Who Wins in an Energy Boom?
Evidence from Wage Rates and Housing

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Abstract

This paper presents evidence on the distributional effects of energy extraction by examining the effect of the recent U.S. energy boom on wage rates and housing. The boom increased local wage rates in almost every major occupational category. The increase occurred regardless of whether the occupation experienced a corresponding change in employment, suggesting a tighter labor market that benefited local workers. Wage rates also increased substantially across the entire wage rate distribution, although the percentage increase was slightly higher at the bottom of the distribution than at the top. Local housing values and rental prices both increased, thereby benefiting landowners. For renters, the increase in prices was completely offset by a contemporaneous increase in income. The results suggest that bans on drilling have negative monetary consequences for a large share of local residents.

Keywords: oil; natural gas; hydraulic fracturing; fracking; resource extraction; labor market effects; resource curse; Dutch disease; wage rates; housing values; rental prices
JEL Codes: J23, Q33, R31

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1 Introduction

Recent changes in the drilling technologies and practices have had a dramatic impact on energy development in the United States. Hydraulic fracturing, or "fracking", in which water, sand, and chemicals are injected into shale reserves to allow for extraction of natural gas and oil, has led to a large increase in U.S. production of gas and oil. In addition to having trillions of dollars in direct value, shale gas and oil withdrawals may reduce domestic energy prices thereby leading to increases in consumer surplus and enhanced growth in other sectors of the economy (Mason et al., 2015; Hausman and Kellogg, 2015).

While fracking has led to substantial economic benefits, fracking has also been linked to various types of social damages, including potential contamination of water systems (Osborn et al., 2011; U.S. Environmental Protection Agency, 2011; Olmstead et al., 2013), increased depreciation and congestion of local infrastructure (U.S. GAO, 2012), and problems associated with rapid in-migration, such as increased crime rates (James and Smith, 2017). Due to the potential damages associated with fracking, policymakers have considered regulating drilling through moratoria, taxes, or restrictions on drilling techniques and materials. For example, citing environmental and health concerns, Governor Andrew Cuomo announced a ban on fracking in New York state at the end of 2014 despite the fact that the state overlays the Marcellus Shale, which contains large and valuable gas reserves. Municipalities in other states that permit fracking, such as Texas and Pennsylvania, have used local ordinances and zoning laws to ban or regulate drilling.

Debates about drilling policies center, at least in part, on how energy booms affect the local economy because communities are more likely to support drilling when more individuals in the community benefit from it. Labor market effects are often the primary focus of these debates. For example, in the 2014 Pennsylvania Gubernatorial race, Republican candidate Tom Corbett opposed a 5 percent severance tax placed on natural gas production that was proposed by his opponent. Corbett justified his opposition by describing the benefits of shale development to local workers.[1]

[1] The effects of fracking on local communities have also been a part of national-level debates, such as the 2016 Democratic Presidential Primary. At the 2014 National Clean Energy Summit, Hillary Clinton emphasized the possibility of natural gas as a bridge to a clean energy economy and noted that expanding production leads to job creation. Bernie Sanders, in contrast, supported a ban on fracking.

In this paper, I attempt to inform debates on drilling policies–which often have national implications–by examining how the recent U.S. energy boom has affected local economies. There are a wide variety of economic outcomes that can be influenced by an energy boom and I focus on wage rates, housing values, and rental prices. Wage rates are important because they represent the primary way in which workers who are employed and unwilling to switch occupations can be affected by the boom. Housing values are important because land appreciation is a direct avenue by which energy booms can benefit local landowners. Rental prices are another avenue by which booms can benefit landowners and, perhaps more importantly, provide a measure of local price inflation. Local inflation can undermine other monetary gains and potentially turn the boom into a loss for those who are unable to tap into its benefits. A common theme across the outcomes is that each one represents a type of price. Price effects are particularly relevant in an examination of the distributional effects of energy booms because they can easily affect residents who are not directly connected to the energy boom. For example, effects on non-price outcomes, such as income per capita, may reflect changes experienced by a smaller share of the population, such as those owning parcels overlaying resource endowments.

The analysis is based on a difference-in-differences empirical framework and annual panel data on energy production, wage rates, and housing from non-metropolitan regions in the United States. To preview the main results, I estimate that the recent U.S. energy boom increased wage rates in local economies in booming areas by 7% between 2006 and 2014. The increase occurred across almost all occupations regardless of whether the occupation experienced a contemporaneous increase in employment, suggesting that the overall labor market became tighter in booming areas, thereby benefiting local workers.[2] The wage rate effects were largest in percentage terms in the lower parts of the wage rate distribution. With respect to the housing market, I estimate that the boom increased housing values in booming areas by 12% between 2007 and 2012. Rental rates increased by an estimated 5% over the same time period. The increase in rental prices was small in comparison to other monetary gains. Additionally, there is no evidence that the boom increased the cost

[2]The increase in wage rates in occupations that did not experience a contemporaneous increase in employment also suggests that the increase in wage rates was caused by higher pay rates as opposed to changes in the composition of specific occupations within each major occupational category.

of rent when measured as a percentage of household income. In sum, the results indicate that there are many monetary "winners" from energy development in local communities and very few losers. An implication of the results is that bans on drilling have negative monetary consequences for a large share of local residents.

This paper contributes to the literature on the local effects of energy booms.[3] This literature has predominantly focused on income and employment and has generally documented positive effects (Jacobsen and Parker, 2016; Feyrer et al., 2017; Maniloff and Mastromonaco, 2017; Fetzer, 2014; Allcott and Keniston, 2018; Weber, 2012; Marchand, 2012; Michaels, 2011; James and Aadland, 2011; Papyrakis and Gerlagh, 2007; Black et al., 2005a, Aragon and Rud, 2013; Caselli and Michaels, 2013).[4] Wage rates, housing values, and rental prices have been less studied.

With respect to wage rates, the most closely related studies are those that examine how the current U.S. energy boom affected worker outcomes. Allcott and Keniston (2018) use data on oil and production data from 1960-2014, a period that includes both the recent boom and the 1970s boom, to examine the effect of oil and gas production. They present evidence that a county with a one standard deviation in additional oil and gas endowment averaged about one percent higher wages between 1969 and 2014. Fetzer (2014) uses data on shale plays and oil and gas wells to evaluate the effect of the recent U.S. boom on economic outcomes, finding that a one percent increase in the mining sector employment share increased earnings in the mining sector by six percent, earnings in construction and transportation by nearly three percent, and earnings in local services and manufacturing by about two percent. Feyrer et al. (2017) also examine the effect of the recent boom on wage income and find that every million dollars of oil and gas extracted produced $66,000 of wage income within the county in which it was extracted and $243,000 of wage income within 100 miles of the new production. Bartik et al. (2017) investigate the effect of the fracking boom on wage and salary income and find that it increased wage and salary income by 8.9 to 13.0 percent.

[3]See Marchand and Weber (2017) for a thorough review of the literature on local labor markets and natural resources.

[4]Another strand of the literature has focused on the effect of booms on educational attainment. Cascio and Narayan (2015) find that the fracking boom increased demand for low-skilled labor and increased high school dropout rates for male teens. Morisette et al. (2015) documents reduced university enrollment rates during a Canadian oil boom. Black et al. (2005b) documents decreased high school enrollment during an Appalachian coal boom.

Relative to the existing literature, this paper makes several key contributions that are helpful in shedding light on how widely the labor market benefits were experienced. First, I estimate how wage rates changed separately for twenty-two separate occupational categories. Note that, while prior work has examined how effects on earnings vary across industrial sectors, these studies do not provide an indication of what will happen across occupations if labor markets are segmented by skill and occupation rather than by industry.[5] For example, the largest occupational category in the U.S. is office and administrative support. The generally positive effect of the boom on earnings across numerous economic sectors does not imply that office and administrative support workers benefit from the boom because office and support workers do not comprise a large share of any one major industrial sector. A null effect on wage rates for office and administrative workers could be masked by within-sector increases in a different subset of occupations. In general, seeing broad wage benefits across occupations, as I document, provides new evidence that the benefits of the boom were widely spread. Secondly, I focus on how the the wage rate effects varied across the distribution of wage rates.[6] Again, this assists in investigating how broadly the effects of the boom were experienced and whether they were concentrated in higher or lower paying jobs. The finding that wages increased substantially across the distribution provides additional evidence that the benefits of the boom were widely spread. Finally, I focus specifically on effects on wage rates. Earlier studies that find that booms lead to increases in earnings per worker, are not sufficient to establish that wage rates change because earnings per worker can adjust either through changes in the wage rate paid to employees or in the number of hours worked by employees. Changes in wage rates will have a stronger effect on worker welfare because, unlike changes driven by increases in the number of hours worked, changes in wage rates are not accompanied by reduced leisure.

With respect to housing, this paper contributes to a recent literature that has documented mixed evidence on the effect of the shale boom on housing values. On the nega-

[5]If individuals can easily change industries, but not occupations, then studying effects by industry will mask heterogeneity in the effects of fracking. Conversely, if individuals can easily change occupations, but not industries, then studying effects by occupation will mask heterogeneity in the effects of fracking.

[6]In related work, Basso (2017) presents evidence that the 1970s and 1980s boom increased income by a similar percentage across the income distribution, but that the negative effects of the bust were stronger for lower income households.

tive side, Muehlenbachs et al. (2015) find that shale gas development had a negative effect on groundwater-dependent homes in Pennsylvania and Gopalakrishnan and Klaiber (2014) find that shale extraction had a negative effect on housing values in Washington County, PA.[7] On the positive side, Weber et al. (2016) find evidence that the shale boom increased housing values in zip codes with shale endowments in northeastern Texas and Boslett et al. (2016) find that the moratorium on shale drilling in New York state decreased home values, indicating a positive relationship between drilling and home values. Bartik et al. (2017) find that fracking increased median housing values by 5.7 percent and median rental prices by 2.0 percent. [8] Similar to Bartik et al. (2017), I attempt to provide more general evidence on the relationship between shale development and housing values by studying the phenomenon in a national geographic setting, by examining effects on both housing values and rental prices, and by examining the housing effects in an empirical setting where they can be directly compared to the labor market effects.

The paper has several limitations. One limitation is that I cannot control for changes in the composition of skill within the population of individuals living in a boom area. As such, even though the distribution of wages may change, I cannot conclusively show that there is a change in the wage per efficiency unit of labor. Another limitation is that I cannot completely control for changes in the housing market that occur through compositional changes. While I do not find evidence that the boom led to the construction of additional housing units, compositional changes could still occur through changes in the share of houses that are rented, changes in the total number of occupied housing units, and quality changes occurring through maintenance and renovations. Some of the estimated effects on housing values and rental prices, therefore, may reflect these compositional changes. A third limitation is that I do not examine non-wage labor market effects, including unemployment, labor market participation, or hours worked per week. Effects on these outcomes could provide another channel by which local residents could benefit from increased labor demand. A final limitation is that I cannot adjust wage rates for local price inflation because I do not have

[7]While not as closely related to the recent U.S. energy boom, Boxall et al. (2005) also present evidence that supports a negative relationship. They find that housing values are negatively correlated with sour gas wells and flaring oil batteries in Central Alberta, Canada.

[8]Bartik et al. (2017) also estimate willingness-to-pay (WTP) for allowing fracking of $1,300 to $1,900 per household annually.

access to a local price index. Adjusting for local price inflation would likely lead to smaller estimates of wage rate increases because the boom appears to have led to an increase in local prices, at least for rental units. The estimated effect of the boom on median wage rates (7 percent) is greater than the effect on rental prices (5 percent), which provides some suggestive yet inconclusive evidence that wages rates increased in booming areas even when adjusting for local price inflation.

2 The U.S. Energy Boom

The recent U.S. energy boom has primarily been facilitated by advances in technology related to hydraulic fracturing, or "fracking." Fracking involves high-pressure injections of liquid mixtures into geologic formations containing oil and gas reserves, such as shale. The pressure creates fissures that allow for the extraction of previously inaccessible reserves. Fracking was invented in 1947, but recent innovations in drilling techniques–most notably horizontal drilling, advanced proppants, and multi-stage fracking–have made fracking more economically viable.

Figure 1 displays national trends in production of natural gas and oil in the United States. Production began to increase dramatically in the latter half of the 2000s and has continued to surge through 2014. The dashed lines in Figure 1 represent oil and gas production from shale resources. The increase in extraction from shale explains nearly all of the recent increase in gas and oil production.[9]

In order to motivate the empirical analysis, it is worth briefly discussing how an energy boom might affect local economies in areas that experience surges in energy production.[10]

[9]For Figure 1, overall gas and oil production levels were obtained from the USEIA (2015a). USEIA (2015a) also reports data on shale gas withdrawals, but not oil withdrawals. For shale oil, data on extraction were obtained from USEIA (2015b), which reports information on withdrawals from the seven most prolific shale regions (Bakken, Niobrara, Eagle Ford, Permian, Haynesville, Utica, and Marcellus).

[10]The purpose of this section is to provide a brief description of the most straight-forward manner in which an energy boom will affect local economies and I mostly focus on direct and positive effects. There are two substantial literatures on ways in which resources, often indirectly, can harm economies. Models of "Dutch Disease" (e.g., Cordon and Neary, 1982) show that resource booms can harm open economies by creating a contraction in the tradable sector due to increases in local factor prices. The literature on the "Natural Resource Curse" (e.g., Sachs and Warner, 1995, 1999, and 2001) similarly argues that resource abundance can harm economies, especially in the case of weak institutions (see Deacon (2011) and van der Ploeg (2011) for reviews). Empirical evidence related to the resource curse and Dutch Disease, which has typically been

In general, increases in prospecting, drilling, and associated operations in a booming area are expected to lead to an immediate increase in employment in the extractive industry as well as connected industries, such as construction and transportation. Employment may also increase if the boom lowers local energy prices thereby attracting more industrial activity (Kahn and Mansur, 2015). The increase in employment will lead to increases in in-migration and daily visitors (i.e. commuters) and increased demand for local goods and services.[11] Employment will increase in the sectors providing local goods and services as well. Local incomes are expected to increase due to royalty payments and potentially increases in earnings, if wage rates rise or if employees work longer hours.[12] Increases in local incomes will reinforce the increase in demand for local goods and services. Government transfer payments may decrease if the strengthened economy reduces the pool of households eligible for social programs.

With respect to wage rates, the increase in the demand for labor is expected to increase wage rates unless migration is sufficient to create an offsetting increase in the labor supply.[13] If the costs of relocating are not zero,[14] then the change in the labor supply will not be sufficient to offset the increase in demand and wage rates will increase. The change in labor supply will be substantially short of what is required to offset the increase in demand if prospective employees believe the increase in labor demand will be short-lived, as is often the case with energy booms.

Across occupations, effects on wage rates will depend on how the boom affects demand for

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evaluated at the national level, is mixed. In a recent evaluation of sub-national Dutch Disease based on U.S. oil and gas development, Allcott and Keniston (2018) present evidence that there are actually *positive* spillovers from oil and gas production to manufacturing industries, potentially due to agglomeration spillovers. Positive spillovers could be one explanation for the widespread wage rate increases documented in the present paper.

[11]For example, Vachon (2015) provides evidence that the Bakken oil boom increased the migration rate into oil counties in North Dakota by 2.6 percentage points. Wilson (2018) provides evidence that exposure to news coverage on the fracking boom increased migration rates to fracking counties. Population and demand may also increase due to increased births, as Kearney and Wilson (2018) present evidence that the fracking boom increased fertility.

[12]Royalty payments will not have an effect on incomes in areas with separate surface and mineral rights where mineral rights are predominantly owned by non-residents. Brown et al. (2016) present evidence that royalty payments are often received by individuals living far from mineral resources.

[13]Firms will be able to pay more for labor without operating at a loss if they experience a contemporaneous increase in demand. For locally-traded goods, firms will be able to continue operating without a loss by passing costs on to consumers. Firms may also choose to operate at a loss in the short-term if they believe the boom will be short-lived and there are substantial start-up and shut-down costs.

[14]Using a structural model of worker job-choice that incorporates location, sector, and occupation moving costs, Bartik (2018) estimates that the costs of moving are at least \$16,000.

the occupation, the amount of migration (which in turn depends on moving costs and beliefs about the duration of the boom), occupational moving frictions, industrial moving frictions, the skill composition of migrants, occupation-specific skill requirements, and occupational differences in the gradients of the marginal productivity of labor curves. The combined effect of these forces across occupations is unclear. For example, consider again the office and administrative support occupational category. The effects of the boom on the wage rate received by these workers might be expected to be zero or relatively small because the work is not strongly connected to the boom and therefore subject to a smaller increase in demand. In contrast, the effects of the boom might be expected to be larger because workers might be less likely to migrate for a relatively low-paying job, which would lead to a relatively greater shortage of qualified office and administrative support workers because they tend to receive lower wage rates.

With respect to housing, the increased demand for housing from migrants is expected to provide upward pressure on both housing values and rental prices.[15] The royalty payments from extraction will provide further upward pressure on housing values. In contrast, disamenities from extraction, such as environmental degradation, will provide downward pressure.[16] The net effect of these competing forces is unclear.

In the subsequent analysis, I empirically examine whether the scenarios described above unfolded. While I examine some broad economic variables (e.g., employment and income per capita), I focus especially on outcomes related to wage rates and housing because they play a key role in the distributional effects of the energy boom and because there is generally more uncertainty about the effect of the boom for these outcomes.

[15]In addition to migration induced by employment opportunities, demand for housing may also increase because booms expand the tax base from producing wells thereby lowering tax rates and increasing the funds available for public goods (Weber et al., 2016).

[16]A substantial literature has shown that "locally undesirable land uses" are often associated with decreases in property values (Mastromonaco, 2015; Muehlenbachs et al., 2015; Gamper-Rabindran and Timmins, 2013; Sanders, 2012; Davis, 2011; Greenstone and Gallagher, 2008; Davis, 2004).

3 Data and Descriptive Statistics

County-level data on annual oil and gas withdrawals were obtained from the U. S. Department of Agriculture's Economic Research Service. The data, which were published in 2014 and for which an update is not planned, represent the first time nation-wide data on annual production has been available at the county-level. The data are available from 2000-2011. Oil production is measured in barrels and natural gas production is measured in metric cubic feet (Mcf). The withdrawal amounts were also converted to a joint production variable measured in dollars using the average price for natural gas and oil over the sample period ($5.80 per Mcf and $57.90 per barrel).[17]

Data on labor market outcomes were obtained from the Bureau of Labor Statistics' Occupational Employment Statistics (OES) program. The key feature of the OES data is that, unlike alternative sources such as the Bureau of Economic Analysis' Regional Economic Accounts (REA), the data include information on hourly wage rates. For hourly workers, wage rates are based on their hourly wage, whereas for salaried workers wage rates are based on their salary divided by the number of hours worked annually.[18] The data include information on the mean hourly wage rate and the hourly wage rate of the first decile, first quartile, median, third quartile, and ninth decile of the wage rate distribution. Information on all measurements is available overall and by twenty-two major occupational categories.[19] The data also include information on employment levels for each occupational category. The OES data are available annually for metropolitan and non-metropolitan areas. I limit the analysis to non-metropolitan areas (NMAs) because energy extraction is likely to have the strongest and most statistically detectable effect in these areas. The data are aggregated

[17] The conversion to dollars follows a conversion procedure described in the technical documents accompanying the USDA dataset. An alternative procedure is to convert the data to dollars by multiplying the production values times the average annual prices, as opposed to the average price over the entire sample period. The benefit of using average prices is that it allows for the oil and gas variables to be combined into a single variable while still allowing changes in the new variable to be driven by changes in extraction patterns, as opposed to price fluctuations.

[18] The data do not include information on compensation for self-employed individuals.

[19] OES data are based on estimates computed from a semi-annual mail survey of non-farm establishments. As such, the OES variables, like most BLS variables, are measured with error. Because the OES variables are dependent variables in the upcoming regression, the measurement error should lead to larger standard errors, but not biased estimates. Similar logic applies to the variables from the American Community Survey and the Regional Economic Accounts, which I discuss later in this section.

geographically based on place of work.[20]

County-level data on housing values and rental prices were acquired from 5-year estimates from the American Community Survey (ACS) and the 2000 Decennial Census.[21] The ACS variables include median rental price, median value of owner-occupied housing, median rent as a percentage of household income, and the number of housing units.[22] All values are based on five-year estimates using data from the five years up to and including the year in which they are labeled. Five-year estimates are available for 2009-2014, and I code each five-year estimate based on the middle year from the period from when the data were collected (i.e. the data from the 2009 dataset is coded to 2007) because the data effectively approximate a rolling average. I discuss this issue in further detail later in the paper in Section 4. Variables from the 2000 Decennial Census include the median value of owner-occupied housing and the number of housing units. These variables can be identically compared across the Census and the ACS. For median gross rent and median rent as a percentage of income, comparisons across the ACS and Census cannot be made.[23]

Annual data on incomes per capita, earnings per capita, population, and current transfer payments per capita for each U.S. county from 2001 to 2013 were acquired from the Bureau of Economic Analysis' Regional Economic Accounts (REA). The BEA data have been used in other studies of energy booms that focused predominantly on income and employment effects (e.g., Jacobsen and Parker, 2016).

The OES data are reported by non-metropolitan area, which represent combinations of non-metropolitan counties. An NMA includes about 12 counties on average, though there is substantial variation.[24] To merge all datasets, I aggregate the county-level datasets to the

[20]Due to the way in which the OES data are geocoded, if wage rates differ between commuters and local residents, then my results will not precisely identify changes in wage rate for the population of local residents.

[21]The ACS is an ongoing survey that the Census uses to compute 5-year, 3-year and 1-year estimates. The 3-year and 1-year estimates cannot be used because they do not include most rural counties.

[22]Housing data are based on one family houses on less than 10 acres without a business or medical office on the property. All rent variables are based on gross rents, which include the estimated monthly cost of utilities and fuels. The use of gross rent eliminates variation in rental prices driven by variation in whether utilities and fuels are included in the rental payments. Median rent as a percentage of household income reports the median value for rental households based on individual responses for income and rental prices (i.e. it is not calculated based on aggregated median rent and income levels).

[23]See the ACS/Census Table Comparison page at www.census.gov.

[24]NMAs in states where the average county is geographically larger are typically comprised of fewer counties.

NMA-level using the NMA-county crosswalk provided in the OES data.[25] I limit the analysis to the continental U.S., excluding the state of Virginia.[26] I drop nine counties that are listed in multiple NMAs. I also drop NMAs for which the composition of counties changed over the course of the sample. These drops lead to the exclusion of 7 out of 160 NMAs.

The combined dataset is comprised of a panel dataset at the NMA-year level. Most variables are reported for only a subset of the years. In particular, the OES wage data are only available from 2006-2014, the oil and gas data are only available through 2011, and the housing data are available for 2000 and 2007-2012. The BEA population and economic data are only available through 2013. Regardless, as I will discuss when describing the methodology, the combined dataset still allows for an examination of the recent effects of the energy boom.

I generate several variables, the foremost of which is an indicator for a "boom" area. I define boom NMAs as NMAs in which annual extractions of oil and gas were at least $500 million greater in 2011 than in 2006. The year 2006 was chosen because it is the first year for which OES data are available for NMAs and 2011 was chosen because it is the last year that oil and gas data are available.[27] The $500 million cut point results in 17 of 160 NMAs being classified as boom areas, as can be seen in Figure 2, which presents a histogram of the change in oil and gas revenues across NMAs. The threshold for a boom area was set at $500 million because it limits the "treatment" areas to those that have had large increases in energy extraction, yet still provides a sufficient number of treatment observations for adequate statistical power. As I will show in Section 4.3, the results are robust to adjustments in the threshold used to define boom areas.[28] In addition to generating a boom variable, I

[25]Population and all oil and gas variables are aggregated as an unweighted summation. Income per capita, net earnings per capita, personal current transfer receipts per capita, median rental price, and median value of owner-occupied housing are aggregated using a population-weighted mean.

[26]Virginia is dropped because the BLS and the Census code sub-regions within Virginia differently. The Census treats each Virginia township as a distinct region in county datasets whereas the BLS does not. The BLS coding is used in the OES data whereas the Census coding is used for the USDA data.

[27]The selection of boom areas is extremely similar if the change from 2000 to 2011 in oil and gas production is used to define boom areas. The only difference is that two NMAs–Eastern Montana and Eastern & Southern Colorado–are also classified as boom areas.

[28]Binary measures of booms regions are common in the literature (Jacobsen and Parker, 2016; Marchand, 2012; Weber, 2012; Black et al., 2005a) because they enable a transparent, graphical comparisons of boom and non-boom areas. A continuous measure of productions requires a broad set of assumptions about temporal lags and functional forms. The purpose of the present paper is not to provide precise parameters of how each well drilled or barrel extracted leads to changes in wage rates or housing prices, because that relationship

also generate indicator variables for non-boom regions with some production of gas and oil between 2006 and 2011 and zero production between 2006 and 2011. I label these variables as "some-production" and "zero-production," respectively.

Figure 3 presents information on trends in gas and oil extraction for boom and some-production areas. Boom areas had a relatively steady production trend leading up to the mid-2000s, at which point production begins to increase rapidly and nearly doubles by 2011. In some-production areas, production is level or very slightly declining throughout the sample period.

A map of all NMAs is presented in Figure 4. Boom areas are represented by the dark-blue regions and some-production areas are represented by the light-blue regions. The gray areas had zero production over 2000-2011. The white areas are metropolitan regions or areas that have been dropped from the analysis for reasons described previously. The booming areas are located near prominent shale plays and basins including the Bakken in western North Dakota; the Niobrara in Wyoming, Colorado, and Utah; the Eagle Ford and Permian in Texas; the Haynesville near western Louisiana, and the Utica and Marcellus near the northern Appalachians. “Some-production” areas are generally located near boom areas and areas with “zero-production” areas are located further away from boom areas.

Summary statistics for oil and gas variables, major economic variables, and housing variables are presented in Table 1. The varying number of observations across variables primarily reflects differences in the years spanned by the original datasets. About 10 percent of areas are boom areas, 40 percent are some-production areas, and 50 percent have had zero production. The typical NMA has a population of about 300,000, income per capita of $35,000, net earnings per capita of $21,000, and personal current transfer receipts per capita of $7,500. Average median home value is a bit over $150,000. Average median rent is about $700/month and about 30 percent of household income. In the typical NMA, there are about 150,000 housing units.

Summary statistics for wage variables are presented in Table 2. The table presents a complete set of summary statistics for the mean wage rate. For other measures of wage

likely depends on many situation-specific factors. Rather, the purpose is to provide a general characterization of the type of effects that are likely to be experienced locally during an energy boom.

rates (i.e. top decile, median), the table only presents the mean. The typical mean hourly wage in the sample is about $18. There is a substantial range in the wage distribution, as the wage at the first decile is about $8 whereas the average at the ninth decile is over $30. There is also substantial variation in hourly wages across occupations. Low-skill service jobs, such as food preparation and ground maintenance are paid the least, at about $10. High-skill occupations, such as legal work and engineering receive larger hourly salaries, at about $30 and workers employed in management are paid the most, earning nearly $40. Construction and extraction occupations, which are likely to be the most directly affected by the boom, receive average hourly wages at about $20 per hour.

4 Empirical Analysis

I examine the effects of the recent U.S. energy boom using a difference-in-differences (DiD) framework that compares how boom areas changed relative to non-boom areas during the period after production levels started increasing. Within the DiD framework, areas that did not experience the boom effectively serve as a control group that is used to compute a counterfactual for what boom areas would have experienced over time were it not for the energy boom. The extent by which boom areas differ from the counterfactual indicated by the non-booming areas provides an estimate of the effect of the energy boom.

Because the time period for which data are available differs across variables, the years used in the analysis depend on the outcome being examined. For each outcome, I compare the change in boom areas over time relative to the first year in which the outcome variable is available and discuss the trends within the context of corresponding changes in production levels. In general, I expect "boom effects" to steadily increase over time because the boom had not yet peaked as of 2014 (see Figure 1).

4.1 Comparison of Means

I begin the analysis by presenting a graphical comparison of means between boom and non-boom areas for three sets of variables: major economic variables (population, income per capita, net earnings per capita, employment, and personal current transfer receipts per capita), wage rate variables, and housing variables. For each outcome presented, I display means annually for boom and non-boom areas. I also display how the difference in means between the two groups has changed since the beginning of the sample. Means are plotted against the left-hand axis, which is log-scaled. The difference in means, as measured in log points, is plotted on the right-hand axis.[29] When present, a divergent trends in means during the latter part of the 2000s is evidence that the energy boom affected an outcome.

Figure 5 presents estimates for major economic variables. These outcomes have generally been considered in other studies of energy booms and thus do not constitute the primary contribution of the paper, but they are helpful for initially characterizing the effects of the boom. For each outcome, the trend is nearly flat until 2005, at which point the boom areas begin to increase relative to non-boom areas. The beginning of the apparent boom effects in 2005 is consistent with the change in production levels, which most clearly begin to diverge in 2006 (see Figure 3). The reason for the one-year delay in production is that wells take time to be completed, so while production changes began in 2006, operations related to drilling and construction of related infrastructure likely began in the prior year.[30] Relative to non-boom areas, mean levels of population, income per capita, net earnings per capita, and employment all increased between 2001 and 2013. Personal current transfer receipts per capita decreased.

Means related to overall hourly wage rates and employment are presented in Figure 6. Separate graphs are presented for the mean hourly wage and the hourly wage at the 1st decile, median, and 9th decile of the wage distribution. The year 2006 is the first year in the OES data and serves as the point of comparison in the graphs. Because the boom appears to have begun in 2005 (based on Figure 5), evaluating the boom by comparing changes relative to 2006 likely will lead to conservative estimates of the effect of the boom. Despite the conservative comparison, all hourly wage plots indicate that the boom has increased wage rates. The estimated effect is larger at the first decile and median than it is at the 9th decile.

Figure 7 presents a comparison of means for the housing variables. Similarly to the

[29]The range of the right-hand axis is fixed across all graphs to facilitate comparisons across outcomes.

[30]There are a variety of stages to pre-drilling and drilling. Initial geological surveys and permitting can take more than half a year; staking out the well and wellpad boundaries takes one to two months; drilling and completion take about a month (Shale Reporter, 2015).

major economic variables, the two groups appear to be on comparable trends during the early to mid-2000s. Starting in the latter 2000s, clear boom effects are present. Both owner-occupied housing values and rental prices have experienced relative increases in booming areas. The percentage increase in owner-occupied housing values is substantially larger than the increase in rental prices. The likely explanation for the larger effect on owner-occupied housing is that the increase reflects both an increase in demand for housing and an increase in value from royalty payments.[31] There is no evidence that rent as a percentage of income increases, which indicates that renters are able to tap into the monetary benefits of the boom. There is little evidence that the boom has led to substantial amounts of new construction, as trends in housing units do not appear to diverge. The lack of new construction suggests that the effects of the boom can be attributed to actual price changes as opposed to a change in the composition of the housing stock although, as described in Section 1, I cannot control for all channels by which the composition of the housing stock could have adjusted.

4.2 Estimates

I next investigate the effects of the energy boom using a set of regressions. The primary purpose for the first set of estimates is to formalize the results that can be seen visually in the figures presenting the comparison of means. I then present a new set of results examining how the boom has affected wage rates across different occupational categories.

Estimates are based on a regression of the form

$$\text{Outcome}_{it} = \alpha_i + \gamma_t + \lambda_t \sum \text{Boom}_i \times \text{Time Period}_t + \epsilon_{it}, \tag{1}$$

where i indexes areas, t indexes years, α_i is a vector of NMA fixed effects that controls for time-invariant differences across areas, γ_t is a set of year dummy variables that controls spatially-uniform time trends, and λ_t represents a set of coefficients on the interaction terms comprised of an indicator for whether an area is a boom area and a dummy vari-

[31]The effect of royalty payments may be limited in the ACS data by the fact that the data are recorded based on houses on parcels that are less than ten acres. The effect of the boom on housing values for houses overlaying large parcels in booming areas would likely be larger than the effects documented in this paper.

able corresponding to a year, and ϵ_{it} is an error term. In all estimates, standard errors are clustered by NMA.[32] The coefficients of primary interest are those represented by λ_t, which indicate how booming areas changed relative to non-boom areas over the sample period. An increasing trend across years during the boom period (2005 and later) in the magnitudes of the coefficients on the interaction terms can be interpreted as evidence of boom effects.

Identification of the effects of the boom in the above specification depends exclusively on the assumption that non-boom areas provide a valid counterfactual for the time trend that would have been experienced in boom areas absent the boom (i.e. the "common trends" assumption). While not empirically testable, the validity of this assumption is supported by Figure 5, which indicates that boom and non-boom areas were on similar time trends in major economic variables during the early 2000s, and Figure 7, which shows that there was not a substantial relative change in the difference in home values and number of housing units in boom and non-boom areas between 2000 and 2007. I investigate the sensitivity of the results to the choice of different control groups and specifications in Section 4.3.

Estimates that correspond to the comparison of means presented in Figures 5, 6, and 7 are reported in Tables 3, 4, and 5, respectively. The results reflect the patterns presented in the figures and can be summarized as follows.[33] Boom areas experienced relative increases in population (5.7%), income per capita (11.8%), earnings per capita (16.7%), and employment (13.6%) between 2001 and 2013. Consistent with less use of social programs, personal current transfer receipts per capita decreased by 5.9%.[34] Mean wage rates increased by

[32]I have also estimated models in which standard errors are clustered by state and models using the wild bootstrap (Cameron et al., 2008). The *p*-values from such models are slightly elevated, but most statistically significant coefficients in the present analysis remain so when using these alternatives. For example, for Table 4, the *p*-values on the "Boom × 2014" term based on the primary analysis, using the wild bootstrap, and when clustering by state, respectively within the parentheses, are as follows: Column 1 (.000, .000, .007); Column 2 (.000, .000, .005); Column 3 (.000, .000, .005); Column 4 (.000, .000, .005); Column 5 (.000, .000, .013); Column 6 (.000, .000, .001). For Table 5, the *p*-values on the "Boom × 2012" term based on the primary analysis, using the wild bootstrap, and when clustering by state, respectively within the parentheses, are as follows: Column 1 (.000, .000, .015); Column 2 (.000, .000, .093); Column 3 (.655, .712, .815); Column 4 (.020, .022, .157).

[33]The estimates are not precisely identical to the effects indicated by the comparison of means because the comparison of means involves aggregating the data and then taking logs whereas the estimates are calculated using logged variables and the disaggregated data. Relative to the estimates, the comparisons of means calculations implicitly places a greater weight on observations with larger values for the dependent variable.

[34]The likely explanation for the decrease in transfers is that stronger booming economies decreased dependability/eligibility on government programs. On the one hand, the decrease in transfers may somewhat offset the disproportionate wage rate benefits from the boom for lower deciles. On the other hand, this decrease provides evidence that fewer low-income households were relying on governmental programs, which indicates

about 7% between 2006 and 2013. There is evidence that the wage effects were larger in the bottom part of the wage rate distribution as the increases for the first decile and first quartile of the wage rate distribution (7.1% and 9.7%) are larger than the increases for third quartile and ninth decile (6.2% and 4.8%). Both housing values and rental prices increased between 2007 and 2012, though the estimated increase in home values (12.5%) is more than double the effect on rent (5.0%).[35,36] All of the changes are statistically significant.[37] Additionally, the insignificant coefficients on the interaction terms corresponding to the early-2000s in Table 3 and the insignificant coefficient on interaction term corresponding to 2000 in Table 5 support the assumption that non-boom areas provide a valid counterfactual for time trends in boom areas.

I next examine how wage and employment effects varied across occupational categories. There are two reasons why variation across occupational categories is of interest. First, examining the extent to which wage effects spilled over outside of jobs directly related to extraction provides an indication of how much the benefits of the boom extended across the community. Secondly, examining how the wage effects relate to the employment effects sheds light on whether the changes in wage rates were driven by compositional changes (i.e. changes in the specific types of occupations of comprising each major occupational category) or a tighter overall labor market. An increase in wage rates in occupations that did not experience changes in employment would be most consistent with a tighter overall labor market.

To investigate the labor market effects of the energy boom across occupations, I estimate models that are analogous to those that evaluate overall mean wage and employment effects

that the boom provided benefits to some of the households that were most in need.

[35] I choose 2007 as the year of reference for the housing variables because it is the first year of data that is available across all four variables.

[36] Table 5 provides some modest evidence that the number of housing units increased in boom areas in 2012. This is unlikely to mean that the observed changes in home values and rental prices are driven by compositional changes because the effects on homes values and rental prices emerge well before the effect on housing units. Also, alternative specifications discussed in Section 4.3 indicate a positive boom effect on housing values and rental prices, yet fail to show an increase in the number of housing units (e.g., Table A.15).

[37] Inferring significance for the housing variables (from the ACS) is complicated because the data, roughly, represent a rolling five-year average based on overlapping datasets. However, if the data are restricted to the 2009 and 2014 5-year estimates, which do not overlap, a DiD analysis produces point estimates that are nearly identical to those on the “Boom × 2012” term in Table 5 and the coefficients are significant for the specifications investigating home values and median rent.

(see columns 1 and 4 of Table 4), except that the outcomes in the new set of results are the mean wage rate and employment level for a specific occupational category. In order to present a consolidated set of results, the only coefficients I present from these models are the coefficients on the "Boom × 2014" interaction term, which indicates the relative change in the outcome for boom areas since the beginning of the sample.

The results, which are based on 44 separate regressions, are presented in Figure 8. The occupations are sorted based on the estimated wage effect. The coefficient for mean wage is significant at the 5-percent level in 18 of 22 cases, indicating that the boom raised wage rates for almost every occupational category. The increase in wage rates is comparable across most categories and the confidence interval for the wage estimates only fails to include the estimated effect across all occupations (7%) in two instances.

Changes in employment were much more varied across occupations than the changes in wage rates. Unsurprisingly, construction and extraction experienced the largest change, increasing by over 60 percent. Other occupations with significant changes include transportation and moving; life, physical, and social sciences (i.e. technicians); sales; architecture and engineering; personal care and service; office and administrative support; food preparation and serving; business and financial operations; legal; installation maintenance and repair; and computer and mathematical. Some of these occupations have likely increased because they are directly connected to the extraction sector (i.e. architecture and engineering), while others have likely increased due to the increase in population and daily visitors (i.e. food preparation and serving).

Strikingly, there is no evidence of a relationship between the wage effects and the employment effects. The correlations between the wage coefficient and employment coefficient across occupations is .07. Collectively, the wage and employment results are consistent with a tighter local labor market that required employers to pay more to hire and retain employees across occupations. The most likely explanation for the tightness of the labor market is that migration was not sufficient to offset the increase in the demand for labor due to the costs of relocating and beliefs about the temporary nature of energy booms. This interpretation is consistent with the results in Table 3, which indicate that the percentage increase in population caused by the boom was less than half the percentage increase in employment. Regardless of the cause, the increase in wages represents a substantial and perhaps surprisingly widespread benefit that accrued to local workers.

I also re-produce Figure 8 for wage rates at the first and ninth decile of the distribution, as reported in Figure 9 and Figure 10. These results, in some sense, are comparable to the analysis based on means, in that the wage rate increases are evident across occupations and are not strongly correlated to changes in employment. A new insight provided by this analysis, however, is that there is less evidence of differences in boom effects at the top and bottom of the distribution based on the occupation-specific analysis than there is based on the overall analysis. The mean effect on wage rates at the ninth decile across occupations in the occupation-specific analysis is .063, which is only 11 percent lower than the mean effect on wage rates at the first decile across occupations in the occupation-specific analysis (.071). Recall that in the overall analysis provided in Table 4, the effect on wage rates in the ninth decile (.048) was 33 percent lower than those in the first decile (.071). The implication of these results is that the boom had differential effects across the distribution of wage rates primarily because it had relatively larger effects on low-wage occupations rather than because it created broad changes in within-occupation wage rate distributions. Further analysis of how the effects varied across occupations supports this conclusion. In particular, the five occupations with the lowest mean wage rates experienced, on average, a 7.0 percent increase in wage rates because of the boom. In contrast, the five occupations with the highest mean wage rates experienced, on average, a 5.4 percent increase in wage rates because of the boom.

Another question with respect the effects of the boom on wage rates is whether the effects are primarily driven by occupations in industries that are closely connected to extraction, including the mining, construction, and transportation and warehousing industries. To examine this, I use data on the industrial composition of each occupational category to calculate the share of jobs in each major occupational category that are in the closely connected industries listed above.[38] These results, along with the 2014 mean wage coefficient for each occupational category, are reported in Table 6. The results suggest that wage effects

[38]The analysis is based on information on the industrial composition of each occupational category as reported in the 2014 Occupational Employment Statistics.

are experienced substantially even in occupations that do not work in closely connected industries. Many occupational categories for which an extremely small share of jobs fall in closely connected sectors still experienced a substantial increase in wage rates. Additionally, the correlation between the wage effects and concentration measure is weak (.30) and statistically insignificant.

4.3 Robustness Checks

The validity of the difference-in-differences methodology hinges on the assumption that non-boom areas can be used to control for time trends that are unrelated to the boom. I investigate this assumption in several ways, including more thorough investigations of pre-existing trends, allowing for different time-trends across Census divisions, dropping NMAs with some production from the control group, dropping boom-adjacent NMAs, and instrumenting for the boom using resource endowments. The results of these investigations are discussed here and the graphical and tabular output related to them are presented in the online appendix.

To more thoroughly investigate pre-existing trends, I reproduce the comparison of means present in Figure 5 with an additional decade of data added to the beginning of the sample. The graphs are provided in Figure A.1. These figures also support that assumption that boom and non-boom areas are reasonable counterfactuals, as they indicate the two groups were on very similar trends throughout the 1990s and leading into the 2000s.

While the previous analysis indicates boom and non-boom areas followed similar time paths leading into the boom, it is possible that differential regional trends that were unrelated, yet correlated with the boom could have caused boom and non-boom NMAs to diverge during the 2000s. If so, then estimates of the effects of the boom would be biased. To control for this possibility, I reproduce the main results using a model that allows for the nine separate Census divisions to be diverging linearly though the sample. Results are reported in Table A.1, Table A.2, Table A.3, and Figure A.2 and are similar to those in the main text.

Another potential sources of bias is the boom contemporaneously affecting some-production areas. Areas with some-production tend to be located close to booming areas and are likely to have a subset of workers with skill sets that are particularly well-suited to economies with elevated levels of oil and gas production. Accordingly, these areas may be affected by the boom, most likely through out-migration. If some-production areas are affected by the boom, then using them as "control" areas would be problematic.[39]

To examine whether the results are robust to excluding some-production areas from the control group, I re-estimate all of the previous models after excluding these areas from the sample. The results from these models are presented in Table A.4, Table A.5, Table A.6, and Figure A.3. The estimates are generally very similar to those presented in the earlier models. The wage rate point estimates are, if anything, slightly larger.

In a related set of estimates, I show that the key results are robust to dropping any non-boom NMA that is adjacent to a boom region. Dropping boom-adjacent NMAs is another way of addressing concerns that out-migration from control areas into boom areas biases the estimates because out-migration should be most substantial in areas that are closest to booming areas. The results are presented in Table A.7, Table A.8, Table A.9, and Figure A.4. The estimates in these tables are similar to those presented in the main text, which stands in contrast to what would be expected if out-migration from nearby areas was driving the results.

The estimates may also be biased is if areas that actively pursued extraction did so for reasons correlated with pre-existing economic trends. For example, an economically depressed area might be less likely to ban fracking than an area experiencing rapid economic growth. To address this concern, I employ an instrumental variables approach in which I instrument for the boom using resource endowments. I measure resource endowments based on the twenty-three major shale plays in the United States.[40] In these models, in the first stage, I instrument for the *Boom*-by-year interactions using interactions of shale play indicators and year effects. Second-stage results are reported in Table A.10, Table A.11, Table A.12, and Figure A.5. Results are similar, though at times slightly larger, than those in the main text.

Another potential concern related to the analysis is the arbitrary cut point used to define

[39] More formally, if some-production areas are also affected by the boom it would be a violation of the "stable unit treatment value assumption."

[40] These data are recorded in shape files available at: `www.eia.gov/maps/map_data/TightOil_ShaleGas_Plays_Lower48_EIA.zip`.

booming areas. To address this, I show that the results are robust to changing the threshold used to define boom areas. In particular, I present results in Table A.13, Table A.14, Table A.15, and Figure A.6 based on a boom threshold of $100 million instead of $500 million. Under the new definition there are twenty-four boom areas, as opposed to the original seventeen. Results are similar, though at times a bit smaller, indicating that areas that went through smaller booms experienced more modest effects.

Finally, I examine whether the results are driven by the Bakken region, where the effects of the boom were particularly profound (Richter et al., 2018). To do so, I exclude the two booming NMAs that overlay the Bakken from the analysis. Results are reported in Table A.16, Table A.17, Table A.18, and Figure A.7. While the magnitude of the main effects decreases by around one-third, the results remain similar in terms of direction and significance, indicating substantial effects even excluding the Bakken. It should be noted, however, that even when excluding the Bakken, the analysis provides estimates of the average effect of the energy boom in booming areas. There may be anecdotal cases when wage rates remained unchanged or when housing and rental prices experienced larger changes. In general, if an area is at the epicenter of a boom, it is likely that the effects of a boom will be larger than if an area is going through a smaller boom or is on the fringe of a booming region.

Across all robustness checks, the correlation between the wage and employment coefficients in the occupational-specific analysis remains low. In particular, the correlation for the robustness checks based on including Census division time trends, dropping some-production NMAs, dropping boom-adjacent NMAs, instrumenting with resource endowments, using a boom threshold of 100 million, and dropping the Bakken are .24, .05, .03, -.16, .02, and .01, respectively. For context, the correlation for the primary analysis is .07.

5 Conclusion

The paper presents new evidence on the local effects of energy booms, an issue that has received considerable attention due to ongoing debates about drilling policies in the United States. In particular, I show that the recent U.S. energy boom had a substantial positive effect on wage rates, housing values, and rental prices in local economies. Consistent with the boom creating a tighter local labor market that benefited workers, the increase in wage rates occurred across almost all major occupational categories. Additionally, wage rates increased in every segment of the wage rate distribution and the largest percentage effects were in the lower parts of the wage rate distribution.[41] With respect to housing, the estimated increase in housing values (12.4%) was much larger than the increase in rental prices over the same period (5.0%).

The primary implication of this paper is that bans on drilling for oil and gas have negative monetary consequences for a wide variety of local residents. If energy development is prohibited, workers will not benefit from increased wage rates and homeowners will miss out on royalty payments and elevated housing values. While allowing drilling may lead to local price inflation, the evidence in this paper suggests that the labor market effects of the boom are typically sufficient to offset the increase in prices even for households, such as renters, who are most directly exposed to the price effects.[42] These findings may be of interest to local jurisdictions, who at times have imposed their own regulations on drilling, and also to state or national policymakers evaluating larger-scale options. From a state or national perspective, the negative effects of bans on local economies are perhaps exacerbated by the fact that bans will have larger effects per person in rural communities with low population densities than in urban settings (due to the natural link between the amount of land and the size of oil and gas reserves). Rural communities have often been prioritized for policies encouraging economic development.[43]

While the broad monetary benefits of the boom increase the importance of avoiding unnecessary restrictions on drilling, the findings should not be taken as a blanket endorsement for oil and gas extraction. Restrictions may be justified by non-monetary concerns, such as environmental degradation. Additionally, if drilling is allowed, it may still be optimal for local areas to collect impact fees (or at least receive revenue from state-level fees) in order

[41] As mentioned earlier, because I cannot control for changes in the skill composition of the labor market, these results do not imply that the boom created a change in the wage per efficiency unit of labor.

[42] Renters are more exposed than home owners because increases in property values are costly for renters but beneficial for homeowners.

[43] In principle, concerns about the distributional effects of a ban could be offset by a redistribution of revenue from other sources. In such a case, the estimates provided in this paper and elsewhere in the literature could be helpful in deriving the parameters of such a policy.

to offset some of the negative effects of drilling such as increased depreciation of infrastructure. Some of this revenue might also be reserved to aid local economies in the inevitable transition into a post-boom economy. Similarly, the results should not be taken to indicate energy booms do not create any losers. Retired individuals on fixed incomes could be harmed, for example, if their rental prices increase.[44]

Appropriately formulating policies on energy exploration and extraction at the local level and beyond requires a detailed understanding of the effects of energy production, especially with respect the development of shale resources which have only recently become a significant component of U.S. energy production and are poised to remain so. While monetary and environmental factors are perhaps the most prominent outcomes that need to be considered, the effect of booms on other factors, such as road depreciation, highway safety, education and other public services, and energy security may also be important. Future research in these areas followed by the careful design of policies would be of substantial local and national benefit.

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[44]Based on the 2010 Census, 1.7% of the population in booming NMAs was 65 or older and also a renter.

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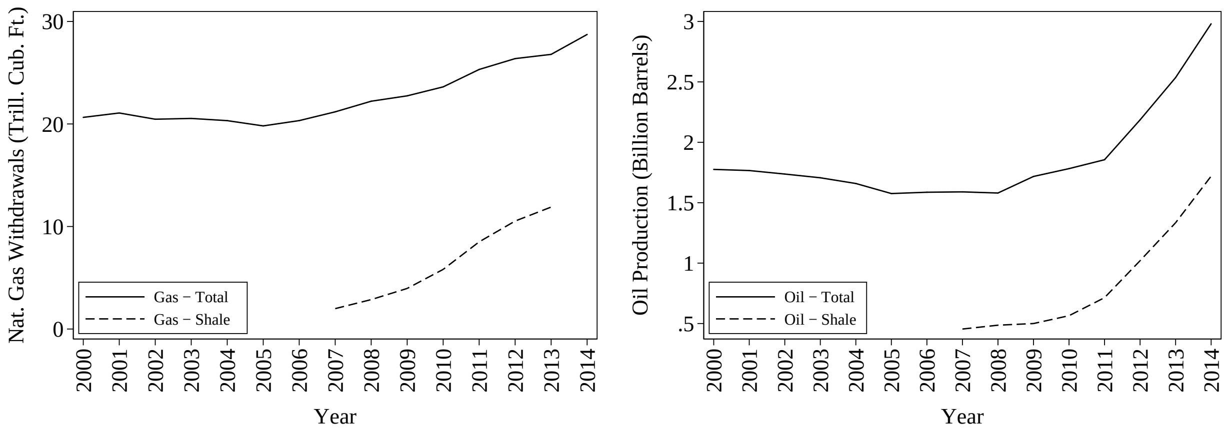
7 Figure and Tables



(a) Gas

(b) Oil

Figure 1: **National Trends in Oil and Gas Production in Continental U.S.** The data sources are the USEIA (2015a) and USEIA (2015b).

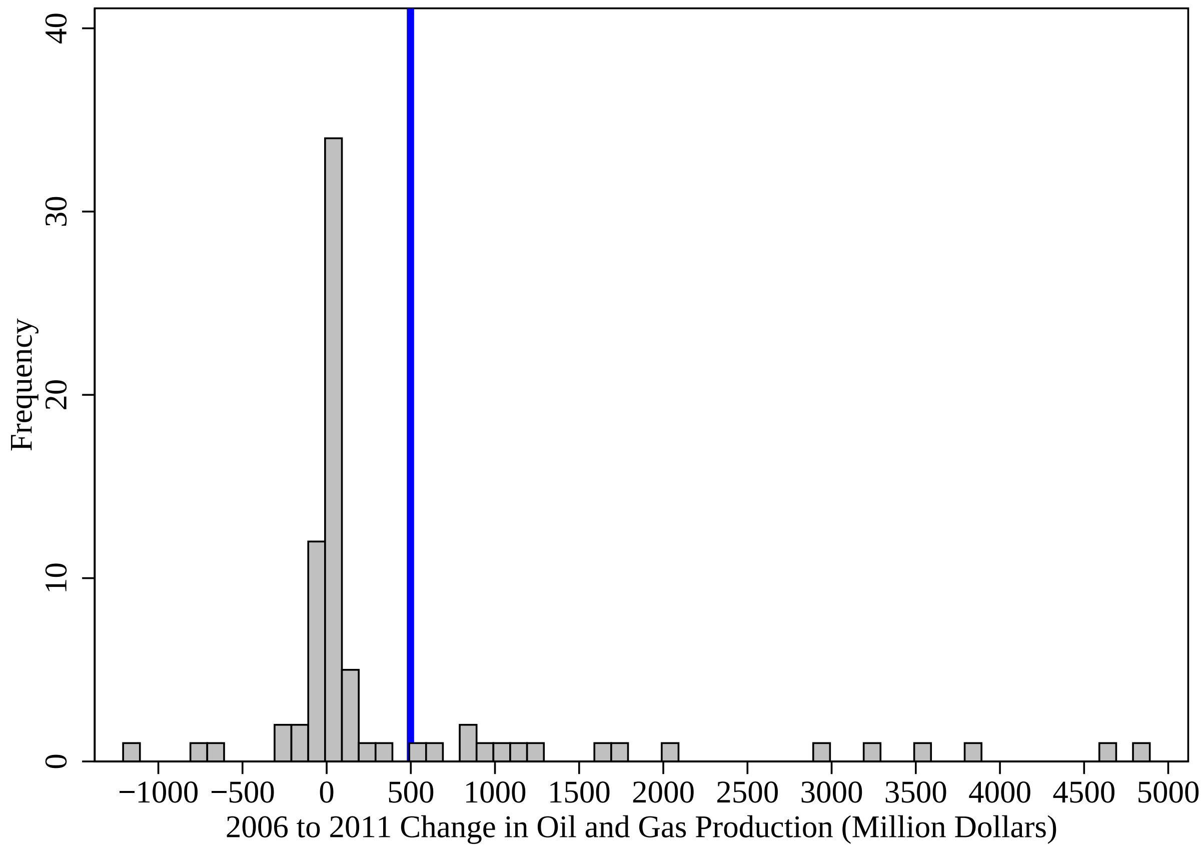


Figure 2: **Histogram of Change in Annual Oil and Gas Production from 2006 to 2011.** Areas with zero production are excluded from the data used for the histogram. The vertical line corresponds to the $500 million threshold used for the definition of a "boom" area.

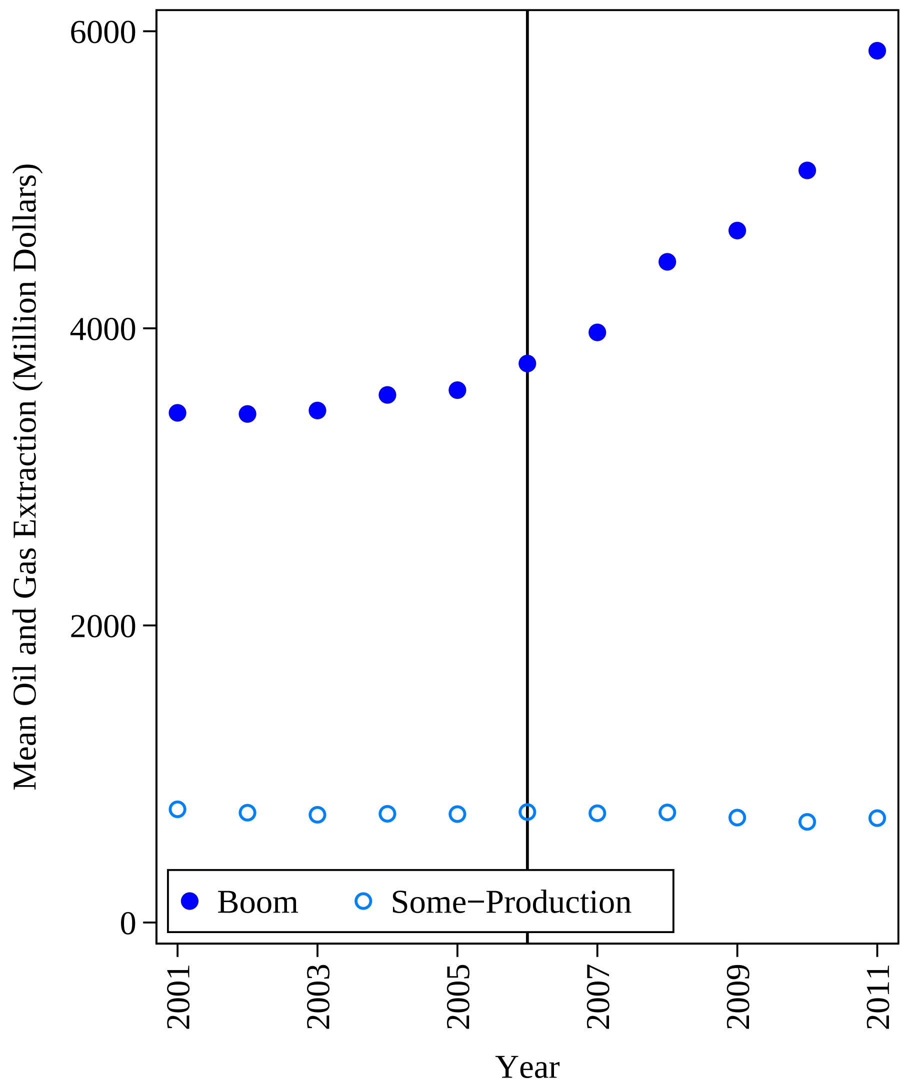


Figure 3: **Trends in Mean Oil and Gas Revenue by Category.** There are 17 boom areas and 60 some-production areas.

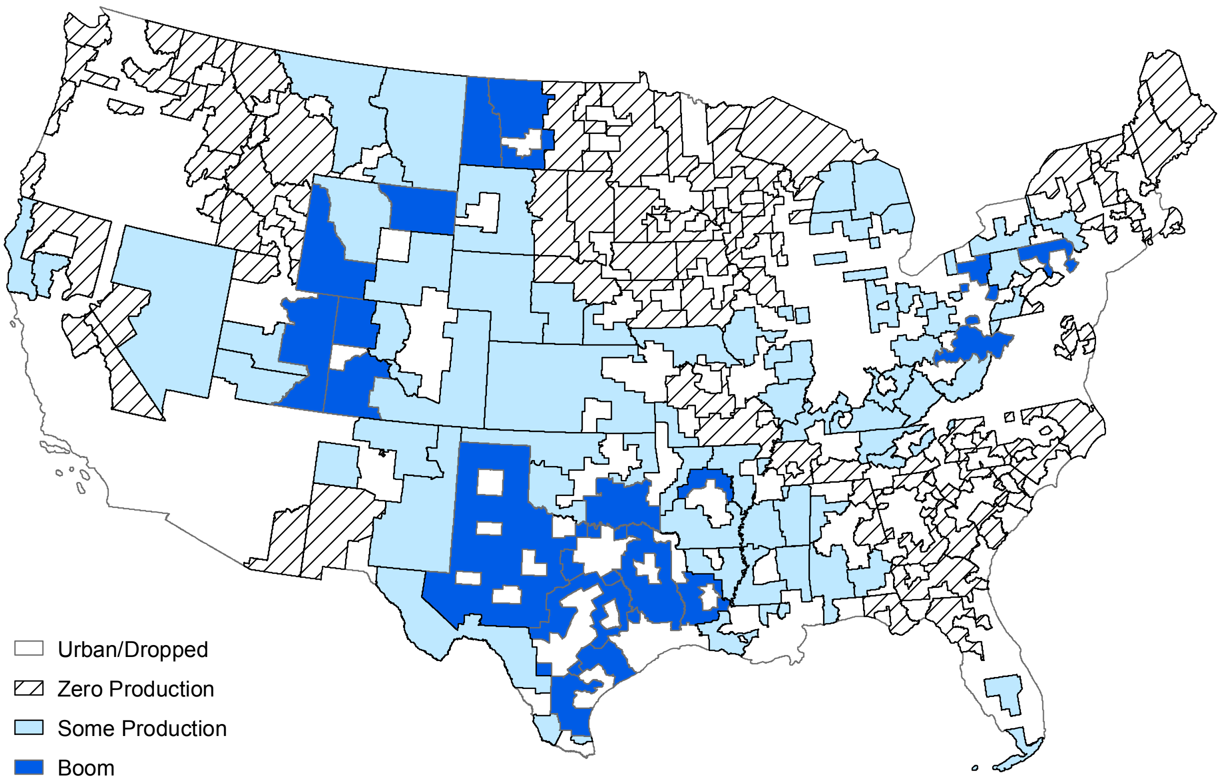


Figure 4: **Map of Boom Areas**. Non-white polygons represent non-metropolitan areas (NMAs) as defined by the Bureau of Labor Statistics.

Table 1: Summary Statistics for Non-Wage Variables

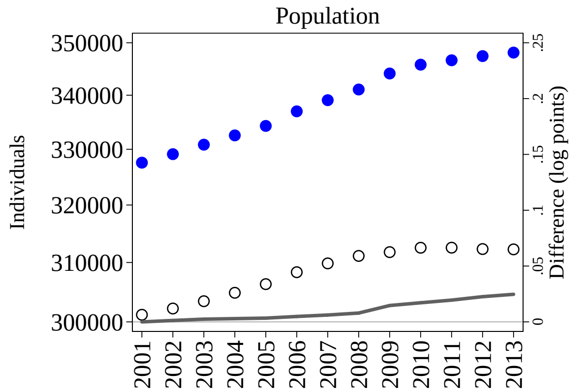
Variable	Mean	St. Dev.	Min.	Max.	Obs.
Boom	0.11	0.31	0.0	1.0	2,295
Some Production	0.39	0.49	0.0	1.0	2,295
Zero Production	0.50	0.50	0.0	1.0	2,295
Oil (Thous. Brrls.)	4,605.63	21,986.17	0.0	294,551.8	1,836
Gas (MMcf)	80,994.30	228,443.11	0.0	1,833,681.5	1,836
Oil and Gas Production (Mlln. $s)	736.43	2,379.13	0.0	27,689.9	1,836
Chg. in Oil and Gas Prod. (Mlln. $s)	217.94	826.92	-1,159.4	4,868.3	2,295
Population	311,742.25	204,955.06	17,610.0	1,000,724.0	1,989
Income per Capita	35,427.06	7,317.42	20,827.1	90,724.9	1,989
Net Earnings per Capita	21,185.84	5,677.48	11,963.4	70,124.4	1,989
Pers. Curr. Trans. Receipts per Capita	7,418.82	1,534.46	1,904.4	11,755.2	1,989
Median Owner-Occupied Home Value	146,791.44	74,953.23	55,965.3	510,415.0	1,071
Median Gross Rent	701.98	151.82	460.3	1,326.9	918
Median Rent as Percentage of Income	28.74	2.97	19.2	37.3	918
Housing Units	149,253.44	94,641.22	7,937.0	532,382.0	1,071

Notes: The unit of observation is an NMA and a year. Data sources are the USDA (2014), the USBEA (2015), and the US Census (2015).

Table 2: Summary Statistics for Wage Rate and Employment by Occupation

Variable	Mean Wage Rate					Measure of Wage Rate					Emp.
						1st Dec.	1st Qrt.	Median	3rd Qrt.	9th Dec.	
Summary Statistic	Mean	St. Dev.	Min.	Max.	Obs.	Mean	Mean	Mean	Mean	Mean	Mean
All Occupations	18.12	2.49	14.6	41.0	1,373	8.45	10.32	14.77	21.99	31.47	105,134.63
Architecture And Engineering	31.24	3.79	21.5	55.7	1,352	16.72	21.80	29.36	38.65	48.56	1,261.52
Arts, Design, Ent., Sports, And Media	17.90	3.02	10.5	39.0	1,353	8.78	10.83	15.23	22.08	30.56	844.13
Building And Grounds Cleaning And Maint.	11.69	1.44	8.9	19.7	1,376	8.06	8.96	10.67	13.45	16.98	3,611.73
Business And Financial Operations	27.27	2.98	20.6	50.3	1,356	14.43	18.81	24.98	33.07	42.61	2,703.87
Community And Social Service	19.38	2.26	14.3	28.4	1,356	10.77	13.81	18.30	23.92	29.92	1,669.76
Computer And Mathematical	28.55	3.72	19.0	46.4	1,349	15.08	19.66	26.54	35.38	45.18	847.80
Construction And Extraction	19.27	2.93	13.7	33.3	1,373	11.40	14.10	17.94	23.07	29.28	5,457.51
Education, Training, And Library	21.09	2.77	15.0	36.7	1,363	9.89	13.50	20.53	26.97	32.86	7,897.22
Farming, Fishing, And Forestry	14.44	2.31	7.5	23.1	1,304	8.89	10.47	13.18	17.13	22.06	680.37
Food Preparation And Serving Related	9.85	1.05	7.9	15.7	1,377	7.69	8.12	8.98	10.65	13.50	9,595.76
Healthcare Practitioners And Technical	30.84	3.76	22.9	46.0	1,368	13.48	18.25	25.27	34.18	53.21	5,827.02
Healthcare Support	12.42	1.62	8.7	19.8	1,368	8.80	9.95	11.62	13.98	17.15	3,598.00
Installation, Maintenance, And Repair	19.76	2.06	15.1	32.9	1,364	10.73	13.88	18.47	24.38	31.11	4,970.16
Legal	32.05	6.85	14.7	58.4	1,299	13.78	17.94	25.60	39.60	57.25	405.71
Life, Physical, And Social Science	26.64	3.16	18.2	43.2	1,325	14.11	18.12	24.55	32.80	41.72	765.03
Management	39.41	4.76	26.9	67.5	1,360	17.19	24.90	35.14	47.90	65.51	4,025.29
Office And Administrative Support	14.68	1.40	12.2	23.8	1,376	8.79	10.64	13.58	17.47	22.30	15,563.55
Personal Care And Service	11.20	1.31	7.6	17.8	1,357	7.87	8.56	9.89	12.29	16.54	2,661.95
Production	16.38	2.27	12.0	28.7	1,355	9.40	11.49	15.00	19.71	25.48	11,469.59
Protective Service	18.85	3.63	12.7	32.5	1,349	9.99	13.26	18.10	23.24	28.88	2,740.48
Sales And Related	14.24	1.51	10.5	21.4	1,375	7.96	8.75	10.64	15.82	24.77	10,367.26
Transportation And Material Moving	15.35	1.78	11.7	24.2	1,368	8.60	10.54	14.05	18.52	24.13	8,386.73

Notes: The unit of observation is an NMA and a year. The data source is the USBLS (2015). With the exception of the final column, this table presents summary statistics for various measures of hourly wage rates. For example, the 1st row indicates that, across NMAs, the average mean hourly wage rate across all occupations is \$18.12, and the average hourly wage rate at the first decile, first quartile, median, third quartile, and ninth decile of the wage rate distribution across all occupations is \$8.45, \$10.32, \$14.77, \$21.99, and \$31.46, respectively. The final column presents mean employment levels. Each row presents results for the corresponding occupational category as indicated by the first column.



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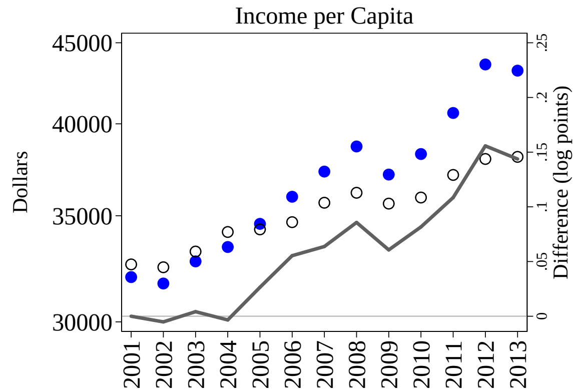

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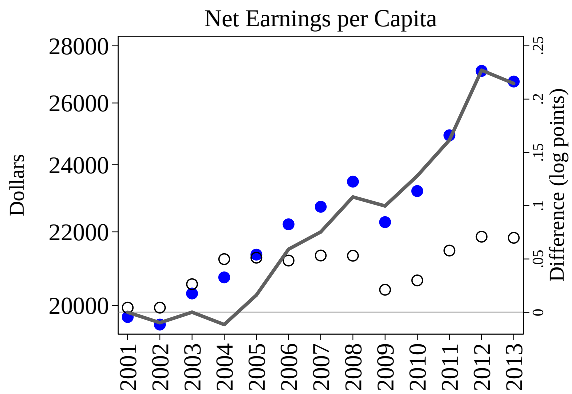

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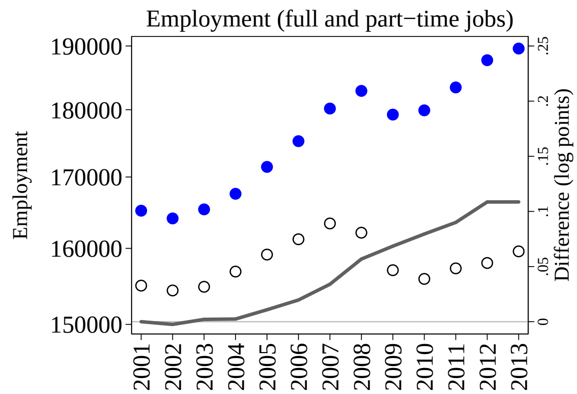

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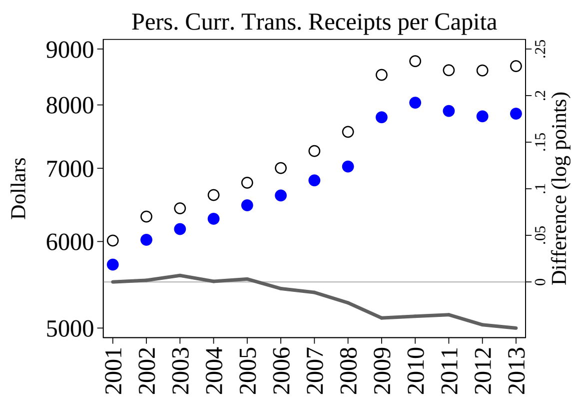


(e)

Figure 5: **Comparison of Trends in Means for Major Economic Variables.** In the scatter plots, solid markers represent boom areas and hollow markers represent non-boom areas and the markers are plotted on the left axis. The gray line represents the difference between the two groups relative to the difference in 2001 and is plotted on the right axis.

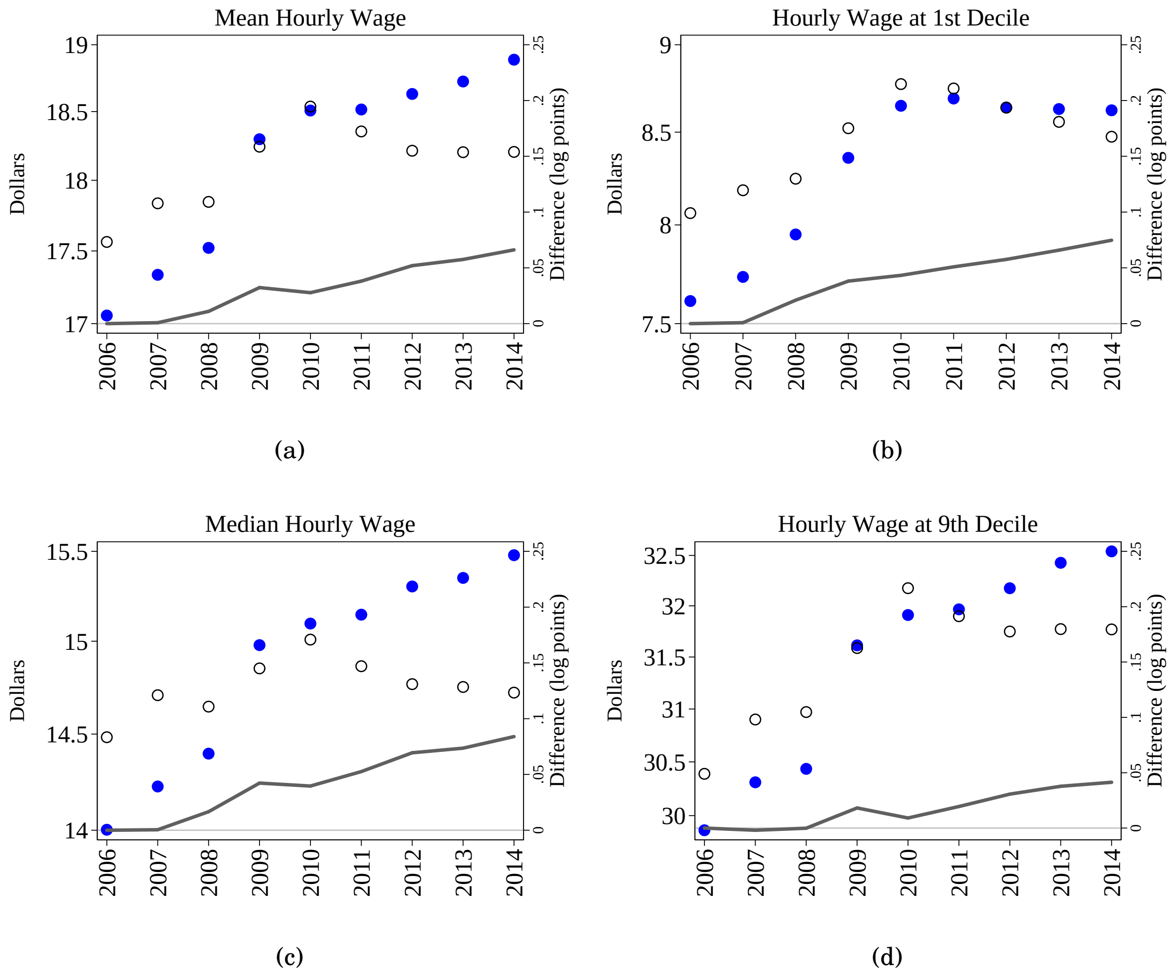


Figure 6: **Comparison of Trends in Means for Wage Variables.** In the scatter plots, solid markers represent boom areas and hollow markers represent non-boom areas and the markers are plotted on the left axis. The gray line represents the difference between the two groups relative to the difference in 2006 and is plotted on the right axis.

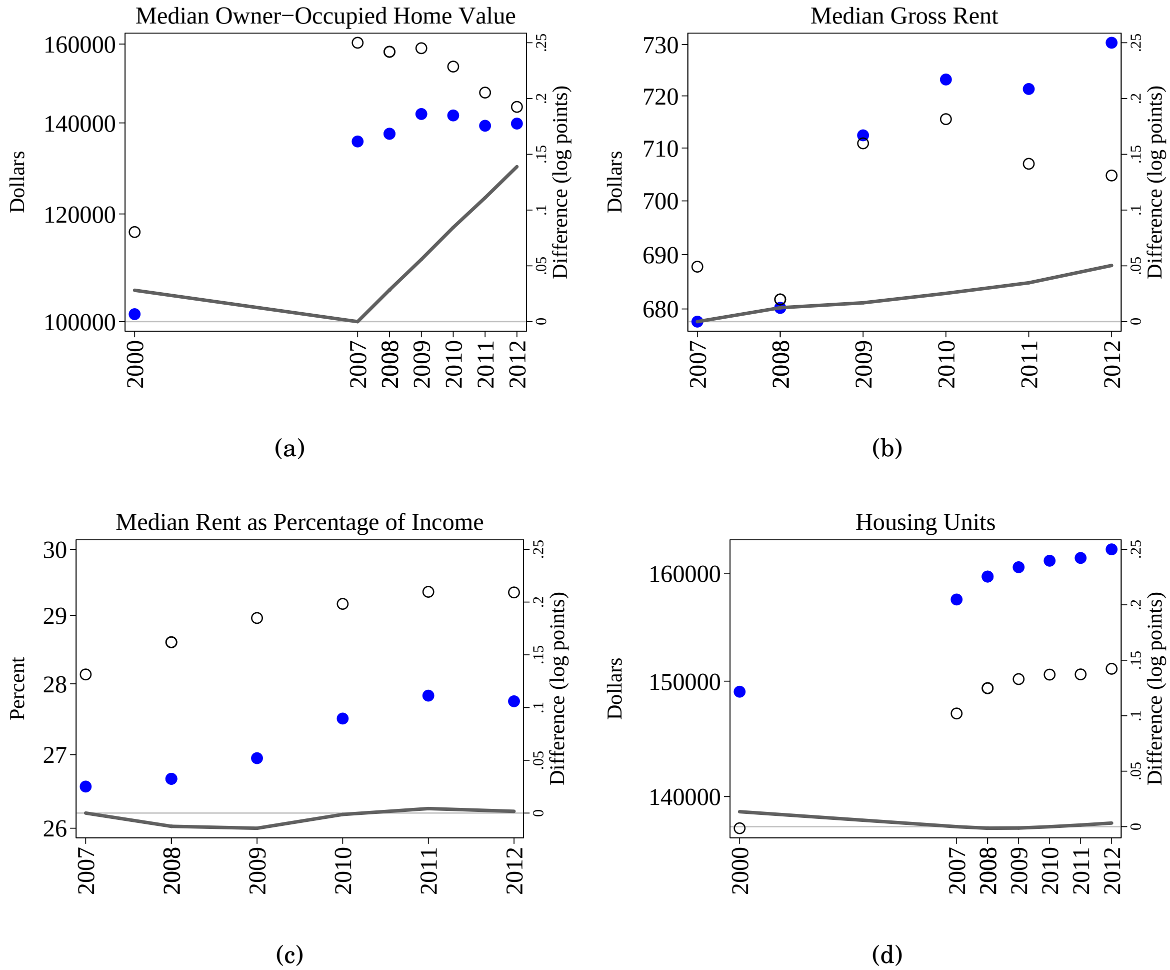


Figure 7: **Comparison of Trends in Means for Housing Variables.** In the scatter plots, solid markers represent boom areas and hollow markers represent non-boom areas and the markers are plotted on the left axis. The gray line represents the difference between the two groups relative to the difference in 2007 and is plotted on the right axis. Years correspond to the center years of the 5-year estimates reported by the ACS.

Table 3: Estimates of the Effect of the Boom on Major Economic Variables Relative to 2001

	ln(Pop.)	ln(Inc. Per Cap.)	ln(Earn. per Cap.)	ln(Emp.)	ln(Curr. Trans. per Cap.)
	(1)	(2)	(3)	(4)	(5)
Boom × 2002	0.003	-0.006	-0.011*	-0.003	0.000
	(0.002)	(0.005)	(0.006)	(0.003)	(0.005)
Boom × 2003	0.003	0.002	-0.002	-0.002	0.006
	(0.004)	(0.008)	(0.012)	(0.004)	(0.007)
Boom × 2004	0.004	-0.006	-0.012	0.000	-0.001
	(0.005)	(0.007)	(0.008)	(0.006)	(0.006)
Boom × 2005	0.005	0.021*	0.012	0.009	0.001
	(0.007)	(0.012)	(0.014)	(0.009)	(0.009)
Boom × 2006	0.008	0.044**	0.050***	0.023*	-0.011
	(0.009)	(0.019)	(0.019)	(0.014)	(0.010)
Boom × 2007	0.014	0.053***	0.064***	0.039**	-0.017
	(0.012)	(0.018)	(0.023)	(0.017)	(0.013)
Boom × 2008	0.019	0.077***	0.096***	0.065***	-0.029*
	(0.015)	(0.021)	(0.031)	(0.020)	(0.015)
Boom × 2009	0.030*	0.056***	0.088**	0.076***	-0.045***
	(0.017)	(0.021)	(0.036)	(0.018)	(0.015)
Boom × 2010	0.034**	0.073***	0.113**	0.089***	-0.043**
	(0.017)	(0.028)	(0.044)	(0.019)	(0.017)
Boom × 2011	0.039**	0.094**	0.138**	0.108***	-0.042**
	(0.017)	(0.038)	(0.057)	(0.028)	(0.020)
Boom × 2012	0.049**	0.128**	0.177**	0.135***	-0.054**
	(0.019)	(0.053)	(0.075)	(0.039)	(0.022)
Boom × 2013	0.057**	0.118**	0.167**	0.136***	-0.059**
	(0.022)	(0.050)	(0.073)	(0.044)	(0.026)
R-squared	0.338	0.624	0.262	0.396	0.954
Obs.	1989	1989	1989	1989	1989

Notes: Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table 4: Estimates of the Effect of the Boom on Wage Rates Relative to 2006

	Wage Measure					
	Mean	1st Dec.	1st Qrt.	Median	3rd Qrt.	9th Dec.
	(1)	(2)	(3)	(4)	(5)	(6)
Boom × 2007	0.009***	0.003	0.011***	0.010***	0.002	0.007**
	(0.003)	(0.006)	(0.004)	(0.003)	(0.003)	(0.004)
Boom × 2008	0.019***	0.022***	0.027***	0.025***	0.008	0.009
	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)
Boom × 2009	0.032***	0.037***	0.043***	0.042***	0.023**	0.019**
	(0.008)	(0.006)	(0.008)	(0.007)	(0.009)	(0.009)
Boom × 2010	0.036***	0.044***	0.054***	0.049***	0.028***	0.019*
	(0.009)	(0.007)	(0.008)	(0.008)	(0.010)	(0.010)
Boom × 2011	0.046***	0.052***	0.066***	0.061***	0.036***	0.029**
	(0.013)	(0.009)	(0.013)	(0.016)	(0.014)	(0.012)
Boom × 2012	0.059***	0.058***	0.077***	0.076***	0.050***	0.040***
	(0.016)	(0.012)	(0.019)	(0.021)	(0.017)	(0.014)
Boom × 2013	0.064***	0.065***	0.083***	0.080***	0.057***	0.047***
	(0.018)	(0.016)	(0.023)	(0.023)	(0.018)	(0.016)
Boom × 2014	0.070***	0.071***	0.097***	0.089***	0.062***	0.048**
	(0.021)	(0.019)	(0.026)	(0.024)	(0.020)	(0.019)
R-squared	0.429	0.610	0.235	0.235	0.305	0.360
Obs.	1373	1373	1373	1373	1373	1373

Notes: Dependent variables are the logarithm of the variable indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table 5: Estimates of the Effect of the Boom on Housing Relative to 2000 or 2007

	ln(Home Value) (1)	ln(Med. Rent) (2)	ln(Rent as % of Inc.) (3)	ln(Housing Units) (4)
Boom × 2000	0.017			0.007
	(0.031)			(0.011)
Boom × 2008	0.023***	0.013***	-0.010*	0.008
	(0.004)	(0.004)	(0.006)	(0.008)
Boom × 2009	0.045***	0.017**	-0.012	0.010
	(0.010)	(0.007)	(0.009)	(0.010)
Boom × 2010	0.073***	0.026**	0.002	0.014
	(0.018)	(0.010)	(0.014)	(0.011)
Boom × 2011	0.099***	0.034**	0.008	0.019
	(0.028)	(0.016)	(0.015)	(0.012)
Boom × 2012	0.124***	0.050**	0.004	0.025*
	(0.036)	(0.021)	(0.016)	(0.014)
R-squared	0.677	0.553	0.302	0.621
Obs.	1071	918	918	1071

Notes: Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Years correspond to the center years of the 5-year estimates reported by the ACS. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

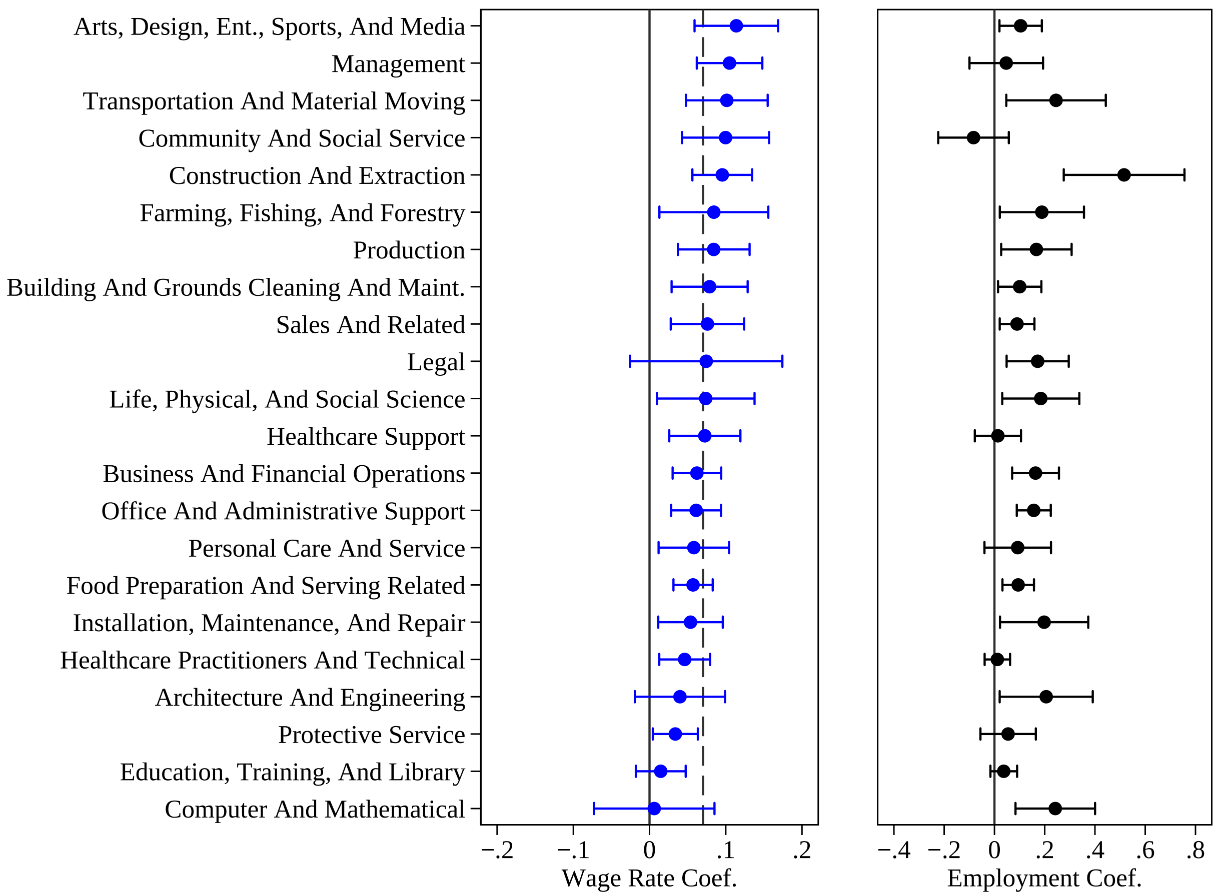


Figure 8: **Estimates of the Effect of the Boom on Mean Wage Rates and Employment in 2014 Relative to 2006 for Each Occupational Category.** Each coefficient comes from a separate regression with the logarithm of the corresponding dependent variable as indicated by both axes. The coefficients presented are those on the "Boom × 2014" interaction terms. The vertical dashed line represents the overall estimate across all occupations (see the first column of Table 4). The whiskers represent 95-percent confidence intervals. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level.

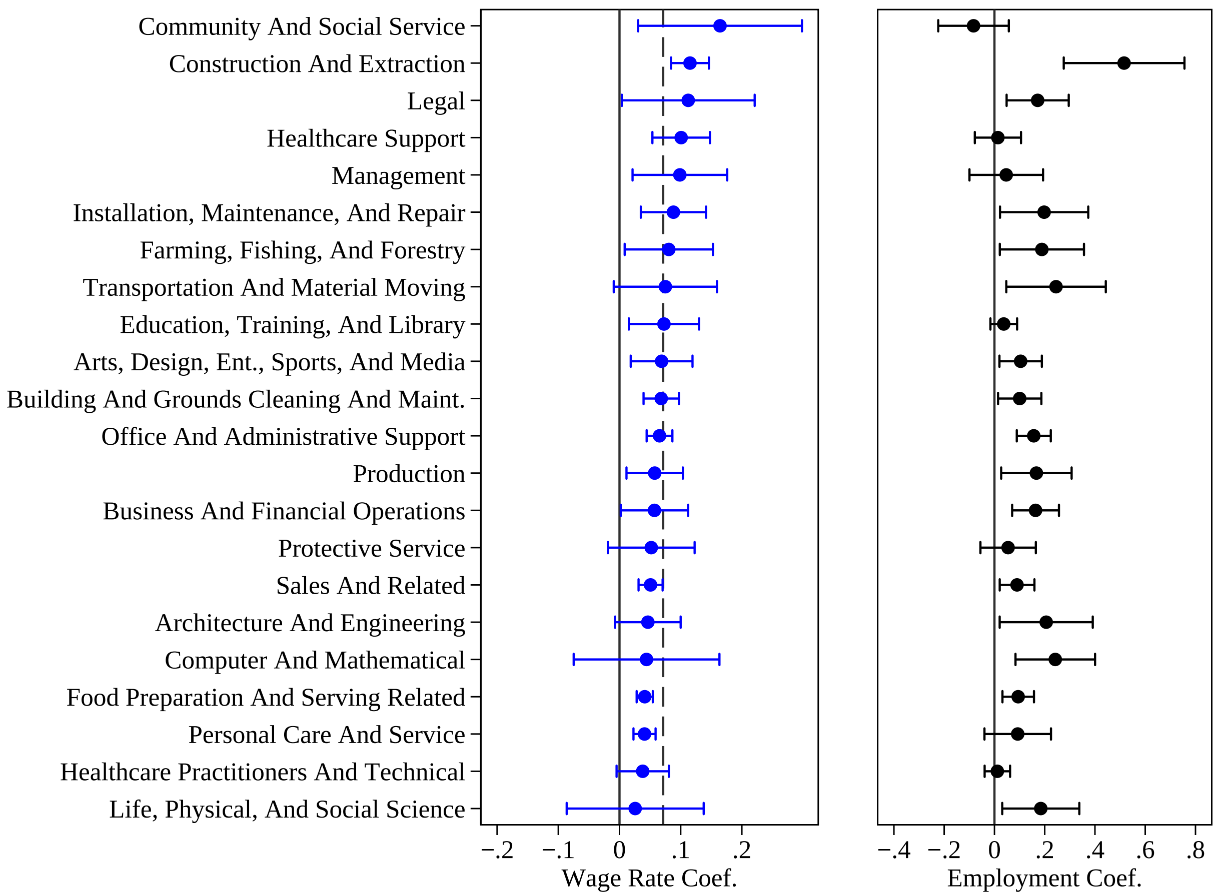


Figure 9: **Estimates of the Effect of the Boom on 10th Percentile Wage Rates and Employment in 2014 Relative to 2006 for Each Occupational Category.** Each coefficient comes from a separate regression with the logarithm of the corresponding dependent variable as indicated by both axes. The coefficients presented are those on the "Boom × 2014" interaction terms. The vertical dashed line represents the overall estimate across all occupations (see the second column of Table 4). The whiskers represent 95-percent confidence intervals. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level.

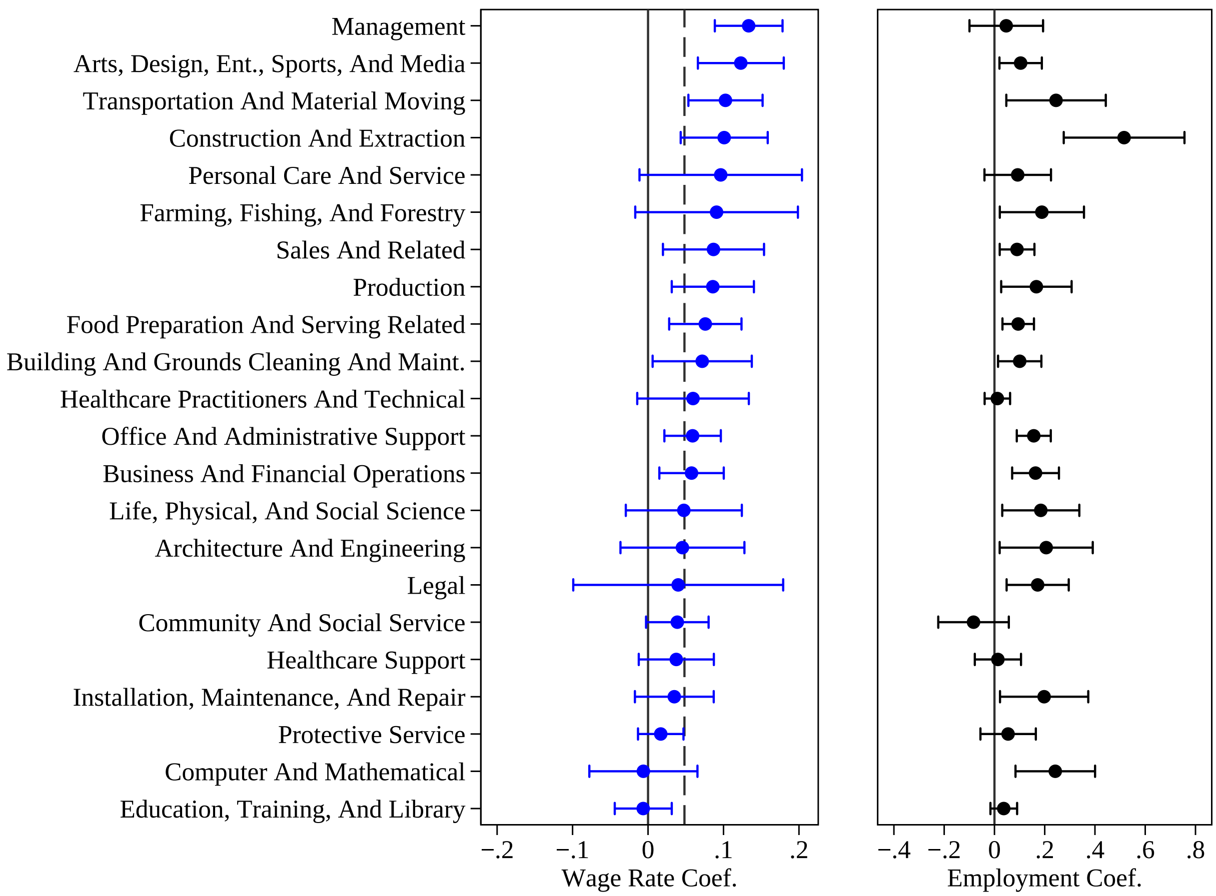


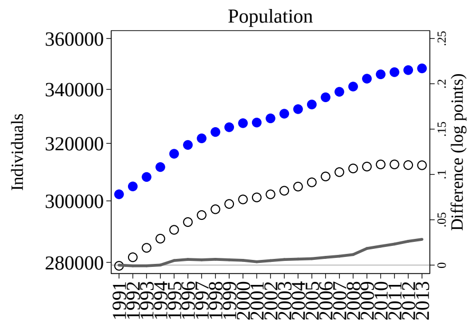
Figure 10: **Estimates of the Effect of the Boom on 90th Percentile Wage Rates and Employment in 2014 Relative to 2006 for Each Occupational Category.** Each coefficient comes from a separate regression with the logarithm of the corresponding dependent variable as indicated by both axes. The coefficients presented are those on the "Boom × 2014" interaction terms. The vertical dashed line represents the overall estimate across all occupations (see the sixth column of Table 4). The whiskers represent 95-percent confidence intervals. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level.

Table 6: Mean Wage Effects and Occupational Concentration in Industries Closely Connected to Extraction

Occupation	2014 Mean Wage Coef. (1)	Concentration (2)
Arts, Design, Entertainment, Sports, and Media Occupations	0.114	0.006
Management Occupations	0.105	0.087
Transportation and Material Moving Occupations	0.101	0.356
Community and Social Service Occupations	0.100	0.000
Construction and Extraction Occupations	0.095	0.787
Farming, Fishing, and Forestry Occupations	0.084	0.007
Production Occupations	0.084	0.027
Building and Grounds Cleaning and Maintenance Occupations	0.079	0.016
Sales and Related Occupations	0.076	0.015
Legal Occupations	0.074	0.007
Life, Physical, and Social Science Occupations	0.074	0.024
Healthcare Support Occupations	0.073	0.000
Business and Financial Operations Occupations	0.062	0.050
Office and Administrative Support Occupations	0.061	0.092
Personal Care and Service Occupations	0.058	0.005
Food Preparation and Serving Related Occupations	0.057	0.001
Installation, Maintenance, and Repair Occupations	0.054	0.171
Healthcare Practitioners and Technical Occupations	0.046	0.002
Architecture and Engineering Occupations	0.040	0.061
Protective Service Occupations	0.034	0.011
Education, Training, and Library Occupations	0.015	0.000
Computer and Mathematical Occupations	0.006	0.013

Notes: The first column reports estimates of the effect of the boom on mean wages in 2014 relative to 2006 across occupations as reported in Figure 8. The second column reports the share of employees within an occupational class that work in the mining, construction, and transportation and warehousing industrial sectors.

A Appendix - FOR ONLINE PUBLICATION ONLY



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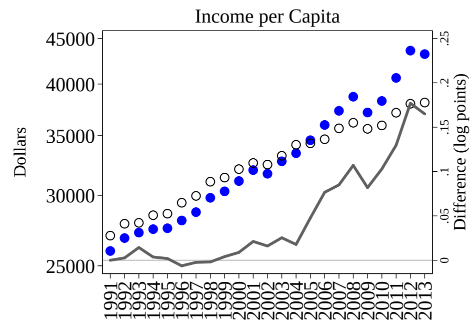

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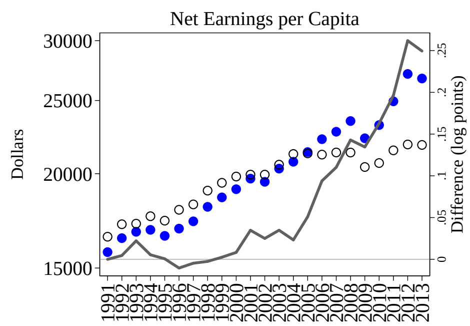

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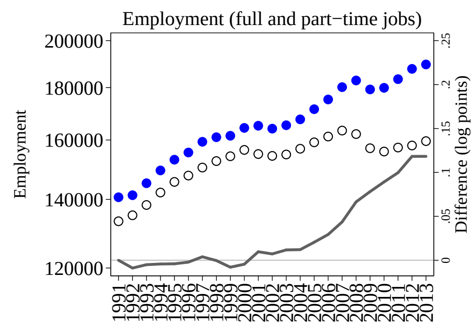
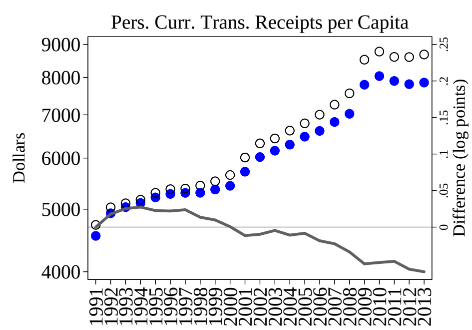


(d)



(e)

Figure A.1: **Comparison of Trends in Means for Major Economic Variables.** In the scatter plots, solid markers represent boom areas and hollow markers represent non-boom areas and the markers are plotted on the left axis. The gray line represents the difference between the two groups relative to the difference in 1991 and is plotted on the right axis.

A.1 Robustness Checks: Separate Census Division Time Trends

Table A.1: Estimates of the Effect of the Boom on Major Economic Variables Relative to 2001; Separate Census Division Time Trends

	ln(Pop.)	ln(Inc. Per Cap.)	ln(Earn. per Cap.)	ln(Emp.)	ln(Curr. Trans. per Cap.)
	(1)	(2)	(3)	(4)	(5)
Boom × 2002	0.004	0.009	0.020	0.020	-0.026***
	(0.033)	(0.012)	(0.013)	(0.031)	(0.009)
Boom × 2003	0.005	0.017	0.028*	0.022	-0.021**
	(0.035)	(0.015)	(0.016)	(0.032)	(0.010)
Boom × 2004	0.006	0.008	0.017	0.024	-0.028**
	(0.036)	(0.016)	(0.013)	(0.034)	(0.011)
Boom × 2005	0.008	0.034*	0.040**	0.034	-0.027**
	(0.037)	(0.020)	(0.018)	(0.035)	(0.013)
Boom × 2006	0.012	0.057**	0.077***	0.049	-0.039***
	(0.038)	(0.028)	(0.025)	(0.037)	(0.013)
Boom × 2007	0.018	0.065**	0.090***	0.066*	-0.045***
	(0.039)	(0.027)	(0.028)	(0.039)	(0.015)
Boom × 2008	0.024	0.088***	0.121***	0.093**	-0.058***
	(0.040)	(0.027)	(0.033)	(0.039)	(0.017)
Boom × 2009	0.036	0.067***	0.112***	0.104***	-0.074***
	(0.041)	(0.025)	(0.038)	(0.037)	(0.017)
Boom × 2010	0.040	0.084***	0.136***	0.118***	-0.072***
	(0.040)	(0.032)	(0.045)	(0.037)	(0.018)
Boom × 2011	0.046	0.105**	0.160***	0.138***	-0.072***
	(0.040)	(0.042)	(0.058)	(0.042)	(0.019)
Boom × 2012	0.057	0.137**	0.198***	0.165***	-0.084***
	(0.041)	(0.056)	(0.075)	(0.050)	(0.021)
Boom × 2013	0.065	0.127**	0.188**	0.167***	-0.089***
	(0.042)	(0.053)	(0.073)	(0.054)	(0.024)
R-squared	0.632	0.884	0.772	0.794	0.967
Obs.	6732	4131	4131	6732	4131

Notes: Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables, as well as separate linear time trends for Census divisions. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.2: Estimates of the Effect of the Boom on Wage Rates Relative to 2006; Separate Census Division Time Trends

	Wage Measure					
	Mean	1st Dec.	1st Qrt.	Median	3rd Qrt.	9th Dec.
	(1)	(2)	(3)	(4)	(5)	(6)
Boom × 2007	0.007**	-0.001	0.008**	0.008**	0.001	0.006*
	(0.003)	(0.007)	(0.004)	(0.003)	(0.004)	(0.004)
Boom × 2008	0.015***	0.013*	0.020***	0.021***	0.006	0.007
	(0.006)	(0.008)	(0.007)	(0.005)	(0.007)	(0.007)
Boom × 2009	0.027***	0.024***	0.034***	0.036***	0.020**	0.016*
	(0.008)	(0.007)	(0.009)	(0.008)	(0.010)	(0.010)
Boom × 2010	0.029***	0.027***	0.041***	0.041***	0.024**	0.015
	(0.010)	(0.008)	(0.009)	(0.009)	(0.011)	(0.011)
Boom × 2011	0.037**	0.030***	0.049***	0.051***	0.031**	0.025*
	(0.015)	(0.011)	(0.016)	(0.018)	(0.015)	(0.014)
Boom × 2012	0.049**	0.032**	0.057**	0.065***	0.044**	0.035**
	(0.019)	(0.015)	(0.023)	(0.023)	(0.019)	(0.016)
Boom × 2013	0.052**	0.035*	0.061**	0.067**	0.050**	0.040**
	(0.021)	(0.021)	(0.028)	(0.026)	(0.020)	(0.018)
Boom × 2014	0.057**	0.038	0.071**	0.074***	0.054**	0.041*
	(0.024)	(0.025)	(0.032)	(0.028)	(0.023)	(0.022)
R-squared	0.476	0.741	0.340	0.308	0.334	0.393
Obs.	1373	1373	1373	1373	1373	1373

Notes: Dependent variables are the logarithm of the variable indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables, as well as separate linear time trends for Census divisions. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.3: Estimates of the Effect of the Boom on Housing Relative to 2007; Separate Census Division Time Trends

	ln(Home Value) (1)	ln(Med. Rent) (2)	ln(Rent as % of Inc.) (3)	ln(Housing Units) (4)
Boom × 2000	0.011			-0.002
	(0.030)			(0.010)
Boom × 2008	0.023***	0.015***	-0.010	0.009
	(0.005)	(0.004)	(0.006)	(0.007)
Boom × 2009	0.047***	0.021***	-0.011	0.013
	(0.011)	(0.007)	(0.010)	(0.009)
Boom × 2010	0.076***	0.031***	0.004	0.018*
	(0.021)	(0.011)	(0.015)	(0.010)
Boom × 2011	0.103***	0.041**	0.010	0.025**
	(0.031)	(0.016)	(0.016)	(0.012)
Boom × 2012	0.128***	0.058***	0.008	0.032**
	(0.041)	(0.022)	(0.018)	(0.014)
R-squared	0.722	0.615	0.335	0.732
Obs.	1071	918	918	1071

Notes: Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables, as well as separate linear time trends for Census divisions. The unit of observation is an NMA and a year. Years correspond to the center years of the 5-year estimates reported by the ACS. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

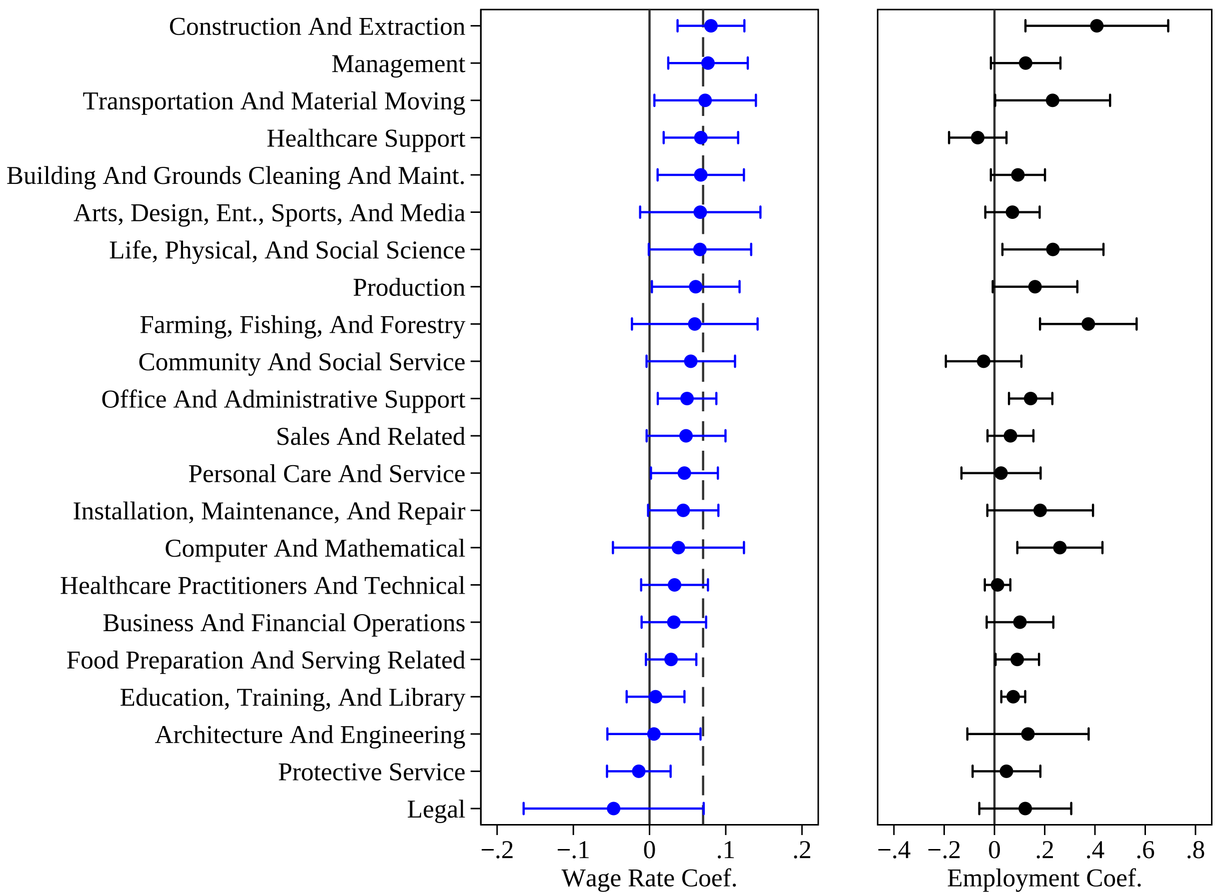


Figure A.2: **Estimates of the Effect of the Boom on Mean Wage Rates and Employment in 2014 Relative to 2006 for Each Occupational Category; Separate Census Division Time Trends.** Each coefficient comes from a separate regression with the logarithm of the corresponding dependent variable as indicated by both axes. The coefficients presented are those on the "Boom × 2014" interaction terms. The vertical dashed line represents the overall estimate across all occupations (see the first column of Table A.2). The whiskers represent 95-percent confidence intervals. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables, as well as separate linear time trends for Census divisions. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level.

A.2 Robustness Checks: Dropping Some-Production NMAs

Table A.4: Estimates of the Effect of the Boom on Major Economic Variables Relative to 2001; Dropping Some-Production NMAs

	ln(Pop.)	ln(Inc. Per Cap.)	ln(Earn. per Cap.)	ln(Emp.)	ln(Curr. Trans. per Cap.)
	(1)	(2)	(3)	(4)	(5)
Boom × 2002	0.001	-0.008	-0.014**	-0.005	0.000
	(0.003)	(0.005)	(0.007)	(0.003)	(0.005)
Boom × 2003	-0.001	0.002	-0.004	-0.006	0.010
	(0.004)	(0.008)	(0.013)	(0.005)	(0.007)
Boom × 2004	-0.002	-0.008	-0.014	-0.008	0.005
	(0.006)	(0.008)	(0.009)	(0.007)	(0.007)
Boom × 2005	-0.002	0.022*	0.012	-0.002	0.008
	(0.008)	(0.012)	(0.014)	(0.010)	(0.009)
Boom × 2006	0.001	0.045**	0.051***	0.012	-0.007
	(0.010)	(0.019)	(0.019)	(0.014)	(0.010)
Boom × 2007	0.005	0.054***	0.064***	0.029	-0.014
	(0.013)	(0.019)	(0.024)	(0.018)	(0.014)
Boom × 2008	0.009	0.081***	0.100***	0.058***	-0.028*
	(0.015)	(0.022)	(0.032)	(0.021)	(0.016)
Boom × 2009	0.021	0.060***	0.091**	0.070***	-0.051***
	(0.017)	(0.022)	(0.037)	(0.018)	(0.016)
Boom × 2010	0.024	0.080***	0.120***	0.086***	-0.047***
	(0.017)	(0.029)	(0.045)	(0.020)	(0.017)
Boom × 2011	0.030*	0.103**	0.149**	0.107***	-0.045**
	(0.018)	(0.039)	(0.058)	(0.028)	(0.020)
Boom × 2012	0.040**	0.136**	0.188**	0.135***	-0.060***
	(0.020)	(0.054)	(0.077)	(0.040)	(0.022)
Boom × 2013	0.048**	0.129**	0.183**	0.135***	-0.067**
	(0.023)	(0.051)	(0.074)	(0.044)	(0.027)
R-squared	0.410	0.583	0.268	0.458	0.960
Obs.	1209	1209	1209	1209	1209

Notes: Observations for some-production NMAs were excluded from the model. Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.5: Estimates of the Effect of the Boom on Wage Rates Relative to 2006; Dropping Some-Production NMAs

	Wage Measure					
	Mean	1st Dec.	1st Qrt.	Median	3rd Qrt.	9th Dec.
	(1)	(2)	(3)	(4)	(5)	(6)
Boom × 2007	0.012***	0.007	0.014***	0.012***	0.006	0.009**
	(0.003)	(0.007)	(0.004)	(0.003)	(0.004)	(0.004)
Boom × 2008	0.022***	0.032***	0.032***	0.029***	0.012*	0.010
	(0.006)	(0.007)	(0.007)	(0.005)	(0.007)	(0.007)
Boom × 2009	0.035***	0.052***	0.049***	0.045***	0.027***	0.019*
	(0.008)	(0.007)	(0.009)	(0.008)	(0.010)	(0.010)
Boom × 2010	0.040***	0.064***	0.063***	0.053***	0.032***	0.018
	(0.009)	(0.008)	(0.009)	(0.009)	(0.010)	(0.011)
Boom × 2011	0.051***	0.075***	0.076***	0.066***	0.041***	0.029**
	(0.013)	(0.011)	(0.013)	(0.016)	(0.014)	(0.013)
Boom × 2012	0.066***	0.082***	0.089***	0.084***	0.057***	0.042***
	(0.017)	(0.013)	(0.019)	(0.021)	(0.017)	(0.015)
Boom × 2013	0.070***	0.089***	0.095***	0.088***	0.063***	0.049***
	(0.018)	(0.017)	(0.023)	(0.023)	(0.018)	(0.017)
Boom × 2014	0.078***	0.095***	0.107***	0.097***	0.069***	0.052**
	(0.021)	(0.019)	(0.027)	(0.025)	(0.020)	(0.020)
R-squared	0.438	0.554	0.272	0.274	0.311	0.368
Obs.	834	834	834	834	834	834

Notes: Observations for some-production NMAs were excluded from the model. Dependent variables are the logarithm of the variable indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.6: Estimates of the Effect of the Boom on Housing Relative to 2007; Dropping Some-Production NMAs

	ln(Home Value) (1)	ln(Med. Rent) (2)	ln(Rent as % of Inc.) (3)	ln(Housing Units) (4)
Boom × 2000	0.067*			0.017
	(0.034)			(0.011)
Boom × 2008	0.024***	0.013***	-0.012*	0.001
	(0.005)	(0.004)	(0.006)	(0.008)
Boom × 2009	0.050***	0.017**	-0.018*	0.002
	(0.010)	(0.007)	(0.010)	(0.010)
Boom × 2010	0.084***	0.025**	-0.004	0.005
	(0.019)	(0.011)	(0.014)	(0.011)
Boom × 2011	0.116***	0.034**	0.002	0.010
	(0.029)	(0.016)	(0.015)	(0.013)
Boom × 2012	0.146***	0.051**	-0.001	0.015
	(0.037)	(0.021)	(0.016)	(0.014)
R-squared	0.748	0.555	0.361	0.699
Obs.	651	558	558	651

Notes: Observations for some-production NMAs were excluded from the model. Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Years correspond to the center years of the 5-year estimates reported by the ACS. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

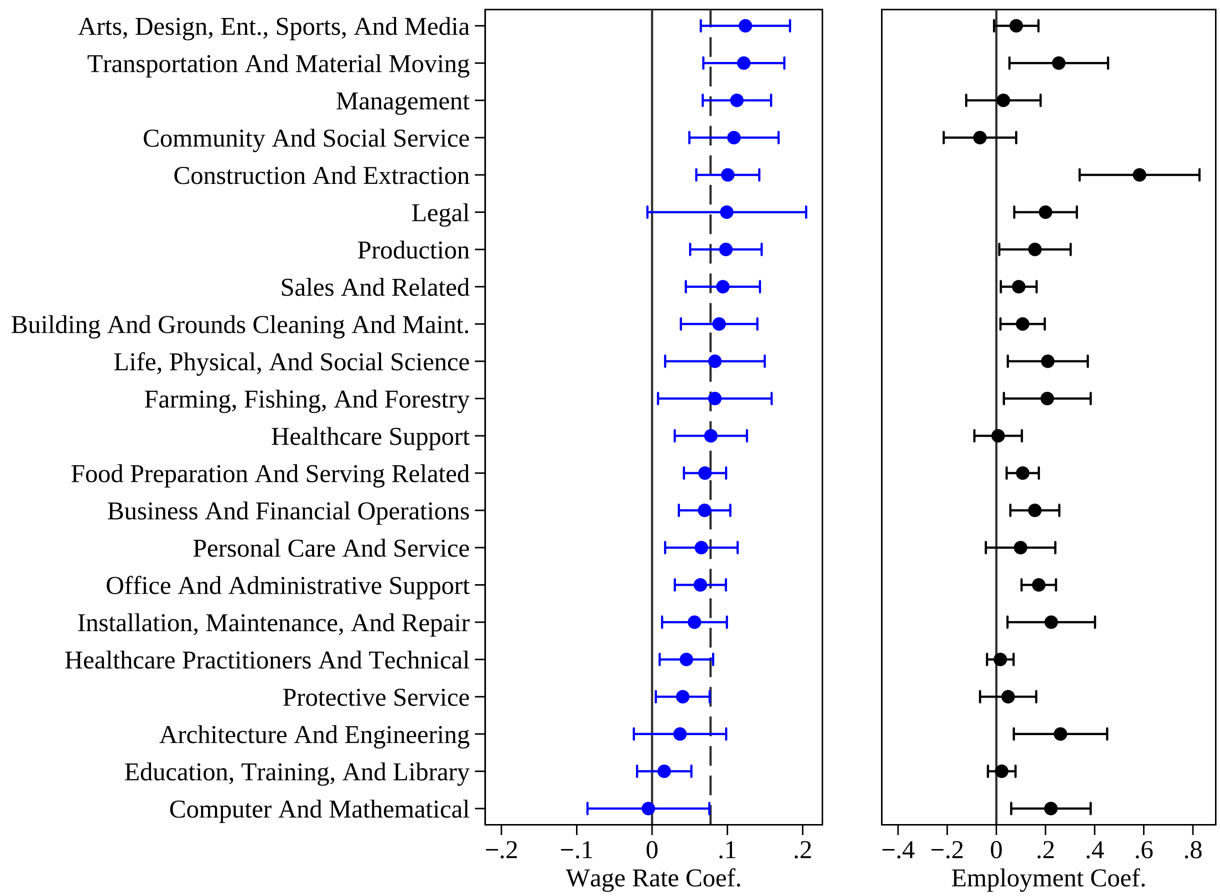


Figure A.3: **Estimates of the Effect of the Boom on Mean Wage Rates and Employment in 2014 Relative to 2006 for Each Occupational Category; Dropping Some-Production NMAs.** Observations for some-production NMAs were excluded from the model. Each coefficient comes from a separate regression with the logarithm of the corresponding dependent variable as indicated by both axes. The coefficients presented are those on the "Boom × 2014" interaction terms. The vertical dashed line represents the overall estimate across all occupations (see the first column of Table A.5). The whiskers represent 95-percent confidence intervals. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level.

A.3 Robustness Checks: Dropping Boom-Adjacent NMAs

Table A.7: Estimates of the Effect of the Boom on Major Economic Variables Relative to 2001; Dropping Boom-Adjacent NMAs

	ln(Pop.)	ln(Inc. Per Cap.)	ln(Earn. per Cap.)	ln(Emp.)	ln(Curr. Trans. per Cap.)
	(1)	(2)	(3)	(4)	(5)
Boom × 2002	0.002	-0.007	-0.014**	-0.003	0.002
	(0.003)	(0.005)	(0.006)	(0.003)	(0.005)
Boom × 2003	0.001	0.004	-0.001	-0.003	0.009
	(0.004)	(0.008)	(0.012)	(0.004)	(0.007)
Boom × 2004	0.001	-0.007	-0.014	-0.002	0.002
	(0.005)	(0.007)	(0.009)	(0.007)	(0.006)
Boom × 2005	0.002	0.023*	0.014	0.006	0.005
	(0.007)	(0.012)	(0.014)	(0.010)	(0.009)
Boom × 2006	0.005	0.047**	0.052***	0.021	-0.008
	(0.010)	(0.019)	(0.019)	(0.014)	(0.010)
Boom × 2007	0.010	0.059***	0.072***	0.039**	-0.015
	(0.013)	(0.018)	(0.023)	(0.018)	(0.014)
Boom × 2008	0.016	0.088***	0.109***	0.070***	-0.028*
	(0.015)	(0.021)	(0.031)	(0.020)	(0.015)
Boom × 2009	0.028	0.063***	0.096***	0.082***	-0.048***
	(0.017)	(0.021)	(0.037)	(0.018)	(0.015)
Boom × 2010	0.032*	0.082***	0.126***	0.097***	-0.045**
	(0.017)	(0.028)	(0.044)	(0.019)	(0.017)
Boom × 2011	0.038**	0.106***	0.153***	0.117***	-0.043**
	(0.017)	(0.039)	(0.057)	(0.028)	(0.020)
Boom × 2012	0.048**	0.143***	0.198**	0.145***	-0.057**
	(0.020)	(0.053)	(0.076)	(0.040)	(0.022)
Boom × 2013	0.056**	0.130**	0.184**	0.145***	-0.063**
	(0.022)	(0.050)	(0.073)	(0.044)	(0.026)
R-squared	0.367	0.609	0.277	0.431	0.960
Obs.	1521	1521	1521	1521	1521

Notes: Observations for NMAs located adjacent to boom areas were excluded from the model. Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.8: Estimates of the Effect of the Boom on Wage Rates Relative to 2006; Dropping Boom-Adjacent NMAs

	Wage Measure					
	Mean	1st Dec.	1st Qrt.	Median	3rd Qrt.	9th Dec.
	(1)	(2)	(3)	(4)	(5)	(6)
Boom × 2007	0.010***	0.008	0.013***	0.010***	0.004	0.007*
	(0.003)	(0.006)	(0.004)	(0.003)	(0.003)	(0.004)
Boom × 2008	0.021***	0.030***	0.031***	0.028***	0.011	0.010
	(0.005)	(0.006)	(0.007)	(0.005)	(0.007)	(0.006)
Boom × 2009	0.036***	0.046***	0.049***	0.045***	0.026***	0.020**
	(0.008)	(0.006)	(0.009)	(0.008)	(0.010)	(0.009)
Boom × 2010	0.041***	0.056***	0.063***	0.055***	0.033***	0.021**
	(0.009)	(0.007)	(0.008)	(0.008)	(0.010)	(0.010)
Boom × 2011	0.053***	0.066***	0.076***	0.069***	0.043***	0.032***
	(0.013)	(0.010)	(0.013)	(0.016)	(0.014)	(0.012)
Boom × 2012	0.068***	0.072***	0.088***	0.086***	0.059***	0.045***
	(0.016)	(0.012)	(0.019)	(0.021)	(0.017)	(0.014)
Boom × 2013	0.072***	0.079***	0.094***	0.090***	0.064***	0.050***
	(0.018)	(0.016)	(0.023)	(0.023)	(0.018)	(0.016)
Boom × 2014	0.078***	0.086***	0.107***	0.098***	0.069***	0.052***
	(0.021)	(0.019)	(0.026)	(0.024)	(0.020)	(0.019)
R-squared	0.445	0.581	0.284	0.281	0.322	0.391
Obs.	1050	1050	1050	1050	1050	1050

Notes: Observations for NMAs located adjacent to boom areas were excluded from the model. Dependent variables are the logarithm of the variable indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.9: Estimates of the Effect of the Boom on Housing Relative to 2007; Dropping Boom-Adjacent NMAs

	ln(Home Value) (1)	ln(Med. Rent) (2)	ln(Rent as % of Inc.) (3)	ln(Housing Units) (4)
Boom × 2000	0.038			0.011
	(0.033)			(0.011)
Boom × 2008	0.027***	0.011***	-0.011*	0.006
	(0.004)	(0.004)	(0.006)	(0.008)
Boom × 2009	0.056***	0.015**	-0.015	0.009
	(0.010)	(0.007)	(0.009)	(0.010)
Boom × 2010	0.089***	0.024**	-0.001	0.013
	(0.019)	(0.010)	(0.014)	(0.011)
Boom × 2011	0.121***	0.034**	0.005	0.018
	(0.028)	(0.016)	(0.015)	(0.012)
Boom × 2012	0.149***	0.052**	0.003	0.023
	(0.037)	(0.021)	(0.016)	(0.014)
R-squared	0.689	0.583	0.351	0.660
Obs.	819	702	702	819

Notes: Observations for NMAs located adjacent to boom areas were excluded from the model. Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Years correspond to the center years of the 5-year estimates reported by the ACS. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

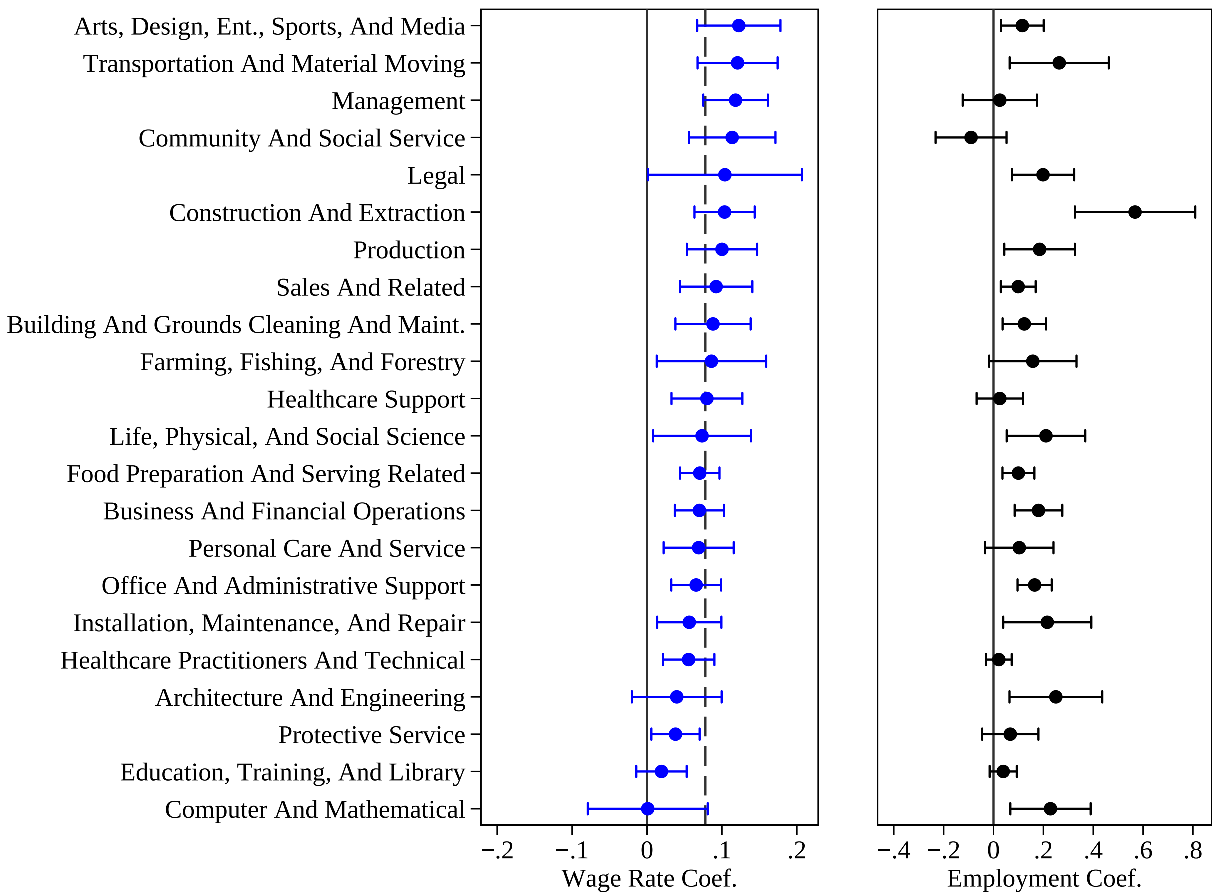


Figure A.4: **Estimates of the Effect of the Boom on Mean Wage Rates and Employment in 2014 Relative to 2006 for Each Occupational Category; Dropping Boom-Adjacent NMAs.** Observations for NMAs located adjacent to boom areas were excluded from the model. Each coefficient comes from a separate regression with the logarithm of the corresponding dependent variable as indicated by both axes. The coefficients presented are those on the "Boom × 2014" interaction terms. The vertical dashed line represents the overall estimate across all occupations (see the first column of Table A.8). The whiskers represent 95-percent confidence intervals. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level.

A.4 Robustness Checks: Instrumenting with Resource Endowments

Table A.10: Estimates of the Effect of the Boom on Major Economic Variables Relative to 2001; Instrumental Variable Results

	ln(Pop.)	ln(Inc. Per Cap.)	ln(Earn. per Cap.)	ln(Emp.)	ln(Curr. Trans. per Cap.)
	(1)	(2)	(3)	(4)	(5)
Boom × 2002	-0.001	-0.006	-0.013	-0.005	0.006
	(0.017)	(0.033)	(0.052)	(0.023)	(0.020)
Boom × 2003	-0.003	0.007	0.003	-0.007	0.015
	(0.016)	(0.027)	(0.042)	(0.022)	(0.020)
Boom × 2004	-0.005	-0.007	-0.018	-0.008	0.009
	(0.015)	(0.029)	(0.044)	(0.022)	(0.018)
Boom × 2005	-0.006	0.030	0.014	-0.001	0.014
	(0.015)	(0.027)	(0.040)	(0.022)	(0.018)
Boom × 2006	-0.005	0.060**	0.060	0.013	-0.001
	(0.014)	(0.029)	(0.041)	(0.021)	(0.017)
Boom × 2007	-0.001	0.073***	0.083**	0.035	-0.007
	(0.014)	(0.026)	(0.037)	(0.022)	(0.017)
Boom × 2008	0.004	0.115***	0.130***	0.074***	-0.020
	(0.015)	(0.025)	(0.039)	(0.020)	(0.017)
Boom × 2009	0.017	0.083***	0.112***	0.092***	-0.050***
	(0.015)	(0.024)	(0.038)	(0.019)	(0.017)
Boom × 2010	0.021	0.115***	0.162***	0.111***	-0.046**
	(0.015)	(0.026)	(0.041)	(0.019)	(0.018)
Boom × 2011	0.028*	0.138***	0.188***	0.137***	-0.044**
	(0.016)	(0.033)	(0.050)	(0.025)	(0.020)
Boom × 2012	0.040**	0.196***	0.257***	0.170***	-0.060***
	(0.018)	(0.047)	(0.067)	(0.036)	(0.022)
Boom × 2013	0.050**	0.172***	0.228***	0.169***	-0.068**
	(0.021)	(0.043)	(0.062)	(0.039)	(0.027)
R-squared	0.336	0.615	0.250	0.383	0.953
Obs.	1989	1989	1989	1989	1989

Notes: Dependent variables are indicated in the columns headings. Estimates come from the second stage of a two-stage model that is similar to equation 1 except that the boom-by-year terms are instrumented for using interactions of shale play indicators and year effects. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.11: Estimates of the Effect of the Boom on Wage Rates Relative to 2006; Instrumental Variable Results

	Wage Measure					
	Mean	1st Dec.	1st Qrt.	Median	3rd Qrt.	9th Dec.
	(1)	(2)	(3)	(4)	(5)	(6)
Boom × 2007	0.017	0.004	0.014	0.015	0.015	0.017
	(0.018)	(0.018)	(0.021)	(0.021)	(0.018)	(0.016)
Boom × 2008	0.035**	0.030*	0.033*	0.039**	0.031*	0.026*
	(0.016)	(0.016)	(0.019)	(0.019)	(0.017)	(0.014)
Boom × 2009	0.053***	0.057***	0.059***	0.060***	0.048***	0.040***
	(0.015)	(0.014)	(0.018)	(0.018)	(0.016)	(0.013)
Boom × 2010	0.061***	0.074***	0.083***	0.072***	0.056***	0.037***
	(0.014)	(0.014)	(0.017)	(0.017)	(0.016)	(0.013)
Boom × 2011	0.072***	0.088***	0.101***	0.087***	0.066***	0.045***
	(0.015)	(0.015)	(0.017)	(0.018)	(0.016)	(0.013)
Boom × 2012	0.091***	0.096***	0.116***	0.110***	0.086***	0.062***
	(0.016)	(0.015)	(0.020)	(0.020)	(0.018)	(0.014)
Boom × 2013	0.095***	0.102***	0.123***	0.116***	0.090***	0.071***
	(0.018)	(0.017)	(0.023)	(0.022)	(0.019)	(0.017)
Boom × 2014	0.101***	0.109***	0.138***	0.127***	0.091***	0.072***
	(0.020)	(0.019)	(0.025)	(0.023)	(0.020)	(0.019)
R-squared	0.414	0.596	0.205	0.215	0.290	0.354
Obs.	1373	1373	1373	1373	1373	1373

Notes: Dependent variables are the logarithm of the variable indicated in the columns headings. Estimates come from the second stage of a two-stage model that is similar to equation 1 except that the boom-by-year terms are instrumented for using interactions of shale play indicators and year effects. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.12: Estimates of the Effect of the Boom on Housing Relative to 2000 or 2007; Instrumental Variable Results

	ln(Home Value) (1)	ln(Med. Rent) (2)	ln(Rent as % of Inc.) (3)	ln(Housing Units) (4)
Boom × 2000	0.067			0.024
	(0.044)			(0.023)
Boom × 2008	0.038	0.009	-0.013	0.006
	(0.033)	(0.013)	(0.013)	(0.010)
Boom × 2009	0.078***	0.009	-0.032**	0.007
	(0.029)	(0.012)	(0.012)	(0.011)
Boom × 2010	0.126***	0.015	-0.021*	0.011
	(0.029)	(0.011)	(0.012)	(0.011)
Boom × 2011	0.169***	0.021	-0.018	0.016
	(0.034)	(0.013)	(0.013)	(0.012)
Boom × 2012	0.206***	0.042**	-0.015	0.021*
	(0.043)	(0.018)	(0.014)	(0.013)
R-squared	0.671	0.551	0.290	0.618
Obs.	1071	918	918	1071

Notes: Dependent variables are indicated in the columns headings. Estimates come from the second stage of a two-stage model that is similar to equation 1 except that the boom-by-year terms are instrumented for using interactions of shale play indicators and year effects. The unit of observation is an NMA and a year. Years correspond to the center years of the 5-year estimates reported by the ACS. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

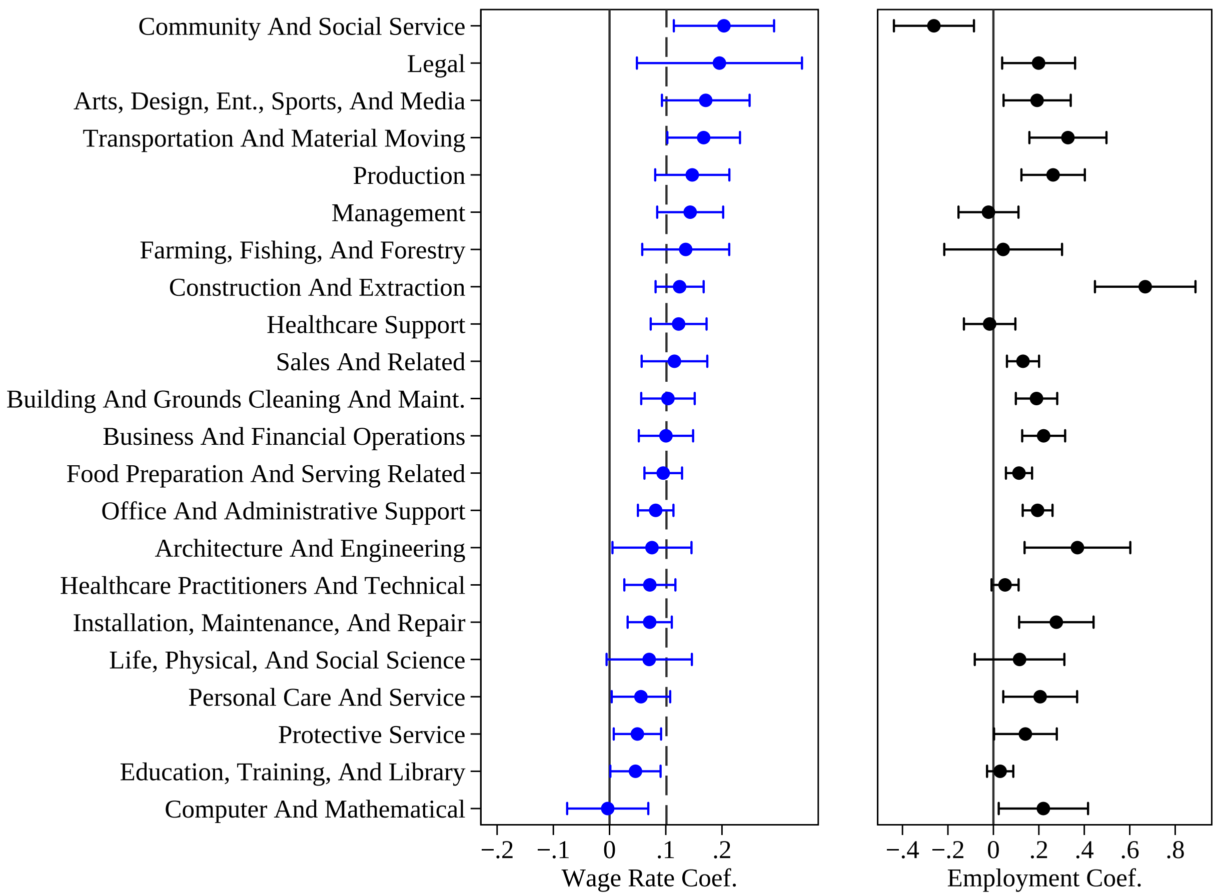


Figure A.5: **Estimates of the Effect of the Boom on Mean Wage Rates and Employment in 2014 Relative to 2006 for Each Occupational Category; Instrumental Variable Results.** Each coefficient comes from a separate regression with the logarithm of the corresponding dependent variable as indicated by both axes. The coefficients presented are those on the "Boom × 2014" interaction terms. The vertical dashed line represents the overall estimate across all occupations (see the first column of Table A.11). The whiskers represent 95-percent confidence intervals. Estimates come from the second stage of a two-stage model that is similar to equation 1 except that the boom-by-year terms are instrumented for using interactions of shale play indicators and year effects. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level.

A.5 Robustness Checks: Boom Threshold of $100 Million

Table A.13: Estimates of the Effect of the Boom on Major Economic Variables Relative to 2001; Boom Threshold of $100 Million

	ln(Pop.)	ln(Inc. Per Cap.)	ln(Earn. per Cap.)	ln(Emp.)	ln(Curr. Trans. per Cap.)
	(1)	(2)	(3)	(4)	(5)
Boom X 2002	0.000	-0.006	-0.013**	-0.005*	-0.000
	(0.002)	(0.004)	(0.005)	(0.002)	(0.004)
Boom X 2003	-0.002	-0.003	-0.006	-0.006*	0.001
	(0.003)	(0.006)	(0.010)	(0.004)	(0.006)
Boom X 2004	-0.004	-0.009	-0.014*	-0.010*	0.001
	(0.005)	(0.006)	(0.007)	(0.006)	(0.005)
Boom X 2005	-0.005	0.015*	0.010	-0.006	0.005
	(0.006)	(0.009)	(0.011)	(0.008)	(0.007)
Boom X 2006	-0.004	0.031**	0.038**	0.005	-0.009
	(0.008)	(0.015)	(0.015)	(0.012)	(0.008)
Boom X 2007	-0.002	0.035**	0.046**	0.016	-0.017*
	(0.010)	(0.015)	(0.018)	(0.015)	(0.010)
Boom X 2008	0.000	0.057***	0.073***	0.038**	-0.026**
	(0.012)	(0.017)	(0.025)	(0.017)	(0.012)
Boom X 2009	0.008	0.044***	0.066**	0.047***	-0.045***
	(0.014)	(0.017)	(0.028)	(0.016)	(0.012)
Boom X 2010	0.009	0.060***	0.091***	0.059***	-0.045***
	(0.014)	(0.021)	(0.033)	(0.018)	(0.013)
Boom X 2011	0.012	0.073**	0.108**	0.073***	-0.042***
	(0.015)	(0.029)	(0.043)	(0.023)	(0.015)
Boom X 2012	0.018	0.098**	0.141**	0.092***	-0.052***
	(0.017)	(0.040)	(0.056)	(0.032)	(0.017)
Boom X 2013	0.023	0.090**	0.132**	0.088**	-0.056***
	(0.019)	(0.037)	(0.054)	(0.035)	(0.020)
R-squared	0.312	0.618	0.253	0.358	0.954
Obs.	1989	1989	1989	1989	1989

Notes: For these models, boom areas were defined using a $100 million as opposed to $500 million threshold. Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.14: Estimates of the Effect of the Boom on Wage Rates Relative to 2006; Boom Threshold of $100 Million

	Wage Measure					
	Mean	1st Dec.	1st Qrt.	Median	3rd Qrt.	9th Dec.
	(1)	(2)	(3)	(4)	(5)	(6)
Boom X 2007	0.009***	0.003	0.009***	0.008***	0.005*	0.009***
	(0.002)	(0.006)	(0.003)	(0.003)	(0.003)	(0.003)
Boom X 2008	0.018***	0.021***	0.020***	0.021***	0.012**	0.010**
	(0.004)	(0.006)	(0.006)	(0.004)	(0.005)	(0.005)
Boom X 2009	0.029***	0.037***	0.034***	0.032***	0.022***	0.018**
	(0.006)	(0.005)	(0.007)	(0.007)	(0.008)	(0.007)
Boom X 2010	0.032***	0.046***	0.045***	0.037***	0.026***	0.016**
	(0.007)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)
Boom X 2011	0.040***	0.054***	0.054***	0.046***	0.031***	0.023**
	(0.010)	(0.008)	(0.011)	(0.013)	(0.011)	(0.009)
Boom X 2012	0.050***	0.059***	0.064***	0.060***	0.043***	0.030***
	(0.012)	(0.009)	(0.015)	(0.016)	(0.013)	(0.011)
Boom X 2013	0.052***	0.063***	0.067***	0.062***	0.046***	0.033**
	(0.014)	(0.012)	(0.018)	(0.018)	(0.014)	(0.013)
Boom X 2014	0.058***	0.068***	0.077***	0.070***	0.052***	0.035**
	(0.016)	(0.014)	(0.020)	(0.019)	(0.015)	(0.015)
R-squared	0.420	0.620	0.223	0.214	0.294	0.348
Obs.	1373	1373	1373	1373	1373	1373

Notes: For these models, boom areas were defined using a $100 million as opposed to $500 million threshold. Dependent variables are the logarithm of the variable indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.15: Estimates of the Effect of the Boom on Housing Relative to 2007; Boom Threshold of $100 Million

	ln(Home Value) (1)	ln(Med. Rent) (2)	ln(Rent as % of Inc.) (3)	ln(Housing Units) (4)
Boom X 2000	0.050*			0.013
	(0.026)			(0.008)
Boom X 2008	0.021***	0.010***	-0.009	-0.006
	(0.004)	(0.004)	(0.006)	(0.007)
Boom X 2009	0.042***	0.014**	-0.013*	-0.006
	(0.008)	(0.006)	(0.008)	(0.009)
Boom X 2010	0.067***	0.017**	-0.006	-0.005
	(0.014)	(0.008)	(0.011)	(0.010)
Boom X 2011	0.092***	0.024*	-0.004	-0.002
	(0.021)	(0.012)	(0.012)	(0.011)
Boom X 2012	0.113***	0.037**	-0.001	0.001
	(0.028)	(0.016)	(0.013)	(0.012)
R-squared	0.676	0.543	0.298	0.620
Obs.	1071	918	918	1071

Notes: For these models, boom areas were defined using a $100 million as opposed to $500 million threshold. Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Years correspond to the center years of the 5-year estimates reported by the ACS. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

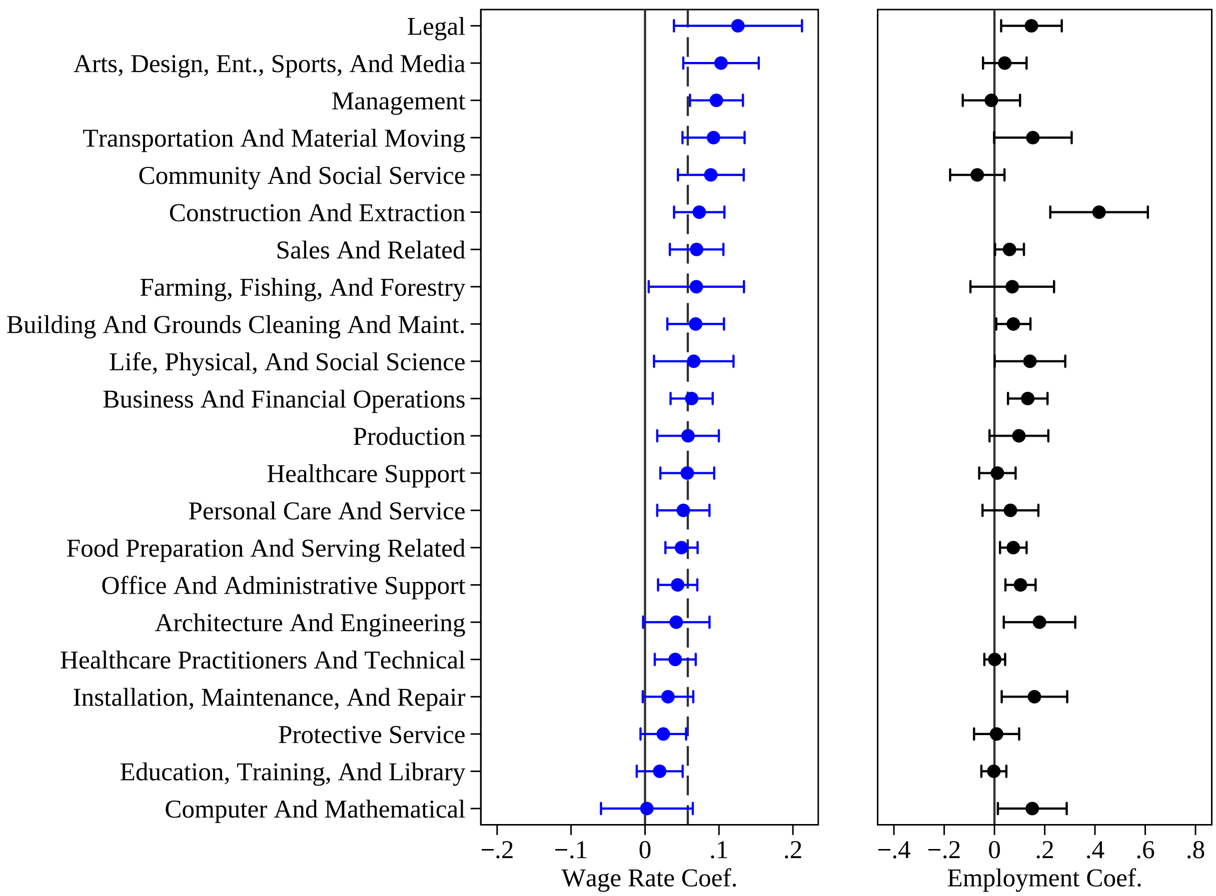


Figure A.6: **Estimates of the Effect of the Boom on Mean Wage Rates and Employment in 2014 Relative to 2006 for Each Occupational Category; Boom Threshold of $100 Million.** For these models, boom areas were defined using a $100 million as opposed to $500 million threshold. Each coefficient comes from a separate regression with the logarithm of the corresponding dependent variable as indicated by both axes. The coefficients presented are those on the "Boom × 2014" interaction terms. The vertical dashed line represents the overall estimate across all occupations (see the first column of Table A.14). The whiskers represent 95-percent confidence intervals. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level.

A.6 Robustness Checks: Dropping Booming NMAs Overlaying the Bakken Play

Table A.16: Estimates of the Effect of the Boom on Major Economic Variables Relative to 2001; Dropping Booming NMAs Overlaying the Bakken Play

	ln(Pop.)	ln(Inc. Per Cap.)	ln(Earn. per Cap.)	ln(Emp.)	ln(Curr. Trans. per Cap.)
	(1)	(2)	(3)	(4)	(5)
Boom × 2002	0.004*	-0.003	-0.006	-0.002	0.002
	(0.002)	(0.004)	(0.004)	(0.003)	(0.005)
Boom × 2003	0.006	-0.007	-0.017***	0.001	0.010
	(0.004)	(0.005)	(0.006)	(0.004)	(0.006)
Boom × 2004	0.007	-0.009	-0.020***	0.003	0.003
	(0.005)	(0.008)	(0.007)	(0.007)	(0.006)
Boom × 2005	0.010	0.016	-0.002	0.013	0.005
	(0.007)	(0.013)	(0.011)	(0.010)	(0.009)
Boom × 2006	0.015	0.041**	0.038**	0.028*	-0.008
	(0.009)	(0.021)	(0.018)	(0.014)	(0.011)
Boom × 2007	0.021*	0.044**	0.043**	0.045**	-0.014
	(0.013)	(0.019)	(0.020)	(0.019)	(0.014)
Boom × 2008	0.026*	0.060***	0.066**	0.067***	-0.024
	(0.015)	(0.019)	(0.026)	(0.022)	(0.016)
Boom × 2009	0.037**	0.029**	0.042*	0.072***	-0.036**
	(0.018)	(0.012)	(0.021)	(0.019)	(0.015)
Boom × 2010	0.038**	0.038***	0.057**	0.077***	-0.031*
	(0.018)	(0.014)	(0.023)	(0.017)	(0.016)
Boom × 2011	0.040**	0.047***	0.068**	0.084***	-0.027
	(0.019)	(0.017)	(0.028)	(0.017)	(0.018)
Boom × 2012	0.045**	0.060***	0.079***	0.094***	-0.034*
	(0.020)	(0.019)	(0.029)	(0.019)	(0.019)
Boom × 2013	0.046**	0.057***	0.077***	0.089***	-0.031
	(0.022)	(0.019)	(0.029)	(0.020)	(0.019)
R-squared	0.331	0.669	0.244	0.424	0.957
Obs.	1963	1963	1963	1963	1963

Notes: Observations for booming NMAs overlaying the Bakken play were excluded from the model. Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.17: Estimates of the Effect of the Boom on Wage Rates Relative to 2006; Dropping Booming NMAs Overlaying the Bakken Play

	Wage Measure					
	Mean	1st Dec.	1st Qrt.	Median	3rd Qrt.	9th Dec.
	(1)	(2)	(3)	(4)	(5)	(6)
Boom × 2007	0.007***	0.005	0.012***	0.008***	0.000	0.005
	(0.003)	(0.007)	(0.004)	(0.003)	(0.003)	(0.004)
Boom × 2008	0.016***	0.023***	0.026***	0.023***	0.005	0.005
	(0.004)	(0.007)	(0.007)	(0.005)	(0.007)	(0.006)
Boom × 2009	0.028***	0.038***	0.042***	0.038***	0.017**	0.014
	(0.007)	(0.006)	(0.009)	(0.007)	(0.008)	(0.009)
Boom × 2010	0.031***	0.045***	0.052***	0.043***	0.022**	0.015
	(0.008)	(0.007)	(0.009)	(0.008)	(0.009)	(0.010)
Boom × 2011	0.034***	0.047***	0.054***	0.045***	0.025**	0.021**
	(0.009)	(0.009)	(0.010)	(0.011)	(0.010)	(0.010)
Boom × 2012	0.041***	0.048***	0.055***	0.052***	0.033***	0.028***
	(0.009)	(0.009)	(0.010)	(0.011)	(0.010)	(0.010)
Boom × 2013	0.043***	0.048***	0.055***	0.051***	0.036***	0.031***
	(0.009)	(0.009)	(0.010)	(0.011)	(0.010)	(0.011)
Boom × 2014	0.045***	0.048***	0.063***	0.058***	0.039***	0.029**
	(0.011)	(0.009)	(0.012)	(0.012)	(0.012)	(0.012)
R-squared	0.431	0.621	0.235	0.208	0.287	0.352
Obs.	1355	1355	1355	1355	1355	1355

Notes: Observations for booming NMAs overlaying the Bakken play were excluded from the model. Dependent variables are the logarithm of the variable indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

Table A.18: Estimates of the Effect of the Boom on Housing Relative to 2007; Dropping Booming NMAs Overlaying the Bakken Play

	ln(Home Value) (1)	ln(Med. Rent) (2)	ln(Rent as % of Inc.) (3)	ln(Housing Units) (4)
Boom × 2000	0.018			0.001
	(0.035)			(0.011)
Boom × 2008	0.020***	0.009**	-0.014**	0.008
	(0.004)	(0.004)	(0.006)	(0.009)
Boom × 2009	0.036***	0.010*	-0.013	0.010
	(0.007)	(0.005)	(0.009)	(0.011)
Boom × 2010	0.052***	0.013**	0.002	0.013
	(0.010)	(0.006)	(0.015)	(0.012)
Boom × 2011	0.064***	0.014	0.006	0.014
	(0.014)	(0.009)	(0.016)	(0.013)
Boom × 2012	0.077***	0.022**	0.002	0.016
	(0.017)	(0.010)	(0.016)	(0.013)
R-squared	0.685	0.587	0.300	0.622
Obs.	1057	906	906	1057

Notes: Observations for booming NMAs overlaying the Bakken play were excluded from the model. Dependent variables are indicated in the columns headings. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Years correspond to the center years of the 5-year estimates reported by the ACS. Standard errors are clustered at the NMA level and reported in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance, respectively.

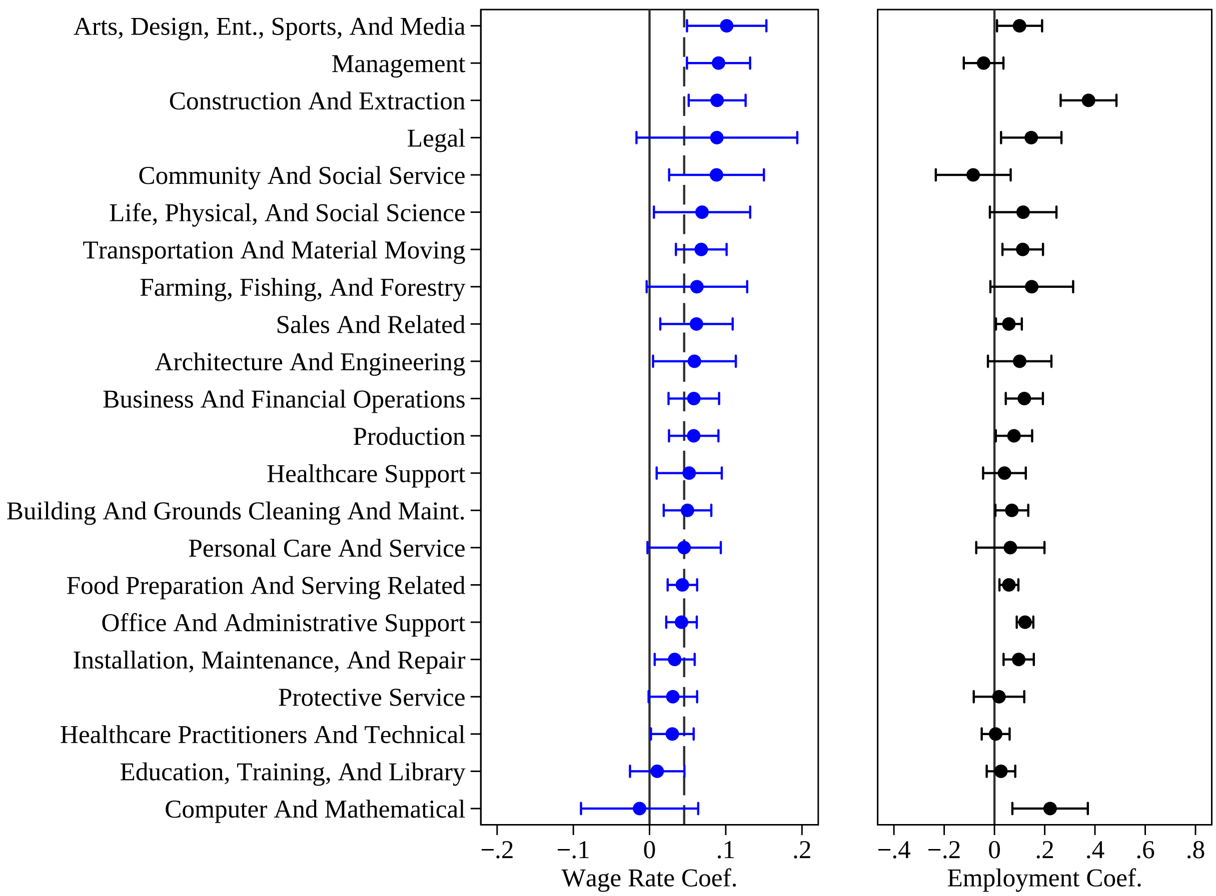


Figure A.7: **Estimates of the Effect of the Boom on Mean Wage Rates and Employment in 2014 Relative to 2006 for Each Occupational Category; Dropping Booming NMAs Overlaying the Bakken Play.** Observations for booming NMAs overlaying the Bakken play were excluded from the model. Each coefficient comes from a separate regression with the logarithm of the corresponding dependent variable as indicated by both axes. The coefficients presented are those on the "Boom × 2014" interaction terms. The vertical dashed line represents the overall estimate across all occupations (see the first column of Table A.17). The whiskers represent 95-percent confidence intervals. All specifications are based on equation 1 and include NMA fixed effects and year dummy variables. The unit of observation is an NMA and a year. Standard errors are clustered at the NMA level.