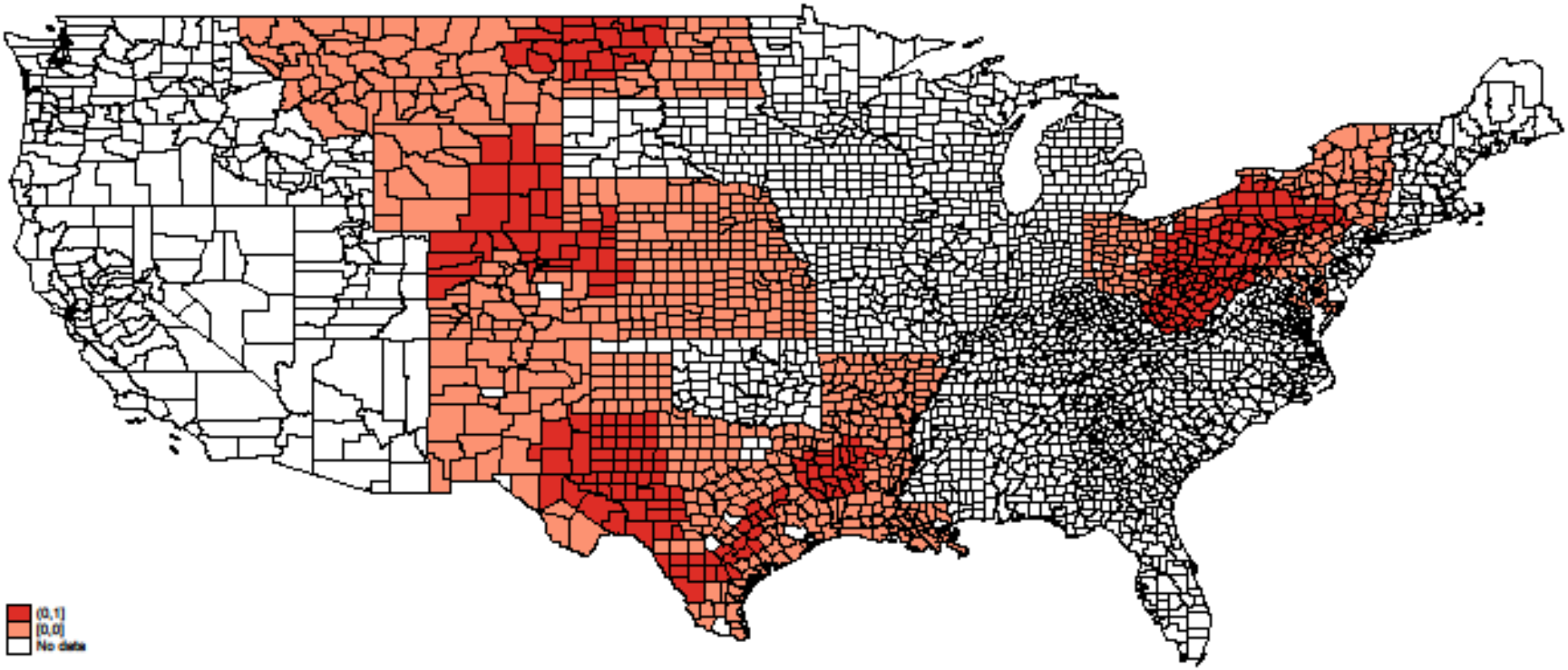
Variable	Treatment Mean*	Control Mean
Population	52663.19	50670.08
Earnings from Work ($)	1198889	1178919
Total Employment	1788661	1843578

*All calculations without outliers, Allegheny, PA and Erie, NY.

Pre-boom Robustness Comparison of Treatment and Control Counties, 2006-2009

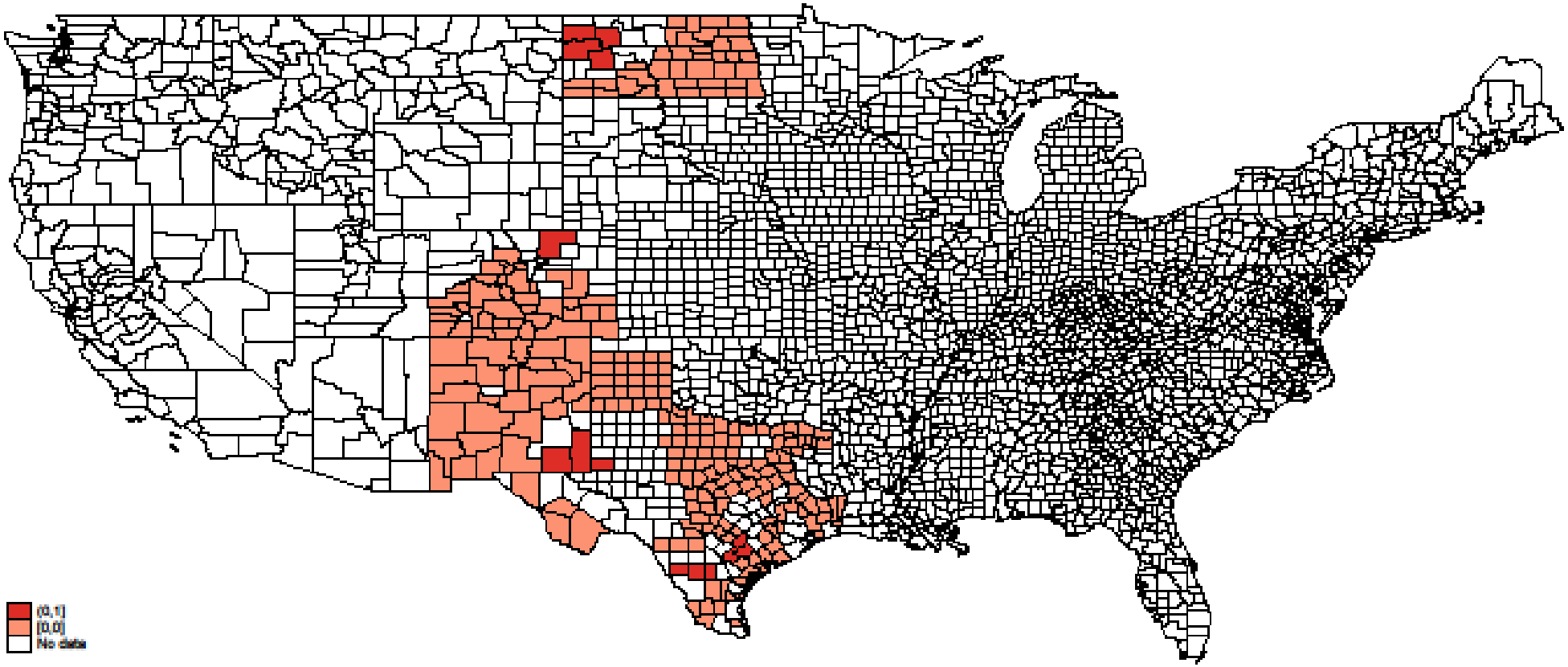
Variable	Treatment Mean	Control Mean
Population	34088.79	35768.72
Earnings from Work ($)	742249.7	537284.2
Total Employment	18051.09	15015.92

Figure 6: Map of Control and Treatment Counties



Author's Note: REIS data, computed using. Dark red indicates a treatment or "boom" county while light red indicates a control or "non-boom" county.

Figure 7: Map of Control and Treatment Counties, Robustness Check



Author's Note: REIS data. Dark red indicates a treatment or "boom" county while light red indicates a control or "non-boom" county.

Table 1: Growth in Employment and Per Capita Income; Treatment Counties, 2006-2013

Average Annual Growth in:	**Treatment** (oil area)
Total Employment (N=2288)	
Pre-Boom period, 2006-2009	0.0093
	(0.125)
Boom period, 2010-2013	0.021
	(0.126)
Per Capita Earnings (N=2288)	
Pre-Boom period, 2006-2009	0.0212
	(0.441)
Boom period, 2010-2013	0.0352
	(0.217)

Notes: Select results, REIS data. Table reports average annual differences in the logarithm of county total earnings and total employment. Standard errors, grouped by county, are reported in parentheses. There are 286 treatment counties, which made up 95% of the growth in oil and gas production between 2008 and 2015.

Table 2: Growth in Employment, Earnings and Earnings per Worker; Treatment and Comparison Counties, 2006-2013

Employment

	lnemp	lnemp	lnemp
boomcount	0.003	0.001	0.001
	(0.8)**	(0.04)	(0.04)
boomt	0.001	0.001	-0.001
	(0.57)	(0.57)	(0.90)
boomboom	0.009	0.009	0.009
	(4.43)**	(4.43)**	(4.41)**
year	N	Y	Y
state	N	N	Y
_cons	0.009	0.043	0.039
	(13.23)**	(20.34)**	(17.14)**
R^2	0.01	0.03	0.04
N	8,662	8,662	8,662

* $p<0.05$; ** $p<0.01$

Earnings

	lninc	lninc	lninc
boomcount	0.084	-0.001	-0.000
	(14.20)**	(0.07)	(0.06)
boomt	0.150	0.150	0.042
	(1.36)	(1.36)	(0.34)
boomboom	0.025	0.025	0.025
	(2.03)*	(2.03)*	(2.03)*
year	N	Y	Y
state	N	N	Y
_cons	12.8	12.6	12.5
	(2.282)**	(2.141)**	(1.259)**
R^2	0.00	0.00	0.01
N	8,662	8,662	8,662

* $p<0.05$; ** $p<0.01$

Earnings per worker

	lnearnemp	lnearnemp	lnearncemp
boomcount	0.024	-0.002	-0.002
	(2.19)**	(0.50)	(0.50)
boomt	0.048	0.041	0.048
	(2.84)**	(2.56)*	(2.84)**
boomboom	0.029	0.029	0.029
	(3.83)**	(3.82)**	(3.83)**
state	N	N	Y
year	N	Y	Y
_cons	3.4	3.3	3.3
	(2.18)**	(2.85)**	(1.89)**
R^2	0.00	0.00	0.00
N	8,662	8,662	8,662

* $p<0.05$; ** $p<0.01$

Notes: Regression results, REIS data. Table reports average annual differences in the logarithm of county total earnings, total employment and earnings per worker between treatment and comparison counties. State and year dummy variables are included in regressions for control purposes. Earnings based on place of work. Standard errors, grouped by county, are reported in parentheses. There are 684 counties of which 286 treatment counties.

Table 3: Growth in Employment, Earnings and Earnings per Worker; Treatment and Comparison Counties, 2006-2013

Average Annual Growth in:	**Difference** (Treatment-Comparison County)
Total Employment (N=8,664)	
Pre-Boom period, 2006-2009	-0.001
	(0.013)
Boom period, 2010-2013	0.009**
	(0.002)
Earnings (N=8,664)	
Pre-Boom period, 2006-2009	-0.0004
	(0.008)
Boom period, 2010-2013	0.025*
	(0.013)
Earnings per Worker (N=8,664)	
Pre-Boom period, 2006-2009	-0.002
	(0.005)
Boom period, 2010-2013	0.029**
	(0.008)

Notes: Select Regression results, REIS data. Table reports average annual differences in the logarithm of county total earnings, total employment and earnings per worker between treatment and comparison counties. State and year dummy variables are included in regressions for control purposes. Earnings based on place of work. Standard errors, grouped by county, are reported in parentheses. There are 684 counties of which 286 treatment counties.

Table 4: Growth in Employment, Earnings and Earnings per Worker; Treatment and Comparison Counties for Robustness, 2006-2013

Employment

	lnemp	lnemp	lnemp
boomt	0.049	-0.024	-0.024
	(8.56)**	(4.68)**	(4.68)**
boomcount	0.039	0.039	0.032
	(0.11)	(0.11)	(0.09)
boomboom	0.257	0.257	0.257
	(3.98)**	(3.98)**	(3.98)**
year	N	Y	Y
state	N	N	Y
_cons	8.925	8.788	8.586
	(118.78)**	(111.54)**	(42.41)**
R^2	0.00	0.00	0.01
N	2,128	2,128	2,128

* $p<0.05$; ** $p<0.01$

Earnings

	lnearn	lnearn	lnearn
boomt	0.102	0.011	0.011
	(10.88)**	(1.07)	(1.07)
boomcount	0.131	0.131	0.122
	(0.33)	(0.33)	(0.30)
boomboom	0.438	0.438	0.438
	(4.22)**	(4.21)**	(4.21)**
year	N	Y	Y
state	N	N	Y
_cons	12.486	12.317	12.051
	(152.12)**	(143.49)**	(51.73)**
R^2	0.01	0.01	0.01
N	2,128	2,128	2,128

* $p<0.05$; ** $p<0.01$

Earnings Per Worker

	lnearnemp	lnearnemp	lnearnemp
boomt	0.001	-0.001	-0.001
	(0.19)	(0.25)	(0.24)
boomcount	0.102	0.102	0.103
	(1.86)	(1.86)	(1.82)
boomboom	0.125	0.125	0.125
	(4.73)**	(4.73)**	(4.72)**
year	N	Y	Y
state	N	N	Y
_cons	3.534	3.530	3.500
	(324.84)**	(234.67)**	(91.25)**
R^2	0.00	0.00	0.00
N	2,128	2,128	2,128

* $p<0.05$; ** $p<0.01$

Notes: Regression results, REIS data. Table reports average annual differences in the logarithm of county total earnings, total employment and earnings per worker between treatment and comparison counties. State and year dummy variables are included in regressions for control purposes. Earnings based on place of work. Standard errors, grouped by county, are reported in parentheses. There are 267 counties of which 14 treatment counties.

Table 5: Growth in Employment, Earnings and Earnings per Worker; Treatment and Comparison Industry Indices, 2006-2013

Employment

	lnemp	lnemp	lnemp
boomt	0.017	-0.032	-0.033
	(2.06)*	(3.49)**	(3.54)**
boomcount	0.172	0.172	0.077
	(1.86)	(1.86)	(0.73)
degree	-0.577	-0.577	-0.579
	(24.71)**	(24.71)**	(24.87)**
degboomcount	-0.078	-0.079	-0.078
	(1.68)	(1.69)	(1.66)
degboomt	-0.081	-0.081	-0.08
	(0.016)	(0.016)	(0.016)
boomboom	0.068	0.068	0.068
	(4.16)**	(4.16)**	(4.18)**
boomboomdeg	-0.058	-0.058	-0.059
	(2.47)*	(2.45)*	(2.48)*
year	N	Y	Y
state	N	N	Y
_cons	6.202	6.111	5.900
	(129.73)**	(123.48)**	(64.13)**
R^2	0.03	0.03	0.04
N	81,324	81,324	81,324

* $p<0.05$; ** $p<0.01$

Earnings

	lnearn	lnearn	lnearn
boomt	0.097	-0.092	-0.092
	(7.83)**	(6.40)**	(6.47)**
boomcount	0.275	0.274	0.174
	(2.70)**	(2.70)**	(1.51)
degree	-0.330	-0.329	-0.330
	(10.57)**	(10.56)**	(10.61)**
degboomcount	-0.156	-0.156	-0.156
	(2.54)*	(2.54)*	(2.53)*
degboomt	0.009	0.008	0.009
	(0.41)	(0.38)	(0.43)
boomboom	0.070	0.071	0.071
	(2.98)**	(3.00)**	(3.03)**
boomboomdeg	0.013	0.013	0.011
	(0.35)	(0.35)	(0.30)
year	N	Y	Y
state	N	N	Y
_cons	9.463	9.112	8.888
	(176.41)**	(148.77)**	(82.83)**
R^2	0.01	0.01	0.02
N	79,489	79,489	79,489

* $p<0.05$; ** $p<0.01$

Earnings per Worker

	lnincemp	lnincemp	lnincemp
boomt	-0.009	-0.022	-0.022
	(2.06)*	(4.45)**	(4.45)**
boomcount	0.078	0.078	0.072
	(4.47)**	(4.47)**	(3.91)**
degree	0.265	0.265	0.265
	(22.46)**	(22.45)**	(22.46)**
degboomcount	-0.012	-0.012	-0.012
	(0.50)	(0.50)	(0.50)
degboomt	-0.068	-0.068	-0.068
	(0.009)	(0.009)	(0.009)
boomboom	0.081	0.081	0.081
	(8.20)**	(8.20)**	(8.20)**
boomboomdeg	-0.087	-0.087	-0.087
	(6.43)**	(6.43)**	(6.43)**
year	N	Y	Y
state	N	N	Y
_cons	3.249	3.226	3.211
	(356.21)**	(260.53)**	(162.71)**
R^2	0.03	0.03	0.03
N	78,889	78,889	78,889

* $p<0.05$; ** $p<0.01$

Notes: Regression results, REIS data. Table reports average annual differences in the logarithm of county total earnings, total employment and earnings per worker between treatment and comparison counties between treatment and control indices. State and year dummy variables are included in regressions for control purposes. Earnings based on place of work. Standard errors, grouped by county, are reported in parentheses. There are 684 counties of which 286 treatment counties. There are 13 industries, 5 treatment and 8 control.

Table 6: Growth in Employment, Earnings and Earnings per Worker; Treatment and Comparison Industry Indices, 2006-2013

Average Annual Growth in:	**Difference** (Treatment-Comparison Industry by Treatment-Comparison County)
Total Employment	
Pre-Boom period, 2006-2009	-0.078
	(0.047)
Boom period, 2010-2013	-0.059*
	(0.024)
Earnings	
Pre-Boom period, 2006-2009	-0.156**
	(2.53)
Boom period, 2010-2013	0.011
	(0.30)
Earnings per Worker	
Pre-Boom period, 2006-2009	-0.012
	(0.02)
Boom period, 2010-2013	-0.087**
	(0.014)

Notes: Select regression results, REIS data. Table reports average annual differences in the logarithm of county total earnings, total employment and earnings per worker between treatment and comparison counties between treatment and control indices. State and year dummy variables are included in regressions for control purposes. Earnings based on place of work. Standard errors, grouped by county, are reported in parentheses. There are 684 counties of which 286 treatment counties. There are 13 industries, 5 treatment and 8 control.

Table 7: Growth in Employment, Earnings and Earnings per Worker; Treatment and Comparison Industry Indices without Mining, 2006-2013

Employment

	lnemp	lnemp	lnemp
boomt	0.011	-0.019	-0.019
	(1.29)	(1.84)	(1.86)
boomcount	0.126	0.126	0.033
	(1.30)	(1.30)	(0.30)
degree	-0.638	-0.638	-0.640
	(25.24)**	(25.24)**	(25.34)**
degboomcount	-0.060	-0.060	-0.058
	(1.34)	(1.34)	(1.28)
degboomt	-0.048	-0.048	-0.048
	(3.11)**	(3.10)**	(3.07)**
boomboom	0.029	0.029	0.029
	(1.75)	(1.75)	(1.76)
boomboomdeg	0.034	0.034	0.033
	(1.23)	(1.23)	(1.18)
year	N	Y	Y
state	N	N	Y
_cons	6.290	6.233	6.030
	(124.81)**	(120.58)**	(64.16)**
R^2	0.04	0.04	0.05
N	76,243	76,243	76,243

* $p<0.05$; ** $p<0.01$

Earnings

	lninc	lninc	lninc
boomt	0.045	-0.117	-0.118
	(3.74)**	(8.19)**	(8.24)**
boomcount	0.172	0.171	0.073
	(1.64)	(1.63)	(0.61)
degree	-0.391	-0.391	-0.392
	(13.15)**	(13.13)**	(13.21)**
degboomcount	-0.053	-0.053	-0.052
	(0.93)	(0.93)	(0.91)
degboomt	0.061	0.060	0.061
	(2.84)**	(2.81)**	(2.84)**
boomboom	0.076	0.076	0.076
	(3.34)**	(3.35)**	(3.35)**
boomboomdeg	0.007	0.007	0.006
	(0.20)	(0.20)	(0.17)
year	N	Y	Y
state	N	N	Y
_cons	9.525	9.222	9.007
	(173.28)**	(149.68)**	(83.58)**
R^2	0.01	0.01	0.02
N	74,763	74,763	74,763

* $p<0.05$; ** $p<0.01$

Earnings per Worker

	lnincemp	lnincemp	lnincemp
boomt	0.016	-0.003	-0.003
	(3.04)**	(0.57)	(0.57)
boomcount	0.049	0.049	0.045
	(3.11)**	(3.11)**	(2.67)**
degree	0.340	0.340	0.340
	(31.00)**	(30.99)**	(30.99)**
degboomcount	-0.005	-0.005	-0.005
	(0.23)	(0.23)	(0.22)
degboomt	-0.071	-0.071	-0.071
	(8.49)**	(8.49)**	(8.48)**
boomboom	0.054	0.054	0.054
	(5.32)**	(5.32)**	(5.32)**
boomboomdeg	-0.014	-0.014	-0.014
	(0.90)	(0.90)	(0.91)
year	N	Y	Y
state	N	N	Y
_cons	3.197	3.160	3.151
	(375.54)**	(266.42)**	(167.75)**
R^2	0.05	0.05	0.05
N	74,220	74,220	74,220

* $p<0.05$; ** $p<0.01$

Notes: Regression results, REIS data. Table reports average annual differences in the logarithm of county total earnings, total employment and earnings per worker between treatment and comparison counties between treatment and control indices. State and year dummy variables are included in regressions for control purposes. Earnings based on place of work. Standard errors, grouped by county, are reported in parentheses. There are 684 counties of which 286 treatment counties. There are 12 industries, 5 treatment and 7 control.

Appendix A: Counties used in this Study

This Appendix lists the treatment counties followed by the control group.

Counties in the Treatment Group (286)

County

MT	DAWSON	TX	WILSON	PA	BEAVER	WV	BRAXTON
MT	MCCONE	TX	ZAVALA	PA	BEDFORD	WV	BROOKE
MT	RICHLAND	AR	COLUMBIA	PA	BLAIR	WV	CABELL
MT	ROOSEVELT	AR	LAFAYETTE	PA	BRADFORD	WV	CALHOUN
MT	SHERIDAN	LA	BIENVILLE	PA	BUTLER	WV	CLAY
ND	BILLINGS	LA	BOSSIER	PA	CAMBRIA	WV	DODDRIDGE
ND	BOTTINEAU	LA	CADDO	PA	CAMERON	WV	FAYETTE
ND	BURKE	LA	CLAIBORNE	PA	CENTRE	WV	GILMER
ND	DIVIDE	LA	DE SOTO	PA	CLARION	WV	GRANT
ND	DUNN	LA	NATCHITOCHES	PA	CLEARFIELD	WV	GREENBRIER
ND	GOLDEN VALLEY	LA	RED RIVER	PA	CLINTON	WV	HAMPSHIRE
ND	MCHENRY	LA	SABINE	PA	COLUMBIA	WV	HANCOCK
ND	MCKENZIE	LA	UNION	PA	CUMBERLAND	WV	HARDY
ND	MCLEAN	LA	WEBSTER	PA	ELK	WV	HARRISON
ND	MERCER	TX	ANGELINA	PA	FAYETTE	WV	JACKSON
ND	MOUNTRAIL	TX	CHEROKEE	PA	FOREST	WV	KANAWHA
ND	RENVILLE	TX	GREGG	PA	FRANKLIN	WV	LEWIS
ND	STARK	TX	HARRISON	PA	GREENE	WV	LINCOLN
ND	WARD	TX	MARION	PA	HUNTINGDON	WV	LOGAN
ND	WILLIAMS	TX	NACOGDOCHES	PA	INDIANA	WV	MARION
TX	ATASCOSA	TX	PANOLA	PA	JEFFERSON	WV	MARSHALL
TX	BASTROP	TX	RUSK	PA	LACKAWANNA	WV	MASON
TX	BEE	TX	SABINE	PA	LAWRENCE	WV	MCDOWELL
TX	BRAZOS	TX	SAN AUGUSTINE	PA	LUZERNE	WV	MERCER
TX	BURLESON	TX	SHELBY	PA	LYCOMING	WV	MINERAL
TX	DEWITT	TX	SMITH	PA	MCKEAN	WV	MINGO
TX	DIMMIT	TX	UPSHUR	PA	MERCER	WV	MONONGALIA
TX	FAYETTE	MD	ALLEGANY	PA	PIKE	WV	MONROE
TX	FRIO	MD	GARRETT	PA	POTTER	WV	MORGAN
TX	GONZALES	NY	ALLEGANY	PA	SOMERSET	WV	NICHOLAS
TX	KARNES	NY	BROOME	PA	SULLIVAN	WV	OHIO
TX	LA SALLE	NY	CATTARAUGUS	PA	SUSQUEHANNA	WV	PENDLETON
TX	LAVACA	NY	CHAUTAUQUA	PA	TIOGA	WV	PLEASANTS
TX	LEE	NY	CHEMUNG	PA	VENANGO	WV	POCAHONTAS
TX	LEON	NY	ERIE	PA	WARREN	WV	PRESTON
TX	LIVE OAK	NY	LIVINGSTON	PA	WASHINGTON	WV	PUTNAM
TX	MADISON	NY	SCHUYLER	PA	WAYNE	WV	RALEIGH
TX	MAVERICK	NY	STEUBEN	PA	WESTMORELAND	WV	RANDOLPH
TX	MCMULLEN	NY	WYOMING	PA	WYOMING	WV	RITCHIE
TX	MILAM	PA	ALLEGHENY	WV	BARBOUR	WV	ROANE
TX	WEBB	PA	ARMSTRONG	WV	BOONE	WV	SUMMERS

WV	TAYLOR	NM	CHAVES	TX	TERRELL
WV	TUCKER	NM	EDDY	TX	TERRY
WV	TYLER	NM	LEA	TX	TOM GREEN
WV	UPSHUR	NM	ROOSEVELT	TX	UPTON
WV	WAYNE	TX	ANDREWS	TX	VAL VERDE
WV	WEBSTER	TX	BAILEY	TX	WARD
WV	WETZEL	TX	BORDEN	TX	WINKLER
WV	WIRT	TX	COCHRAN	TX	YOAKUM
WV	WOOD	TX	COKE	OH	BELMONT
WV	WYOMING	TX	CONCHO	OH	CARROLL
CO	ADAMS	TX	CRANE	OH	COLUMBIANA
CO	ARAPAHOE	TX	CROCKETT	OH	COSHOCTON
CO	BOULDER	TX	CROSBY	OH	GUERNSEY
CO	BROOMFIELD	TX	CULBERSON	OH	HARRISON
CO	CHEYENNE	TX	DAWSON	OH	HOCKING
CO	GARFIELD	TX	DICKENS	OH	JEFFERSON
CO	JACKSON	TX	ECTOR	OH	MAHONING
CO	JEFFERSON	TX	EDWARDS	OH	MONROE
CO	KIT CARSON	TX	FISHER	OH	MORGAN
CO	LARIMER	TX	FLOYD	OH	MUSKINGUM
CO	LOGAN	TX	GAINES	OH	NOBLE
CO	MESA	TX	GARZA	OH	PERRY
CO	MOFFAT	TX	GLASSCOCK	OH	PORTAGE
CO	MORGAN	TX	HALE	OH	STARK
CO	PHILLIPS	TX	HOCKLEY	OH	TRUMBULL
CO	RIO BLANCO	TX	HOWARD	OH	TUSCARAWAS
CO	ROUTT	TX	IRION	OH	WASHINGTON
CO	SEDGWICK	TX	KENT	OH	WAYNE
CO	WASHINGTON	TX	KIMBLE		
CO	WELD	TX	LAMB		
CO	YUMA	TX	LOVING		
KS	CHEYENNE	TX	LUBBOCK		
KS	SHERMAN	TX	LYNN		
NE	CHEYENNE	TX	MARTIN		
NE	DEUEL	TX	MENARD		
NE	GARDEN	TX	MIDLAND		
WY	ALBANY	TX	MITCHELL		
WY	CAMPBELL	TX	MOTLEY		
WY	CARBON	TX	NOLAN		
WY	CONVERSE	TX	PECOS		
WY	GOSHEN	TX	REAGAN		
WY	JOHNSON	TX	REAL		
WY	LARAMIE	TX	REEVES		
WY	NATRONA	TX	SCHLEICHER		
WY	NIOBRARA	TX	SCURRY		
WY	PLATTE	TX	STERLING		
WY	WESTON	TX	SUTTON		

Counties in Control Group (786)

Arkansas, AR
Bradley, AR
Carroll, AR
Cleveland, AR
Conway, AR
Crawford, AR
Cross, AR
Dallas, AR
Desha, AR
Fulton, AR
Garland, AR
Grant, AR
Hot Spring, AR
Howard, AR
Independence, AR
Johnson, AR
Lawrence, AR
Lee, AR
Logan, AR
Lonoke, AR
Miller, AR
Nevada, AR
Newton, AR
Ouachita, AR
Phillips, AR
Pulaski, AR
St. Francis, AR
Scott, AR
Sebastian, AR
Stone, AR
Union, AR
Washington, AR
White, AR
Archuleta, CO
Baca, CO
Bent, CO
Chaffee, CO
Conejos, CO
Custer, CO
Douglas, CO
Fremont, CO
Gunnison, CO
Hinsdale, CO
Huerfano, CO
La Plata, CO
Las Animas, CO
Lincoln, CO
Montezuma, CO
Montrose, CO
Otero, CO
Park, CO
Prowers, CO
Pueblo, CO
Anderson, KS
Atchison, KS
Barber, KS
Barton, KS
Butler, KS
Clark, KS
Coffey, KS
Comanche, KS
Cowley, KS
Crawford, KS
Dickinson, KS
Douglas, KS
Edwards, KS
Ellis, KS
Finney, KS
Ford, KS
Franklin, KS
Gove, KS
Graham, KS
Grant, KS
Gray, KS
Greenwood, KS
Harper, KS
Harvey, KS
Haskell, KS
Johnson, KS
Kingman, KS
Kiowa, KS
Lane, KS
Leavenworth, KS
Lyon, KS
McPherson, KS
Marion, KS
Meade, KS
Miami, KS
Montgomery, KS
Morris, KS
Morton, KS
Neosho, KS
Phillips, KS
Pratt, KS
Reno, KS
Rice, KS
Riley, KS
Rooks, KS
Russell, KS
Sedgwick, KS
Seward, KS
Shawnee, KS
Stafford, KS
Stanton, KS
Stevens, KS
Sumner, KS
Wilson, KS
Acadia, LA
Assumption, LA
Avoyelles, LA
Beauregard, LA
Calcasieu, LA
Caldwell, LA
Cameron, LA
Catahoula, LA
Concordia, LA
East Baton Rouge, LA
Evangeline, LA
Iberia, LA
Iberville, LA
Jefferson, LA
Jefferson Davis, LA
Lafayette, LA
Lafourche, LA
La Salle, LA
Lincoln, LA
Livingston, LA
Madison, LA
Orleans, LA
Ouachita, LA
Plaquemines, LA
Rapides, LA
St. John the Baptist, LA
St. Landry, LA
St. Martin, LA
St. Mary, LA
St. Tammany, LA
Tangipahoa, LA
Terrebonne, LA
Vermilion, LA
Vernon, LA
Washington, LA
Winn, LA
Anne Arundel, MD
Cecil, MD
Harford, MD
Queen Anne's, MD
St. Mary's, MD
Somerset, MD
Washington, MD
Worcester, MD
Big Horn, MT
Carbon, MT
Chouteau, MT
Fallon, MT
Flathead, MT
Gallatin, MT
Glacier, MT
Hill, MT
Lake, MT
Lewis and Clark, MT
Madison, MT
Mineral, MT
Missoula, MT
Musselshell, MT
Park, MT
Petroleum, MT
Rosebud, MT
Sanders, MT
Silver Bow, MT
Yellowstone, MT
Buffalo, NE
Cedar, NE
Hitchcock, NE
Holt, NE
Kimball, NE
Lancaster, NE
Red Willow, NE
Catron, NM
Colfax, NM
De Baca, NM
Do¤a Ana, NM
Harding, NM
Hidalgo, NM
Mora, NM
Otero, NM
Quay, NM
Rio Arriba, NM
Sandoval, NM
San Juan, NM
San Miguel, NM
Santa Fe, NM
Taos, NM
Torrance, NM
Valencia, NM
Albany, NY
Chenango, NY
Cortland, NY
Delaware, NY
Dutchess, NY
Essex, NY
Genesee, NY
Herkimer, NY
Jefferson, NY
Lewis, NY
Madison, NY
Oneida, NY
Onondaga, NY
Ontario, NY
Orange, NY
Orleans, NY
Oswego, NY
Putnam, NY
Rensselaer, NY
St. Lawrence, NY
Schenectady, NY
Sullivan, NY
Tompkins, NY
Ulster, NY
Washington, NY
Yates, NY
Adams, ND
Benson, ND
Bowman, ND
Burleigh, ND
Dickey, ND
LaMoure, ND
Morton, ND
Ransom, ND
Slope, ND
Walsh, ND
Ashland, OH
Ashtabula, OH
Clark, OH
Delaware, OH
Fairfield, OH
Fulton, OH
Gallia, OH
Geauga, OH
Hardin, OH

Henry, OH
Highland, OH
Holmes, OH
Jackson, OH
Knox, OH
Licking, OH
Logan, OH
Medina, OH
Meigs, OH
Miami, OH
Morrow, OH
Ottawa, OH
Richland, OH
Ross, OH
Scioto, OH
Seneca, OH
Warren, OH
Wyandot, OH
Adams, PA
Berks, PA
Carbon, PA
Chester, PA
Crawford, PA
Dauphin, PA
Erie, PA
Juniata, PA
Lancaster, PA
Monroe, PA
Northampton, PA
Northumberland, PA
Schuylkill, PA
York, PA
Anderson, TX
Aransas, TX
Archer, TX
Austin, TX
Baylor, TX
Blanco, TX
Bosque, TX
Brazoria, TX
Brooks, TX
Brown, TX
Burnet, TX
Caldwell, TX
Calhoun, TX
Callahan, TX
Cameron, TX
Carson, TX
Cass, TX
Chambers, TX
Childress, TX
Clay, TX
Coleman, TX
Collingsworth, TX
Colorado, TX
Comal, TX
Comanche, TX
Cooke, TX
Dallam, TX
Donley, TX
Duval, TX
Eastland, TX
Erath, TX
Foard, TX
Fort Bend, TX
Franklin, TX
Freestone, TX
Galveston, TX
Gillespie, TX
Gray, TX
Grayson, TX
Grimes, TX
Guadalupe, TX
Hansford, TX
Hardeman, TX
Hardin, TX
Hartley, TX
Haskell, TX
Hemphill, TX
Henderson, TX
Hill, TX
Hood, TX
Houston, TX
Hutchinson, TX
Jack, TX
Jasper, TX
Jeff Davis, TX
Jefferson, TX
Jim Hogg, TX
Jim Wells, TX
Johnson, TX
Jones, TX
Kaufman, TX
Kendall, TX
Kerr, TX
King, TX
Kinney, TX
Kleberg, TX
Knox, TX
Liberty, TX
Limestone, TX
Lipscomb, TX
Llano, TX
McLennan, TX
Matagorda, TX
Medina, TX
Mills, TX
Montague, TX
Montgomery, TX
Moore, TX
Morris, TX
Navarro, TX
Nueces, TX
Ochiltree, TX
Orange, TX
Palo Pinto, TX
Parker, TX
Parmer, TX
Polk, TX
Potter, TX
Presidio, TX
Rains, TX
Randall, TX
Refugio, TX
Rockwall, TX
Runnels, TX
San Patricio, TX
San Saba, TX
Shackelford, TX
Starr, TX
Stephens, TX
Taylor, TX
Throckmorton, TX
Titus, TX
Tyler, TX
Uvalde, TX
Van Zandt, TX
Victoria, TX
Walker, TX
Waller, TX
Washington, TX
Wharton, TX
Wichita, TX
Wilbarger, TX
Williamson, TX
Wise, TX
Wood, TX
Young, TX
Zapata, TX
Big Horn, WY
Crook, WY
Fremont, WY
Hot Springs, WY
Lincoln, WY
Park, WY
Sheridan, WY
Sublette, WY
Sweetwater, WY
Teton, WY
Uinta, WY
Washakie, WY

Counties in the Robustness Control Group (252)

Alamosa, CO
Archuleta, CO
Baca, CO
Bent, CO
Chaffee, CO
Clear Creek, CO
Conejos, CO
Costilla, CO
Crowley, CO
Custer, CO
Delta, CO
Dolores, CO
Eagle, CO
Elbert, CO
Fremont, CO
Gilpin, CO
Grand, CO
Gunnison, CO
Hinsdale, CO
Huerfano, CO
Kiowa, CO
Lake, CO
La Plata, CO
Las Animas, CO
Lincoln, CO
Mineral, CO
Montezuma, CO
Montrose, CO
Otero, CO
Ouray, CO
Park, CO
Pitkin, CO
Prowers, CO
Pueblo, CO
Rio Grande, CO
Saguache, CO
San Miguel, CO
Summit, CO
Teller, CO
Catron, NM
Cibola, NM
Colfax, NM
Curry, NM
De Baca, NM
Do¤a Ana, NM
Grant, NM
Guadalupe, NM
Harding, NM
Hidalgo, NM
Lincoln, NM
Los Alamos, NM
Luna, NM
McKinley, NM
Mora, NM
Otero, NM
Quay, NM
Rio Arriba, NM
Sandoval, NM
San Juan, NM
San Miguel, NM
Santa Fe, NM
Sierra, NM
Socorro, NM
Taos, NM
Torrance, NM
Union, NM
Valencia, NM
Adams, ND
Barnes, ND
Benson, ND
Bowman, ND
Burleigh, ND
Cass, ND
Cavalier, ND
Dickey, ND
Eddy, ND
Emmons, ND
Foster, ND
Grand Forks, ND
Grant, ND
Griggs, ND
Hettinger, ND
Kidder, ND
LaMoure, ND
Logan, ND
McIntosh, ND
Morton, ND
Nelson, ND
Oliver, ND
Pembina, ND
Pierce, ND
Ramsey, ND
Ransom, ND
Richland, ND
Rolette, ND
Sargent, ND
Sheridan, ND
Sioux, ND
Slope, ND
Steele, ND
Stutsman, ND
Towner, ND
Traill, ND
Walsh, ND
Wells, ND
Anderson, TX
Aransas, TX
Archer, TX
Armstrong, TX
Austin, TX
Bandera, TX
Baylor, TX
Blanco, TX
Bosque, TX
Bowie, TX
Brewster, TX
Briscoe, TX
Brooks, TX
Brown, TX
Burnet, TX
Caldwell, TX
Calhoun, TX
Callahan, TX
Camp, TX
Carson, TX
Cass, TX
Castro, TX
Chambers, TX
Childress, TX
Clay, TX
Coleman, TX
Collingsworth, TX
Colorado, TX
Comal, TX
Comanche, TX
Cooke, TX
Coryell, TX
Cottle, TX
Dallam, TX
Deaf Smith, TX
Delta, TX
Donley, TX
Duval, TX
Eastland, TX
Ellis, TX
Erath, TX
Falls, TX
Fannin, TX
Foard, TX
Franklin, TX
Freestone, TX
Gillespie, TX
Goliad, TX
Gray, TX
Grayson, TX
Grimes, TX
Guadalupe, TX
Hall, TX
Hamilton, TX
Hansford, TX
Hardeman, TX
Hardin, TX
Hartley, TX
Haskell, TX
Hays, TX
Hemphill, TX
Henderson, TX
Hill, TX
Hood, TX
Hopkins, TX
Houston, TX
Hudspeth, TX
Hunt, TX
Hutchinson, TX
Jack, TX
Jackson, TX
Jasper, TX
Jeff Davis, TX
Jim Hogg, TX
Jim Wells, TX
Johnson, TX
Jones, TX
Kaufman, TX
Kendall, TX
Kerr, TX
Kinney, TX
Kleberg, TX
Knox, TX
Lamar, TX
Lampasas, TX
Liberty, TX
Limestone, TX
Lipscomb, TX
Llano, TX
McCulloch, TX
McLennan, TX
Mason, TX
Matagorda, TX
Medina, TX
Mills, TX
Montague, TX
Moore, TX
Morris, TX
Navarro, TX
Newton, TX
Ochiltree, TX
Oldham, TX
Orange, TX
Palo Pinto, TX
Parker, TX
Parmer, TX
Polk, TX
Potter, TX
Presidio, TX
Rains, TX
Randall, TX
Red River, TX
Refugio, TX
Roberts, TX
Robertson, TX
Rockwall, TX
Runnels, TX
San Jacinto, TX
San Patricio, TX
San Saba, TX
Shackelford, TX
Sherman, TX
Somervell, TX
Starr, TX
Stephens, TX
Stonewall, TX
Swisher, TX
Taylor, TX
Throckmorton, TX
Titus, TX
Trinity, TX
Tyler, TX
Uvalde, TX
Van Zandt, TX

Victoria, TX
Walker, TX
Waller, TX
Washington, TX
Wharton, TX
Wheeler, TX
Wichita, TX
Wilbarger, TX
Willacy, TX
Wise, TX
Wood, TX
Young, TX
Zapata, TX

Counties in the Robustness Treatment Group (14)

Weld, CO
Eddy, NM
Lea, NM
Dunn, ND
McKenzie, ND
Mountrail, ND
Williams, ND
Andrews, TX
DeWitt, TX
Dimmit, TX
Gonzales, TX
Karnes, TX
La Salle, TX
McMullen, TX

Appendix B: NAICS/BEA Industries and Definitions

This Appendix lists the control industries followed by the treatment group. All definitions taken from the Bureau of Economic Analysis Guide to Industry Classifications adapted from the North American Industry Classification System, 2012.

Industries in the Control Group

WHOLESALE TRADE:
The wholesale trade sector (ISI codes 4231–4251) comprises businesses engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The wholesaling process is an intermediate step in the distribution of merchandise. Wholesalers are organized to sell or arrange the purchase or sale of (a) goods for resale (goods sold to other wholesalers or retailers), (b) capital or durable nonconsumer goods, and (c) raw and intermediate materials and supplies used in production. Wholesalers sell merchandise to other businesses and normally operate from a warehouse or office. These warehouses and offices are characterized by having little or no display of merchandise. In addition, neither the design nor the location of the premises is intended to solicit walk-in traffic. Wholesalers do not normally use advertising directed to the general public. Customers are generally reached initially via telephone, in-person marketing, or by specialized advertising that may include Internet and other electronic means. Although in general, wholesaling normally denotes sales in large volumes, durable nonconsumer goods may be sold in single units. Sales of capital or durable nonconsumer goods used in the production of goods and services, such as farm machinery, medium and heavy duty trucks, and industrial machinery are included in wholesale trade.

RETAIL TRADE:
The retail trade sector (ISI codes 4410–4540) comprises businesses selling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. Retailers sell merchandise to the general public. Store retailers operate permanent point-of-sale locations. Non-store retailers reach customers through methods such as the broadcasting and publishing of direct response advertising, the publishing of traditional and electronic catalogues, and distribution through vending machines. Businesses may be engaged in providing after-sales services such as repair and installation. Businesses that both manufacture and sell their products to the general public, such as retail bakeries, are not classified in retail trade, but rather in manufacturing.

TRANSPORTATION AND WAREHOUSING:
The transportation and warehousing sector (ISI codes 4810–4939) comprises businesses providing transportation of passengers and cargo, scenic and sightseeing transportation, support activities related to transportation, and warehousing and storage for goods. Businesses in transportation use transportation equipment or transportation related facilities as a productive asset.

REAL ESTATE AND RENTAL AND LEASING:
Real estate (2012 NAICS code 531) Businesses engaged in renting or leasing real estate to others; managing real estate for others; selling, buying or renting real estate for others; and providing real estate related services, such as appraisal services.

ARTS, ENTERTAINMENT, AND RECREATION:
The arts, entertainment and recreation sector (ISI codes 7110-7130) comprises businesses that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons.

ACCOMMODATION AND FOOD SERVICES:
The accommodation and food services sector (ISI codes 7210-7220) comprises businesses providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption. The sector includes both accommodation and food services because the two activities are often combined at the same business.

CONSTRUCTION:
The construction sector (ISI codes 2360–2380) comprises businesses engaged in the construction of buildings or engineering projects (e.g., highways and utility systems). Work performed includes new work, additions, alterations, or maintenance and repairs. This sector includes businesses engaged in the preparation of sites for new construction

and businesses engaged in the subdividing of land for sale as building sites. Construction performed by a business primarily engaged in an activity other than construction, for its own account and use, and by its own employees (force construction), is excluded from this industry, and is classified according to the principle activity of the business.

MINING, QUARRYING, AND OIL AND GAS EXTRACTION:
The mining, quarrying, and oil and gas extraction sector (ISI codes 2111–2133) comprises businesses that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas. The term mining is used in the broad sense to include quarrying, well operations, crushing, washing, and other operations performed at the mine site. This sector consists of two basic activities: (1) mine operation and (2) mining support activities. Mine operations are classified according to the natural resource mined. Businesses that mine, but further process the mined materials into a finished product, are classified in manufacturing. For example, a business operating a granite quarry, producing dimension stone, and further shaping the dimension stone into building stone would be classified in manufacturing.

Industries in the Treatment Group

INFORMATION:
The Information sector (ISI codes 5111–5191) comprises businesses engaged in producing and distributing information and cultural products; providing the means to transmit or distribute these products as well as data or communications; and processing data. (Cultural products are those that directly express attitudes, opinions, ideas, values, and artistic creativity; provide entertainment; or offer information and analysis concerning the past and present.)

The unique characteristics of information and cultural products, and of the processes involved in their production and distribution, distinguish businesses in the Information sector from those in other sectors. Some of these characteristics are:

1. Unlike traditional goods, an "information or cultural product" such as an on-line newspaper or a television program does not necessarily have tangible qualities, nor is it necessarily associated with a particular form.
2. Unlike traditional services, the delivery of informational and cultural products does not require direct contact between the supplier and the consumer.
3. The intangible property aspect of information and cultural products makes the processes involved in their production and distribution different from goods and services. Only those possessing the rights to these works are authorized to reproduce, alter, improve, and distribute them.
4. Distributors of information and cultural products can add value to the products they distribute. For instance, broadcasters add advertising to the original product. This capacity means that unlike other distributors of goods and services, some information distributors may derive revenue not from the sale of the distributed product to the final consumer, but from those who pay for adding information to the original product.

FINANCE AND INSURANCE:
The finance and insurance sector (ISI codes 5221–5252) comprises businesses engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions. Three principal types of activities are included:

1. Raising funds by taking deposits and/or issuing securities, and in the process, incurring liabilities.
2. Pooling of risk by underwriting insurance and annuities.
3. Providing specialized services facilitating, or supporting, financial intermediation, insurance, or employee benefit programs.

PROFESSIONAL, SCIENTIFIC, AND TECHNICAL SERVICES:
Not defined but includes services such as legal, accounting, engineering, computer systems design, management consulting, scientific consulting, technical consulting, research and development, and advertising.

MANAGEMENT OF COMPANIES AND ENTERPRISES:
Not defined but includes holding companies (except bank holding companies) and corporate, subsidiary, or regional management offices.

EDUCATIONAL SERVICES:
Businesses engaged in providing instruction and training in a wide variety of subjects.