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DISCUSSION PAPER SERIES

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ABSTRACT

Who Benefits from Local Oil and Gas Employment? Labor Market Composition in the Oil and Gas Industry in Texas*

This paper examines local labor market outcomes from an oil and gas boom in Texas. We examine two main outcomes across gender, race, and ethnicity: the probability of employment in the oil and gas industry and the log wages of workers employed outside the oil and gas industry. We find that men and women both gain employment in the oil and gas industry during booms, but such gains are much larger for men and are largest for black and Hispanic men. We also find positive income spillovers for workers in other industries that are similar in magnitude across demographic groups.

JEL Classification: J20, Q33, Q40, R10

Keywords: oil, natural gas, employment, gender, race, energy

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1. Introduction

This paper examines local labor markets in Texas to explore how local growth in oil and gas employment differentially affects workers by gender, race, and ethnicity. Texas is unique among states in the scale of its oil and gas production. Texas produces more crude oil than any other state, and has more than one-third of total U.S. proved reserves (EIA Texas 2018).[1] Between 2000 and 2016, Texas onshore fields produced 29 percent of the average annual U.S. oil production, this increased to 33 percent between 2011 and 2016 (EIA oil 2018). Texas is also the top natural gas producing state and has one-fourth of U.S. natural gas proved reserves (EIA Texas 2018).[2] Texas onshore production of natural gas from 2000-2016 was 27 percent of total U.S. production (EIA ng 2018).

Oil and natural gas production in Texas and the United States as a whole expanded significantly after 2000, in large part due to the implementation of hydraulic fracturing techniques and a boom in energy prices between 2000 and 2011 (Fitzgerald 2013; Economist 2014; Kelsey et al. 2016).[3,4] In 2014, the United States became the world's largest oil producer (Oyedele 2015). Based on data from the U.S. Bureau of Labor Statistics, between 2000 and 2014, employment in the oil and gas extraction sector grew 58 percent (BLS 2018). The energy sector has historically followed a boom and bust cycle, and this period of expansion was no

[1]From 2000 and 2011, Texas crude oil production was higher than any other state and second only to federal offshore drilling in the Gulf of Mexico (GOM), since 2012, Texas production exceeds even GOM offshore production (EIA oil, 2018).
[2] Since 2000, Texas onshore natural gas production has exceeded all states and offshore production areas (EIA ng, 2018).
[3] Hydraulic fracturing technology refers to the combined use of existing horizontal drilling and hydraulic fracturing technologies. The combined use of these technologies led to the "shale revolution", which started in the Barnett Shale in Texas in 1998 and spread across the U.S. in the mid-2000s (Fitzgerald 2013).
[4] Hydraulic fracturing technology allowed access to previously economically inaccessible oil and natural gas reserves. The type of resources found depends largely on geology. Oil and natural gas are commonly located together in the same reservoir and natural gas is generally found during exploration for the more valuable commodity, oil. A boom in oil prices is expected to increase production of both toil and natural gas.

different. Due largely to a worldwide surplus in the supply of oil, prices dropped and U.S. oil production fell beginning in mid-2014 (See Figure 1). Between June 2014 and January 2015, oil prices dropped 57 percent and between September 2014 and August 2015, U.S. oil production dropped by 120,000 barrels a day (Egan 2015; Gold 2015). The oil and natural gas price declines led to widespread layoffs throughout the industry in 2015 and 2016 (Hardzinski 2016; Hiller 2016; Miller 2016; Proctor 2016; Franklin 2015).

Although it did not last forever, the boom in oil and gas employment provided a significant opportunity for new workers to enter the industry, including women and minorities. Historically, the labor force in the oil and gas industry nationally has been largely male and predominantly white (Price 2015). There have been accusations of widespread and on-going gender and racial discrimination in the industry, but the industry has countered that in recent years diversity is increasing (Litvak 2016; Velarde 2014; Gillula and Fullenbaum 2014; Pruitt and Nethercutt 2002). Barriers hindering women and minorities from entering any industry contribute to broader national concerns about income inequality and pay gaps by gender and race. Oil and gas booms typically lead to an increase in high paying jobs in the short term and may lead to additional benefits for women and minorities if they are able to take advantage of the new job opportunities.

In order to assess if the oil and gas boom affected the racial/ethnic and gender composition of the oil and gas industry in Texas, we first examine the probability of gaining employment in the oil and gas industry during the boom by race and gender. We find that the gains are concentrated among men, and the employment gains are especially strong for black males and Hispanic males. We find positive effects on employment for women as well. We then estimate income spillovers for workers in Texas not employed in the oil and gas industry. We find that increased oil and gas employment in a local area had positive, statistically significant, and economically important income spillovers for local workers in other industries. Furthermore, the income spillovers were widespread and similar in size across gender, racial, and ethnic groups.

2. Background

2.1 Racial/Ethnic Diversity in the Oil and Gas Industry

Minorities have historically made up a relatively small share of the labor force in the oil and gas industry. As stated previously, some have argued that this is due largely to discrimination in the labor market in general and in the oil and gas market specifically. There have been several complaints of racial discrimination in the oil and gas industry dating back to the 1980s (Brady 2017; Litvak 2016; Pruitt and Nethercutt 2002). However, according to a forecast from the American Petroleum Institute (API), employment by black and Hispanic workers is expected to rise to 40 percent of total employment by 2035 (Gillula, Fullenbaum, and Winkel 2016). This forecast is due in large part to the expected increased demand for energy workers and the aging of the existing oil and gas field workers (Brady 2017). To meet the forecast will require a significant shift in the labor composition in the industry. According to data from the decennial census and American Community Survey (ACS), between 1990 and 2014, the share of black employment in oil and gas increased only from 4.6 to 6.4 percent while Hispanic employment increased from 7.9 to 20.8 percent (Ruggles et al. 2018). Large employment gains have been experienced by Hispanic workers, but continued growth is required to meet the forecast.[5]

[5] The share of Asian employment in the oil and gas industry has increased from 1.6 percent in 1990 to 2.7 percent in 2014. Over the same period, the share of white employment decreased from 85.4 to 67.4 percent.

In Texas, during the oil and gas boom there were increases in oil and gas industry diversity that mirrored the changes occurring at the national level. For racial/ethnic groups there were gains, particularly for Hispanic workers; the share increased from 18.9 percent in 2000 to 32.6 percent in 2014. This is a dramatic increase from the share in 1990, which was 13.8 percent. The black employment share gains were less pronounced. The share of black employment increased from 4.7 percent in 2000 to 5.5 percent in 2014, from a share of 4.8 percent in 1990. For Asian workers, the employment share remained small, but increased from 2.2 percent in 2000 to 4.1 percent in 2014 from an employment share of only 1.2 percent in 1990. Over this same period, the share of white employment declined from 73 percent to 55 percent from a high of 80 percent in 1990 (Ruggles et al. 2018).

Economists have examined several factors that affect the employment and wages of minority workers, including discrimination (Kreisman and Rangel 2015; Lang and Manove 2011; Hellerstein, Neumark, and McInerney 2008; Hersch 2008; Bertrand and Mullainathan 2004; Reimers 1983), differences in labor force participation (Antecol and Bedard 2004), and differences in pre-labor market characteristics such as education (Black et al 2006; Carneiro, Heckman, and Dimitriy 2005; Neal and Johnson 1996). Each of these factors plays a role in the representation of minority workers across industries.

Spatial mismatch is also an important concern. Spatial mismatch theory states that in the last several decades job growth has been predominantly a suburban phenomenon while black workers reside disproportionately in urban areas relative to white workers. This mismatch of jobs in suburban areas and black workers in urban areas has been widely cited in the literature as a significant factor in higher rates of unemployment for black workers in recent decades (Holzer et al 2011; Aslund, Osth, and Zenou 2010; Partridge and Rickman 2008; Wang 2008; Johnson

2006; McQuaid 2006; Partridge and Rickman 2006; Houston 2005; Brueckner and Zenou 2003; Smith and Zenou 2003; Zenou and Boccard 2000; Holzer et al. 1994; Kain 1992; Holzer 1991; Ihlanfeldt and Sjoquist1990). In terms of the oil and gas sector, spatial mismatch theory might explain a portion of the lower share of employment for black workers in oil and natural gas fields. These jobs are typically located in rural areas as the majority of oil and gas development occurs outside metropolitan areas.

Networks may also play important roles in finding good jobs in expanding industries (Patacchini and Zenou 2012; Battu et al. 2011; Ioannides and Loury 2004; Topa 2001). Potential entrants into an industry may benefit from social connections to workers already in the industry who can provide information about job openings and serve as references. African Americans may be persistently disadvantaged by historical underrepresentation in the oil and gas industry and limited connections with workers already in the industry.

2.2 Gender Diversity in the Oil and Gas Industry

Historically, women have been underrepresented in the oil and gas industry (Brady 2015; Price 2015; Ditrrick 2014; Feltus 2008). There are many possible factors including a difficult working environment that has discouraged women, discrimination, and a skill mismatch due to women being historically underrepresented in engineering fields (AMMA 2017; API 2015; Brady 2015; GI 2015; and Price 2015). During the boom period, the increased demand for petroleum engineers required oil and gas firms to diversify their hiring in order to meet their increased demand for workers (Brady 2017; Brady 2015; Price 2015). This increased demand for engineers, however, may be offset by low numbers of women working in the oil and natural gas fields where the share of female workers was below 5% in 2010 (Brady 2015, Gillula and

Fullenbaum 2014, p.21, 25). Over the period 1990 to 2014, the share of women working in the oil and gas industry declined from 19.5 percent to 14.6 percent. For Texas the same pattern holds, the share of female employment decreased from 21 percent in 2000 to 17.5 percent in 2014. The share was in fact higher prior to the boom in 1990 at 23.5 percent (Ruggles et al. 2018). The oil and gas boom did not lead to an increase in the share of women in the industry nationally.

More generally, there is a large research literature on gender differences in labor market outcomes. These include examinations of wage differentials (Autor, Katz, and Kearney 2008; Mulligan and Rubinstein 2008; Mueller and Plug 2006; Topel 1994), differences in labor force participation (Compton and Pollak 2014; Fernandez 2013; Eckstein and Lifshitz 2011; Fogli and Veldkamp 2011; Gayle and Golan 2011; Coen-Pirani, Leon, and Lugauer 2010; Aguero and Marks 2008; McKinnish 2004), and examinations of gender composition and discrimination in the workplace (Niederle and Vesterlund 2007; Buser Niederle, and Oosterbeek 2014; Bertrand and Hallock 2001). This paper builds on this literature by examining the composition of female workers in Texas in a male dominated oil and gas industry that underwent a significant period of expansion and rapid hiring across skill levels.

2.3 Oil and Gas Spillovers on Local Economies

Increased oil and gas production requires an influx of workers, particularly in rural areas where the oil and gas fields are primarily located. This may lead to increased spending on construction, accommodations and local services in communities near oil and gas development. Oil and gas companies have argued that the expansion of oil and gas development during the boom period had a significant positive impact on local economies, including increased income and job growth (API 2017). The academic literature, however, has found mixed results in terms of the local economic benefits of the post-2000 oil and gas boom (Weinstein, Partridge, and Tsvetkova 2018; Agerton et al. 2017; Feyrer, Mansur, Sacerdot 2017; Maniloff and Mastromonaco 2017; Tsvetkova and Partridge 2016; Lee 2015; Michieka and Richard 2015; Munasib and Rickman 2015; Paredes et al. 2015; Weinstein 2014; Weber 2012). Overall, the research points to local economic benefits from oil and gas development, but there is some variation by region and in terms of the magnitude of the effects. In a notable recent study, Feyrer, Mansur and Sacerdote (2017) find that new oil and gas extraction between 2005 and 2012 added 640,000 jobs in the United States and decreased the overall unemployment rate by 0.43. Locally, they find that each million dollars in oil and gas production led to an additional $80,000 in wage income within an oil and gas producing county. Nearly 40 percent of that income was due to local economic spillovers, providing income to workers outside the oil and gas industry. They also find that two-thirds of these income increases persist for two year after the initial production increase (Feyrer, Mansur and Sacerdote 2017).

3. Data and Methods

3.1 Data

The data for our analysis were obtained from IPUMS-USA (Ruggles et al. 2018). We use individual-level microdata from the year 2000 decennial census long-form questionnaire (5% sample) and the American Community Survey (ACS), 2001-2016, conducted by the U.S. Census Bureau.[6] The data include detailed individual information

[6] The year 2000 sample is a five percent random sample of the U.S. population. For 2001-2004, the ACS is a roughly 0.4 percent annual sample of the population, and each year of the ACS during 2005-2016 includes a one percent sample of the population.

on age, gender, race, ethnicity, birthplace, education, employment, and income. In order to focus on employment composition in Texas, a key oil and gas producing state, we restrict our analytical sample to persons residing in Texas who at the time of their survey were ages 18-61 and employed. We use pooled cross-sectional data to compare similar people in the same geographic areas over time, but due to data limitations, it is not possible to link individuals across time.

While Texas has 254 counties, our data are combined into 49 local geographic areas. Due to confidentiality protections, the level of geographic specificity is limited for sparsely populated areas. The finest level of geographic identification is the Census Bureau constructed Public Use Microdata Area (PUMA), and confidentiality protections require that PUMAs are defined to contain at least 100,000 residents. This allows for geographic identification for heavily populated areas, but it requires that sparsely populated areas are combined with other nearby areas until the population threshold is met. Our regression analyses are also affected by the availability of PUMA identifiers and changes in PUMA boundaries beginning in 2012.[7] PUMA boundaries were the same for 2000 and 2005-2011, but were redrawn beginning in 2012. To construct consistent PUMAs, we use the IPUMS consistent PUMA variable, CPUMA0010. The result is 49 consistent PUMAs (local areas), some of which include a single urban area and some of which include several adjacent sparsely populated counties.[8] Combining sparsely populated areas into geographically large consistent PUMAs hides variation within the consistent PUMA. Our estimates of the oil and gas employment share for consistent PUMAs are essentially weighted averages of the areas within consistent PUMAs. The limited geographic specificity means that

[7] PUMA identifiers are not available for 2001-2004, so these years are excluded from our regression analysis, but they are included in our descriptive figures showing statewide trends.
[8] We use the terms consistent PUMA and local area interchangeably.

we cannot isolate oil and gas employment effects in sparsely populated areas. However, for our regression analysis, this does have the advantage of internalizing spillovers across areas within consistent PUMAs. Our preferred regression models use instrumental variables to estimate local average treatment effects (LATE). For robustness, we also examine differences between metropolitan and non-metropolitan areas.

Figure 2 provides a map of the 49 consistent PUMAs and illustrates how oil and gas employment rates varied among them in year 2000 by grouping them based on the standard deviations their energy employment is above or below the mean.[9] The energy employment share in 2000 has unweighted mean of 0.016 and unweighted standard deviation of 0.026 across consistent PUMAs. We see that there were considerable differences, some areas had very little oil and gas employment (less than one percent of total employment) and others had oil and gas employment accounting for more than 10 percent of total employment in the area in 2000. This highlights the fact that opportunities for employment in the oil and gas industry were not equally dispersed across Texas. Figure 3 illustrates the change in the oil and gas share of employment during the 2000-2014 period. This shows which areas had the biggest gains in terms of oil and gas share of employment. There are similarities, areas with high oil and gas employment shares in 2000 also tended to experience relatively high growth in the oil and gas employment share over time. However, there is also some notable growth in areas that did not have especially high oil and gas employment shares in 2000.

[9] Individual oil and gas employment is defined based on responses to industry of employment. The oil and gas employment rates in Figures 3-5 are defined based on the number of workers in the oil and gas industry divided by the total number of workers; individual survey weights are used.

Figure 4 illustrates statewide trends over time in oil and gas employment rates separately for men and women. The figure shows that both saw increased employment in the oil and gas industry after 2000 that peaked in 2014 and then declined. However, the oil and gas industry employment rate was consistently higher for males and increased over time more for males than females. This suggests that males may have gained more than women from the oil and gas boom. Figure 5 illustrates time changes in oil and gas employment rates in Texas separately for the four major racial/ethnic groups. All four groups experienced increased oil and gas employment between 2000 and 2014, but there were some ups and downs along the way. White workers had the highest oil and gas employment rate in every year, and black workers had the lowest oil and gas employment rate in all but one year (2004).

3.2 Regression Model

We estimate linear regressions using both ordinary least squares (OLS) and two-stage least squares (2SLS).[10] Our basic model is:

$$Y_{igct} = \theta_g OilGasShare_{ct} + \beta_g X_{igct} + \gamma_{gc} + \delta_{gt} + \varepsilon_{igct}$$

where Y_{igct} is one of two individual-level dependent variables for individual *i* in demographic group *g* living in local area *c* in survey year *t*. Our first dependent variable is a binary variable indicating whether individual i is employed in the oil and gas industry (versus employed in some other industry). We estimate a linear model with a binary dependent variable, a linear probability model (LPM), rather than a probit or logit model. LPM is warranted because we a have a large individual-level dataset and include a large number of fixed effects, which create difficulties in

[10] Our analysis is conducted in Stata using the REGHDFE command (Correia 2017).

estimation and accuracy for non-linear models (Greene 2004).[11] LPM is the primary approach for studies using binary dependent variables with fixed effects in quasi-experimental settings (Angrist and Pischke 2009). Our second dependent variable is the natural log of earned income during the previous 12 months. Our main explanatory variable of interest is $OilGasShare_{ct}$, which measures the share of employment in area *c* and year *t* that is in the oil and gas industry.[12] The detailed individual-level data we use allows us to control for important individual characteristics, X_{igct}; these include detailed dummy variables for age, education, marital status, number of children present, and state of birth (country of birth for foreign-born workers). We also control for hours worked during the previous year in regressions with log earned income as the dependent variable.[13]

Our research is fundamentally interested in how energy employment impacts vary across demographic groups, so we define four mutually exclusive racial/ethnic groups: white, black, Asian, and Hispanic. In constructing these, persons reporting Hispanic ethnicity are assigned to the Hispanic group regardless of their race; i.e., the white, black, and Asian groups are non-Hispanic. Due to data limitations and small sample sizes, we exclude from the regression analyses persons who are not in one of these four race/ethnicity categories.[14] We split each of these four racial/ethnic groups into gender-

[11] In particular, fixed effects create an incidental parameters problem that biases maximum likelihood estimates of probit and logit models (Greene 2004). Additionally, our preferred estimates use instrumental variables, which would further complicate the use of non-linear models with fixed effects.

[12] This variable is computed in multiple steps. We first compute the oil and gas share in each local area and year based on where jobs are located, i.e., PUMAs of workplace, in order to account for the fact that some workers live and work in different places. This measure is then matched to the local areas where people live. Thus,$OilGasShare_{ct}$, is a measure of the oil and gas employment share for jobs located in the area where an individual lives.

[13] Most years of the ACS only report the number of weeks worked the previous year in intervals. We include dummies for each weeks worked interval, and we include a continuous variables for the log of the usual number of hours worked per week.

[14] These excluded persons account for less than two percent of all workers ages 18-61 in Texas.

specific categories yielding eight groups based on combinations of gender, race and ethnicity in our analyses.

Table 1: Panel A includes sub-sample weighted means for the eight demographic groups for the two dependent variables and explanatory variable of interest. There are some consistent patterns. The means for both dependent variables are larger for men than women within each racial/ethnic group. In addition, notably, the means for the explanatory variable of interest, local oil and gas share, are largely comparable across demographic groups for the full sample, though slightly smaller for Asians.

Figures 2 and 3 show that employment opportunities in the oil and gas industry were not equally dispersed across Texas. Table 1: Panels B and C examine the means for the eight demographic groups separately for high and low oil and gas areas. There is more variation in local oil and gas employment shares across demographic groups in Panel B with the highest rate for Hispanics. The means for individual employment in oil and gas are consistently higher in Panel B than Panel C as expected, but the differences across groups are also notable. In particular, the oil and gas employment differential between Panels B and C is larger for males than females and is particularly large for Hispanic males. Of course, these means may reflect permanent differences across areas and may not be informative about the effects of the recent boom and bust. Our empirical analyses focus on determining the effects of the oil and gas boom and bust on the employment and income outcomes for the eight demographic groups.

Our regressions include demographic group-specific controls for consistent PUMA fixed effects (γ_{gc}) and year fixed effects (δ_{gt}). Our inclusion of consistent PUMA fixed effects accounts for time-invariant factors that affect our dependent variables. Our inclusion of year fixed effects accounts for all aggregate factors affecting all areas and individuals in a given year, such as macroeconomic fluctuations and aggregate government policy changes. ε_{igct} is a mean zero error term. We cluster standard errors by consistent PUMA to account for the grouped nature of our main explanatory variable and possible serial correlation within areas.

In order for OLS to give accurate estimates, the error term needs to be uncorrelated with the explanatory variables. This condition may fail to hold for various reasons including measurement error in our primary variable of interest, $OilGasShare_{ct}$. If measurement error is random, it will attenuate OLS coefficient estimates toward zero, but estimates would likely still have the correct sign. However, OLS may also suffer from sampling error that induces correlation between the oil and gas employment dependent variable and the explanatory variable of interest since these come from the same source; this could cause a positive bias for OLS estimates.

3.3 Instrumental Variables

Our preferred estimates use instrumental variables (IV) with 2SLS. 2SLS regresses the explanatory variable of interest ($OilGasShare_{ct}$) on the IV in the first stage and then forms a prediction based on the first-stage to include in the second-stage in place of the explanatory variable of interest. We examine two related instrumental variables, one that is preferred and the other as a robustness check. Our preferred instrument, IV2000, is constructed as follows:

$$IV2000_{ct} = OilGasShare_{c,2000} \times OilGasShare_{US,t}.$$

Our secondary instrumental variable is IV2014 and is constructed similarly as follows:

$$IV2014_{ct} = OilGasShare_{c,2014} \times OilGasShare_{US,t}.$$

IV2000 combines the oil and gas industry employment share in consistent PUMA c in year 2000 ($OilGasShare_{c,2000}$) with the oil and gas industry employment share for the rest of the United States (excluding Texas) in year t ($OilGasShare_{US,t}$). IV2014 follows the same idea but uses the year 2014 oil and gas share in area c.

Our construction of IV2000 builds on previous research using variants of the shift-share instrument strategy (Bartik 1991; Moretti 2010; Partridge et al. 2017; Charles et al. 2018). The spatial variation relies on differences in oil and gas employment across areas in 2000, which largely precedes the subsequent shale boom.[15] The temporal variation relies on the changes in oil and gas employment experienced in the rest of the U.S. outside of Texas. Our main results with IV2000 limit the analysis to the sample from the 2005-2016 ACS; i.e., we exclude the year 2000 sample when we employ IV2000 because the instrument is by construction related to $OilGasShare_{ct}$ for year 2000 observations in ways that would threaten the exogeneity of the instrument. When we use IV2014, we exclude the 2014 sample observations from the analysis for similar reasons.

A valid instrument must be both relevant and exogenous. The relevance condition requires that the instrument be a good predictor in the first stage. We expect the relevance condition to be satisfied for IV2000 for two main reasons. First, we expect oil and gas employment shares in 2000 to be correlated with subsequent growth in oil and gas employment shares during the energy boom; i.e., areas with existing employment in oil and gas will see growth when the industry starts to boom. Second, we expect the timing of changes in oil and gas employment in the rest of the U.S. to be driven by industry conditions related to technology and

[15] New technologies were implemented in parts of Texas earlier than the rest of the U.S., so there was some uptick in oil and gas development in parts of Texas in 2000, but it was still small compared to later increases that began after 2005.

prices that affect oil and gas employment in Texas around the same time. We test the relevance condition based on first-stage diagnostic tests for the strength of the instrument.

The exogeneity condition requires that the instrument be uncorrelated with the error term in the second stage. We first consider the spatial portion of IV2000, $OilGasShare_{c,2000}$. Because the spatial variation is determined at least five years before the 2005-2016 ACS samples, we can be assured that the relationship is not driven by reverse causality. Second, the timing and extent of the subsequent boom in oil and gas employment due to new technology and increased energy prices were not widely or clearly anticipated in 2000, at least not in ways that would cause workers to alter their behavior five or more years in advance. Next, we consider the temporal variation, the source of temporal variation in IV2000, $OilGasShare_{US,t}$, is due to changes in industry technology and prices that are arguably external to individual workers in Texas at the same time. Thus, we expect the IV2000 instrument should be exogenous.

IV2014 should satisfy the relevance condition for similar reasons as IV2000. However, it is intentionally constructed based on the peak of the boom, which somewhat limits the argument for exogeneity. Since IV2000 is based on spatial variation in year 2000, there is potential concern that it might miss some of the oil and gas boom from shale development in areas that did not have significant oil and gas employment prior to the shale boom. IV2014 incorporates oil and gas employment in these "new" oil and gas areas and allows us to examine whether our results are robust to a more shale-inclusive measure. IV2000 is our preferred instrument because of its stronger claim to exogeneity.

One potential threat to exogeneity for both instruments is spatial spillovers that cross consistent PUMA boundaries. For example, some oil and gas workers commute long distances from areas with very little oil and gas employment to work in areas with high oil and gas employment. Similarly, spending multipliers from oil and gas to other industries may cross consistent PUMA boundaries as oil and gas firms and workers consume goods and services produced outside their consistent PUMA. This implies that the actual treatment may be understated in low oil and gas areas, which would attenuate estimates toward zero. Thus, our regression results below may be viewed as lower bounds.

4. Empirical Results

4.1 Gaining Employment in the Oil and Gas Industry

The regression results for the oil and gas industry employment dependent variable are presented in Table 2. OLS results are presented in Panel A. Our preferred 2SLS results using IV2000 are presented in Panel B. Panel C provides 2SLS results using IV2014, which we view as a robustness check. Each of the eight columns of the table corresponds to one of our eight demographic groups. Columns 1-4 are for white males, black males, Hispanic males, and Asian males, respectively. Columns 5-8 are for white females, black females, Hispanic females, and Asian females, respectively. We report the coefficients and standard errors for our main explanatory variable of interest, $OilGasShare_{ct}$, but we do not report the results for the other explanatory variables because they are too numerous and simply intended as control variables.[16] The local oil and gas share is measured as the number of oil and gas jobs divided by the total number of jobs, so a one-unit increase in this share would mean going from zero oil and gas

[16] The exact number of dummy control variables varies slightly across groups because some state/country of birth categories are completely empty for some groups. However, all groups have more than 200 dummy explanatory variables included making their results too numerous to present. In general, variables with clear expectations had coefficients of the expected sign.

employment to all oil gas employment in the area. The oil and gas share in our analytical sample has a minimum value of zero and a maximum value of 0.268; the mean share is 0.020 and the standard deviation is 0.025.[17] The dependent variable is an indicator variable equal to one for workers employed in the oil and gas industry and zero for those not. Thus, a coefficient of one would mean that a one percentage point increase in the explanatory variable would increase the probability of oil and gas employment by one percentage point.

All OLS coefficient estimates in Panel A of Table 2 are positive, and all but the estimates for Asian males and Asian females in Columns 4 and 8 are statistically different from zero at the one percent level of significance. However, the magnitudes vary quite a bit across the eight groups. In particular, the magnitudes are generally larger for men than women, but even within each gender, there is some variation across racial/ethnic groups. The coefficient estimate is largest for Hispanic males (1.19), followed by black males (0.955) and then white males (0.648). The coefficient is smallest for black females (0.091) and no female group has an OLS coefficient larger than 0.3. These results suggest that local increases in oil and gas employment increase the likelihood of getting a job in the oil and gas industry for most groups of workers, but the impact varies across demographic groups. Hispanic males and black males seem to gain the most in terms of obtaining oil and gas employment, while black females gain the least.

OLS estimates may suffer from measurement error and other sources of endogeneity. Our preferred estimates in Table 2 are those in Panel B from 2SLS using IV2000. Our first-stage diagnostic tests indicate that IV2000 is a strong instrument in all

[17] The summary statistics are for the full sample, but the summary statistics across demographic groups are comparable.

cases except for in Columns 4 and 8 for Asian males and Asian females, respectively. According to Stock and Yogo (2005), the weak instrument test critical value based on a 5% size distortion of a 5% Wald test is 16.38 for our case. In Panel B, the first stage Kleibergen-Paap Wald F statistics (Kleibergen and Paap 2006) exceed 16.38 in Columns 1-3 and 5-7 but fall below 16.38 in Columns 4 and 8, so we should be cautious in interpreting the results in Columns 4 and 8 .[18]

Interestingly, the pattern of results is similar between Panels A and B, but there are some apparent differences.[19] First, the coefficient estimate increases substantially for black males to 2.023 in Panel B. The coefficient estimates increase for some other groups as well including Hispanic males (1.351), Hispanic females (0.502), and white females (0.37). Asian males and Asian females have especially large coefficient estimate increases from Panel A to B, but their estimates are very noisy and not statistically significant. The coefficient estimates decrease from Panel A to B for white males (0.491) and black females (-0.34), and the black female coefficient estimate is now negative but not statistically different from zero. Overall, black males and Hispanic males continue to be the most responsive to local oil and gas employment in terms of gaining jobs in the industry. The coefficient of 2.023 for black males indicates that a one standard deviation (0.025) increase in the local oil and gas share would increase the probability of oil and gas employment for black males by five percentage points on average. Black males are indeed quite responsive to local oil and gas employment booms in their local areas. Among females, Hispanic females have the largest statistically significant coefficient (0.502), indicating that a one standard deviation increase in the local oil and gas share would increase the

[18] For brevity, we do not report the first-stage coefficients on the instrument, but they were positive and statistically significant in all cases as expected.

[19] The bottom of Panel B reports the p-values for tests that the OLS results are endogenous, which amount to testing the statistical significance of the difference between OLS and 2SLS coefficients. None of the OLS endogeneity tests in Panel B are significant at the five percent level for any group; the test for black males is significant at the ten percent level.

probability of employment for Hispanic females by 1.3 percentage points. The effect for women is less than for men, but still economically significant.

Results in Panel C using IV2014 are generally similar to results in Panel B using IV2000. Some of the coefficient estimates are larger, while others are smaller, but none of the coefficient estimates in Panel C is statistically different at the ten percent level from its corresponding estimate in Panel B. Hispanic males (1.618) and black males (1.386) still have the two largest coefficients that are statistically significant, but the Hispanic male coefficient is larger in Panel C than in Panel B, while the black male coefficient decreases from Panel B to C. For women, the coefficient for white females increases slightly (0.399), while the coefficient for Hispanic females decreases (0.359). Thus, for Hispanic females and black males, using IV2014, the coefficients indicate that a one standard deviation increase in local oil and gas share leads to a 0.9 and 3.4 percentage point increase in the probability of oil and gas employment on average, respectively. Some variation in coefficient estimates is to be expected with different instruments, but the qualitative pattern of results is largely similar.

Overall, the results in Table 2 suggest that both men and women gain jobs in the oil and gas industry when oil and gas employment grows in their local area. Thus, both genders appear to benefit. However, the gains are not evenly distributed across genders or racial/ethnic groups. Men are more likely than women to gain employment in the oil and gas industry due to increased local oil and gas employment. Hispanic males and black males are especially likely to gain oil and gas employment, while black females appear to gain the least and may not gain at all.

4.2 Income Effects

While we expect that gaining oil and gas employment provides direct benefits to the workers who get those oil and gas jobs, additional benefits may spillover to local workers outside the oil and gas industry via local income multipliers. Specifically, a boom in the local oil and gas industry may increase local demand for restaurants, retail stores, personal services, and other places where oil and gas workers spend money in the local economy. This increased demand for local labor will drive up wages and incomes in the local areas, even for workers not working in the oil and gas industry. In any given year of our data period, less than three percent of all workers in Texas are employed in the oil and gas industry. However, the other 97 percent or more may still benefit from local oil and gas development through these local spillover effects.

Table 3 reports the estimated effects of the local oil and gas employment share on the log earnings of workers employed outside the oil and gas industry. Table 3 is structured similarly to Table 2 with three panels and eight columns.[20] The OLS results in Panel A indicate significant positive effects for only five of the eight groups, with estimates for black males, Asian males, and black females not statistically significant at the ten percent level or higher. As discussed before, there are some limitations with OLS estimates.

Panel B of Table 3 presents our preferred income results from 2SLS estimation using IV2000. The weak identification statistics are above the relevant critical value for all groups except for Asian males and Asian females. Only five of the eight groups have statistically significant 2SLS coefficient estimates, but now black males, black females and Asian females are the ones not statistically significant at conventional levels. However, it is important to note

[20] The sample sizes in Table 3 are slightly smaller than in Table 2 because Table 3 excludes workers employed in the oil and gas industry and excludes workers with non-positive earnings in the prior 12 months. A few workers have non-positive earnings because they are new entrants to the labor market, work unpaid for a family business, or are self-employed without making a positive income.

that all of the coefficient estimates in Panel B are relatively large and most are comparable in magnitude. Thus, it is likely incorrect to conclude that there is zero effect for black males, black females, and Asian females. Their estimates are too noisy to draw strong inferences, but their estimated coefficients are comparable in magnitude to other groups. The largest coefficient estimate in Panel B is for Asian males (8.587).

OLS endogeneity tests in Panel B of Table 3 are significant at the five percent level for five of the eight groups and significant at the ten percent level for a sixth group. In all six of these cases, the OLS coefficient estimates are smaller than the corresponding 2SLS estimate in Panel B. This indicates that these OLS coefficient estimates in Table 3 are biased downward due to endogeneity.[21] In all instances, our preferred estimates are from 2SLS using IV 2000.

Interpreting the magnitude of the income spillover effects in Table 3 requires consideration of the size and dispersion of the $OilGasShare_{ct}$ explanatory variable. As noted above, $OilGasShare_{ct}$ has a mean of 0.020 and a standard deviation of 0.025. The dependent variable is the natural log of earned income. Thus, a hypothetical coefficient of 2.0 would imply that a one standard deviation increase in the local oil and gas share of employment would increase average wages for workers outside the oil and gas industry by about five percent. All coefficients in Panel B exceed 2.0 except for Asian females (1.928), which is very close to 2.0, so these are meaningfully large effects. Workers outside the oil and gas industry appear to benefit in a very real way from increased oil and gas employment in their area. It is also worth noting that the income spillover

[21] Endogeneity is a much more severe problem for OLS in Table 3 than in Table 2. While we can only speculate, this may suggest that OLS results in Table 1 have competing negative and positive biases that partially offset, while OLS in Table 3 is much more strongly affected by negative bias.

estimates are not very different between genders or racial/ethnic groups except for Asian males.

2SLS results in Panel C using IV2014 are largely similar to those in Panel B using IV2000. However, the coefficient estimates in Panel C are statistically significant for seven of the eight groups, with only the estimate for Asian females not significant. The coefficient magnitudes are generally similar to corresponding estimates in Panel B, and none of the coefficient estimates in Panel C is statistically different at the ten percent level from its corresponding estimate in Panel B. In terms of estimated magnitude, the most notable increase from Panels B to C is for black females (4.639) and the most notable decrease is for Asian females (0.40).

While Table 3 estimates spillover effects on income, one might also be interested in the direct effects on income for workers receiving high-paying jobs in the oil and gas industry during a boom. Unfortunately, we are not able to estimate this effectively with our data, in part because we only observe individuals at a single point in time, i.e., we do not have individual-level panel data. Essentially, we do not have enough information to construct a valid counterfactual about how much individual workers who gained employment in the oil and gas industry would have earned had the industry not boomed and they not gained oil and gas employment. Table 4 extends Table 3 and provides estimated effects of the local oil and gas employment share on average log incomes of all workers, including both workers employed in the oil and gas sector and workers employed outside of oil and gas. The results are overall quite similar to Table 3, which should be expected since the oil and gas workers added in Table 4 account for less than three percent of the total workforce. Focusing on 2SLS results using IV2000 in Panel B of Table 4, we see that the largest increase in coefficient is for Hispanic males and black females are the only group with a (slightly) smaller coefficient estimate in Table 4 than in Table 3.

The takeaway from Table 4 is that incorporating direct effects from income in oil and gas employment increases the income benefits from local oil and gas employment. This is consistent with expectations that oil and gas jobs are typically high-paying and that more workers getting these jobs during oil and gas booms will increase average wages in an area.

4.3 Additional Robustness Checks

We also conducted additional sensitivity analysis with results in Table 5. First, in Panels A and B, we estimated OLS regressions for Tables 2 and 3 excluding year 2000 to ensure that including year 2000 was not driving differences with the preferred 2SLS results; this did not significantly change the OLS results. Second, in Panels C and D, we simultaneously used IV2000 and IV2014 as instruments in the same 2SLS regressions; results were not significantly different from our preferred estimates in Tables 2 and 3 that just use IV2000. Third, in Panels E and F, we excluded the five largest geographic area consistent PUMAs, which may have noisily estimated oil and gas shares; most of the main results were qualitatively similar, except the oil and gas employment dummy outcome for white males using IV2000 was no longer significant at the ten percent level, though the coefficient estimate is not statistically different from the preferred estimate in Panel B of Table 2.

We also experimented with altering the set of control variables in our IV2000 2SLS models. In Panels G and H, we excluded the education, marriage, and children control variables (which might be affected by local oil and gas employment shocks) and this did not significantly alter the results relative to our preferred 2SLS specifications in Panel B of Tables 2 and 3. We also experimented with adding a Bartik (1991) style shift-share control variable in Panels I and J.

The Bartik control predicts local employment outside the oil and gas sector in year *t* by multiplying industry employment shares in year 2000 by the national growth (excluding local growth) factor in employment by industry between year 2000 and year *t* and then sums across industries. Results with the Bartik control were qualitatively similar to our preferred estimates. Similarly, we also estimated 2SLS models with time-varying controls for consistent PUMA characteristics including the manufacturing share of employment, the service industry share of employment, the health care industry share of employment, the share of the population with a college degree, and the share of the local workforce that is female. Results are in Panels K and L of Table 5. The results for the local oil and gas employment share are qualitatively similar to the main estimates without the additional controls. Furthermore, these time-varying control variables are typically not significant in Panels K and L, bolstering our confidence in excluding them from the main model.

We next examined if the effects of the local oil and gas employment share varied between metropolitan and non-metropolitan areas; IV2000 2SLS results are in Panels M-P of Table 5. Metropolitan areas are expected to have different oil and gas job opportunities than non-metropolitan areas. Specifically, non-metropolitan areas are expected to have more oil field related jobs, while metropolitan areas are expected to have more office jobs. Metropolitan sample results in Panels M and N are qualitatively similar to our main results for the full sample, though the effect on oil and gas employment for white males is not quite statistically significant at the ten percent level. Unfortunately, the non-metropolitan sample sizes for Panels O and P are much smaller and the estimates are often noisier; particularly notable in contrast to the main results for the full sample, the oil and gas employment coefficient for black males becomes small (0.143) and statistically insignificant and the black female income coefficient is effectively zero

(0.030) in non-metropolitan areas. However, both of these have large standard errors implying wide confidence intervals, and we cannot make strong inferences about differences between metropolitan and non-metropolitan areas.

Finally, we replaced our local oil and gas employment share variable calculated from the IPUMS data with the local mining employment share computed from the Quarterly Workforce Indicators (QWI) dataset in Panels Q and R; the results were again qualitatively similar.

4.4 Nationwide Effects Excluding Texas

In order to determine if the effects of the local share of oil and gas employment on employment in the oil and gas sector and income outside of the oil and gas sector were limited to Texas, we expanded our analysis to the rest of the United States excluding Texas.[22] We constructed consistent PUMAs for all states using the same method that we used for Texas. However, Census Bureau confidentiality protections limit geographic identification such that many states have only a few consistent PUMAs and some have only one (the entire state). We constructed a corresponding version of IV2000 that excludes temporal variation for each own state. Specifically, IV2000 combines the year 2000 share of oil and gas employment in each consistent PUMA with the post-2000 change in the national oil and gas employment share excluding the own state.

Our findings are presented in Table 6. Panels A and B present OLS and 2SLS results for the dependent variable individual oil and gas employment (corresponding to Table 2 Panels A and B). Panels C and D of Table 6 present OLS and 2SLS results for the dependent variable the log earned income of workers outside the oil and gas industry

[22] We also examined results for the national sample including Texas. As expected, they reflect a weighted average between the results for Texas and the rest of the United States.

(corresponding to Table 3 Panels A and B). Our discussion focuses on the preferred 2SLS results. It is important to note that the first-stage F-statistics are typically smaller for the rest of the United States than for Texas and often slightly below 10, so some caution is warranted, but the instrument appears strong enough to make reasonable inferences.

The results for men in Table 6 Panel B are consistent in direction and magnitude with the corresponding estimates in Table 2 except for white males, for which the coefficient increases to 1.698. For women in Panel B, only white females have a significant coefficient (0.509) at the ten percent level. In addition, the Hispanic female coefficient was significant in Table 2 but is reduced in magnitude in Table 6 Panel B (0.168) and no longer significant. The results in Panel D of Table 6 are directionally consistent with Table 3, but the coefficients estimates are larger except for Asian males. The coefficient estimate is especially large for black females (11.231). Overall, the findings in Table 6 Panel D indicate that increases in the local share of oil and gas employment have positive income spillovers for workers outside the oil and gas industry in the national sample excluding Texas. Thus, Table 6 suggests some differences between Texas and the rest of the U.S. in terms of how the benefits of local oil and gas development are distributed, but the benefits are still generally large and widespread.

4.5 Occupational Employment in the Texas Oil and Gas Industry

While Table 2 is informative about the overall effects on individual employment in the oil and gas industry, it does not tell us about the type of work being done. Table 7 builds on Table 2, with analyses of employment in specific occupations in the oil and gas industry. We define seven occupation groups: extraction, transportation, technicians/repairers, construction trades, managerial/professional, administrative/clerical, and all other oil and gas industry occupations. We then create dummy dependent variables for oil and gas industry employment in each of these seven occupation groups and estimate 2SLS linear probability models using IV2000. Results are reported in the seven panels of Table 7. The analysis includes the full sample and the dependent variables are joint outcomes for working in the oil and gas industry *and* working in a particular occupation. The specification is otherwise identical to Table 2 Panel B. First-stage F-statistics are identical to corresponding statistics in Table 2 and are thus omitted to conserve space.

We are cutting the data very thinly, so most of the estimates in Table 7 are not statistically significant, but there are some notable results among those that are significant. First, increases in the local oil and gas share increases extraction occupation employment for black males (0.648) and Hispanic males (0.374). Hispanic males (0.219) and Hispanic females (0.058) significantly gain employment in transportation occupations in the oil and gas industry. Five groups gain managerial and professional occupation employment in the oil and gas industry including white males (0.268), black males (0.413), Hispanic males (0.279), white females (0.187), and Hispanic females (0.158). Black males (0.318) and white females (0.186) gain administrative and clerical occupations in oil and gas, but black females experience significant negative effects (-0.266). The causes of these job losses for black females are unclear, but the result supports the findings in Table 2 Panel B that the positive employment effects of increased local oil and gas employment do not extend to black females. Black males (0.346) and Hispanic females (0.055) significantly gain in oil and gas employment in other occupations. Overall, the gains for females appear to be concentrated in office occupations, while the gains for men are spread across various occupations including both office jobs and field jobs.

4.6 Employment in Other Industries in Texas

We also examined the effect of the local oil and gas employment share on the probability that individuals gain employment in specific non-oil and gas industries. This analysis is designed to shed light on how local oil and gas booms affect the industrial composition of the rest of the local economy, e.g., because of positive or negative spillovers, and how the changing industrial composition effects vary across sex and race/ethnicity. 2SLS results using IV2000 are reported in Table 8. Each panel corresponds to a different dependent variable. The specification is otherwise identical to Panel B of Table 2; first-stage F-statistics are identical to corresponding ones in Table 2.

Panel A indicates statistically significant negative effects on agricultural employment for white males (-0.229), Hispanic males (-0.364), and white females (-0.105), suggesting that oil booms draw workers away from agricultural employment. Hispanic females experience increased employment in multiple industries including construction (0.358), transportation (0.268), and manufacturing (0.413). White females also have increased employment in manufacturing (0.413), but no other group has significant positive effects for construction, transportation, or manufacturing. This may suggest some positive spillovers to these industries related to oil and gas, but with relative opportunities that especially benefit females. For the wholesale industry, Hispanic females have a significant positive coefficient (0.289), while there are significant negative effects for white males (-0.278) and Asian males (-1.120), which may suggest that the wholesale industry loses male workers to the higher paying oil and gas jobs and fills these openings by hiring more Hispanic females. Hispanic males (-0.400) and Hispanic females (-0.424) become significantly less likely to work in the retail industry, which is a low paying industry that may struggle to compete with higher paying alternatives. For the finance industry, black males have increased employment (1.247) and Hispanic males have decreased employment (-0.231), neither of which is strongly expected or easily explained. Business services lose Hispanic females (-0.373) and Asian females (-2.253), and personal services lose white females (-0.269), likely to higher paying alternatives. Professional services lose Hispanic females (-1.246). For public administration, white males gain employment (0.174), while Hispanic males experience decreases (-0.284), neither of which is strongly expected or easily explained. Overall, the results are consistent with workers shifting from lower paying industries to higher paying ones, especially for Hispanic females and white females. This movement to higher paying industries is good for workers though may present a challenge for low-paying industries that struggle to compete.

5. Conclusion

Oil and gas employment boomed in Texas from 2005-2014, due to new technology that made shale resources profitable to develop. Oil and gas booms have the potential to benefit many workers, both directly through employment in the high-paying oil and gas industry and indirectly via spillover effects to other industries. However, the incidence of these benefits may vary by worker gender, race, and ethnicity. For example, it is widely known that oil and gas industry employment is disproportionately male and white, and the benefits from oil and gas booms may be expected to be concentrated among white males as well, which would exacerbate existing income inequalities including pay gaps by gender, race, and ethnicity.

We use data from the 2000 decennial census and 2001-2016 American Community Survey to examine how effects of increased oil and gas employment in Texas vary by gender, race, and ethnicity. We first present descriptive trends for the state as a whole and find that men had a stronger oil and gas employment response than women as expected. Descriptive evidence also suggests that African Americans lag the other major racial/ethnic groups in gaining oil and gas employment in Texas. We additionally conduct regression analysis of the effects of local oil and gas employment on two individual labor outcomes: gaining employment in the oil and gas industry and the natural log of annual income for workers employed outside the oil and gas industry. In order to address concerns regarding endogeneity in OLS estimates, we used a two-stage least squares regression model. We estimate these regressions separately for eight demographic groups that include gender-specific categories for white, black, Hispanic, and Asian workers.

Our preferred estimates indicate that most groups that we examine experience an increased likelihood of employment in the oil and gas industry in Texas due to the oil and gas boom. However, the effects vary across groups. In particular, men generally had a higher probability of gaining oil and gas employment than women did during the boom. The largest gains were found for Hispanic males and black males. White and Hispanic females also had positive gains in employment, while black females appear to gain very little in oil and gas employment or not at all.

While historically minority groups have comprised a small share of oil and gas employment, our findings indicate that the boom was particularly beneficial for Hispanic and black males. This suggests that the boom increased racial/ethnic diversity in the oil and gas industry and Texas. It also increased opportunities for women, specifically white and Hispanic women. Our findings indicate that the employment gains from the oil and gas boom were distributed across racial/ethnic groups and genders.

Less than three percent of all workers in Texas are employed in the oil and gas industry, so most workers are not directly affected by employment gains in the oil and gas industry. However, we find that income spillovers are economically important and generally similar in magnitude for white males and females and Hispanic males and females. A one standard deviation increase in the local oil and gas employment share increases incomes by more than five percent for these groups. While income spillover coefficients are not statistically significant at conventional levels for black males and females, the magnitudes are similar to other groups. Additional analysis indicates that the positive income effects from local oil and gas employment are even larger if we incorporate the direct effects from workers gaining high-paying jobs in the oil and gas industry.

Public policy decisions regarding the oil and gas industry have important consequences for various stakeholders, with benefits for some and costs for others. Our study cannot resolve any particular policy dispute, and there are certainly considerations beyond labor market impacts. For instance, there are local concerns associated with oil and gas development including road noise and congestion, earthquakes, and negative environmental impacts including air and water pollution (Ellsworth 2013; Fry et al. 2015; Keranen et al. 2014; Wang et al. 2014). Higher wages in areas experiencing natural resource booms may partially reflect compensating differentials that offset negative externalities. Oil and gas booms may also affect prices for housing and other local goods and services that further alter how the benefits are distributed. While this paper does not address the total net benefits of oil and gas development, we hope this research contributes to energy policy discussions by providing useful evidence on the distribution of labor market benefits from local oil and gas employment growth. Our results suggest that the labor market benefits are quite widespread and economically meaningful. Many workers appear to benefit from increased oil and gas employment in their local area via higher average incomes. The labor market benefits do not just accrue to workers in the oil and gas industry; we find strong evidence of income spillovers accruing to workers outside the oil and gas industry. The benefits do not just accrue to men; they accrue to women too, especially via income spillovers. The benefits do not just accrue to one or two racial/ethnic groups; they appear to benefit all of the major demographic groups considered. Thus, not only are there positive labor market impacts from oil and gas employment in an area, they appear to be widespread across different groups of workers.

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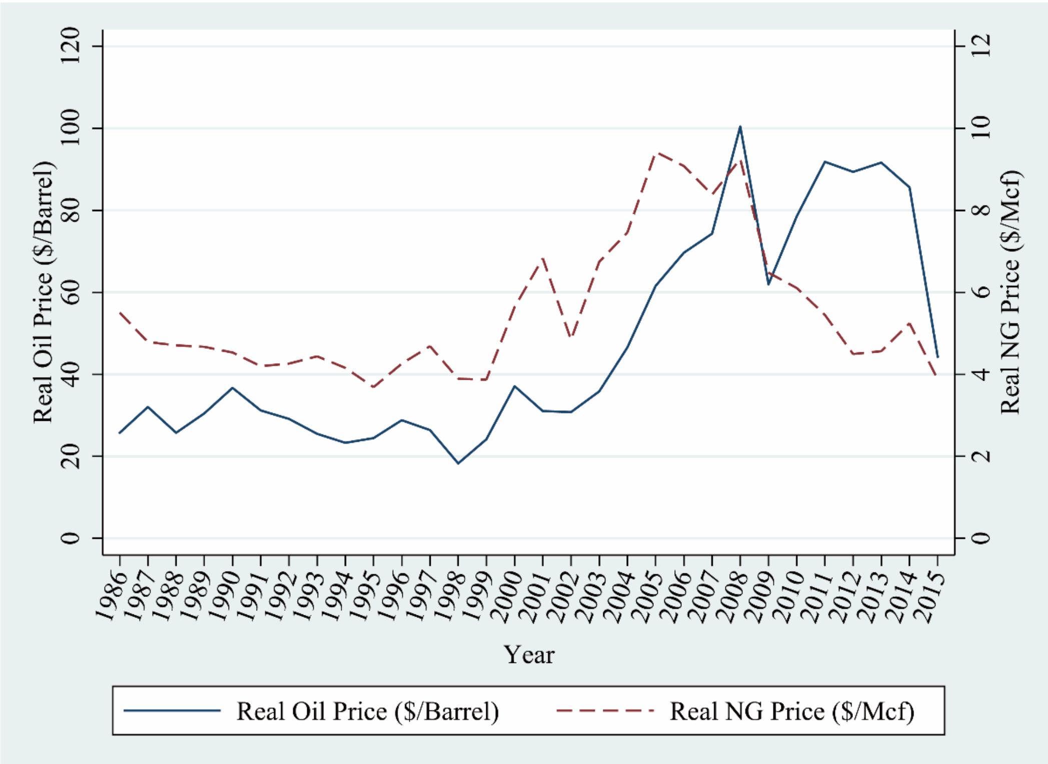
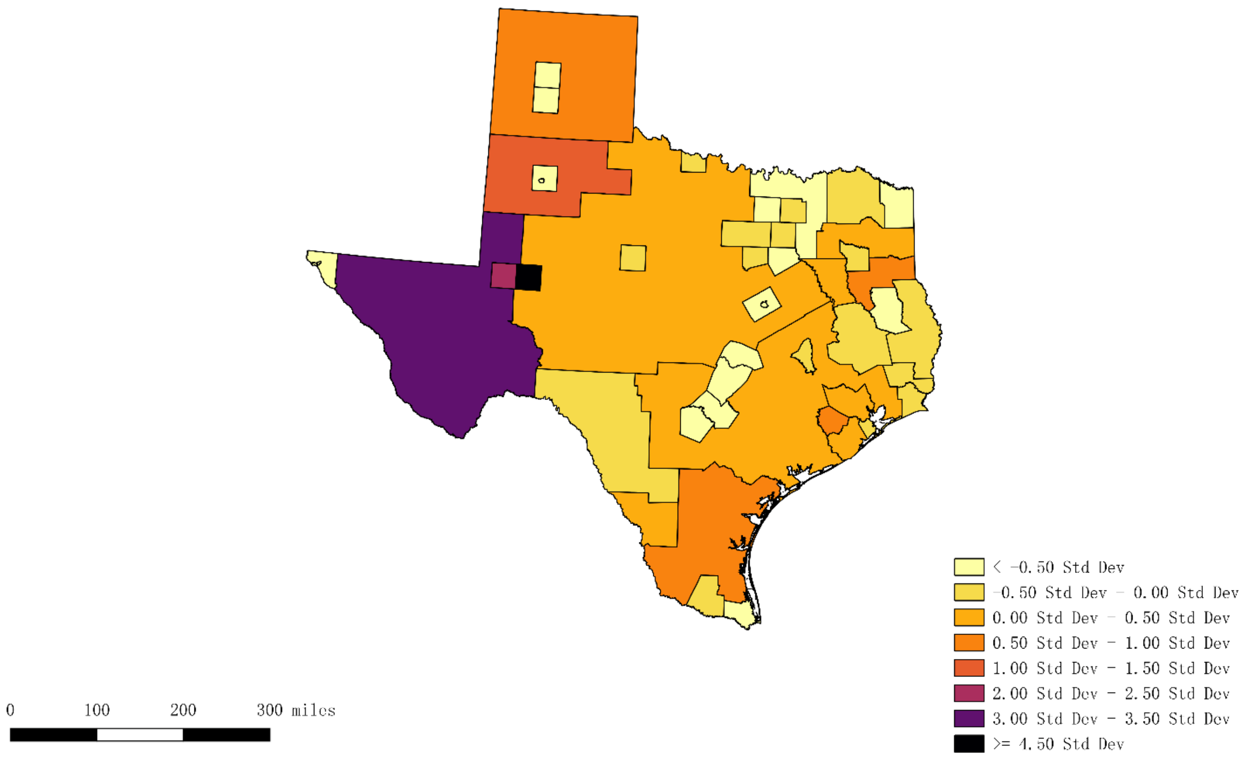
Figure 1: U.S. Real Oil and Natural Gas Prices: 1986-2015



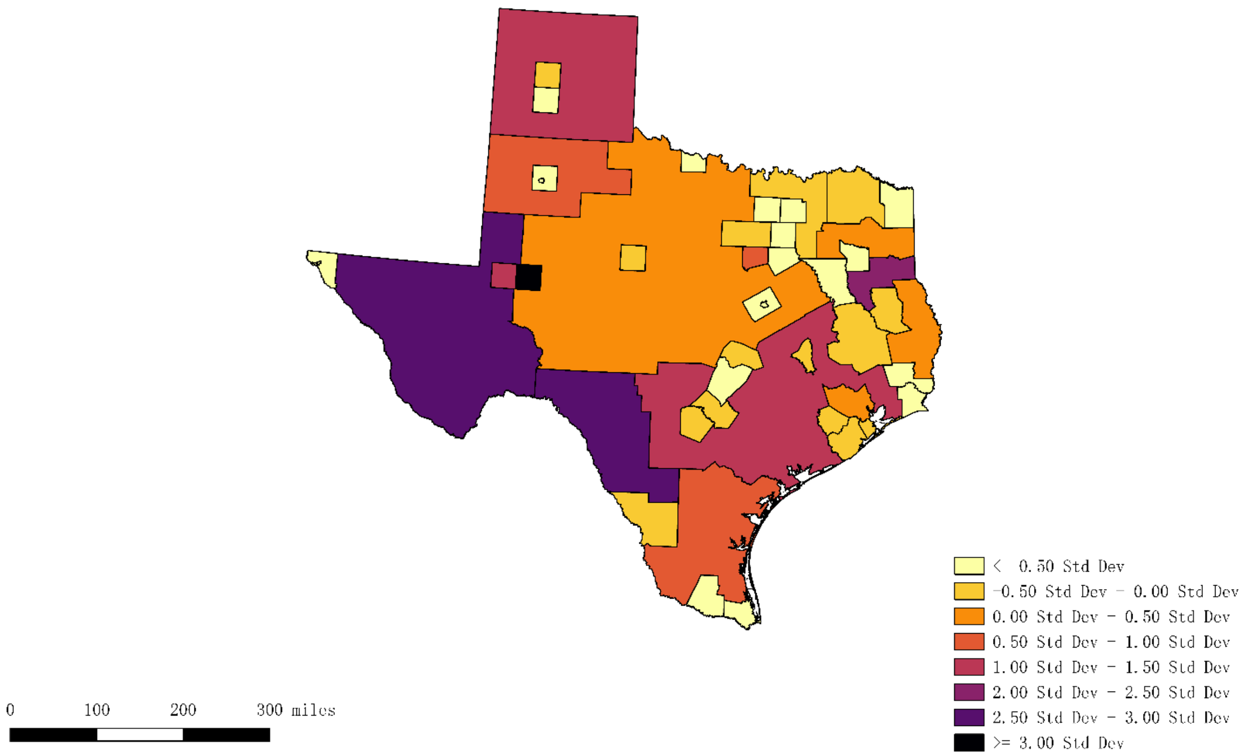
Source: EIA: U.S. Natural Gas citygate price ($/Mcf); EIA: Cushing, OK WTI Spot Price FOB ($/Barrel) 2016
Note: Prices are converted to real prices using the Federal Reserve Economic Data (FRED) Gross Domestic product chained index.

Figure 2: Map of Year 2000 Energy Employment in the 49 Consistent PUMAs of Texas



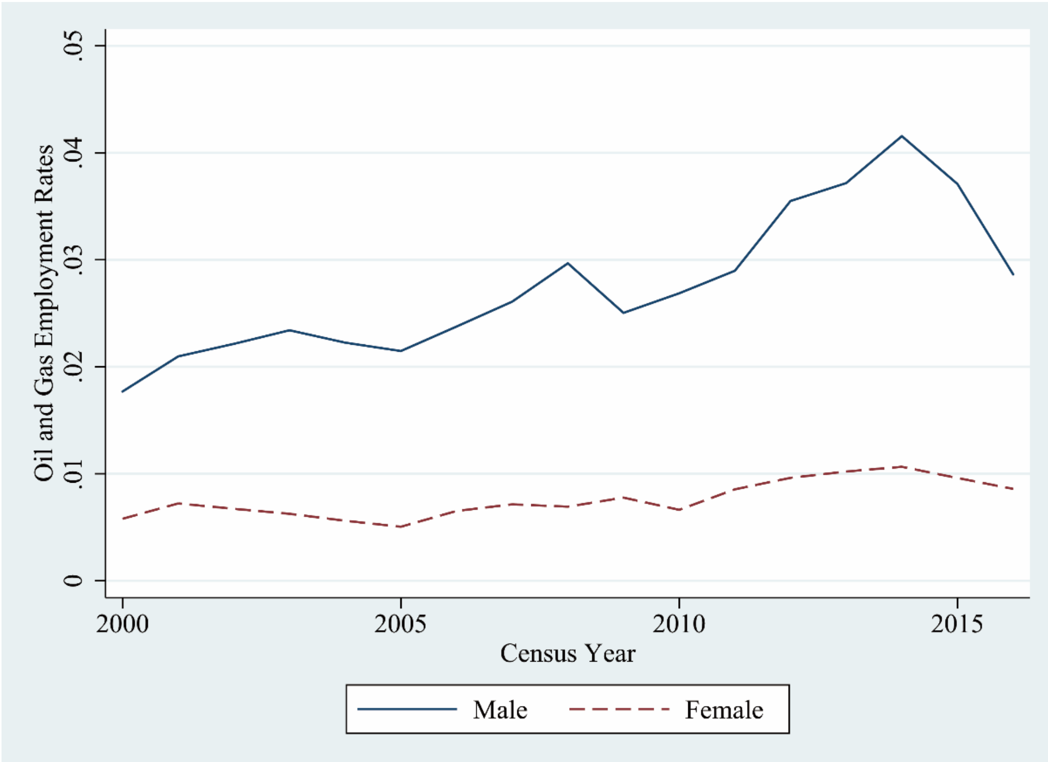
Source: Constructed by authors based on IPUMS data. The boundaries are for the 49 consistent PUMAs of Texas, some of which comprise a single urban area while others are aggregates of several contiguous counties. The energy employment share is measured as the share of oil and gas employment relative to total employment in all industries. The energy employment share in 2000 has an unweighted mean of 0.016 and an unweighted standard deviation of 0.026. The map categorizes consistent PUMAs based on the standard deviations that their energy employment is above or below the mean.

Figure 3: Map of 2000-2014 Change in Energy Employment Share across Consistent PUMAs



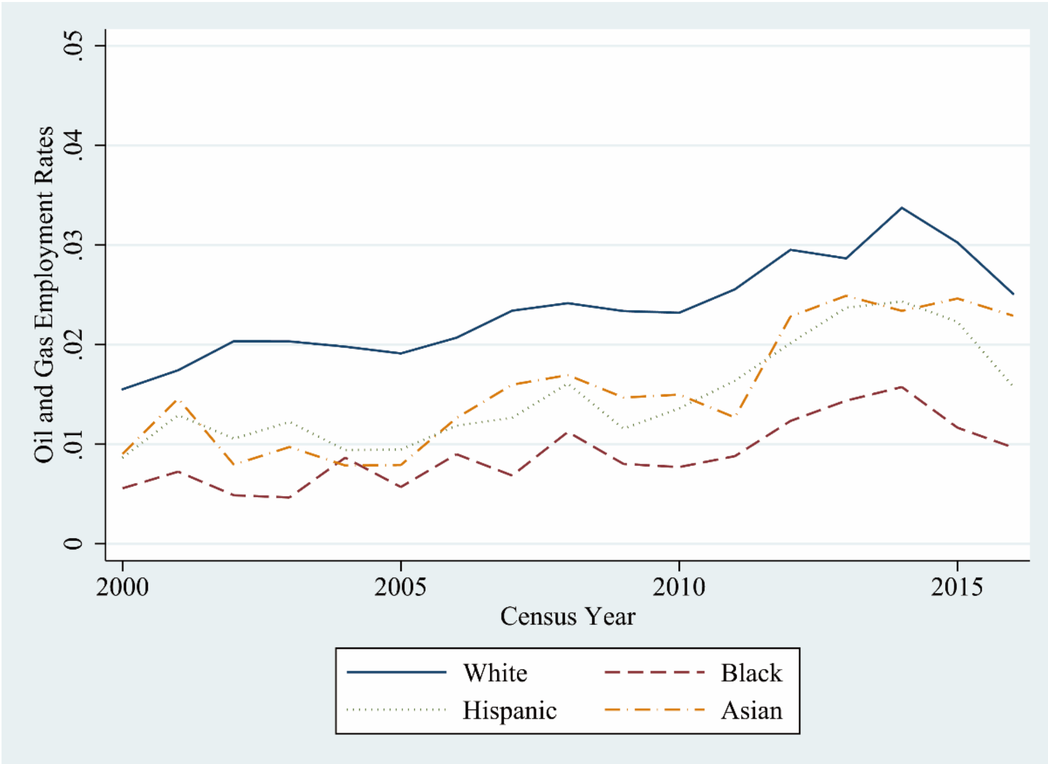
Source: Constructed by authors based on IPUMS data. The boundaries are for the 49 consistent PUMAs of Texas. We compute the energy employment share for each consistent PUMA in 2000 and 2014 and then the 2000-2014 change. The change in the energy employment share has an unweighted mean of 0.020 and an unweighted standard deviation of 0.029. The map categorizes consistent PUMAs based on their 2000-2014 change in energy employment share relative to the standard deviation in the change across consistent PUMAs.

Figure 4: Texas Oil and Gas Employment Rates over Time for Men and Women in IPUMS



Note: Total employment in the oil and gas industry among workers ages 18-61 residing in Texas increased between 2000 and 2014 from 84,986 to 260,573 for males and from 22,658 to 55,212 for females. By 2016, oil and gas employment had fallen to 184,514 for males and 46,543 for females. The increases in the size of the oil and gas industry between 2000 and 2014 are large in part because Texas' population was increasing during this period.

Figure 5: Texas Oil and Gas Employment Rates over Time by Race/Ethnicity in IPUMS



Note: The increase in total employment in the oil and gas industry among workers ages 18-61 residing in Texas from 2000-2014 by race/ethnicity was from 78,509 to 173,710 for whites, from 5,012 to 20,993 for blacks, from 20,353 to 103,069 for Hispanics, and from 2,378 to 13,040 for Asians. 2016 oil and gas employment by race/ethnicity was 129,315 for whites, 13,688 for blacks, 70,686 for Hispanics, and 13,910 for Asians. The Texas oil and gas industry experienced some increased racial/ethnic diversity during this period because Texas as a whole was experiencing an increase in population and becoming more diverse.

Table 1: Sub-Sample Weighted Means for Main Variables by Demographic Group

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
A. Full Sample								
Individual Employed in Oil & Gas	0.036	0.015	0.025	0.023	0.011	0.006	0.004	0.013
Log Income Outside Oil & Gas	10.623	10.160	10.048	10.577	10.137	9.976	9.684	10.181
Local Oil and Gas Share	0.021	0.020	0.021	0.018	0.020	0.020	0.020	0.019
B. High Oil & Gas Areas								
Individual Employed in Oil & Gas	0.059	0.026	0.066	0.045	0.014	0.006	0.007	0.025
Log Income Outside Oil & Gas	10.505	10.142	10.077	10.571	9.988	9.906	9.629	10.231
Local Oil and Gas Share	0.035	0.032	0.042	0.031	0.035	0.031	0.042	0.031
C. Low Oil & Gas Areas								
Individual Employed in Oil & Gas	0.027	0.012	0.015	0.018	0.010	0.005	0.003	0.010
Log Income Outside Oil & Gas	10.668	10.164	10.041	10.578	10.193	9.994	9.699	10.169
Local Oil and Gas Share	0.015	0.017	0.016	0.015	0.015	0.017	0.015	0.016

Note: All samples are restricted to persons who at the time of their survey were ages 18-61, employed, and resided in the state of Texas. High oil & gas areas in Panel B are those with local oil and gas share in 2000 above the median. Low oil & gas areas in Panel C are those with local oil and gas share in 2000 at or below the median. High black workers areas in Panel D are those with local black employment share in 2000 above the median.

Table 2: Effects of Local Oil and Gas Employment Shares on Individual Oil and Gas Employment by Demographic Group

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
A. OLS								
Local Oil and Gas Share	0.648***	0.955***	1.190***	0.399	0.252***	0.091***	0.234***	0.268
	(0.107)	(0.222)	(0.084)	(0.381)	(0.027)	(0.030)	(0.083)	(0.275)
Number of observations	484927	66173	268172	32886	413622	80201	204410	28368
B. 2SLS using IV2000								
Local Oil and Gas Share	0.491*	2.023***	1.351***	1.146	0.370***	-0.340	0.502**	1.501
	(0.248)	(0.562)	(0.172)	(1.354)	(0.066)	(0.336)	(0.209)	(1.319)
Number of observations	343875	48150	204076	26839	296301	59077	159416	23458
Weak identification statistic	55.824	18.804	67.958	5.541	52.710	18.843	55.381	8.205
OLS endogeneity test p-value	0.609	0.096	0.296	0.481	0.109	0.348	0.173	0.322
C. 2SLS using IV2014								
Local Oil and Gas Share	0.673***	1.386***	1.618***	1.423	0.399***	-0.003	0.359**	1.698
	(0.248)	(0.367)	(0.146)	(1.559)	(0.056)	(0.233)	(0.148)	(1.410)
Number of observations	456445	61786	249629	30335	389139	74935	189791	26188
Weak identification statistic	85.837	44.582	98.216	9.138	87.814	40.247	80.025	10.460
OLS endogeneity test p-value	0.696	0.261	0.024	0.369	0.072	0.650	0.223	0.272

Notes: The dependent variable is an oil and gas industry employment dummy. All samples are restricted to persons who at the time of their survey were ages 18-61, employed, and resided in the state of Texas. Samples in Panel A cover year 2000 and 2005 - 2016; Panel B excludes 2000; Panel C excludes 2014. A large number of age, birth place, educational attainment, marital status, present of children, consistent PUMA, and year dummies are absorbed by the REGHDFE command in Stata and not reported. All regressions use Census/ACS survey weights. Standard errors are shown in parentheses and are clustered by consistent PUMA. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Spillover Effects of Oil and Gas Employment on Log Incomes of Workers Outside the Oil and Gas Industry

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
A. OLS								
Local Oil and Gas Share	0.954***	0.166	0.896***	-0.188	0.673***	1.039	1.072***	2.047**
	(0.211)	(0.571)	(0.313)	(0.885)	(0.224)	(0.672)	(0.363)	(0.811)
Number of observations	465228	64542	258569	32004	405577	78973	200768	27844
B. 2SLS using IV2000								
Local Oil and Gas Share	2.862***	2.396	2.324***	8.587**	2.375***	2.431	2.491***	1.928
	(0.652)	(1.535)	(0.527)	(4.166)	(0.564)	(1.820)	(0.359)	(2.429)
Number of observations	330102	47364	198187	26207	292618	58730	158665	23164
Weak identification statistic	45.847	17.160	56.397	5.637	49.868	18.628	53.377	8.378
OLS endogeneity test p-value	0.022	0.063	0.020	0.013	0.000	0.443	0.001	0.976
C. 2SLS using IV2014								
Local Oil and Gas Share	2.765***	3.450**	2.476***	7.622**	2.339***	4.639***	1.966***	0.400
	(0.524)	(1.432)	(0.648)	(3.625)	(0.621)	(1.466)	(0.352)	(3.717)
Number of observations	438183	60262	240759	29534	381476	73740	186237	25693
Weak identification statistic	85.136	40.430	95.050	9.352	89.957	38.472	79.056	10.795
OLS endogeneity test p-value	0.006	0.035	0.006	0.003	0.000	0.033	0.004	0.802

Notes: The dependent variable is log total earned income. All samples are restricted to persons who at the time of their survey were ages 18-61, employed outside the oil and gas industry, and resided in the state of Texas. Samples in Panel A cover year 2000 and 2005 - 2016; Panel B excludes 2000; Panel C excludes 2014. Log usual hours worked per week are controlled for. A large number of weeks worked, age, birth place, educational attainment, marital status, present of children, consistent PUMA, and year dummies are absorbed by the REGHDFE command in Stata and not reported. All regressions use Census/ACS survey weights. Standard errors are shown in parentheses and are clustered by consistent PUMA. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Effects of Local Oil and Gas Employment on Log Incomes Including Oil and Gas Workers

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
A. OLS								
Local Oil and Gas Share	1.256***	0.260	1.559***	-0.023	0.809***	1.083	1.152***	2.209**
	(0.210)	(0.553)	(0.318)	(0.843)	(0.224)	(0.654)	(0.388)	(0.825)
Number of observations	481757	65437	265348	32670	409642	79362	201533	28149
B. 2SLS using IV2000								
Local Oil and Gas Share	3.135***	2.539*	3.132***	8.746**	2.525***	2.407	2.655***	3.596
	(0.608)	(1.501)	(0.485)	(4.120)	(0.547)	(1.674)	(0.375)	(2.903)
Number of observations	343362	48123	203954	26810	295870	59047	159331	23435
Weak identification statistic	55.685	18.780	67.940	5.597	52.713	18.891	55.434	8.261
OLS endogeneity test p-value	0.015	0.062	0.014	0.014	0.000	0.429	0.001	0.621
C. 2SLS using IV2014								
Local Oil and Gas Share	3.209***	3.411**	3.466***	7.802**	2.529***	4.630***	2.122***	2.290
	(0.496)	(1.456)	(0.555)	(3.839)	(0.615)	(1.448)	(0.359)	(4.213)
Number of observations	453301	61050	246810	30122	385188	74097	186919	25972
Weak identification statistic	85.287	43.065	97.549	9.169	87.117	39.427	79.271	10.395
OLS endogeneity test p-value	0.003	0.044	0.002	0.004	0.000	0.031	0.002	0.847

Notes: The dependent variable is log total earned income. All samples are restricted to persons who at the time of their survey were ages 18-61, employed, and resided in the state of Texas. Samples in Panel A cover year 2000 and 2005 - 2016; Panel B excludes 2000; Panel C excludes 2014. Log usual hours worked per week are controlled for. A large number of weeks worked, age, birth place, educational attainment, marital status, present of children, consistent PUMA, and year dummies are absorbed by the REGHDFE command in Stata and not reported. All regressions use Census/ACS survey weights. Standard errors are shown in parentheses and are clustered by consistent PUMA. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 5: Sensitivity Analysis

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
<u>A. Table 2: OLS excluding year 2000</u>								
Local Oil and Gas Share	0.584***	0.969***	1.166***	0.389	0.250***	0.088***	0.234***	0.238
	(0.110)	(0.248)	(0.085)	(0.399)	(0.033)	(0.030)	(0.087)	(0.290)
Number of observations	343875	48150	204076	26839	296301	59077	159416	23458
<u>B. Table 3: OLS excluding year 2000</u>								
Local Oil and Gas Share	0.831***	0.074	0.731**	-0.283	0.679***	1.215*	1.012**	2.009**
	(0.228)	(0.707)	(0.317)	(0.935)	(0.221)	(0.716)	(0.383)	(0.905)
Number of observations	330102	47364	198187	26207	292618	58730	158665	23164
<u>C. Table 2: 2SLS using IV2000 and IV2014</u>								
Local Oil and Gas Share	0.735***	1.355**	1.433***	0.909	0.389***	-0.127	0.297**	0.703
	(0.231)	(0.551)	(0.126)	(0.782)	(0.076)	(0.277)	(0.134)	(0.514)
Number of observations	343875	48150	204076	26839	296301	59077	159416	23458
Weak identification statistic	91.353	31.169	160.676	26.784	87.737	34.989	159.677	47.118
OLS endogeneity test p-value	0.555	0.616	0.010	0.320	0.039	0.952	0.803	0.545
Hansen J overidentification p-value	0.007	0.036	0.560	0.738	0.696	0.227	0.150	0.390
<u>D. Table 3: 2SLS using IV2000 and IV2014</u>								
Local Oil and Gas Share	2.452***	2.959*	2.197***	5.493***	2.328***	4.129***	2.022***	1.628
	(0.422)	(1.565)	(0.441)	(1.958)	(0.583)	(1.324)	(0.414)	(2.075)
Number of observations	330102	47364	198187	26207	292618	58730	158665	23164
Weak identification statistic	76.647	31.957	153.958	25.854	81.014	34.590	151.467	46.473
OLS endogeneity test p-value	0.008	0.063	0.005	0.002	0.000	0.033	0.001	0.871
Hansen J overidentification p-value	0.362	0.541	0.602	0.256	0.884	0.067	0.212	0.850

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
E. Table 2: 2SLS using IV2000 excluding five largest consistent PUMA								
Local Oil and Gas Share	0.360	2.307***	1.304***	1.238	0.471***	-0.460	0.683**	1.681
	(0.378)	(0.668)	(0.300)	(1.691)	(0.105)	(0.356)	(0.276)	(1.656)
Number of observations	277436	43677	174136	25658	240526	54551	136072	22302
Weak identification statistic	67.190	15.574	130.850	5.075	65.927	16.429	128.655	7.753
OLS endogeneity test p-value	0.653	0.103	0.525	0.486	0.072	0.335	0.201	0.281
F. Table 3: 2SLS using IV2000 excluding five largest consistent PUMA								
Local Oil and Gas Share	3.611***	2.456	2.332***	11.109**	2.699***	2.356	2.371***	1.557
	(1.084)	(1.880)	(0.728)	(5.356)	(0.968)	(2.173)	(0.481)	(2.877)
Number of observations	268453	43014	170711	25052	237734	54216	135498	22018
Weak identification statistic	56.692	14.564	109.806	5.132	61.306	16.256	125.576	7.839
OLS endogeneity test p-value	0.045	0.140	0.108	0.023	0.002	0.515	0.006	0.835
G. Table 2: 2SLS using IV2000 excluding controls for education, marriage, and children								
Local Oil and Gas Share	0.487*	2.019***	1.343***	1.097	0.375***	-0.344	0.502**	1.486
	(0.247)	(0.569)	(0.169)	(1.406)	(0.067)	(0.339)	(0.210)	(1.347)
Number of observations	343875	48150	204076	26839	296301	59077	159416	23458
Weak identification statistic	55.830	18.771	67.938	5.544	52.686	18.813	55.296	8.175
OLS endogeneity test p-value	0.588	0.099	0.295	0.495	0.101	0.348	0.173	0.331
H. Table 3: 2SLS using IV2000 excluding controls for education, marriage, and children								
Local Oil and Gas Share	2.577***	1.462	2.428***	6.720	2.282***	2.089	2.475***	1.712
	(0.690)	(1.613)	(0.538)	(5.260)	(0.629)	(1.891)	(0.464)	(3.964)
Number of observations	330102	47364	198187	26207	292618	58730	158665	23164
Weak identification statistic	45.851	17.134	56.392	5.647	49.842	18.597	53.294	8.343
OLS endogeneity test p-value	0.039	0.340	0.010	0.030	0.001	0.601	0.002	0.920

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
I. Table 2: 2SLS using IV2000 with Bartik controls								
Local Oil and Gas Share	0.480*	2.039***	1.343***	1.077	0.357***	-0.339	0.507**	1.485
	(0.247)	(0.565)	(0.165)	(1.299)	(0.070)	(0.337)	(0.210)	(1.286)
Bartik Controls	0.061	-0.215*	0.103	-0.443*	0.077**	-0.009	-0.066**	-0.196
	(0.054)	(0.111)	(0.079)	(0.247)	(0.031)	(0.048)	(0.028)	(0.173)
Number of observations	343875	48150	204076	26839	296301	59077	159416	23458
Weak identification statistic	51.118	18.865	66.880	5.761	48.512	18.712	54.777	8.552
OLS endogeneity test p-value	0.573	0.097	0.282	0.497	0.135	0.347	0.173	0.319
J. Table 3: 2SLS using IV2000 with Bartik controls								
Local Oil and Gas Share	2.789***	2.354	2.273***	8.829**	2.315***	2.181	2.442***	1.886
	(0.657)	(1.511)	(0.538)	(4.326)	(0.575)	(1.449)	(0.362)	(2.413)
Bartik Controls	0.417	0.670	0.780	1.514	0.340	2.563***	0.696*	-0.536
	(0.308)	(0.634)	(0.538)	(1.026)	(0.335)	(0.772)	(0.386)	(1.283)
Number of observations	330102	47364	198187	26207	292618	58730	158665	23164
Weak identification statistic	42.421	17.244	56.503	5.850	45.987	18.493	52.899	8.715
OLS endogeneity test p-value	0.025	0.046	0.017	0.014	0.001	0.391	0.001	0.960

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
K. Table 2: 2SLS using IV2000 with additional local controls								
Local Oil and Gas Share	0.497	2.182***	1.556***	1.306	0.371***	-0.412	0.571**	1.238
	(0.306)	(0.716)	(0.267)	(1.615)	(0.073)	(0.442)	(0.281)	(1.224)
Local Manufacturing Share	-0.015	-0.111	-0.033	0.188	0.021	-0.004	0.018	0.187*
	(0.042)	(0.121)	(0.060)	(0.195)	(0.025)	(0.034)	(0.028)	(0.107)
Local Service Share	-0.050	-0.002	0.014	0.065	-0.020	-0.005	0.015	-0.035
	(0.040)	(0.099)	(0.048)	(0.155)	(0.017)	(0.031)	(0.029)	(0.068)
Local Health Share	-0.073	0.076	0.053	0.279	-0.055*	-0.026	0.017	0.439
	(0.057)	(0.170)	(0.079)	(0.578)	(0.032)	(0.042)	(0.039)	(0.344)
Local College Graduates Share	0.026	0.062	-0.113**	-0.100	0.020	0.002	0.047	-0.044
	(0.035)	(0.088)	(0.043)	(0.205)	(0.019)	(0.020)	(0.033)	(0.134)
Local Female Employment Share	0.070	0.075	0.208*	0.086	0.041	-0.059	0.039	-0.098**
	(0.053)	(0.064)	(0.109)	(0.070)	(0.026)	(0.052)	(0.054)	(0.047)
Number of observations	343875	48150	204076	26839	296301	59077	159416	23458
Weak identification statistic	50.657	28.430	35.271	8.581	50.085	27.255	28.080	13.222
L. Table 3: 2SLS using IV2000 with additional local controls								
Local Oil and Gas Share	3.030***	2.863	2.321***	8.137*	2.406***	2.068	2.618***	1.859
	(0.838)	(1.889)	(0.783)	(4.257)	(0.695)	(2.131)	(0.693)	(3.396)
Local Manufacturing Share	0.267	0.618	0.318	1.548*	0.061	0.438	0.340	-0.661
	(0.176)	(0.531)	(0.361)	(0.807)	(0.192)	(0.385)	(0.260)	(0.666)
Local Service Share	0.244*	0.149	0.004	0.333	-0.076	0.121	-0.034	-0.088
	(0.129)	(0.362)	(0.188)	(0.431)	(0.145)	(0.380)	(0.193)	(0.675)
Local Health Share	0.169	0.182	0.039	1.711	0.374	1.024*	0.346	1.511
	(0.233)	(0.695)	(0.360)	(1.054)	(0.245)	(0.525)	(0.330)	(1.019)
Local College Graduates Share	-0.213	0.083	-0.142	-0.532	-0.205	-0.180	-0.205	-0.593
	(0.131)	(0.413)	(0.198)	(0.518)	(0.162)	(0.428)	(0.238)	(0.622)
Local Female Employment Share	-0.035	0.431	0.125	-0.349	0.047	-0.611**	0.166	-0.183
	(0.179)	(0.303)	(0.295)	(0.582)	(0.179)	(0.277)	(0.278)	(0.497)
Number of observations	330102	47364	198187	26207	292618	58730	158665	23164
Weak identification statistic	45.577	25.221	35.119	8.487	49.241	26.807	27.673	13.615

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
M. Table 2: 2SLS using IV2000 - metropolitan sample								
Local Oil and Gas Share	0.519	2.443***	1.169***	1.254	0.424***	-0.402	0.611**	1.679
	(0.344)	(0.574)	(0.263)	(1.519)	(0.072)	(0.369)	(0.264)	(1.478)
Number of observations	268376	42251	177011	25971	230781	51915	139329	22538
Weak identification statistic	50.510	15.443	68.788	5.192	49.292	15.792	52.295	7.792
OLS endogeneity test p-value	0.861	0.055	0.653	0.452	0.171	0.352	0.195	0.340
N. Table 3: 2SLS using IV2000 - metropolitan sample								
Local Oil and Gas Share	3.109***	1.365	1.930***	10.108**	2.080***	2.360	2.267***	1.782
	(0.852)	(1.543)	(0.685)	(4.675)	(0.620)	(2.036)	(0.475)	(2.591)
Number of observations	259918	41661	173635	25352	227913	51581	138710	22246
Weak identification statistic	38.850	14.238	53.296	5.256	44.552	15.574	49.396	7.916
OLS endogeneity test p-value	0.062	0.276	0.042	0.011	0.016	0.201	0.008	0.908
O. Table 2: 2SLS using IV2000 - non-metropolitan sample								
Local Oil and Gas Share	0.621*	0.143	2.088**	-0.736	0.372*	0.063	0.468*	-0.079
	(0.325)	(1.224)	(0.783)	(1.207)	(0.182)	(0.100)	(0.265)	(0.093)
Number of observations	75491	5890	27045	848	65507	7151	20078	896
Weak identification statistic	51.873	16.512	3.183	42.496	50.324	14.409	2.257	50.181
OLS endogeneity test p-value	0.982	0.697	0.033	0.286	0.147	0.986	0.178	0.740
P. Table 3: 2SLS using IV2000 - non-metropolitan sample								
Local Oil and Gas Share	1.922	11.653**	3.861**	-7.705	2.585***	0.030	3.992	12.889
	(1.128)	(4.800)	(1.382)	(6.456)	(0.518)	(2.447)	(2.322)	(9.004)
Number of observations	70175	5695	24532	835	64693	7137	19945	894
Weak identification statistic	43.897	16.203	2.643	43.566	49.378	14.124	2.192	55.899
OLS endogeneity test p-value	0.351	0.016	0.188	0.152	0.039	0.243	0.185	0.237

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
Q. Table 2: 2SLS using IV2000 with QWI data								
QWI Local Mine Share	0.541*	2.333***	1.565***	1.489	0.410***	-0.370	0.560**	1.582
	(0.294)	(0.566)	(0.236)	(1.627)	(0.082)	(0.354)	(0.214)	(1.314)
Number of observations	343875	48150	204076	26839	296301	59077	159416	23458
Weak identification statistic	69.845	18.415	51.541	10.901	65.243	18.099	48.591	12.947
OLS endogeneity test p-value	0.390	0.049	0.364	0.752	0.080	0.316	0.168	0.317
R. Table 3: 2SLS using IV2000 with QWI data								
QWI Local Mine Share	3.174***	2.758	2.686***	10.775**	2.639***	2.619	2.780***	2.026
	(0.728)	(1.779)	(0.698)	(4.381)	(0.756)	(1.816)	(0.561)	(2.663)
Number of observations	330102	47364	198187	26207	292618	58730	158665	23164
Weak identification statistic	55.830	16.808	41.334	9.513	60.206	17.594	46.766	12.423
OLS endogeneity test p-value	0.040	0.148	0.287	0.050	0.014	0.637	0.077	0.954

Notes: The large number of dummy controls are the same as in the corresponding Tables 2 and 3 and not reported. Estimated marginal effects are reported in Panel Y and Z. All regressions use Census/ACS survey weights. Standard errors are shown in parentheses and are clustered by consistent PUMA. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Nationwide Sample (Excluding Texas)

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
A. Table 2: national sample - OLS								
Local Oil and Gas Share	1.103***	0.908***	1.258***	0.630***	0.227***	0.066*	0.175*	0.235***
	(0.081)	(0.199)	(0.170)	(0.232)	(0.027)	(0.036)	(0.100)	(0.083)
Number of observations	7489892	761995	1160091	475176	6744461	952515	897144	450166
B. Table 2: national sample using IV2000								
Local Oil and Gas Share	1.698***	2.581***	1.009**	2.272	0.509*	-0.194	0.168	0.603
	(0.287)	(0.730)	(0.441)	(2.320)	(0.296)	(0.162)	(0.164)	(0.433)
Number of observations	5241115	532497	871722	368611	4785977	677285	693132	354475
Weak identification statistic	9.994	9.634	51.969	7.190	9.537	10.576	53.423	9.524
OLS endogeneity test p-value	0.031	0.069	0.555	0.472	0.361	0.252	0.896	0.376
C. Table 3: national sample - OLS								
Local Oil and Gas Share	2.169***	0.143	1.983**	-0.221	1.523***	1.129**	1.523***	3.129***
	(0.432)	(0.659)	(0.801)	(1.002)	(0.313)	(0.493)	(0.586)	(1.112)
Number of observations	7411943	750739	1142669	471179	6684324	941168	883983	445693
D. Table 3: national sample using IV2000								
Local Oil and Gas Share	6.842***	5.963**	2.716*	7.600	4.741***	11.231***	3.797***	5.449*
	(1.189)	(2.448)	(1.495)	(6.036)	(0.776)	(1.813)	(1.128)	(3.189)
Number of observations	5208325	530980	868973	367974	4776111	676865	692519	354036
Weak identification statistic	10.646	10.134	45.414	7.866	9.725	10.739	54.052	9.397
OLS endogeneity test p-value	0.002	0.026	0.517	0.243	0.003	0.025	0.089	0.582

Notes: The large number of dummy controls are the same as in the corresponding Tables 2 and 3 and not reported. The national sample excludes Texas. IV2000 excludes temporal variation from each own state. All regressions use Census/ACS survey weights. Standard errors are shown in parentheses and are clustered by consistent PUMA. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 7: Effects of Local Oil and Gas Employment Shares on Individual Employment in Specific Occupations in the Oil and Gas Industry by Demographic Group

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
A. Extraction: 2SLS using IV2000								
Local Oil and Gas Share	0.103	0.648*	0.374*	0.134	-0.002	-0.017	0.003	-0.021
	(0.083)	(0.362)	(0.220)	(0.101)	(0.006)	(0.021)	(0.004)	(0.019)
B. Transportation: 2SLS using IV2000								
Local Oil and Gas Share	-0.070	0.002	0.219**	0.179	0.003	0.001	0.058*	0.746
	(0.104)	(0.155)	(0.092)	(0.132)	(0.010)	(0.003)	(0.032)	(0.740)
C. Technicians and repairers: 2SLS using IV2000								
Local Oil and Gas Share	0.118	-0.032	0.080*	0.119	-0.045*	-0.000	0.032	0.027
	(0.075)	(0.056)	(0.044)	(0.179)	(0.024)	(0.020)	(0.034)	(0.022)
D. Construction trades: 2SLS using IV2000								
Local Oil and Gas Share	-0.067	0.329	0.203	0.036	0.034	0.015	0.036	0.057
	(0.072)	(0.208)	(0.183)	(0.046)	(0.023)	(0.023)	(0.027)	(0.056)
E. Managerial and professional: 2SLS using IV2000								
Local Oil and Gas Share	0.268***	0.413*	0.279*	0.649	0.187***	-0.047	0.158***	0.583
	(0.050)	(0.224)	(0.144)	(0.867)	(0.068)	(0.321)	(0.051)	(0.606)
F. Administrative and clerical: 2SLS using IV2000								
Local Oil and Gas Share	0.007	0.318**	0.111	0.294	0.186***	-0.266**	0.160	0.049
	(0.064)	(0.150)	(0.073)	(0.286)	(0.064)	(0.129)	(0.109)	(0.078)
G. Other oil and gas occupations: 2SLS using IV2000								
Local Oil and Gas Share	0.132	0.346**	0.086	-0.267	0.006	-0.025	0.055***	0.060
	(0.105)	(0.148)	(0.117)	(0.410)	(0.043)	(0.019)	(0.015)	(0.074)

Notes: The dependent variable is a dummy for employment in a specific occupation in the oil and gas industry. Specifications are otherwise identical to Panel B of Table 2. Standard errors are shown in parentheses and are clustered by consistent PUMA. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 8: Effects of Local Oil and Gas Employment Shares on Individual Employment in Other Industries by Group

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
A. Agriculture: 2SLS using IV2000								
Local Oil and Gas Share	-0.229**	-0.048	-0.361*	0.006	-0.105**	0.067	-0.010	-0.086
	(0.100)	(0.274)	(0.185)	(0.203)	(0.051)	(0.053)	(0.050)	(0.142)
B. Construction: 2SLS using IV2000								
Local Oil and Gas Share	0.207	-0.495	0.036	-0.078	0.043	0.024	0.358***	0.877
	(0.175)	(0.434)	(0.282)	(0.583)	(0.078)	(0.154)	(0.114)	(0.703)
C. Manufacturing: 2SLS using IV2000								
Local Oil and Gas Share	0.297	-1.275	-0.024	2.604	0.413**	0.401	0.425**	1.512
	(0.216)	(0.836)	(0.250)	(1.797)	(0.197)	(0.613)	(0.163)	(1.506)
D. Transportation: 2SLS using IV2000								
Local Oil and Gas Share	0.053	0.373	0.274	0.842	0.130	0.762	0.268*	0.924
	(0.305)	(1.048)	(0.224)	(1.256)	(0.122)	(0.807)	(0.141)	(1.480)
E. Wholesale: 2SLS using IV2000								
Local Oil and Gas Share	-0.278**	-0.630	0.170	-1.120*	0.014	0.098	0.289**	-0.280
	(0.110)	(0.783)	(0.109)	(0.639)	(0.091)	(0.281)	(0.110)	(0.564)
F. Retail: 2SLS using IV2000								
Local Oil and Gas Share	-0.203	0.881	-0.400**	0.706	-0.104	-0.011	-0.424*	1.329
	(0.184)	(0.925)	(0.164)	(1.270)	(0.137)	(1.194)	(0.222)	(1.157)
G. Finance: 2SLS using IV2000								
Local Oil and Gas Share	-0.191	1.247*	-0.231**	-0.816	-0.157	-0.591	0.257	0.239
	(0.149)	(0.666)	(0.106)	(0.898)	(0.153)	(0.457)	(0.294)	(1.272)

	(1) White Males	(2) Black Males	(3) Hispanic Males	(4) Asian Males	(5) White Females	(6) Black Females	(7) Hispanic Females	(8) Asian Females
H. Business services: 2SLS using IV2000								
Local Oil and Gas Share	0.179	-0.243	-0.144	-2.029	-0.112	0.442	-0.373**	-2.253**
	(0.155)	(0.432)	(0.212)	(1.947)	(0.144)	(0.686)	(0.151)	(0.880)
I. Personal services: 2SLS using IV2000								
Local Oil and Gas Share	0.014	-0.062	-0.025	-1.201	-0.269**	0.619	-0.134	0.334
	(0.072)	(0.271)	(0.092)	(1.208)	(0.122)	(0.658)	(0.184)	(1.104)
J. Entertainment services: 2SLS using IV2000								
Local Oil and Gas Share	-0.031	0.004	-0.099	0.057	-0.005	0.159	-0.021	-0.263
	(0.077)	(0.224)	(0.071)	(0.250)	(0.044)	(0.236)	(0.075)	(0.229)
K. Professional services: 2SLS using IV2000								
Local Oil and Gas Share	-0.238	-0.921	-0.267	-0.448	-0.323	-1.393	-1.246***	-4.252
	(0.212)	(0.871)	(0.208)	(1.508)	(0.383)	(1.469)	(0.390)	(2.569)
L. Public administration: 2SLS using IV2000								
Local Oil and Gas Share	0.174*	-0.510	-0.284***	0.137	0.113	-0.199	0.101	0.200
	(0.091)	(0.617)	(0.091)	(0.372)	(0.124)	(0.739)	(0.172)	(0.683)

Notes: The dependent variable is a dummy for employment in a specific industry group in each panel. Specifications are otherwise identical to Panel B of Table 2. Standard errors are shown in parentheses and are clustered by consistent PUMA. * p < 0.1, ** p < 0.05, *** p < 0.01.