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Who benefits from an oil boom? Evidence from a unique Alaskan data set

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ABSTRACT

Oil booms have been shown to increase local employment and wages. But these effects reflect the aggregated experience of residents, commuters, and recent migrants alike. This paper takes advantage of a unique data set that identifies a rich set of labor market outcomes by place of residence, rather than by place of work. Exploiting this feature of the data, we examine the effect of a major oil boom on employment and wage outcomes in the North Slope Borough of Alaska. This analysis is juxtaposed with a more conventional one that uses place-of-work data collected from the Bureau of Economic Analysis. Using the Synthetic Control Method, we find that the oil boom of the late 2000s significantly increased non-residential employment. While the boom caused residential employment to shift from the public to the private sector, total residential employment was unaffected. There is weak evidence that residential wages increased in response to the boom. These results are important as drilling decisions are often negotiated locally by interest groups that might be less concerned with general equilibrium effects.

1. Introduction

Due to advancements in hydraulic fracturing and horizontal drilling technology, as well as high energy prices, in the mid-2000s shale-energy-rich U.S. counties experienced a sudden and significant economic shock. There is now a large literature examining the short run social and economic consequences of sub-national energy booms generally, and of the shale-energy boom in particular.[1] Consistent with economic theory (e.g., Corden and Neary, 1982), such studies tend to find that wages and employment rise during energy booms. While there are a number of advantages associated with using sub-national data in this context (it is relatively detailed and reliable and unobserved heterogeneity is minimized) there are also some drawbacks. One concern is that, because labor migration frictions are (relatively) small, it is difficult to disentangle residential effects from aggregated ones.[2,3]

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[1] See for some examples, Alcott and Keniston, 2017; Brown, 2014; Fetzer, 2014; Feyrer et al., 2017; Jacobsen, 2016; James and Smith, 2017; Komarek, 2016; Lee, 2015; Maniloff and Mastromonaco, 2017; Miljkovic and Ripplinger, 2016; Munasib and Rickman, 2015; Paredes et al., 2015; Weber, 2012, 2014 and Weinstein et al. (2018).

[2] The shale-energy boom, for example, caused significant inward migration (Alcott and Keniston, 2017; Feyrer et al., 2017; James and Smith, 2019).

[3] Sub-national examinations of the income and labor market effects of the shale boom typically rely on one of three sources of data: (1) the Census Bureau's employment and payroll data in the County Business Patterns (CBP), (2) the Bureau of Labor Statistics' (BLS) employment and wage tabulations

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In light of the observed migratory response to resource booms, researchers have more recently estimated the effects of resource booms on "people" and not simply "places" (Wrenn et al., 2015; Jacobsen et al., 2019; Kovalenko, 2020; Gittings and Roach, 2019), and we contribute to this emerging literature. We estimate the residential effects of a large localized oil boom in North Slope Alaska, making use of a unique Alaskan data set that provides wage and employment statistics by place of residence rather than place of employment.

Residential addresses for these data are established when eligible Alaskans file for the Permanent Fund Dividend (PFD) in the spring (January–March) of each year. To qualify for a PFD, a person must (i) have been a resident of Alaska for at least a full calendar year before applying and (ii) intend to live in Alaska indefinitely.[4] For example, if a person permanently moves to Alaska in the summer of 2020, they would not be eligible to file for a PFD until the spring of 2022. Temporary out-of-state workers and short term migrants (e.g., those that live in the state less than one calendar year) that do not intend to live in Alaska indefinitely are therefore ineligible to apply for the PFD and so would not be counted as a residents in these data. Even Alaskan residents that move to the North Slope from another borough have little incentive to report a non-permanent address change when filing for a PFD and so would not be counted as North Slope residents either. This feature of the data is distinct from other sources of residential information that are based off of income tax returns such as the Origin–Destination files provided by the Census Bureau.[5] In fact, recent migrants may update their mailing address on file with the IRS even when their move is temporary. This problem is potentially magnified if there are tax advantages associated with claiming residency in another state, such as income tax avoidance.[6] It is therefore difficult to rely on federal income tax returns to disentangle newcomers from the pre-existing residential population.

Our analysis is made up of two parts. We first estimate aggregate effects of the 2000s North Slope oil boom using place-of-work data provided by the Bureau of Economic Analysis. We then estimate residential effects and juxtapose them to the aggregate ones. A number of important insights emerge. First, aggregate employment in the North Slope increased significantly in response to the oil boom, but this is entirely due to non-residential hires. Second, we document negligible residential employment effects for both men and women. Third, the composition of residential employment shifted from the public to the private sector. Fourth, there may have been a modest increase in residential wages in response to the oil boom.

A surprising feature of our analysis is the extent to which residential effects vary from aggregated ones. Whereas the oil boom in the North Slope caused total employment to increase by roughly 50%, we document a statistically insignificant *decline* in residential employment. Policy makers and practitioners alike who are interested in understanding the residential effects of economic shocks are cautioned against drawing any conclusions from aggregated economic data such as that provided by the BEA and BLS. These results are especially important as the decision to drill for oil and gas is often negotiated locally by interest groups that care little about general equilibrium effects.

2. Background

The discovery of the Prudhoe Bay oil field in 1968 proved to be one of the most important events in the economic history of the State of Alaska. Construction of the Trans-Alaska Pipeline System, the only means by which to move crude oil from Alaska's North Slope fields to tankers in Valdez, began in 1974 and was completed in 1977. At peak production, the Prudhoe Bay oil field supplied three percent of the world's oil. According to the Energy Information Administration (EIA), six of the one hundred largest oil fields in the United States are in the North Slope. The North Slope is large (roughly the size of Oregon) and according to the EIA, averaged from 2000 to 2017, it produced nearly all of the oil in the state of Alaska (97%). The state government, which owns the Prudhoe Bay oil field, has collected more than $70 billion in petroleum revenues through 2004 (AOGA, 2005). These revenues have paid almost all state general expenses since 1978. Revenue collected from taxes levied on oil and gas properties have also been substantial.

The discovery of oil in Prudhoe Bay, the inception of the North Slope Borough in 1972, and the formation of the regional and village Alaska Native corporations changed the structure of the North Slope economy. Prior to these developments, both public and private employment opportunities on the North Slope were limited. The North Slope villages could only afford limited local government, and the year-round jobs were mostly associated with federal and state agencies.[7] Major

derived from various unemployment insurance programs, and (3) the Bureau of Economic Analysis' (BEA) estimates of total wage and salary disbursements and employment. The CBP data reflects surveys of business establishments, the BLS data are collected from state or federal unemployment insurance programs, and the BEA data are derived from the BLS data, but various adjustments are made to account for people that do not have unemployment insurance (such as elected officials or interns employed by hospitals for example). Importantly, all of these data are defined by where people work, and not where they live.

[4] See data description for additional details on PFD eligibility.

[5] Individual residence data used to produce the Origin–Destination files provided by the Census Bureau comes from the Composite Person Record (CPR) which is constructed from multiple administrative sources. These data provide a single address for each individual even when contributing administrative data may have contained multiple residences. However, for most individuals, residence information is apparently sourced from federal tax returns submitted to the Internal Revenue Service (IRS) (Leggieri et al., 2002).

[6] Of the five other states that do not impose a state individual income tax, three are among the most resource-rich states in the U.S. (Alaska, Texas and Wyoming).

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

economic changes occurred with the formation of the borough and its ability to tax oil development at Prudhoe Bay and related industrial facilities. Between 1978 and 1983, the borough collected more than 350 million dollars from property taxes and another 107 million from federal and state transfers (Knapp and Knebesky, 1983). As a result, the borough started providing many public services that were previously covered by state and federal entities. The Borough also implemented major infrastructure projects (i.e., schools, houses, utility systems, airports, roads, etc.) and later became the largest employer of North Slope residents with jobs created for government administration and construction projects.

The oil industrial complex in the North Slope has limited direct linkages to the rest of the region's economy. Some of the oilfield service companies operating in the Prudhoe Bay and Alpine areas are subsidiaries (or joint ventures) of village corporations. These service companies have provided jobs to a number of local residents. However, few North Slope residents are typically employed by the large, multinational corporations that produce the oil. Although, oil-producing companies are the largest employers in the region. A small number of North Slope residents are directly employed in the oil and gas industry. The low level of resident participation is not unique to the oil and gas sector. In 2018, 37% of private sector employees were not residents of Alaska, and another 55% were not residents of the North Slope (Kreiger and Whitney, 2018).[8] Most of these workers live in camps far from the main city and are likely to leave the North Slope during rotation. While it is difficult to determine the exact amount of earnings spent within the borough, it is reasonable to assume that a large share leaks out of the area given the nature of the work schedule, geographic isolation, and lack of road connection to neighboring towns and cities.

In 2015, the North Slope had 9887 permanent residents with 4685 of them above the age of 16 years old. Of those, 3358 are employed with local government representing almost 60% of all employment in the region. The three largest private sectors are education and health services, trade, and professional services. These three sectors account for 66% of all private sector employment. While the Borough is incredibly rich with oil, it has a fairly limited economy with a heavy dependence on local government.

Table 8 provides some simple descriptive statistics for Alaska boroughs.[9] Note that for most boroughs, total employment exceeds residential employment. For example, according to BEA data, total employment in Aleutians East in 2001 was 3125, whereas it was just 733 according to place of residence data (labeled ALARI in Table 1).[10] This discrepancy is due to the fact that Aleutian East is home to large commercial fisheries that attract labor from outside the borough. Also note that for the North Slope, the BEA data show that the average wage was $72,829 whereas according to ALARI data it was just $33,000. This suggests that the presence of oil in the North Slope attracted high wage and income earners from outside the borough.

3. Existing literature

There exists a large literature examining the short and long-run effects of natural-resource booms, discoveries, and dependence. (Sachs and Warner, 1995,Sachs and Warner, 2001) helped motivate this literature by identifying an inverse relationship between economic growth and natural-resource dependence.[11] The inverse relationship between economic growth and resource dependence has since been shown to exist across U.S. states (Papyrakis and Gerlagh, 2007), and also across U.S. counties (James and Aadland, 2011).

More recently this literature has utilized advanced identification strategies that rely on "quasi" natural field experiments. For example, in a county-level analysis of the economic effects of the recent shale boom, Weber (2012, 2014) defines treatment counties based off the exogenous location of shale oil and gas fields. By interacting this treatment definition with the timing of the energy-price boom of the mid 2000s, the causal effect of regional energy booms can be estimated. Utilizing data from the Bureau of Economic Analysis (BEA), Weber (2012) finds that, "a large increase in the value of gas production caused modest increases in employment, wage and salary income, and median household income".[12] A similar instrument is used by Maniloff and Mastromonaco (2017), who examine the employment effects of the shale boom at the county level. They find that doubling the number of wells in a typical county raises employment by roughly 3%. Examining the labor market effects of the shale boom in Arkansas, North Dakota, and Pennsylvania, Munasib and Rickman (2015) use the Synthetic Control Method and document significant effects of the shale boom, especially in North Dakota (measured in terms of increases in employment and income per capita, and decreases in the poverty rate). Examining the effect of the natural gas boom in counties above the Marcellus shale formation, Komarek (2016) finds that, relative to New York counties that did not develop their unconventional natural gas deposits (due to a variety of drilling moratoriums), the shale boom elevated employment and wages per job by 7% and 11%, respectively.[13]

Feyrer et al. (2017) examine the county-level economic effects of the shale boom and draw specific attention to spatial spillovers. Relying on data from the Bureau of Labor Statistics, as well as the Internal Revenue Service, they find that only

[8] According to the Alaska Department of Labor, 54% of the North Slope population in 2016 was Native American. We do not have data on sector-level employment by race but only 1.1% of North Slope residents are directly employed in the Natural resources sector. An earlier analysis by Northern Economics (2006) shows that more than 50% of the share of residents employed in Natural Resources were Inupiat in 1998.

[9] See Fig. 1 for a map of Alaskan boroughs.

[10] ALARI stands for Alaska Local and Regional Information.

[11] Natural-resource dependence is typically defined as a measure of the value of natural-resource production relative to total production.

[12] Weber (2014) similarly utilizes data collected from the BEA.

[13] See Marchand and Weber (2018) for a review of the literature examining the labor market effects of natural resource shocks.

Table 1
Basic descriptive statistics.

Year	Population	Employment (BEA)	Employment (ALARI)	Avg income (BEA)	Avg income (ALARI)
Aleutians East	2590	3125	733	20,368	20,464
Aleutians West	5501	3529	1952	31,647	32,787
Anchorage	264,274	181,349	118,312	32,432	31,273
Bethel	16,171	7930	7270	23,620	17,882
Bristol Bay	1196	1219	631	27,236	30,111
Denali	1850	2127	887	31,948	30,440
Dillingham	4840	3488	2118	21,587	21,719
Fairbanks North Star	51,231	84,814	34,898	28,885	27,509
Haines	2334	1541	1071	18,160	19,608
Hoonah-Angoon	NA	NA	1167	NA	17,138
Juneau	30,502	22,136	15,443	29,056	28,492
Kenai Peninsula	49,986	27,531	22,023	22,860	27,698
Ketchikan	13,789	9721	6643	26,190	25,591
Kodiak Island	13,748	9156	5879	23,311	22,113
Kusilvak	7051	2327	2893	16,914	13,135
Lake and Peninsula	1715	1150	823	19,231	15,796
Matanuska-Susitna	61,807	21,904	26,561	18,759	28,237
Nome	9167	4199	4183	25,302	20,798
North Slope	7530	9487	3636	72,829	33,003
Northwest Arctic	7251	3241	3050	41,668	25,246
Petersburg	NA	NA	1288	NA	22,516
Prince of Whales – Hyder	NA	NA	2933	NA	19,093
Sitka	8727	6182	3815	22,461	25,164
Skagway	NA	NA	419	NA	23,389
Southeast Fairbanks	5705	2324	2215	22,692	20,316
Valdez-Cordova	10,114	6870	4874	28,706	32,827
Wrangell	NA	NA	1042	NA	23,033
Yakutat	764	502	369	20,607	20,596
Yukon-Koyukuk	6364	2939	3196	26,330	17,522

Note: All data are measured in 2001. See data description for data sources. Observations include both Boroughs and Census Areas. "Avg Income" refers to average wage and salary earned per employed person. ALARI stands for Alaska Local and Regional Information and corresponds to residential information. A full set of descriptive statistics, including the broad set of ALARI outcomes are available from the authors upon request.

a fraction of the total economic gains associated with fracking remain in the county of production. They also find that the economic effects of drilling reach up to two-hundred miles away from the point of extraction. (James and Smith (2019),James and Smith (2020) however document more modest propagation effects. Richter et al. (2018) examine the spatial dispersion of the effects of the Bakken oil boom in North Dakota. They find that for producing counties, the shale boom generated a 30% increase in income per capita, a 20% decrease in the poverty rate and a more than 30% decrease in the unemployment rate. They identify more modest economic gains for non-producing counties within one hundred miles of energy production. These broad findings are consistent with other work as well (see for example Wilson, 2016 and Vachon, 2017). Drawing on the Alaskan experience, Carrington (1996) notes that the construction of the Trans-Alaska Oil Pipeline System from 1974 to 1977 caused migration to Alaska to surge.[14] For example, he notes that in 1980, 41% of the Alaskan population had moved there in the past five years (compared to just 11.7% the rest of the United States).

Examining the long run effects of historical energy discoveries and booms, two seminal contributions stand out. Michaels (2011) examines the long run (e.g., 60–70 years) effect of major oil field discoveries in southern U.S. counties. He documents modest economic gains associated with "resource-based specialization" including increased income per capita and added infrastructure. Jacobsen and Parker (2016) similarly examine the long run (roughly 20 years) effects of the oil boom of the late 1970s using BEA data. They find that counties that boomed in the late 1970s and early 1980s suffered from higher levels of unemployment and lower levels of income by the year 2000. Haggerty et al. (2014) also examine long run effects of oil and gas specialization among counties within major oil-producing U.S. states. They find that a longer duration of oil and gas specialization is associated with higher crime rates and lower levels of both income per capita and education attainment.

Couched within a broader, county-level examination of the economic effects of hydraulic fracturing, Weinstein et al. (2018) estimate the effect of energy production on both aggregate and residential total earnings. The "place of residence" earnings data is collected from the BEA and reflects adjusted "place of work" earnings data. The BEA resident adjustment, which could be positive or negative, is the net inflow of earnings from inter-regional commuters. To construct the residential adjustment, the BEA utilizes decennial journey-to-work commuter data between states and counties which is collected by the U.S. Census Bureau. There are some limitations of this data however. First, the residential adjustment is only made for total earnings—including but not limited to wage and salary income, dividends, interest, rent, and transfers. However,

[14] This point was more recently echoed by James (2016).

variation in wage and salary income alone is arguably more reflective of changes in local labor market outcomes. Additionally, residential adjustments are not made for other outcomes, including employment.

In a similar vein to this paper, Jacobsen et al. (2019) exploit a longitudinal data set to estimate the effect of the 1970s oil boom on people that lived in boom towns prior to the boom. By following individual outcomes over decades, they find that exposure to the oil boom—regardless of where one lived years later—reduced cumulative income earnings for working-age people. For older people, exposure caused them to postpone retirement longer than they otherwise would have. More broadly, they write that, "...the boom was a curse for the average household". Similarly, Alina Kovalenko (2019) exploits unique administrative panel data to estimate the effect of the recent shale-energy boom on the education attainment and employment outcomes of young people in Texas. Similar to other research (e.g., Black et al., 2005) she finds that the shale boom increased high school dropout rates but also wage rates up to six years after leaving school.

Most similar to the present paper, Wrenn et al. (2015), examine both residential and non-residential employment effects of unconventional natural gas recoveries in Pennsylvania. Noting that BEA and BLS employment data reflect a person's place of work, and not necessarily of residence, they use the number of residential tax returns in the state to gauge residential employment. Defining their treatment group of counties based off of well construction, they find that, "for counties in which there is significant well activity, the employment impacts estimated using the BEA and BLS data are more than twice as large as the impact estimated from the tax data".

More recently, Gittings and Roach (2019) estimate the labor market effects of the Marcellus and Utica shale booms using Origin–Destination Employment Statistics produced by the Longitudinal Employer-Household Dynamics Program at the Census Bureau. Because these data files describe where employees both live and work, they can be used to estimate the effects of an economic shock on both residents and non-residents. Based off of this data, Gittings and Roach (2019) find that, "increases in the value of new oil and gas production significantly increases local workplace employment and average earnings in the county, but that job gains go mostly to workers who reside outside of the county".

4. Data

4.1. Bureau of Economic Analysis (BEA)

Employment and wage outcomes defined by place-of-work are collected from the BEA. As previously discussed, this data is quite similar to that provided by the BLS, though some modifications are made to account for individuals not covered by state or federal unemployment insurance. The BEA also makes adjustments to account for misreporting in state and federal unemployment insurance programs. The BEA gives equal weight to full-time and part time jobs in its estimates of employment. Wage and salary jobs and proprietors' jobs are counted, but unpaid family workers and volunteers are not. Proprietors' employment consists of the number of sole proprietors and the number of general partners.

Wage and salary income data are also collected from the BEA and is measured before various deductions including social security contributions and voluntary contributions to pension plans. Both employment and income data are available at: https://www.bea.gov/regional/index.htm.

4.2. Alaska Local and Regional Information (ALARI)

Residential wage and employment data comes from the Alaska Local and Regional Information database provided by the Alaska Department of Labor. This data is established by matching wage record file data with Permanent Fund Dividend (PFD) information. The wage record file is derived from Alaska Department of Labor and Workforce Development's Occupational Database and contains quarterly earnings, and occupation and industry information on workers covered by unemployment insurance within Alaska. The Alaska Department of Labor aggregates these data to the borough (or county) level and we present summary statistics in Table 7.[15]

The PFD file is a list of Alaskans who either applied for or received a PFD. As mentioned in the introduction of this paper, the Permanent Fund Dividend is paid to Alaska residents that have lived within the state for a full calendar year (January 1–December 31), and intend to remain an Alaskan resident indefinitely. Beyond those basic requirements, eligibility for the PFD requires that a person has (i) not claimed residency in any other state or country or obtained a benefit as a result of a claim of residency in another state or country any time since December 31 [of two years prior], (ii) not been sentenced or incarcerated as a result of a felony or misdemeanor in the previous year, and (iii) not been absent from Alaska for more than 180 days and was physically present in Alaska for at least 72 consecutive hours at sometimes during the previous two years.[16] Workers included in the Occupational Database were considered Alaska residents if they applied for a PFD in at least one of the two most recent years. Convicted felons are not permitted to receive a PFD and so are not included in this data. We acknowledge that an oil boom has the potential to permanently attract new residents. To the extent that this occurred

[15] These data are publicly available at: http://live.laborstats.alaska.gov/alari/.

[16] See https://pfd.alaska.gov/Eligibility/Requirements for additional details regarding PFD eligibility.

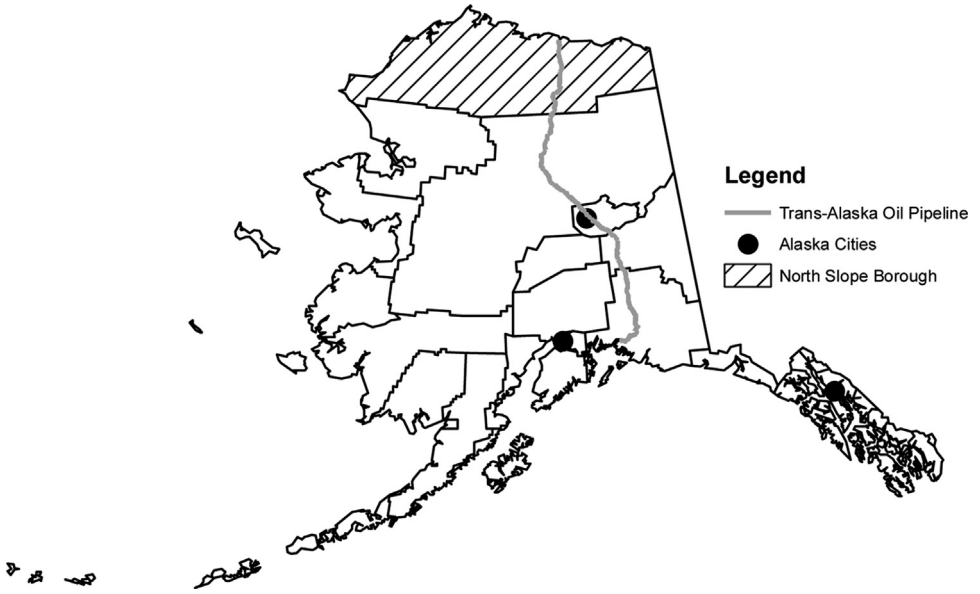


Fig. 1. Alaskan Boroughs. **Note**: Alaskan cities (defined as having at least 30,000 people in 2010, are marked with black dots. Those cities are Anchorage, Fairbanks, and Juneau.

during the oil boom in the North Slope borough, our estimates for the pre-existing residential population are upper bounds as some fraction of the employment and income gains may have gone to recent migrants to the area.[17]

5. Identification

The North Slope is unique for a variety of reasons, only one of which is that it is heavily endowed with fossil fuels. It is the northern-most region in the state of Alaska (see Fig. 1) and it is relatively sparsely populated. Referencing Table 1, at the start of our sample period (2001) the population of the North Slope was 7530 whereas that in Anchorage was 264,274 and in the average borough it was 24,342 (though the median population (7391) was more similar to that in the North Slope). According to BEA data, at the start of the sample period wage and salary income was also much higher in the North Slope than in other boroughs. Anchorage is clearly not a suitable comparison unit for the North Slope. Rather than subjectively choosing a set of comparison units based off of geographic proximity or economic similarity, we construct one using the Synthetic Control Method (SCM).

Abadie et al. (2010) argue that, unlike the traditional regression-based difference-in-difference model that restricts unobserved effects to be time-invariant, SCM allows the effects of such unobserved characteristics to vary with time. In particular, Abadie et al. (2010) show that by matching on pre-event outcomes and characteristics, a synthetic control also effectively matches on time-varying unobserved factors.[18]

Finally, because the construction of a synthetic control does not require access to post intervention outcomes, SCM allows us to decide on a study design without knowing its bearing on its findings (Abadie et al., 2010). The ability to make decisions on research design while remaining blind to how each particular decision affects the conclusions of the study is a safeguard against actions motivated by a "desired" finding (Rubin, 2001).

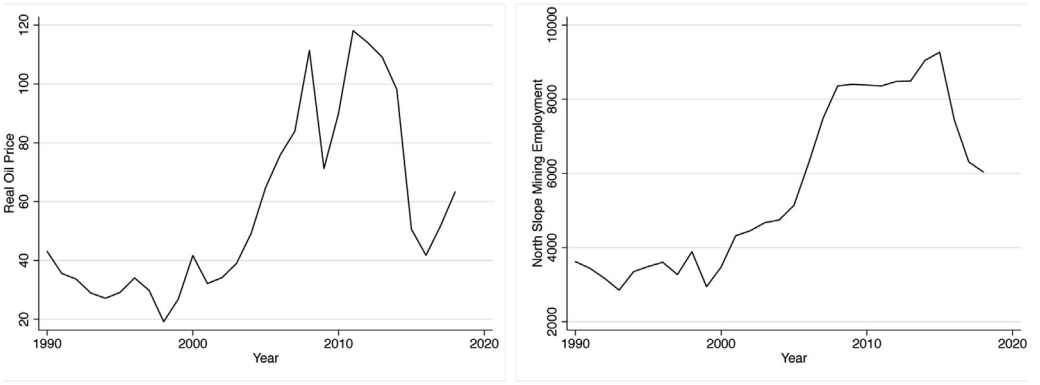
To obtain the synthetic control we follow Abadie and Gardeazabal (2003) and Abadie et al. (2010). For counties $i = 1, \ldots, J+1$ and periods $t = 1, \ldots, T$ suppose state $i = 1$ is exposed to the intervention (oil price shock) at time $t^* \in (1, T)$. The observed outcome for any borough i at time t is

$$Y_{i,t} = Y_{it}^N + \alpha_{it} S_{it}, \tag{1}$$

where Y_{it}^N in Eqn 1 is the outcome for borough i at time t in the absence of the intervention, the binary indicator variable, S_{it}, denotes the intervention taking the value of 1 if $i = 1$ and $t > t^*$, and α_{it}, the coefficient to be estimated, is the effect of the intervention for state i at time t.

[17] See Tables in Appendix D for full set of summary statistics for both the ALARI and BEA data.

[18] As Abadie et al. put it, "...only units that are alike in both observed and unobserved determinants of the outcome variable as well as well as in the effect of those determinants on the outcome variable should produce similar trajectories of the outcome variable over extended periods time."



(a) Real Oil Price (b) NS Mining Employment

Fig. 2. Oil price and mining employment. **Note**: Imported crude oil prices are real and 2017 is the base year. Data collected from the Energy Information Administration and is available at: https://www.eia.gov/petroleum/data.php#prices. Mining employment is for the North Slope and includes all individuals employed in any mining sector. This data is collected from the BEA.

Under standard conditions, there exists $W^* = (w_2^*, \ldots, w_{J+t}^*)'$ such that pre-intervention matching is achieved with respect to the outcome variable as well as characteristics (or predictors), and we can use

$$\hat{\alpha}_{1t} = Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}, \quad t \in T_0 + 1, \ldots, T, \tag{2}$$

as an estimator for α_{1t}. The term $\sum_{j=2}^{J+1} w_j^* Y_{jt}$ on the right-hand-side of (2) is simply the weighted average of the observed outcome of the control boroughs for $t \in T_o + 1, \ldots, T$ with weights W^*. The optimal weights placed on each unit are found by minimizing

$$(X_1 - X_0 W)' V (X_1 - X_0 W), \tag{3}$$

where X_1 in Eqn 3 is a $k \times 1$) vector of pre-event predictors for the treatment borough (North Slope), X_0 is a $(K \times J)$ matrix of pre-event predictors for the control group of boroughs, and W is a $(J \times 1)$ vector of weights that are assigned to controls in the donor pool that sum to one. Finally, V is a $(K \times K)$ diagonal matrix, where the diagonal elements describe the importance of each predictor. For each of the outcome variables, we match the log value of the outcome to its pre-intervention levels between 2001 and 2005. We use 2006 as the event year as it coincides with the boom in both the real oil price and North Slope mining employment (see 1, 2 and 3). Though, for robustness we also estimate our baseline set of results using a 2004 event date and document similar results. From Tables 2 and 3 , the units contributing to the counterfactual differ between the place of work and place of residence variables.

6. Results

We first report results using place-of-work BEA data. These data are aggregated across residents and employees and speak to the overall impact of the energy boom. These data are unfortunately limited to total employment and average income. The results nonetheless provide an aggregated benchmark to which we can compare our residential estimates that follow. As described in the previous section, the Alaska Local and Regional Information database provides a broader set of borough-level residential data including average income and total employment, as well as employment by gender, sector, and income bin.

6.1. BEA results

Before turning to the SCM results, notice from Fig. 3 that total BEA employment in the North Slope increased significantly from 2005 to 2008 (from roughly 9000 to 14,000). This immediate observation is reinforced by comparing employment outcomes in the North Slope to the synthetic control. These results are provided in Fig. 4.[19] Panel (a) shows that, prior to the sudden rise in oil prices, variation in employment in the synthetic control matches quite well that in the North Slope. In 2006, however, employment in the two units diverges and there is a significant treatment effect (see panel b). By 2014, the treatment effect is roughly 0.5, which amounts to a 65% increase in total employment.[20]

[19] See Table 2 for weights used for each of the BEA estimations.

[20] Note that because we have log-normalized employment, a treatment effect of 0.5 implies a $e^{0.50} - 1$ =65% increase in employment.

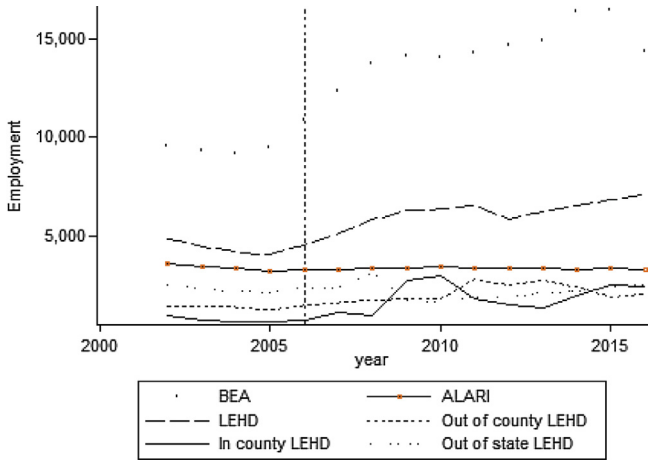
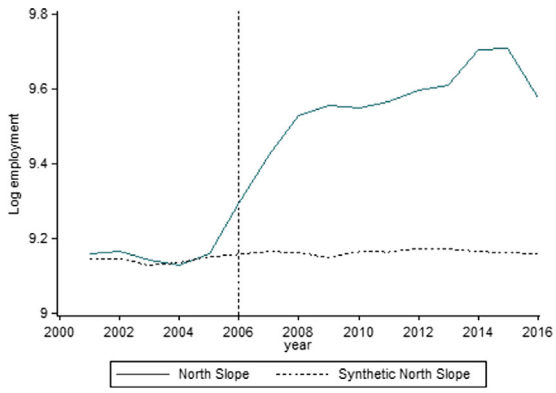
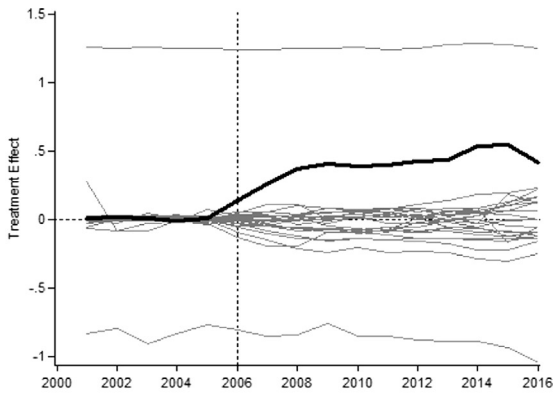


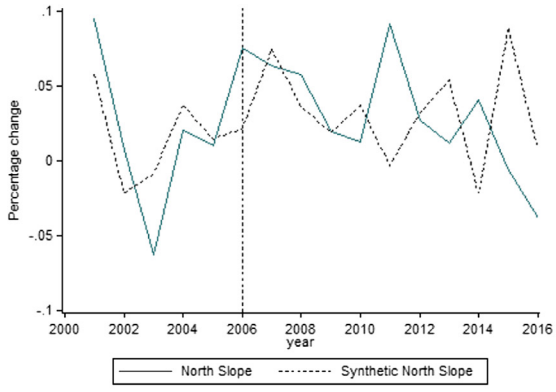
Fig. 3. Employment in the North Slope in BEA, ALARI, and LEHD.



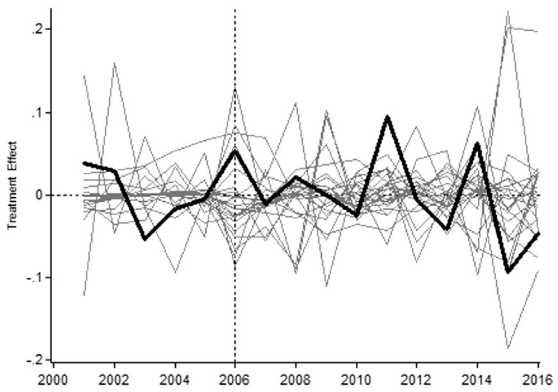
(a) BEA Employment and its Synthetic.



(b) BEA Employment and Placebos



(c) BEA Avg Wage and its Synthetic



(d) BEA Avg Wage and Placebos

Fig. 4. BEA employment and average wage. **Note**: Unique weights used to produce the synthetic units displayed in panels (a) and (c) are given in Table 2. Panels (b) and (d) give the estimated treatment effects along with the placebo tests. See Table 4 for significance testing. We estimate the placebos by looping through each of the donor units and using the $(n-1)$ other units as the new donor pool to estimate the treatment effect for each one of them. The outlier to the upside in panel b is Anchorage which has half of the state's population and therefore does not have a good counterfactual within the state.

Table 2
BEA SCM weights.

Borough	Employment	Average wage
Aleutians East	0.025	0.113
Aleutians West	0	0
Anchorage	0	0
Bethel	0	0
Bristol Bay	0	0.151
Denali	0	0
Dillingham	0	0
Fairbanks	0	0
Haines	0	0.737
Juneau	0.499	0
Kenai	0	0
Ketchikan	0	0
Kodiak	0	0
Lake and Penn	0	0
Matinuska-Susitna	0	0
Nome	0	0
Northwest Arctic	0.296	0
Prince of Wales	0	0
Sitka	0	0
Southeast Fairbanks	0	0
Skagway	0	0
Valdez	0.15	0
Yakutat	0	0
Yukon	0.029	0

Note: These weights are used to construct the synthetic control displayed in panels (a) and (c) of Fig. 4.

It is interesting to compare and contrast these aggregate (resident and non-resident) employment effects to those in the existing literature. For reference, Munasib and Rickman (2015) estimate that the shale boom increased employment in North Dakota by 30–40%. While these estimates are qualitatively smaller than our estimated effect for the North Slope (average treatment effect of roughly 50%), Munasib and Rickman estimate state-level employment effects. The employment effect of the North Dakota oil boom is more pronounced in western, oil-rich counties. For example, from 2006 to 2014, employment in the most oil-rich counties in North Dakota increased by 86%. Over the same time frame employment in non-oil rich North Dakota counties increased by just 22%.[21]

The results for income are given in the bottom two panels of Fig. 4. We again find that pre-event variation in the synthetic unit matches that in the North Slope fairly well. However, unlike with total employment, this trend continues throughout most of the sample period rendering the treatment effect small and statistically insignificant (see panel b).

Taken together, the oil shock caused total employment to increase significantly but had a limited effect on income per worker. This paradoxical finding is likely explained by the fact that the oil boom attracted non-residential employment which helped to alleviate upward pressure on wage rates. The extent to which this occurred is explored in detail in the following subsection.

6.2. ALARI results

6.2.1. Employment and income

We first report the results for total residential employment and average residential income growth. Comparing these outcomes to those in the previous subsection highlights the importance of differentiating between aggregate and residential effects. Referring back to Fig. 3, there is little variation in North Slope residential employment (ALARI) over the sample period. This finding is reinforced by comparing residential employment to the synthetic control over the sample period. From panel (a) of Fig. 5, the oil shock did not increase residential employment. In fact, a few years after the event date (marked by the sudden appreciation in oil prices), residential employment in the North Slope declined relative to the synthetic control. However, from panel (b), this result lacks statistical significance.

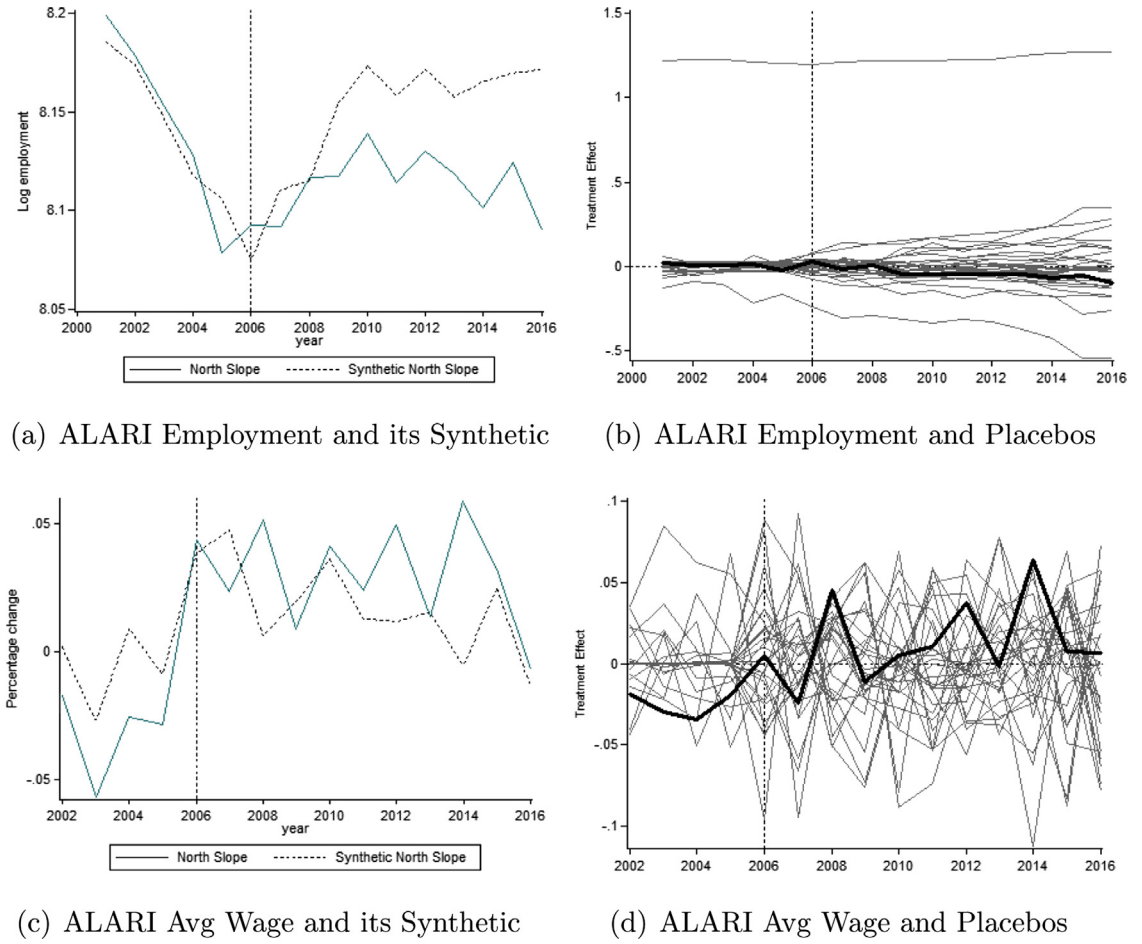
Panel (c) of Fig. 5 gives the results for average wage growth. The treatment effect is typically positive but, similar to the employment result, lacks statistical significance in most years (see panel d). However, from 2006 onward, the treatment effect tends to rise and in 2012 it is roughly 0.06, implying that wage growth that year was about 6% greater than it otherwise would have been. Taken together, there is no evidence that the oil boom affected aggregate residential employment, but some weak evidence that it increased residential wage growth.

[21] Authors calculation based off of aggregate employment data collected from the BEA Regional Economic Accounts. The most oil-rich counties are defined as: Billings, Bowman, Burke, Divide, Dunn, Golden Valley, McHenry, McKenzie, McLean, Mountrail, Renville, Slope, Stark, Ward, and Williams.

Table 3
ALARI SCM weights.

Borough	$<5k	$5k–$10k	$10k–$20k	$20k–$50k	>$50k	Male	Female	New hires	UI	Private	State	Local	16+	Res. employment	Avg. wages
Aleutians East	0	0	0.005	0.336	0	0	0.702	0.077	0	0.258	0.246	0	0.002	0.689	0
Aleutians West	0	0.001	0.318	0.682	0	0	0	0.144	0	0	0	0	0.003	0	0.436
Anchorage	0	0.005	0	0.112	0.08	0.388	0.298	0.066	0	0	0	0.535	0.22	0.311	0
Bethel	0	0.003	0	0	0	0	0	0.014	0.398	0	0	0	0.003	0	0
Bristol Bay	0	0	0.248	0	0	0	0	0.014	0	0.146	0	0	0.003	0	0
Denali	0	0.001	0	0.093	0.296	0	0	0.016	0	0	0	0	0.002	0	0
Dillingham	0	0.001	0	0.428	0	0.016	0	0.015	0	0	0	0	0.004	0	0
Fairbanks	0	0.004	0	0	0	0	0	0.016	0	0	0	0	0.006	0	0
Haines	0	0.119	0	0	0.047	0	0	0.028	0	0	0	0	0.003	0	0
Hoonah	0	0.001	0	0	0.047	0	0	0.011	0	0	0.142	0	0.007	0	0
Juneau	0	0.004	0	0	0	0		0.04	0	0	0	0	0.005	0	0
Kenai	0.028	0.025	0	0	0	0	0	0.029	0	0	0	0	0.007	0	0
Ketchikan	0	0.003	0.429	0	0	0	0	0.023	0	0	0	0	0.077	0	0
Kodiak	0	0.296	0	0	0	0	0	0.235	0	0.514	0	0	0.012	0	0
Kusilvak	0	0	0	0	0	0	0	0	0	0	0.346	0	0.002	0	0
Lake and Penn	0	0.001	0	0	0	0	0	0.018	0	0.083	0	0	0.002	0	0
Matinuska-Susitna	0	0.002	0.322	0	0	0	0	0.16	0.019	0	0	0	0.002	0	0
Nome	0.338	0.002	0	0.112	0	0	0	0.015	0	0	0	0	0.003	0	0
Northwest Arctic	0.404	0.002	0	0	0	0	0	0.017	0	0	0	0	0.003	0	0
Petersburg	0	0	0	0	0	0	0	0.05	0	0	0	0	0.003	0	0
Prince of Wales	0	0.005	0	0	0	0	0	0.017	0	0	0	0	0.008	0	0
Sitka	0	0.002	0	0	0	0	0	0.018	0.304	0	0	0	0.003	0	0
Skagway	0	0.001	0	0	0	0	0	0.014	0	0	0.078	0	0.249	0	0
Southeast Fairbanks	0	0.285	0	0	0	0	0	0.017	0	0	0	0	0.002	0	0.564
Valdez	0	0.008	0	0	0	0	0	0.019	0	0	0	0	0.005	0	0
Wrangell	0.23	0.222	0	0	0	0	0	0.016	0.278	0	0	0.465	0.266	0	0
Yakutat	0	0.001	0	0	0	0.596	0	0.021	0	0	0.189	0	0.085	0	0
Yukon	0	0.004	0	0	0	0	0	0.017	0	0	0	0	0.015	0	0

Note: The first five columns correspond to the number of people within each income bin. “UI” is the number of unemployment insurance claims. “Private” is the number of people working in the private sector and “State” and “Local” are the number of people working in state and local government, respectively. 16+ is the number of residents at least sixteen years old. Res employment is the number of employees who are North Slope residents.



(a) ALARI Employment and its Synthetic

(b) ALARI Employment and Placebos

(c) ALARI Avg Wage and its Synthetic

(d) ALARI Avg Wage and Placebos

Fig. 5. ALARI employment and average wage. In Figure 13 and 14, we present results for ALARI using the same weights as the employment variable. In Figure 15, we use the weights from the BEA data to establish counterfactuals.

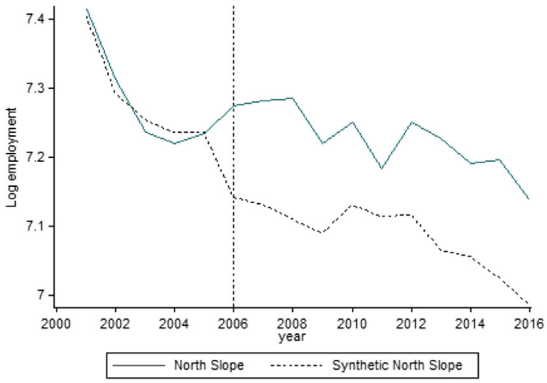
6.2.2. Additional outcomes

The ALARI data is sufficiently rich to explore residential employment effects by gender, sector, and income bin Table 6. We start by separating residential employment into three broad categories: private sector, state government, and local government. These results are provided in Fig. 6 There is suggestive evidence that the oil shock increased private sector employment (panel a) but decreased state government employment (panel c), and had no effect of local government employment (panel e). However, only the effect on state government employment is statistically significant (see Table 4). These findings are consistent with the idea that, in response to rising wages, residents of the North Slope moved from the public sector (state government) to the private sector. As discussed earlier, these two effects offset each other such that the aggregate effect on residential employment is negligent.

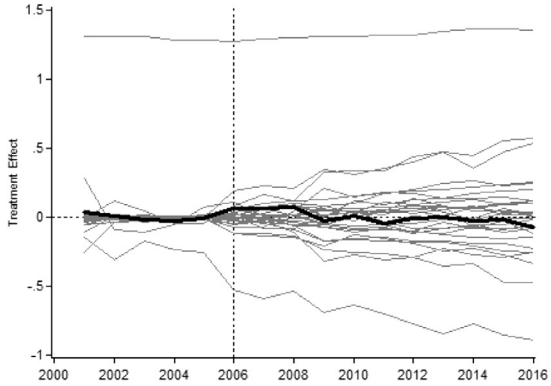
Existing literature has documented important heterogeneous gender effects of natural-resource shocks. For example, Aragón et al. (2018) find that the closure of coal mines in the UK increased male manufacturing employment. Due to imperfect substitutability, female manufacturing employment declined as a result of this shift. We contribute to this growing literature by estimating residential employment effects for males and females separately. These results are provided in Fig. 7 and show that regardless of gender, residential employment was unaffected by the oil boom.

Next, we separate employment into five income bins: less than five thousand, between five and ten thousand, between ten and twenty thousand, between twenty and fifty thousand, and greater than fifty thousand dollars per year. These results, along with the corresponding estimated treatment effects and placebo results are given in Figs. 8 and 9 . While the average treatment effect is insignificant for each income bin (see Table 4), there is suggestive evidence that the oil boom reduced the number of people making less than five thousand dollars and increased the number of people making between ten and twenty thousand dollars. Though it is difficult to interpret these results because we do not observe which income bin workers may have moved from.

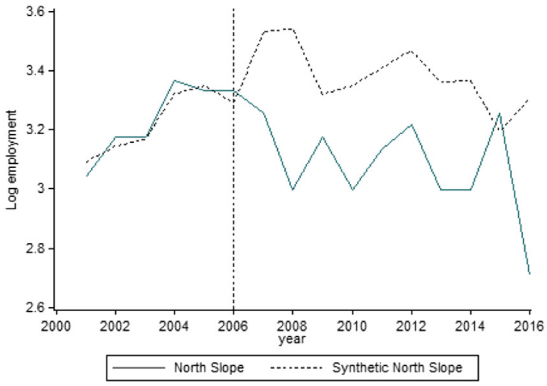
Lastly, we estimate the effect of the oil boom on the number of residential unemployment insurance claims and the number of new hires. New hires may refer to entry into the labor market, or movement within it. For example, if a resident



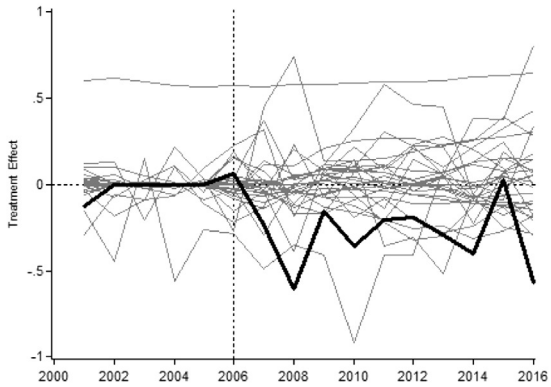
(a) Actual and Synthetic: Private Sector



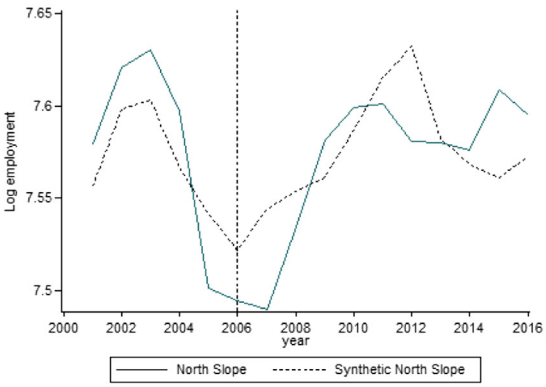
(b) North Slope and Placebos: Private Sector



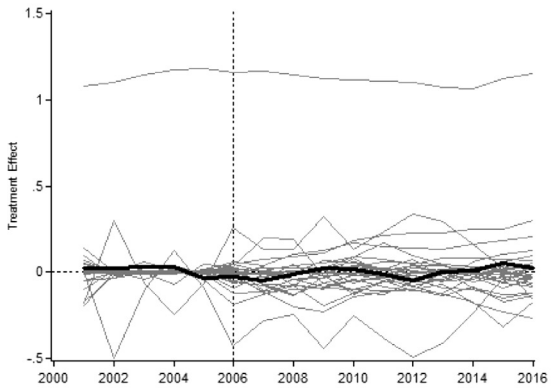
(c) Actual and Synthetic: State Gov.



(d) North Slope and Placebos: State Gov.



(e) Actual and Synthetic: Local Gov.



(f) North Slope and Placebos: Local Gov.

Fig. 6. Employment by sector. In Figure 16, we provide the other ALARI outcomes using the weights from the employment variable.

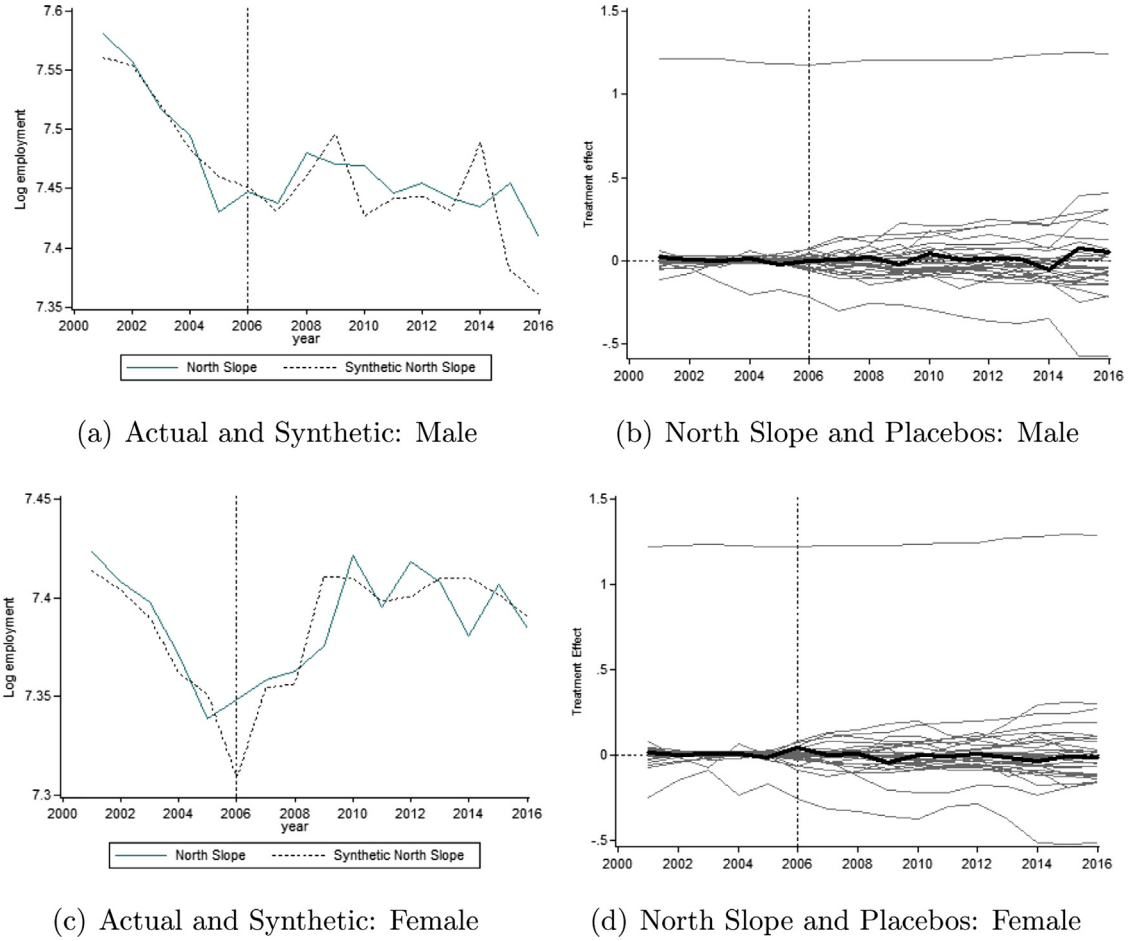
moves from the public sector to the private sector, this shift would be recorded as a new hire. Nonetheless, we think this is a relevant outcome variable to consider as job change is an important component of income growth over a worker's career and is associated with improving economic conditions (Hyatt and McEntarfer, 2012).

These results are provided in Fig. 10 and largely support the earlier set of findings. From panel (a), the number of residential unemployment claims fell in response to the oil boom, which suggests there were enhanced residential labor market opportunities. This result is somewhat surprising given that total residential employment was unaffected by the boom.

Table 4
Statistical significance tests.

Variable name	(*P*-value)	(Rank)
BEA data		
Total employment	0.041	1
Avg income	0.33	8
ALARI data		
Total employment	0.44	13
Avg income	0.68	20
<$5k	0.17	5
$5k–$10k	0.27	8
$10k–$20k	0.13	4
$20k–$50k	0.20	5
>$50k	1	29
Male employment	0.93	27
Female employment	0.82	24
New hires	0.41	12
UI claimants	0.10	3
Private sector	0.0.41	12
State government	0.06	2
Local government	0.93	27

Note: BEA data are complete for 24 units. ALARI data are complete for 29 units. "UI Claimants" is the number of unemployment insurance claims filed. "State Government" and "Local Government" correspond to levels of employment in the state and local government, respectively. "Rank" corresponds to the rank of the North Slope in terms of the absolute change in an outcome variable before and after the intervention period. "*P*-value" is rank over the number of units.



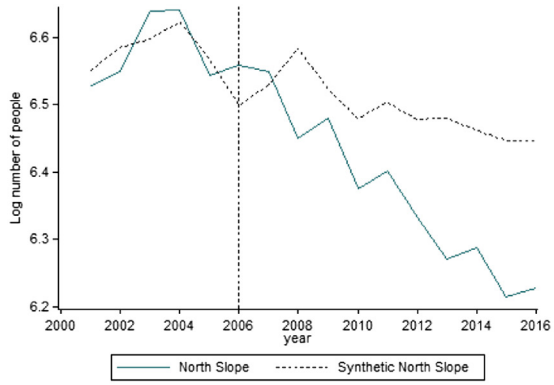
(a) Actual and Synthetic: Male

(b) North Slope and Placebos: Male

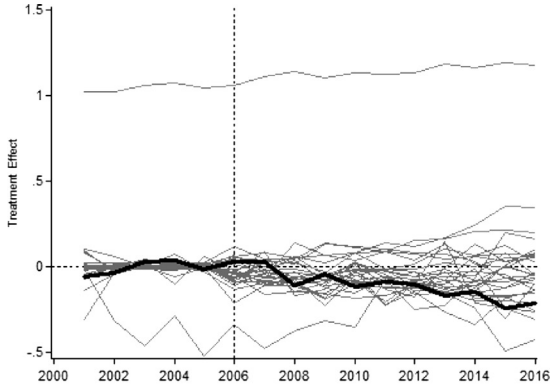
(c) Actual and Synthetic: Female

(d) North Slope and Placebos: Female

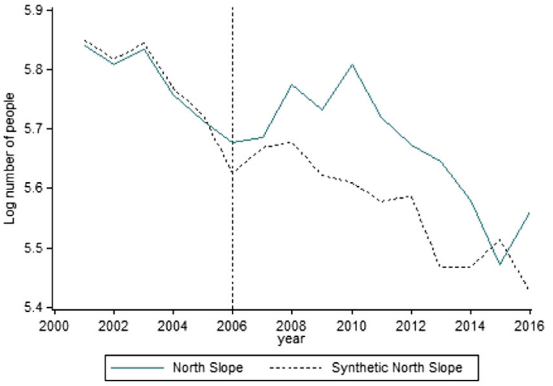
Fig. 7. Employment by gender.



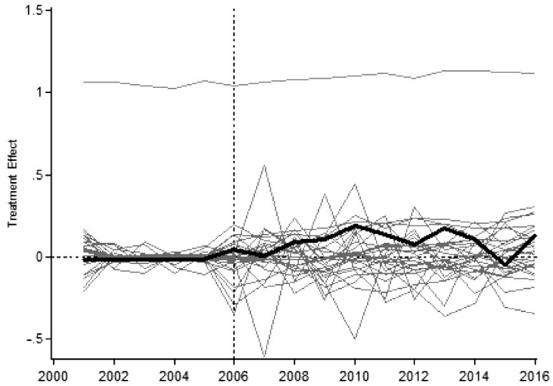
(a) Actual and Synthetic: <$5k



(b) North Slope and Placebos: <$5k



(c) Actual and Synthetic: <$5k-$10k



(d) North Slope and Placebos: <$5k-$10k

Fig. 8. Employment by income bin.

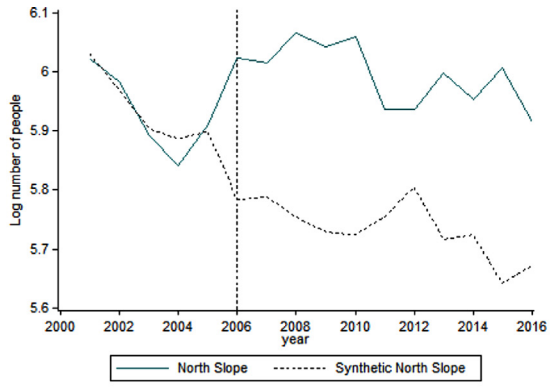
There are a couple of potential explanations for this, one mechanical and the other economic. The mechanical explanation is that this reflects the fact that unique donor weights are used for each outcome variable.[22] From Table 3, for residential employment the major donors are Aleutians East 69% and Anchorage 31%. For unemployment claimants, the major donors are Bethel, Sitka, and Wrangel. The economic explanation—albeit speculative—is that the oil shock increased household income and as a result reduced the number of residents actively seeking employment. Though, this explanation may be unlikely as there is only weak evidence that the oil boom increased residential income growth.

We also document a significant rise in the number of new hires in response to the oil boom. This result is at least partially explained by the fact that the oil boom caused many residents to switch jobs. For example, there is evidence that the oil boom caused residents of the North Slope to move from the public to the private sector, and this shift is reflected in "new hires" (recall that new hires refers to both entry into the labor market, and movement within it).

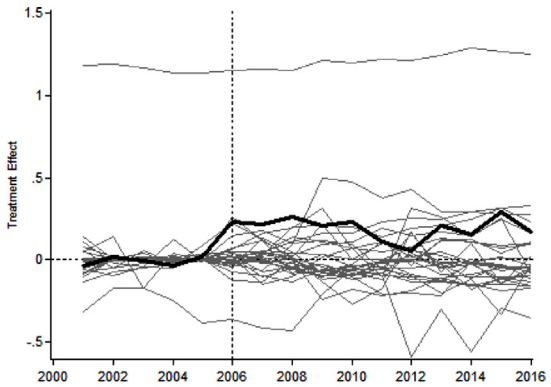
6.3. Robustness checks: alternative samples and specifications

A key identifying assumption is that donor units were not treated by the oil boom in the North Slope. In this regard, one might be concerned that labor migrated to the North Slope from neighboring Northwest Arctic borough if Northwest Arctic is a significant donor unit. In this case, our employment estimates would reflect the combined effect of the oil boom and would be biased upward. To address this concern, we re-estimate our baseline employment effects dropping all contiguous counties to the North Slope. For this specification, significant donor units have either large populations (Juneau) and so

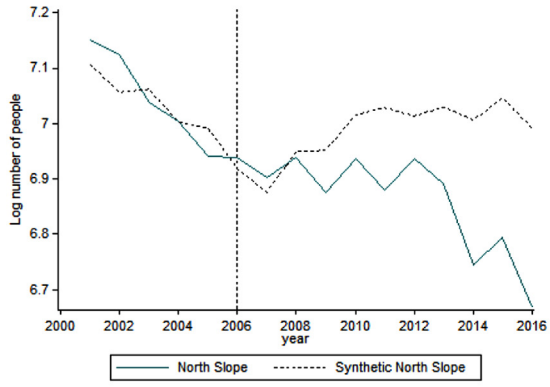
[22] In Appendices A and B we estimate the effect of the oil shock on ALARI outcomes using constant donor weights based off of (i) total ALARI resident employment and (ii) total BEA employment. These results highlight the importance of using unique donor weights for each outcome as pre-event outcomes in the North Slope do not match well those for the synthetic unit.



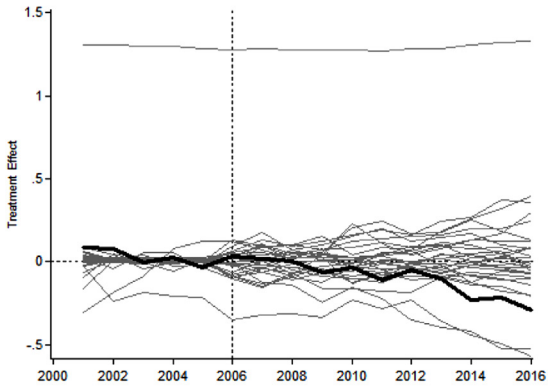
(a) Actual and Synthetic: $10k-$20k



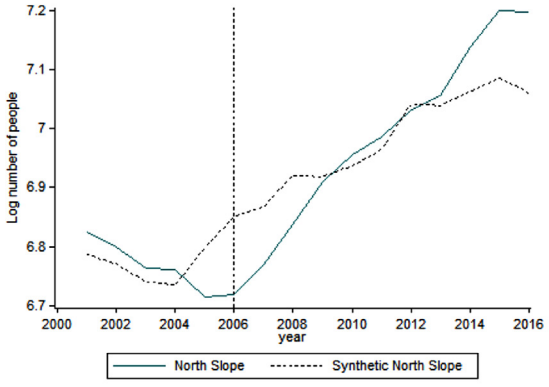
(b) North Slope and Placebos: $10k-$20k



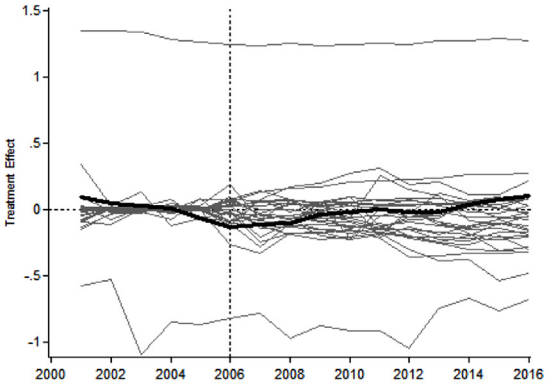
(c) Actual and Synthetic: $20k-$50k



(d) North Slope and Placebos: $20k-$50k



(e) Actual and Synthetic: >$50k

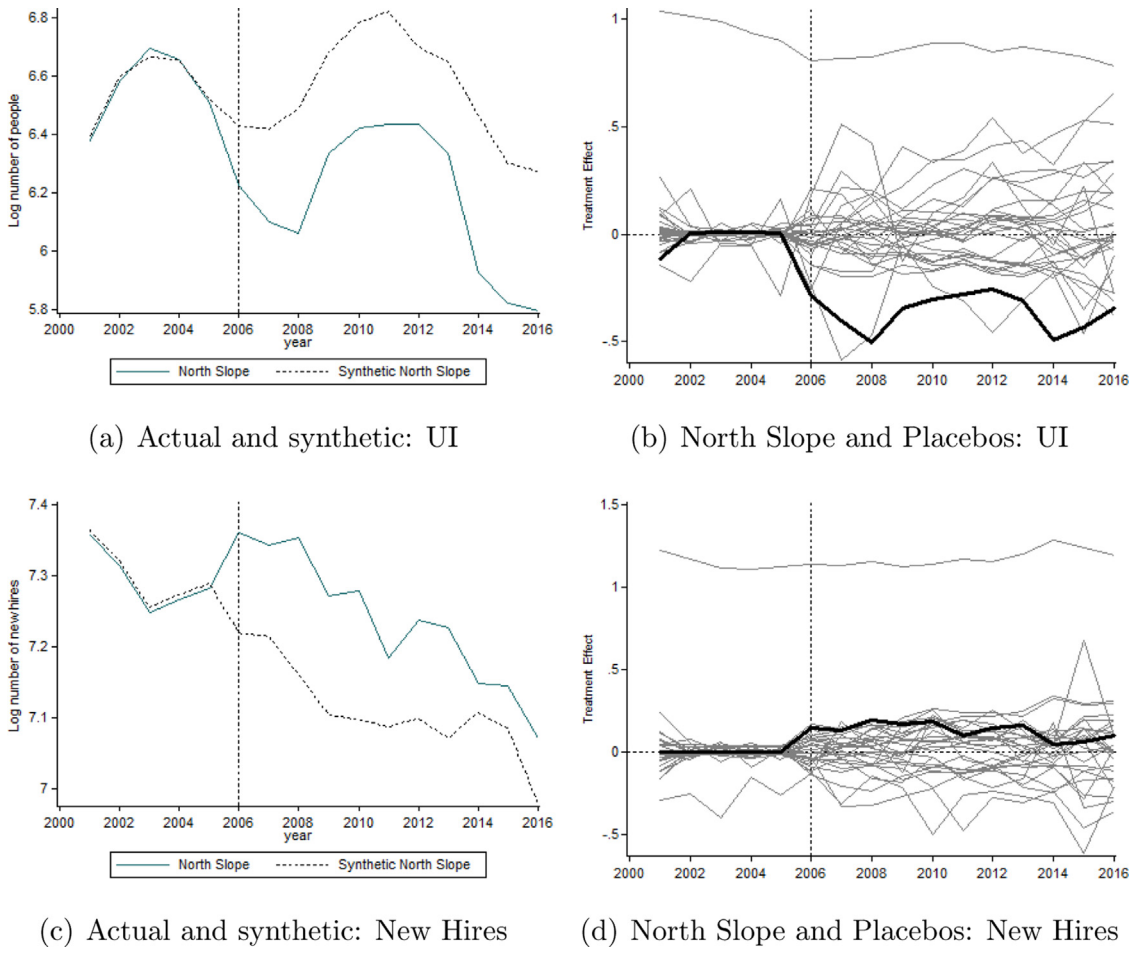


(f) North Slope and Placebos: >$50k

Fig. 9. Employment by income bin continued.

resulting outward migration would likely have a negligible effect, or are located far away from the North Slope (Valdez and Yakutat are 1500 miles from the North Slope, roughly equal to the distance between Calgary, Canada and Los Angeles, California).

Another concern is that, because the North Slope is uniquely positioned on the Northern tip of Alaska, using other more centrally located and populated units as donors yields biased estimates. This is important given that urban areas typically experience faster population growth and that Anchorage was a contributor to the counterfactual in the baseline specification.



(a) Actual and synthetic: UI (b) North Slope and Placebos: UI

(c) Actual and synthetic: New Hires (d) North Slope and Placebos: New Hires

Fig. 10. Unemployment and new hires. **Note**: "UI" is the number of unemployment insurance claims. "New Hires" measures both entry into the labor market and movement within it (e.g., transferring to a new job.).

To address this, and to more generally gauge the sensitivity of our results to the specific set of donor units used in the baseline analysis, we restrict the donor pool to non-urban boroughs by eliminating Anchorage, Fairbanks, and Matanuska borough. We rely on USDA's rural/urban continuum code for classification.

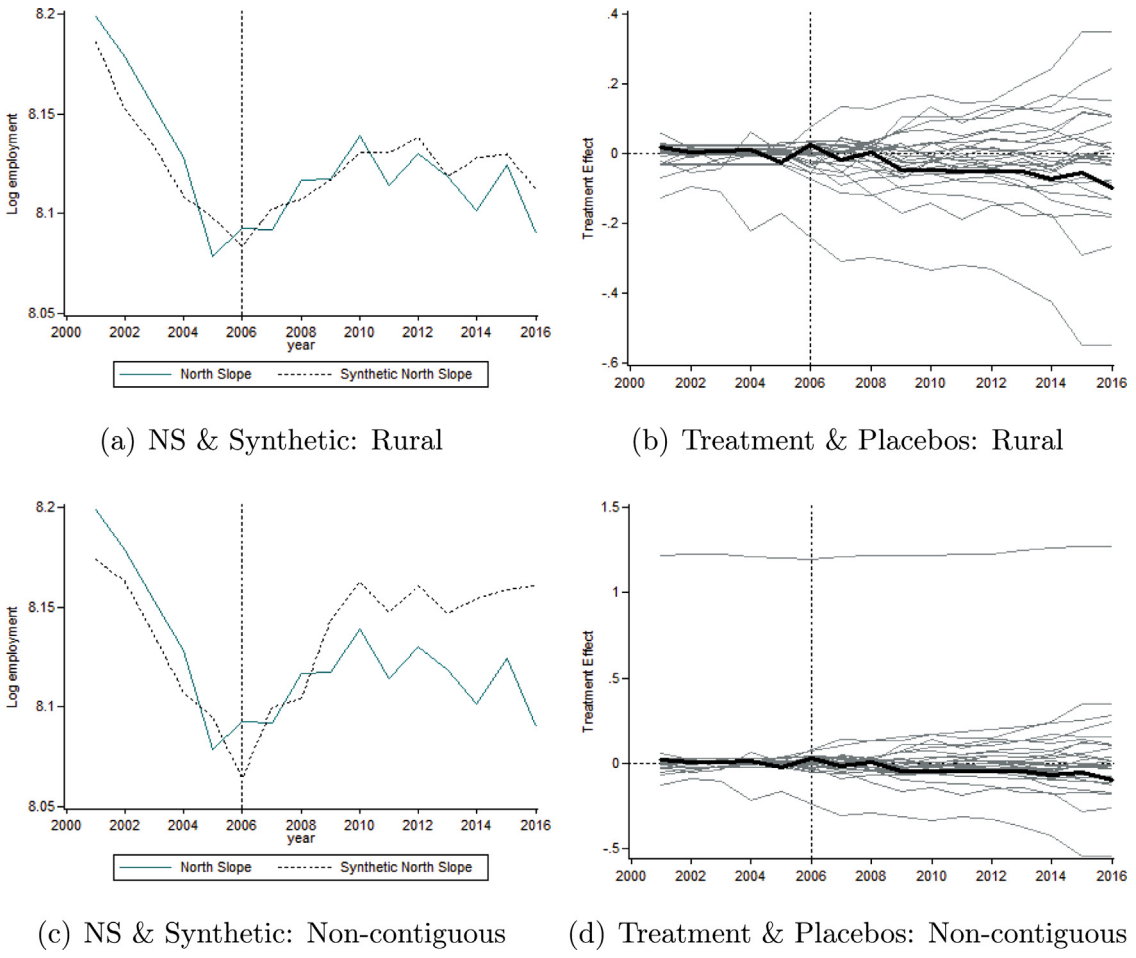
These additional results are provided in Fig. 11. Panels (a) and (b) show the results after restricting the donor pool to non-urban units. Panels (c) and (d) give the results after dropping contiguous boroughs from the donor pool that may send a disproportionate number of workers to the North Slope. Once again, synthetic North Slope employment does not evolve differently relative to the counterfactual and the effect is statistically insignificant.

Another concern is that our results are sensitive to the event year chosen (2006). Our choice of event date was motivated by the timing of the sharp rise in both oil prices and North Slope mining employment. Nonetheless, one may argue that a more suitable event year is 2004, a year before oil prices started to rise (see Fig. 2).

In Fig. 12, we move the intervention date to 2004 to evaluate the sensitivity of our results to the choice of event date. Panels (a) and (b) present the BEA results which are essentially unchanged with the North Slope employment levels clearly much higher than the placebos. Panels (c) and (d) show that, once again, the oil boom had no significant effect on residential employment in the North Slope.

6.4. Further analysis: origin–destination statistics

In their analysis of the residential effects of the Marcellus shale-gas boom, Gittings and Roach (2019) make use of Longitudinal Employer-Household Dynamics (LEHD) Origin–Destination Statistics provided by the Census Bureau. These data are sourced from a variety federal administrative records including the Internal Revenue Service, the Department of Housing



(a) NS & Synthetic: Rural

(b) Treatment & Placebos: Rural

(c) NS & Synthetic: Non-contiguous

(d) Treatment & Placebos: Non-contiguous

Fig. 11. ALARI employment: restricting donor pool. **Note**: Panels (a) and (b) use a donor pool that eliminates urban areas (Anchorage, Fairbanks, and Matanuska borough). We rely on USDA's rural/urban continuum code for classification. Panels (c) and (d) drop from the donor pool all boroughs contiguous to the North Slope.

and Urban Development, the Department of Health and Human Services, among others. Residential address information are largely sourced from federal income tax returns Leggieri et al. (2002).[23]

While these data are commonly used to measure residential economic outcomes, they are not ideal for our purposes as short-term residents (e.g., residents of less than a year) may temporarily update their mailing address on file with the IRS when they arrive in the North Slope. This may be especially true for people who temporarily move to the Alaska as claiming residents helps to avoid paying a state income tax.

Here we explore this idea further and provide empirical evidence of this shortcoming associated with the Origin–Destination Statistics data. Fig. 3 gives residential and aggregate North Slope employment based off of these supplemental LEHD data. Note that both measures of employment increase significantly in tandem with the timing of the oil boom. These are not small effects. In fact, Table 5 gives residential employment in the North Slope using LEHD data over three years: 2002 (prior to the oil boom), 2006 (the start of the boom), and 2010 (during the boom). Note that residential employment increased from 936 to 2957 over this time frame. Recalling that in 2001 the population of the North Slope was just 7530, this clearly should not be interpreted as an increase in employment of pre-existing residents. Further, these employment effects were temporary. Referring back to Fig. 3, by 2013 residential employment in the North Slope had largely returned to its pre-boom level. It is also interesting to note that out-of-state employment declined from 2006 to 2010 by 899, presumably reflecting the fact that some out of state migrants eventually filed their taxes in the North Slope. However, referring back to Fig. 3 and our baseline SCM results, there is no evidence that migrants to the North Slope become

[23] See also Graham et al. (2014) for additional details on how these data are compiled.

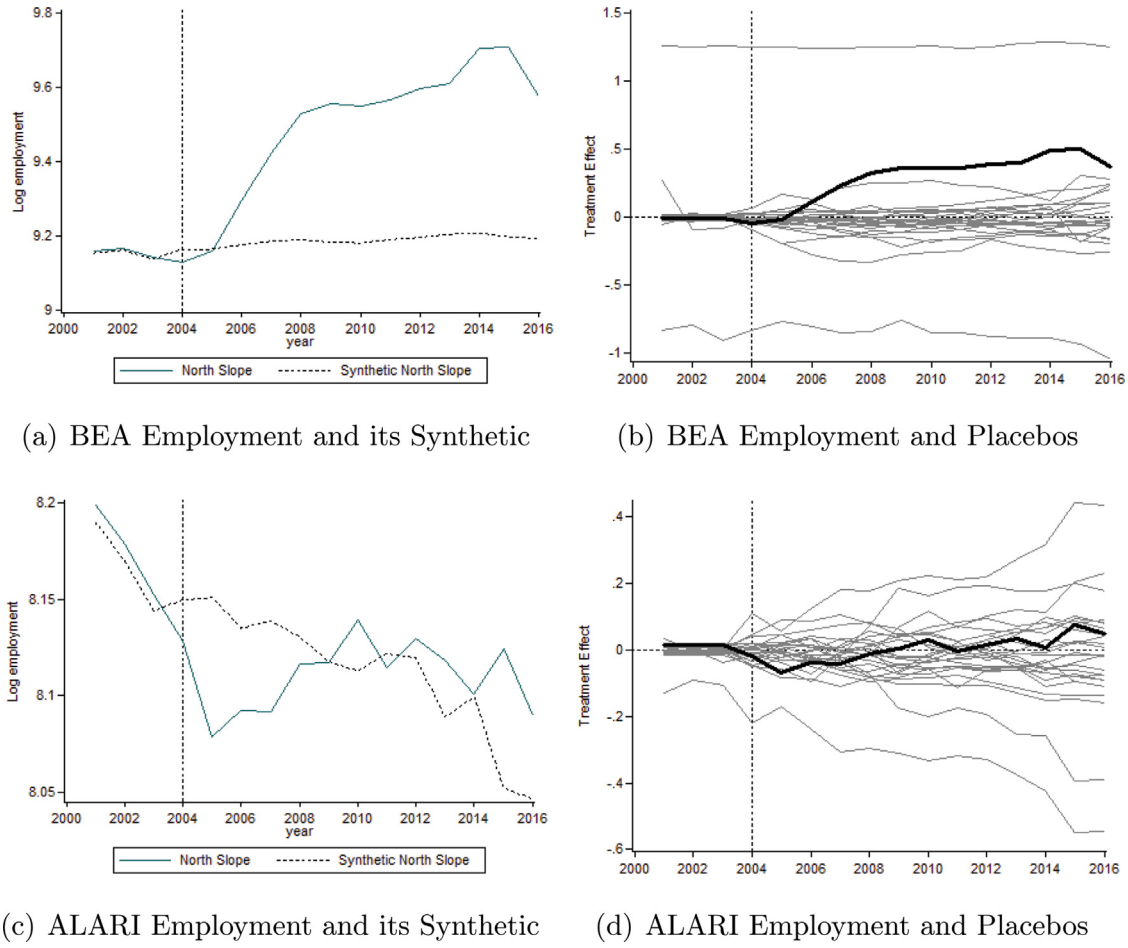


Fig. 12. Alternative specifications: 2004 intervention date.

permanent (and indefinite) residents such that they file for the PFD and so would be counted as residents in the ALARI data.

While the LEHD data may not be well-suited to measure residential effects of the oil boom in the North Slope, it can be used to inform where recent migrants moved from. In Figure 17 of Appendix C, we use these data to estimate the effect of the oil boom on (a) the total number of people employed in the North Slope, (b) the number of people working in the North Slope that moved from outside the state, (c) the number of people working in the North that moved from within the state of Alaska, and (d) North Slope residential employment (recognizing that some recent migrants may claim residency and so would incorrectly be counted as residents). Consistent with the BEA results, these data show that total employment increased significantly as oil prices rose, and that a significant number of the workers came from out of state.

7. Concluding emarks

There is a large literature documenting the various economic effects of natural-resource shocks. However, this literature has largely focused on aggregate effects and does not distinguish between pre-existing residents of a boom town, recent migrants, commuters, and temporary workers alike. We build upon an emerging literature that estimates residential effects of resource booms (Wrenn et al., 2015; Jacobsen et al., 2019; Kovalenko, 2019; Gittings and Roach, 2019), making use of a unique Alaskan data set that aggregates residential economic data to the borough (or county) level.

We supplement these residential data with aggregated "place of work" data collected from the Bureau of Economic Analysis. Juxtaposing the two sets of results yields several important insights. First, consistent with the existing literature, the oil boom in the North Slope caused aggregate employment to increase significantly (by roughly 50%). However, this is entirely driven by non-residents of the North Slope. In fact, we find no evidence that residential employment in the North Slope increased in response to the oil shock. We further document similar results for both men and women and document

Table 5
Employment in the North Slope by place of residence using LEHD data.

Borough of residence	2002	2006	2010
Aleutians East	0	0	10
Aleutians West	0	0	5
Anchorage	116	208	230
Bethel	0	0	0
Bristol Bay	1	0	0
Denali	0	0	0
Dillingham	0	7	0
Fairbanks	536	541	1150
Haines	0	0	0
Hoonah-Angoon	0	25	0
Juneau	1	6	31
Kenai Peninsula	1	16	21
Ketchikan Gateway	0	1	7
Kodiak Island	0	0	0
Lake and Penninsula	0	0	0
Matanuska-Susitna	3	10	22
Nome	0	0	3
Northwest Arctic	139	124	8
North Slope	936	691	2957
Petersburg Census Area	0	0	0
Prince of Wales – Hyder Census Area	287	268	18
Prince of Wales – Outer Ketchikan	0	0	0
Sitka	1	0	13
Skagway	0	0	0
Southeast Fairbanks	169	146	207
Valdez-Cordova	1	3	3
Wade Hampton	159	140	4
Wrangell City and Borough	0	0	0
Yakutat	0	0	0
Yukon	0	0	19
In state total	2349	2154	4740
Out of state	2520	2398	1621
Total	4869	4552	6361

Note: These data are taken from the Longitudinal Employer-Household Dynamics (LEHD) Origin–Desination Statistics provided by the Census Bureau.

suggestive evidence that the boom caused residents to shift from the public to the private sector. We document only weak evidence that the oil boom caused residential wages to rise.

We acknowledge that estimated treatment effects might be specific to Alaska. However, natural resources are often extracted from relatively remote, isolated places—even within in the United States. Further, given the geographic isolation of the North Slope, it is reasonable to think that any resulting inward migration may be small relative to a resource boom in, say, North Dakota where an abundance of labor is in closer proximity. As such, the residential effects reported in this paper are plausible upper bounds on the effects of more typical resource shocks.

Our results offer implications for practitioners and policy makers alike. Estimating effects of economic shocks using place of work data, such as that provided by the Bureau of Labor Statistics, may overstate residential effects. Even residential data based off income tax returns may overstate residential effects as some migrants temporarily update their residential address on file with the Internal Revenue Service. This is important as oil and gas legislation is often negotiated by local interest groups that make decisions by weighing local costs against local benefits. In this context, a variety of policies could be implemented to enhance residential gains, such as “local hire” laws and re-distributive tax policies. However, the feasibility and effectiveness of such programs remain speculative until additional research can be carried out.

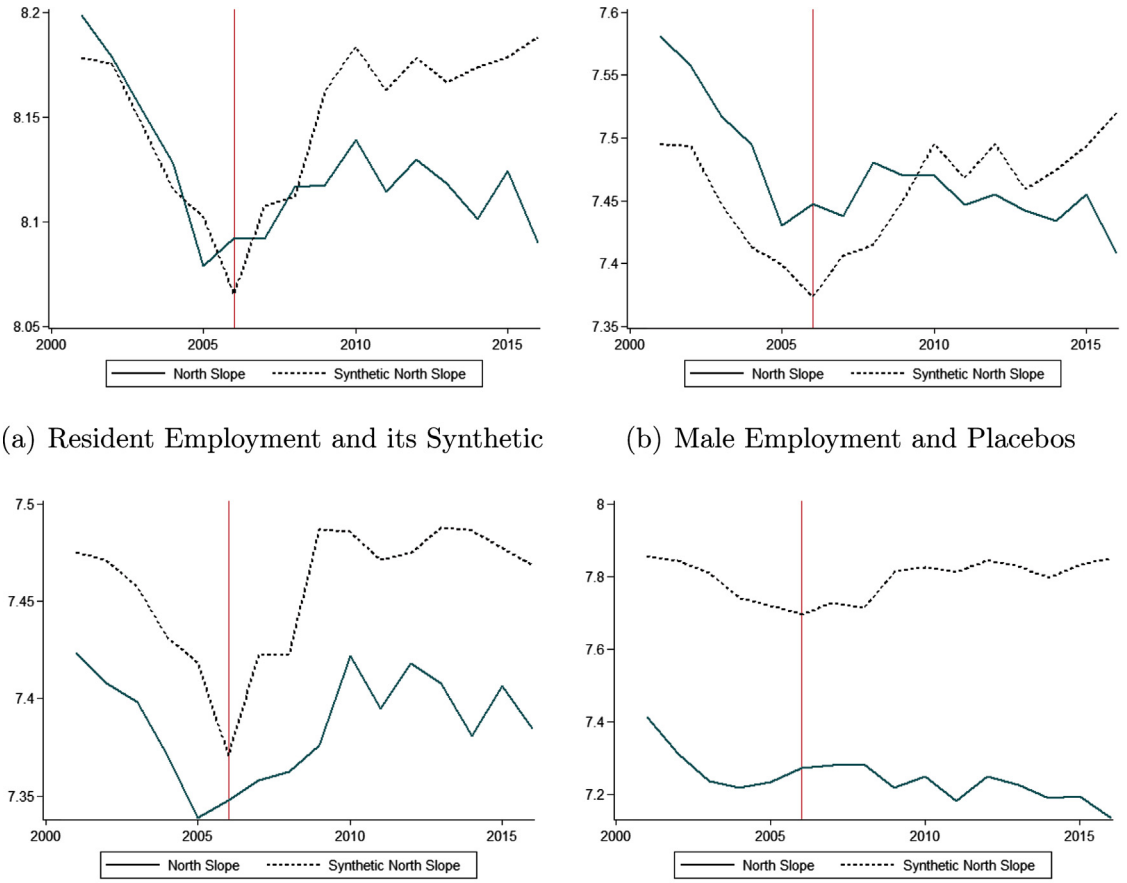
Authors’ contribution

Mouhcine Guettabi and Alex James shaped the idea, conducted the analysis, and wrote the manuscript.

Conflict of interest

None declared.

Appendix A. ALARI decomposition using the same weights as total resident employment



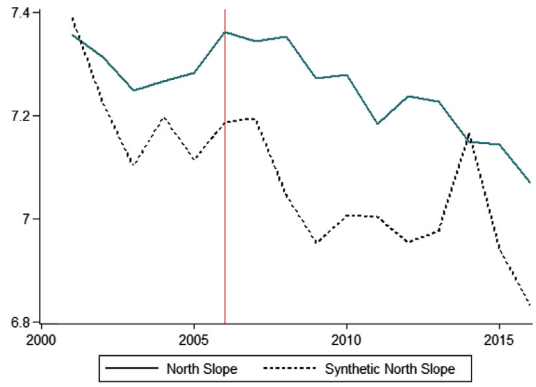
(a) Resident Employment and its Synthetic

(b) Male Employment and Placebos

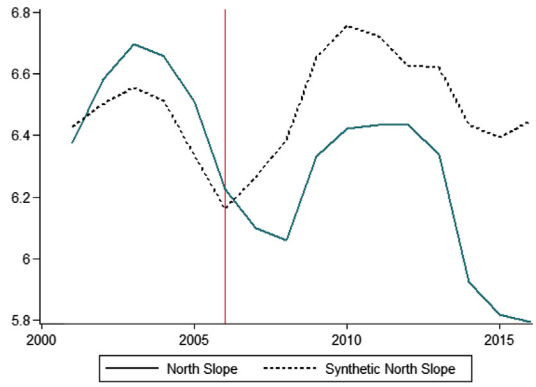
(c) Female Employment and its Synthetic

(d) Private sector Employment and Placebos

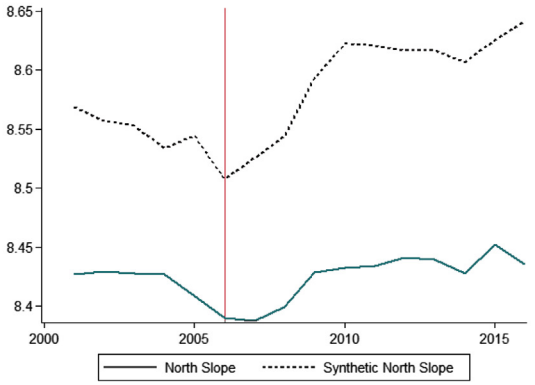
Fig. 13. Same weights as ALARI resident employment.



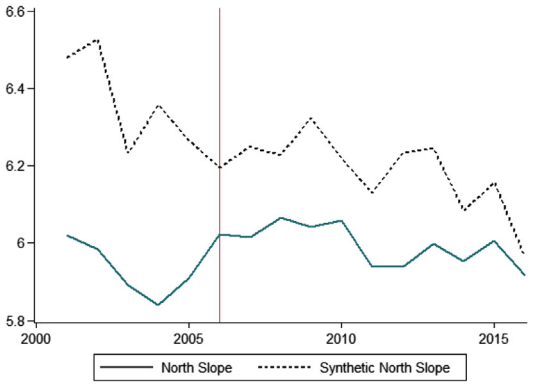
(a) New hires and its Synthetic



(b) UI claims and synthetic



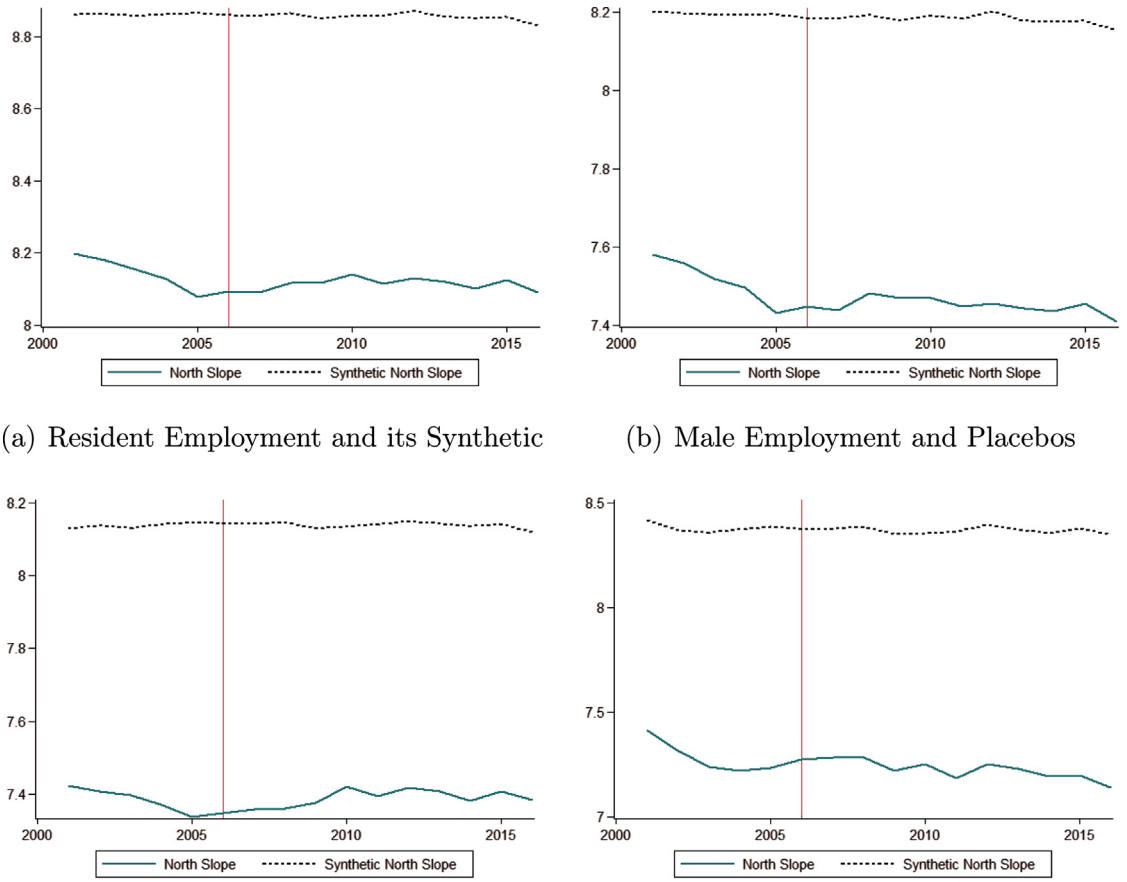
(c) Number of individuals over 16 and its Synthetic



(d) Earners between 10k and 20k

Fig. 14. Same weights as ALARI resident employment (continued).

Appendix B. ALARI decomposition using the same weights as BEA employment



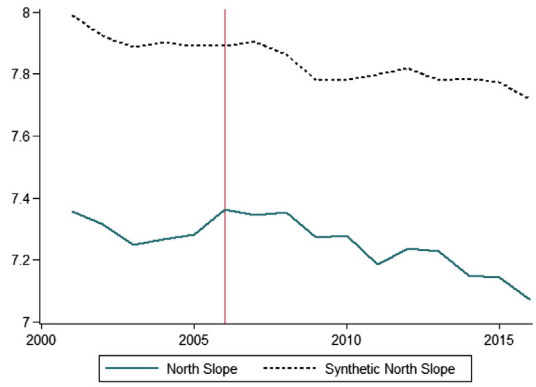
(a) Resident Employment and its Synthetic

(b) Male Employment and Placebos

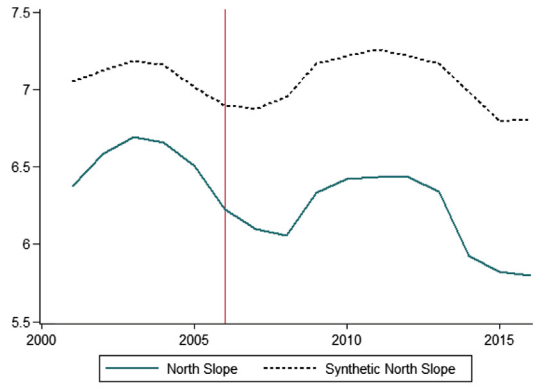
(c) Female Employment and its Synthetic

(d) Private sector Employment and Placebos

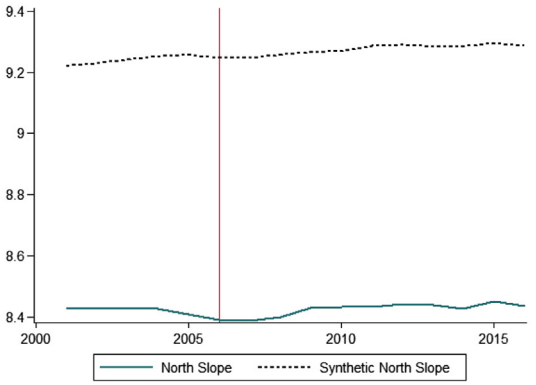
Fig. 15. Same weights as BEA employment.



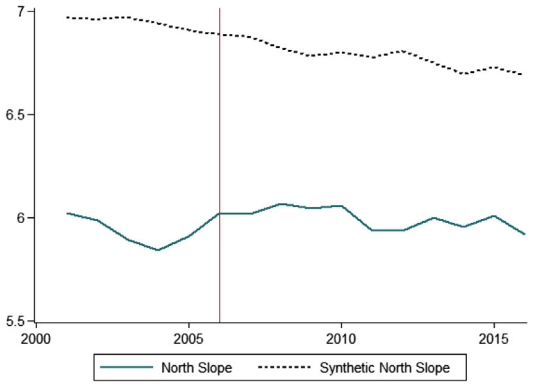
(a) New hires and its Synthetic



(b) UI claims and synthetic



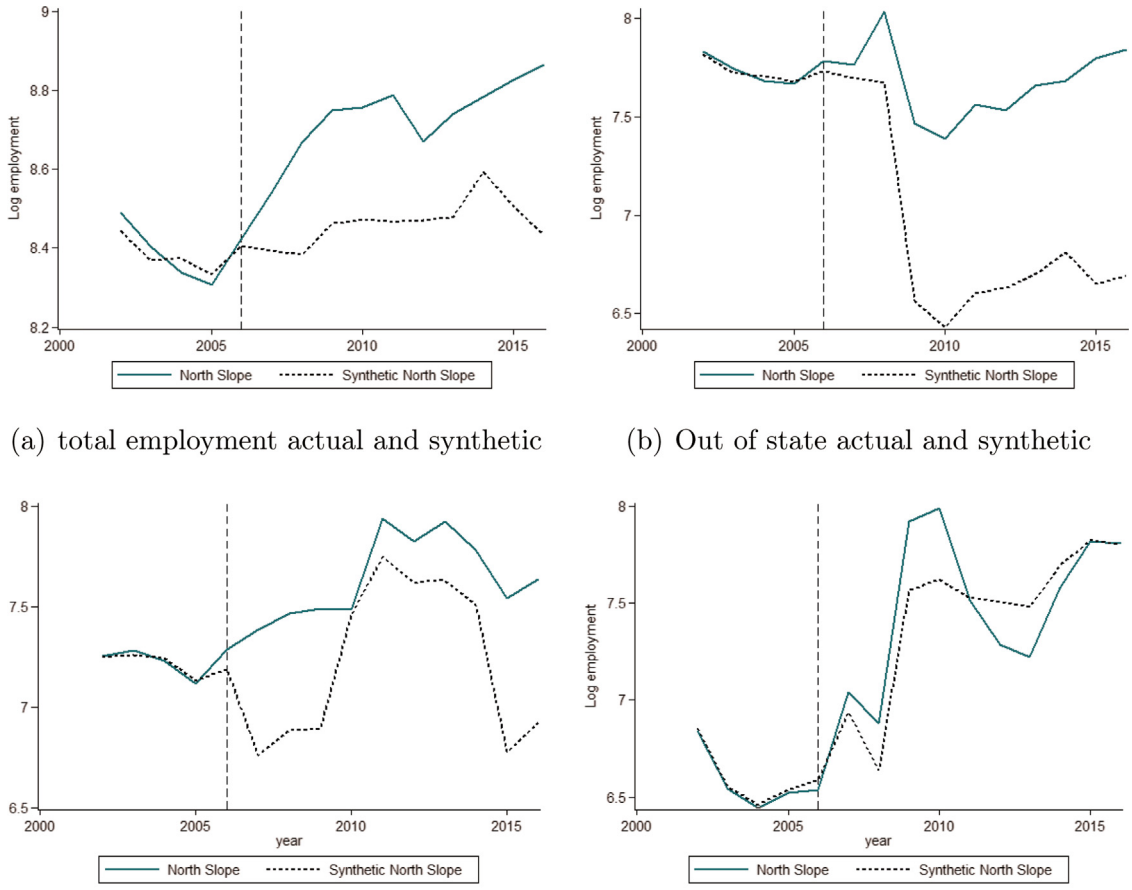
(c) Number of individuals over 16 and its Synthetic



(d) Earners between 10k and 20k

Fig. 16. Same weights as BEA employment (continued).

Appendix C. Actual and synthetic results using LEHD data



(a) total employment actual and synthetic

(b) Out of state actual and synthetic

(c) In state actual and synthetic

(d) In county actual and synthetic

Fig. 17. Actual and synthetic using LEHD data.

Appendix D. Summary statistics

Table 6
ALARI data summary statistics by borough.

	Employment	Residents over 16	Total wages	New hires	UI claimants
Aleutians East Borough	684	1042	18,504,055	239	161
	(34)	(45)	(2,931,282)	(44)	(25)
Aleutians West Census Area	1957	2407	77,326,981	519	470
	(114)	(139)	(11,202,951)	(91)	(91)
Anchorage, Municipality of	126,280	198,117	5,046,765,424	43,090	15,442
	(4548)	(10,342)	(877,195,306)	(2717)	(2939)
Bethel Census Area	7759	10,938	180,688,159	3448	1983
	(218)	(626)	(24,433,315)	(143)	(342)
Bristol Bay Borough	518	786	18,146,365	190	84
	(60)	(56)	(980,372)	(28)	(24)
Denali Borough	820	1447	30,407,036	290	226
	(32)	(21)	(3,620,983)	(46)	(40)
Dillingham Census Area	2150	3301	57,648,680	892	419
	(41)	(126)	(7,654,112)	(57)	(69)
Fairbanks North Star Borough	36,944	59,912	1,327,502,949	13,412	5340
	(1008)	(2584)	(220,783,740)	(1023)	(915)
Haines Borough	1000	1876	25,208,353	379	233
	(33)	(56)	(3,658,608)	(51)	(43)
Hoonah-Angoon Census Area	973	1762	19,079,881	433	331
	(97)	(73)	(1,387,435)	(82)	(56)
Juneau, City and Borough of	15,584	23,249	560,104,551	4845	1811
	(155)	(721)	(78,437,624)	(416)	(319)
Kenai Peninsula Borough	23,145	40,659	842,757,737	8446	4395
	(731)	(2377)	(160,273,368)	(607)	(707)
Ketchikan Gateway Borough	6230	9845	203,221,083	2061	1094
	(135)	(171)	(24,926,802)	(278)	(241)
Kodiak Island Borough	5743	9133	165,901,027	2001	1387
	(92)	(202)	(25,535,915)	(225)	(245)
Kusilvak Census Area	3285	4729	48,998,172	1732	1160
	(220)	(406)	(7,262,103)	(70)	(178)
Lake and Peninsula Borough	798	1176	16,473,542	390	197
	(19)	(23)	(2,122,346)	(37)	(31)
Matanuska-Susitna Borough	34,565	59,679	1,307,248,300	12,538	6394
	(4589)	(9033)	(367,152,443)	(776)	(1212)
Nome Census Area	4315	6150	116,574,107	1943	974
	(76)	(235)	(16,833,371)	(83)	(121)
North Slope Borough	3374	4557	123,803,505	1420	561
	(111)	(82)	(15,568,846)	(118)	(149)
Northwest Arctic Borough	3091	4555	90,460,171	1429	802
	(59)	(188)	(10,335,793)	(93)	(136)
Petersburg Borough	1241	2473	33,463,690	396	237
	(46)	(37)	(3,312,162)	(58)	(44)
Prince of Wales – Hyder Census Area	2730	4613	66,918,896	1086	869
	(113)	(80)	(7,962,942)	(159)	(159)
Sitka, City and Borough of	3814	6222	119,071,208	1261	525
	(72)	(85)	(13,569,938)	(119)	(96)
Skagway, Municipality of	436	718	13,210,740	143	130
	(24)	(32)	(2,310,549)	(14)	(14)
Southeast Fairbanks Census Area	2485	4867	73,326,104	1042	631
	(139)	(398)	(14,075,288)	(112)	(107)
Valdez-Cordova Census Area	4614	7382	170,480,718	1669	913
	(202)	(201)	(13,434,304)	(216)	(143)
Wrangell, City and Borough of	909	1755	25,130,313	313	201
	(55)	(41)	(2,733,551)	(64)	(47)
Yakutat, City and Borough of	325	482	7,684,953	147	76
	(28)	(17)	(632,490)	(38)	(24)
Yukon-Koyukuk Census Area	2959	4442	61,216,181	1525	882
N	464	464	464	464	464

Note: Mean and standard deviations are provided for each variable. The standard deviation is between parentheses. We have 16 years of data for each of the variables in each of the 29 boroughs.

Table 7
ALARI data summary statistics by borough (continued).

	Individuals earning <5k	5k < between < 10k	10k < between < 20k	20k < between < 50k	>50k
Aleutians East Borough	126	67	108	283	1.0e+02
	(23)	(11)	(20)	(33)	(31)
Aleutians West Census Area	187	129	326	714	601
	(30)	(19)	(45)	(48)	(99)
Anchorage, Municipality of	16,786	10,173	16,825	47,385	35,118
	(1438)	(645)	(920)	(1289)	(8423)
Bethel Census Area	2349	995	1270	2010	1134
	(42)	(59)	(94)	(59)	(294)
Bristol Bay Borough	83	47	71	166	150
	(15)	(9.8)	(13)	(36)	(16)
Denali Borough	152	86	120	205	256
	(26)	(14)	(15)	(15)	(30)
Dillingham Census Area	559	239	326	650	376
	(31)	(18)	(25)	(46)	(109)
Fairbanks North Star Borough	5558	3442	5092	13,018	9835
	(760)	(320)	(460)	(456)	(2501)
Haines Borough	220	134	185	328	134
	(43)	(17)	(16)	(19)	(41)
Hoonah-Angoon Census Area	275	153	202	253	90
	(60)	(21)	(21)	(21)	(23)
Juneau, City and Borough of	2076	1298	1918	6187	4105
	(249)	(131)	(175)	(532)	(1112)
Kenai Peninsula Borough	4068	2383	3443	7170	6083
	(575)	(197)	(152)	(210)	(1386)
Ketchikan Gateway Borough	968	622	934	2334	1373
	(132)	(75)	(120)	(120)	(338)
Kodiak Island Borough	971	576	1187	1984	1025
	(124)	(80)	(183)	(131)	(272)
Kusilvak Census Area	1298	485	614	696	192
	(93)	(23)	(30)	(73)	(71)
Lake and Peninsula Borough	247	113	140	201	97
	(25)	(17)	(11)	(12)	(31)
Matanuska-Susitna Borough	5518	3160	4716	11,227	9947
	(210)	(139)	(260)	(928)	(3438)
Nome Census Area	1157	475	647	1254	783
	(70)	(27)	(43)	(86)	(227)
North Slope Borough	633	302	394	1022	1023
	(88)	(30)	(25)	(127)	(178)
Northwest Arctic Borough	793	320	431	876	672
	(33)	(13)	(47)	(77)	(135)
Petersburg Borough	253	131	212	436	208
	(40)	(20)	(32)	(13)	(48)
Prince of Wales – Hyder Census Area	668	328	484	875	376
	(109)	(30)	(62)	(28)	(105)
Sitka, City and Borough of	591	364	585	1536	738
	(68)	(39)	(77)	(80)	(188)
Skagway, Municipality of	61	44	86	157	89
	(9.6)	(6.6)	(6.3)	(10)	(28)
Southeast Fairbanks Census Area	549	301	387	717	532
	(76)	(38)	(29)	(86)	(146)
Valdez-Cordova Census Area	878	459	670	1332	1274
	(132)	(60)	(84)	(75)	(141)
Wrangell, City and Borough of	190	96	145	326	152
	(35)	(21)	(30)	(16)	(38)
Yakutat, City and Borough of	78	39	53	116	40
	(17)	(8)	(12)	(10)	(14)
Yukon-Koyukuk Census Area	984	385	489	742	359
	(80)	(49)	(54)	(55)	(66)
N	464	464	464	464	464

Note: Mean and standard deviations are provided for each variable. The standard deviation is between parentheses. We have 16 years of data for each of the variables in each of the 29 boroughs.

Table 8
BEA summary statistics by borough.

	Total employment	Average earnings
Aleutians East Borough, AK	2380	47,486
	(276)	(11,035)
Aleutians West Census Area, AK	4209	56,491
	(253)	(11,576)
Anchorage Municipality, AK	197,763	61,271
	(10,156)	(9568)
Bethel Census Area, AK	8440	45,525
	(259)	(8496)
Bristol Bay Borough, AK	1590	51,341
	(167)	(10,283)
Denali Borough, AK	2312	51,270
	(148)	(7239)
Dillingham Census Area, AK	3568	42,444
	(161)	(9561)
Fairbanks North Star Borough, AK	56,266	54,357
	(2795)	(9517)
Haines Borough, AK	1708	34,150
	(190)	(6762)
Juneau City and Borough, AK	22,869	55,938
	(666)	(9779)
Kenai Peninsula Borough, AK	30,223	43,740
	(1666)	(6676)
Ketchikan Gateway Borough, AK	10,004	52,607
	(279)	(8902)
Kodiak Island Borough, AK	9310	52,360
	(424)	(9316)
Kusilvak Census Area, AK	2904	32,379
	(200)	(5954)
Lake and Peninsula Borough, AK	1149	41,738
	(36)	(8865)
Matanuska-Susitna Borough, AK	30,716	40,896
	(5375)	(6766)
Nome Census Area, AK	4618	51,333
	(235)	(10,730)
North Slope Borough, AK	12,508	103,897
	(2660)	(17,492)
Northwest Arctic Borough, AK	3258	67,592
	(55)	(14,542)
Sitka City and Borough, AK	6433	48,840
	(179)	(9657)
Southeast Fairbanks Census Area, AK	3428	56,521
	(511)	(13,045)
Valdez-Cordova Census Area, AK	6950	53,003
	(80)	(8361)
Yakutat City and Borough, AK	484	46,778
	(41)	(12,452)
Yukon-Koyukuk Census Area, AK	2722	45,912
	(153)	(7779)
N	432	432

Note: Mean and standard deviations are provided for each variable. The standard deviation is between parentheses. We have 18 years of data for each of the variables in 24 of the 29 boroughs.

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