WAGE AND EMPLOYMENT GROWTH IN AMERICA'S DRUG EPIDEMIC: IS ALL GROWTH CREATED EQUAL?

Michael R. Betz
The Ohio State University
Department of Human Sciences

Lauren E. Jones
The Ohio State University
Department of Human Sciences

December 15, 2017

ABSTRACT—The rise in drug overdose deaths in the United States since the turn of the millennium has been extraordinary. Changes in the medical profession's view of prescription opioids have dramatically increased the availability of potent drugs, but concurrent increases in suicides and liver disease suggest a demand element to the crisis. In particular, drug overdoses are heavily concentrated among those with a high school degree or less, a population that has seen its declines in economic opportunity, physical heath, and relationships in recent decades (Case and Deaton 2017). Some evidence exists linking employment to despair deaths (Hollingsworth 2016; Pierce and Schott 2016). We further this literature by examining the role of wages in addition to employment and decompose employment and wage growth across high-, medium-, and low-paying industry tiers to identify heterogeneous employment and wage growth effects on overdose rates within nonmetro and metro counties. We find significant variation in the effect of employment and wage growth rates on drug overdose death rates at different points on the industry wage distribution. In general, we find that changes in wage growth rates—and in particular bottom-tier wage growth rates—are more important than employment growth rates for nonmetro counties. Changes in both employment and wage growth rates are important for metro counties, but the effects are strongest for bottom-tier employment growth and top-tier wage growth. Lastly, we find effects differ between male and female overdose death rates and black and white rates.

This research was supported by National Institues of Health grant P2C-HD058484, distributed through the Ohio State University's Institute for Population Research.

1. Introduction

Over the past two decades, the number of Americans who have died from drug overdoses has increased by 400 percent (Katz 2017) and drug overdoses are now the leading cause of death among American under age 50 (CDC 2016). Figure 1 plots this increase by gender and race for the United States, between 1999 and 2015 for nonmetro and metro areas. The dramatic increase in deaths has raised many questions about what underlying factors fuel the misuse of drugs and overdose deaths. One hypothesis that has received widespread attention in the popular press is the idea that limited economic opportunity in some areas – especially rust belt states, rural areas and communities particularly hard hit by the recession of 2007 – caused individuals to turn to drugs (for example, Hari 2017; Quinones 2017; Khazan 2017). Journalistic accounts have painted a picture wherein swathes of the country are afflicted with largescale job losses and wage stagnation, due in large part to forces such as offshoring and automation. Responding to these forces, residents have turned to drug misuse as a means of coping with economic and psychological stress. Academic research that validates this hypothesis, however, remains limited.[1] In this paper, we add to the literature by investigating the relationship between drug overdoses and local labor market conditions across different types of industries.

Using proprietary data on county-level employment and wages at the 4-digit (NAICS) industry level and restricted access mortality data, we estimate models that link local employment and work conditions to county-level overdose mortality rates. Our main approach uses Bartik-style variables that capture employment and wage growth driven by national-level industry changes, and thus reduce potential bias from local conditions that may influence both

[1] Other important lines of research have examined supply-side factors to help explain the rapid rise in overdose deaths. These include examinations of the role of prescription drug monitoring systems (Buchmueller and Carey 2017), physician education (Schnell and Currie 2017), and abuse-deterrent drug formulations (Alpert et al. 2017).

economic growth and overdoses independently. To date, much of the research between local economic conditions and overdose rates have used explanatory measures that are susceptible to bias from reverse causality or omitted variables. We also estimate separate models for metro and non-metro counties, as well as by race and gender, to investigate heterogeneity within the effects.

Our second contribution is to determine whether differential effects exist for employment and wage growth across low-, medium-, and high-paying industries. Since overdose rates are concentrated heavily among certain demographics (males and those with a high school degree) the type of industry where growth is occurring likely determines its effect on overdose rates. Lastly, to date, gender differences have largely been neglected in investigations of the impact of economic conditions on overdose rates and deaths of despair. We estimate models of the relationship between labor market outcomes for male and female overdose rates separately. These relationships likely differ, given gender differences in labor force participation rates and mental health responses of those out of the labor market (Kreuger 2017).

Our study builds on research linking local economic conditions to health behavior and mortality, and to drug overdoses in particular. Until recently, much of this work documented a pro-cyclical pattern in health behaviors and all-cause mortality. In general, studies in the United States showed that when the local county or state economy worsens people tend to decrease risky health behaviors (like smoking and binge drinking), and increase exercise; mortality also decreases (for example, Freeman 1999; Rhum 2000; Rhum and Black 2002; Gruber and Frakes 2006; Frijters et al. 2013; Xu 2013). However, recent studies suggest a reversal of the all-cause mortality patterns. Namely, mortality over the past 20 years has become increasingly countercyclical (Rhum 2015).

This reversal appears largely driven by causes that are associated with psychological distress, such as suicide, drug overdoses and alcohol related deaths (Case and Deaton 2015). While suicides have always exhibited a countercyclical mortality pattern (Rhum 2000), the relationship between accidental poisonings (of which over 90 percent are drug overdoses) and the unemployment rate is increasingly strong. Rhum (2015) finds that a one percentage point increase in the state unemployment rate results in 4 percent increase in poisonings – a relationship that is only present since 1991. Furthermore, there is evidence that illicit drug use increases in bad economic times (Arkes 2007; Carpenter et al. 2016). Hollingsworth et al. (2017) provide additional support for this hypothesis by investigating the relationship between county-level unemployment rates and local overdose rates, opioid overdose rates and emergency department visits due to drug overdose. They find that, controlling for county differences, a one percentage point increase in the unemployment rate leads to a 4 percent increase in opioid overdose deaths, a 3 percent increase in all drug overdose deaths, as well as to an 7 percent increase in emergency room visits.

These studies establish a relationship between local unemployment rates and drug overdose rates, and that the relationship has developed since the early 1990s. However, several important questions remain unanswered. While unemployment rates have fluctuated with the business cycle across most of the country, longer-term economic forces have affected certain areas and groups more dramatically, and more negatively, than others have. Evidence is accumulating that low-educated workers are losing ground relative to more well-educated workers in local labor markets due to automation (Baily and Bosworth 2014; Acemoglu and Restrepo 2017) and outsourcing (Autor, Dorn, and Hanson 2013). Thus, employment and wage changes in certain industries may be more important than in others. Furthermore, because of the

geographic distribution of industries across the country, more remote counties have disproportionally born job losses (Partridge et al. 2008). Again, the fact that overdose rates are much higher for less well-educated Americans provides additional evidence that employment effects may differ by industry (Case and Deaton 2017; Kolata and Cohen 2016; Snyder 2017; Rembert et al. 2017).

Pierce and Schott (2016) investigate this question by examining the mortality response to an important trade liberalization policy passed in 2000 charged with hurting workers in manufacturing industries in particular. They find that suicides, and to a lesser degree, accidental poisonings, increased in counties that were more exposed to the trade liberalization policy – the same counties that lost jobs and experienced declines in economic wellbeing as a result of the policy. While this work provides evidence that employment losses in certain industries may be especially important in predicting overdose deaths, the results of the study focus on the effects of one specific policy change, a policy that affected employment through trade alone. We further their work by examining the effect on overdose mortality of employment and wages changes from any source, not just trade liberalization.

The labor market is also increasingly bifurcated. Autor and Dorn (2013) show a polarization in the U.S. labor market between 1988-2005, with growth in both high- and low-skill jobs. This seemingly contradicts the notion that low-skill workers struggle in the current economy, and suggests that labor market conditions could harm poorly-educated workers not simply through employment, but also trough a shift from better paying mid-skill manufacturing jobs to lower-paying retail and service sector jobs. Further, one of the hallmarks of the Great Recession's recovery – a recovery that has coincided with exponential increases in overdose rates – is that wages have stagnated despite consistent declines in the unemployment rate (Mishel

et al. 2015). The relevant question, therefore, with respect to how labor markets influence overdose rates may not only be whether workers have jobs, but *what kind* of jobs, and whether wages in those jobs are growing. To date, no studies investigate the connection between local labor market wage changes and overdose deaths.

Finally, while Rhum (2015) and Hollingsworth et al. (2017) include robust county-level and time controls to help absorb confounding factors, the results from these analyses may reflect relationships other than the causal one of interest. One particularly worrisome issues is reverse causality. Decreases in the unemployment rate may stem from two sources: from more people finding jobs or from more workers dropping out of the labor force. The proportion of prime aged men out of the labor force has steadily increased for decades (Krause and Sawhill 2017). Krueger (2017) shows that nearly 50 percent of the men who have dropped out of the labor force also have a serious health problem and take daily pain medication. If workers are leaving the labor force because of drug use, then some of the observed relationship between unemployment rates and drug use may reflect causation in the reverse direction, rather than the effect of unemployment on drug use. Indeed, when Hollingsworth et al. (2017) estimate their models using the state-level employment to population ratio as their macroeconomic indicator, they find smaller effects on the overdose rate, a finding that is consistent with a reverse causality story.

Our results show that employment and wage growth are both predictors of the overdose deaths, but that there is significant heterogeneity in effects between nonmetro and metro counties and across industry tiers. Overall, we find that changes in wage growth rates are more important for nonmetro counties and changes in both employment and wage growth rates are important for metro counties. Bottom-tier wage growth rates are important for nonmetro areas, where the pattern shifts to top-tier growth rates in metro areas. The rest of the paper is structured as

follows: We outline our data and methods in Section 2, we explain our results in Section 3, and Section 4 offers discussion of our results and our conclusions.

2. Data and Methods

The data for our study come from two primary sources. First, we use detailed annual county-level death rates from the Compressed Mortality File (CMF) 2001-2014 maintained by the National Center for Health Statistics (NCHS) to construct our dependent variables. Every death in the United States is categorized by underlying cause of death according to World Health Organization ICD-10 codes. ICD-10 codes provide detailed cause of death information and are recorded on death certificates in all 50 states. The NCHS compile this information and aggregate it at the county level, which allow us to calculate county-level death rates attributable to drug overdoses[2]. The CMF contain information on deaths by gender, race, ethnicity (Hispanic/non-Hispanic), and age group, as well as county populations of each subgroup, which allows us to calculate death rates for finer subpopulations. Figure 1 details the rise of overdose deaths in the United States between 1999-2015 in nonmetro and metro counties. The crude overdose death rate increases from around 4 per 100,000 in nonmetro areas and 6 per 100,000 metro areas in 1999 to around 16 per 100,000 for both in 2015. Interesting differences exist across both race and gender. It both nonmetro and metro areas, the average male overdose rate starts at a higher initial level than the female rate, and also grows more rapidly over the period, although female overdose death rates also increase rapidly. Perhaps more interesting is the evolution of white and black overdose death rates. In 1999, the black and white rates in both metro and nonmetro counties were similar. Over the next fifteen years, however, black and white rates diverge. In

[2] Following Deaton and Case (2015), we define overdose deaths as the sum of county deaths categorized under ICD-10 codes X40-44, X60-64, and Y10-14. Our definition of overdoses differs slightly in that we do not include poisonings attributable to alcohol in order to more closely measure opioid-related deaths as defined by the US Centers of Disease Control (CDC 2013).

metro counties, the black and white rates grew in tandem until about 2007, at which point the white rate continued to grow, while the black rate fell slightly before accelerating after 2012. In nonmetro counties, the divergence between the white and black rates began immediately, such that the white/black overdose death rate gap grew from 42% in 1999 to 172% in 2014. In our main analysis, we estimate models for these four subpopulations to determine whether changes in the labor market have had differential effects across race and gender.

Figure 2 shows maps of the change in overdose rates between 2001-2014 for each of our subpopulations. Together the maps demonstrate the geographic variation of changes in overdose rates over the period. Pockets of nonmetro areas have experienced large changes in male and white overdose rates, such as in most of the Appalachian region. Conversely, nonmetro areas throughout the Midwest and Great Plains have seen smaller growth in overdose rates across all subpopulations. What is interesting is the variation in geographic patterns across subpopulations. Changes in male and white overdoes death rates follow each other closely, with more dramatic changes in Appalachia, the Northeast, and the Southwest. Female overdose rates have shown less geographic variation, with fewer counties experiencing extreme growth or modest declines in female overdose rates. Black overdose death rates have risen much less dramatically over the period, but some clustering of more severe changes occur in parts of California, Florida, and the Carolinas. Overall, there is significant variation across the country, and within states, in the growth of drug overdose deaths.

Our second key data source contains county-level employment and earnings per worker data by industry from Economic Modeling Specialists International (EMSI). We use these in constructing our key explanatory variables. EMSI compiles data from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW), supplemented by the Bureau

of Economic Analysis' (BEA) Regional Economic Accounts and the US Census Bureau's County Business Patterns to produce county-level employment and earnings per worker data for each 4-digit North American Industry Classification System (NAICS) industries within the county. The advantage of these data is that they include 4-digit NAICS employment and earnings information suppressed in publicly available sources. These data have been used in many county-level economic analyses (Tsvetkova, Partridge, and Betz 2017; Tsvetkova and Partridge 2016; Lobao et al. 2016; Betz et al. 2015; Rupasingha et al. 2015; Dorfman et al. 2011). The employment and earnings data span 2001-2014, which give us information on county employment and wage trends leading up to the sharp rise in overdose death rates after 2003.

We also use annual county-level data from the U.S. Census Bureau and Bureau of Economic Analysis to control for differences in total employment, population, median household income, and poverty rates across counties. Specifically, we use measures of county population from the Bureau of Economic Analysis and county-level median household income and poverty from the Census Bureau's Small Area Income and Poverty Estimates. Table 1 summarizes our key dependent and explanatory variables.

We are interested in how annual changes in county employment and wage growth rates influence annual changes in county drug overdose death rates per 100,000 people. We construct plausibly exogenous "Bartik" variables for employment and wage growth by calculating the inner product of the county 4-digit NAICS industry employment shares within county i in our base year (2001) with each respective industry's national employment (or wage) growth rate. These variables take the form

$$E^{*}_{it,t-1} = \sum_{k} E_{i,k,2001} EG_{k,t,t-1} \quad (1)$$

$$W^{*}_{it,t-1} = \sum_{k} E_{i,k,2001} WG_{k,t,t-1} \quad (2)$$

where $E_{i,k,2001}$ is the share of total employment of industry k in county i in 2001. $EG_{k,t,t-1}$ is the national one-year employment growth rate of industry k between years t and $t-1$ and $WG_{k,t,t-1}$ is the national wage growth rate of industry k between years t and $t-1$. Variables that use county industry shares with national growth rates were introduced by Bartik (1991) and have long been used in the fields of labor and regional economics to estimate the effect of exogenous changes in local-level factors, such as employment and wages. In essence, these variables capture the change in county employment or wages that would have occurred if all industries within the county grew at their national growth rates over the period. We use these variables to mitigate the possible endogenous relationship – including reverse causality – between county-level employment or wages and drug overdose death rates.

Our approach rests on two main assumptions, common to the long literature that employs Bartik instruments: first, after controlling for county-level fixed effects, the initial (2001) share of total county employment accounted for by each industry is independent of changes in local overdose rates; and second, after controlling for year fixed effects, the year-to-year changes in national, industry-specific labor market conditions are independent of changes in local overdose rates. These assumptions allow us to interpret our results as causal. This approach generates estimates with a different interpretation than those from past studies. While previous estimates explain changes in levels of overdose deaths with changes in levels of unemployment, our approach uses changes in *growth rates* of employment and wages. Thus, our approach assumes that individuals are sensitive to changes in trend, rather than to changes in levels, of economic conditions. This distinction is important if changes in labor market conditions are affected by one's frame of reference: a small improvement in wages, for example, may be more meaningful

in counties having experienced recent stagnation than in counties with persistently good wage growth. Our main analysis estimates models of drug overdoses that take the form:

$$D_{it}^{s} = \beta_1 + \beta_2 E_{it,t-1}^{*} + \beta_3 X_{it} + \delta_i + \sigma_t + \epsilon_{its} \quad (3)$$

$$D_{it}^{s} = \beta_1 + \beta_2 W_{it,t-1}^{*} + \beta_3 X_{it} + \delta_i + \sigma_t + \epsilon_{its} \quad (4)$$

where D_{it}^{s} is the county drug overdose death rate per 100,000 persons for subpopulation s in county i and year t. In addition to models for the entire population, we calculate county-level drug overdose death rates for subpopulations s and estimate separate models for white, black, male, and female overdose rates. The variable $E_{it,t-1}^{*}$ represents the "Bartik" variable for employment growth described in equation (1) and X_{it} is a set of controls for annual county-level total employment, population, median household income, and poverty rate. Population is log-transformed to better fit the linear model. County and year fixed effects are represented by δ_i and σ_t respectively and ϵ_{its} is the error term. Equation (4) is identical to Equation (3) with the exception that we replace $E_{it,t-1}^{*}$ with $W_{it,t-1}^{*}$. We estimate separate models for rural and urban areas using the 2003 Census Metropolitan Areas definitions for each subpopulation. This results in observations for 2,024 nonmetro counties and 1,050 metro counties over 13 years for a grand total of 26,311 nonmetro observations and 13,649 metro observations. We weight our regressions by county population and estimate robust standard errors for all of our models.

To capture possible heterogeneous effects of employment and wages across tiers of industries – sorted according to average industry earnings – we develop models that include variables measuring employment and wage growth in high-, medium-, and low-paying industries. We do this by modifying the variables in equations (1) and (2) to reflect industry wage tiers. We order all 302 4-digit NAICS industries according to average earnings per worker nationally in 2001 and assign each industry a rank depending on whether it is in the top third,

middle-third, or bottom-third of average industry earnings per worker. Appendix Table A1 shows the industry rankings across tiers. Next, we use this ranking to calculate expected county employment and wage growth in high-, medium-, and low-paying industries. The variables take the following form:

$$E^{r}_{it,t-1} = \sum_{k} E^{r}_{i,k,2001} EG^{r}_{k,t,t-1} \tag{5}$$

$$W^{r}_{it,t-1} = \sum_{k} E^{r}_{i,k,2001} WG^{r}_{k,t,t-1} \tag{6}$$

All of the variables and subscripts remain the same as in Equations (1) and (2), except for the inclusion of industry rank r representing high-, medium, and low-paying industry tiers[3]. We calculate top-tier, middle-tier, and bottom-tier expected employment and wage growth for each county and substitute $E^{r}_{it,t-1}$ for $E^{*}_{it,t-1}$ and $W^{r}_{it,t-1}$ for $W^{*}_{it,t-1}$ into equations (3) and (4) respectively and estimate the models reflecting the effects of employment and wage growth across different industry compensation tiers.

We have to consider a few things with regard to the industry wage tier rank ordering[4]. First, we consider the possibility that high-, medium- and low-tier industries may be distributed differently across metro and nonmetro counties. In this case, we might be concerned that significant differences in effects between metro and nonmetro areas could be due to, for example, the fact that top-tier industries are drastically more important to the overall economy in metro areas. We compare the proportion of total employment in each wage tier represented in metro and non metro counties, and find there is little difference. Table 2 shows the share of county total employment for each wage tier in metro and nonmetro counties. Metro counties

[3] $E^{r}_{i,k,2001}$ is employment in industry k divided by sum of total county employment of all industries of rank r.

[4] We acknowledge there is a distribution of occupations within industries that sometimes result in large variances in pay across a single industry and our results are subject to this limitation.

have slightly more top and bottom tier industry employment and nonmetro counties have slightly more middle-tier industry employment, but overall differences are minimal. The second question is the extent to which industries travel across wage tiers over time. We find that the three tiers are relatively stable. Over the entire 13-year period, 91% of bottom tier industries, 84% of middle tier industries, and 93% of top-tier industries remained in their initial wage-tier. No industries moved from the top to the bottom or vice versa.

3. Results

We begin by discussing the results in Table 3, which contains our regression results for the entire population. Each specification includes county and time fixed effects to control for fixed unobserved county- and year-specific characteristics that potentially influence the relationship between county drug overdose rates and changes in employment or growth rates. Even numbered columns also contain the additional controls outlined in the Data and Methods section for county specific observable characteristics in an attempt to further mitigate any potential bias in our results. In Panel A of Table 3, we show the results of estimating equations (3) and (5) on employment growth. Looking across the first row of Panel A, we see that changes in employment growth rates are not significantly related to changes in county overdose rates in nonmetro counties, and only weakly related to changes in overdose rates for metro counties. However, as we consider the regression results from Equation (5) in columns 3-4 and 7-8 that disaggregate employment growth into wage tiers, we see that the overall insignificant effect masks heterogeneity in effect sizes and significance across wage tiers.

The left half of Panel A in Table 3 shows that in nonmetro counties bottom- and middle-tier employment growth rates are negatively related to overdose death rates, suggesting that when industries that are more likely to employ lower-educated workers grow faster than the

previous year, overdose death rates decline. We estimate that a one-percentage point increase in low-tier (middle-tier) employment growth rates results in about 0.14 (0.13) fewer overdose deaths per 100,000 people. This suggests a 1% increase in bottom-tier employment growth (e.g. bottom-tier employment grew at 2% this year instead of 1% last year) would result in 0.5 few overdose deaths per 100,000 people. Given the overdose death rate for the entire population was on average about 10 per 100,000 in nonmetro counties over the entire period, this is about a 5% reduction in the overdose death rate. These results imply bottom-tier employment growth changes alone could produce significant differences in overdose rates between counties. For instance, if County A had a robust a 5 percentage point change in bottom tier employment growth (e.g growth went from 1% to 6% over the year) and County B conversely saw bottom-tier employment growth decrease by 5 percentage points (growth went from 1% to -4%), this could produce a difference of 5 overdose deaths per 100,000 between the counties, or 50% of average overdose rates in nonmetro counties.

In metro areas, the bottom-tier industry effect persists and is larger in magnitude such that a 1% increase in employment growth rates results in about 0.4 fewer deaths per 100,000, or about a 3.4% decrease in the average metro county overdose death rate of 11.53. The effect of middle-tier growth disappears in metro areas, and instead we find a positive relationship between changes in top-tier employment growth rates and overdose death rates. Here a one percentage point increase in employment growth in top-tier industries in associated with about 0.12 more drug overdose deaths per 100,000, or a 1% increase on average.

Turning to Panel B, we show the results of estimating equations (4) and (6). In nonmetro counties, we find that changes in aggregate wage growth rates have no relationship with changes in overdose rates (top row), but when disaggregated by wage tier, bottom-tier wage growth rate

changes over the previous year predict changes in county overdose rates for the general population. A one percentage point increase in wage growth among bottom-tier industries reduced the drug overdose rate by about 0.35 people per 100,000. These results are consistent with the employment growth results in Panel A, where changes in the part of the labor market that employs a higher proportion of lower-educated workers have larger impacts overdose rates. Our results suggest that a robust 5-percentage point increase in the wage growth rate from the previous year lowered the county overdose rate by 1 death per 100,000. These are fairly substantial in magnitude. Given that the average nonmetro overdose death rate 10.11 per 100,000, a 5-percentage point increase in the wage growth rate leads to a 10% decline in nonmetro overdose rates.

Unlike nonmetro areas, there is a significant relationship between aggregate wage growth and overdose rates in metro counties (coefficient estimates of -0.41 and -0.39 in the models without and with controls, respectively). When disaggregated by wage tier, we find further differences in the effect of wage growth on overdose rates across wage tiers. Changes in wage growth in bottom-tier industries do not have significant effect on overdose rates in metro counties, but accelerating wage growth in the top- and middle-tier industries reduce overdose rates. A one percentage point increase in the wage growth rate in middle- and top-tier industries decreases overdose death rates by 0.39 and 0.18 per 100,000, respectively

Effects by gender

The results for our overdose rate models by gender are in Table 4, which is organized similarly to Table 3. However, since our parsimonious results differ little from our models that include county controls, we only present the latter. As in Table 3, the employment growth results are presented in Panel A and the wage growth results are presented in Panel B.

Changes in employment growth rates (both disaggregated and in the aggregate) have little impact on male or female overdose rates in nonmetro counties. The one exception is a weakly significant positive top-tier growth effect on male overdose rates, where we estimate that a one percentage point increase in the top-tier employment growth rate results in 0.1 fewer male overdose deaths per 100,000 or a 1% increase on average. The estimated coefficients for middle- and bottom-tier employment growth rates are similar to the overall estimates from Table 3, but are not significantly different than zero. In metro counties, changes in employment growth rates impact changes in male overdose rates, and particularly so if the growth is driven by bottom-tier industries. Here a robust 5% increase in bottom-tier employment growth rates from the previous year would result in a decline in male overdose rates by about 3.3 per 100,000 or a 28% decrease on average. Analogous bottom-tier employment growth would only decrease the female overdose death rate by 0.9 per 100,000 or 8% on average. Top-tier employment growth rates are again positively related to overdose rates when we look by gender. While only the coefficient for women is significant (estimate 0.12), the estimated coefficient for men is nearly identical in magnitude (0.11), and both are very similar to the overall coefficient estimate for both genders (0.11) reported in Table 3.

When we consider the impact of changes in wage growth rates in Panel B, we find that they seem to play a bigger role than changes in employment growth rates in nonmetro counties and that these effects are concentrated at the low end of the wage distribution. We estimate that a one percentage point increase in wage growth in bottom-tier industries results in 0.39 fewer men and 0.32 fewer women per 100,000 dying from overdose. We do not find significant disparities between men and women as we do with changes in employment growth in metro counties in Panel A.

In metro areas, changes in aggregate wage growth have a negative relationship with both male and female overdose rates, but the coefficient is about 60% larger for male overdose rates (-0.49 for men versus -0.31 for women). When we disaggregate the effects by wage tiers, we find the pattern for the entire population—where top-tier wage growth rates are negatively related to overdose rates—holds for male and female overdose rates as well, with the coefficient in the male overdose rate model slightly larger. We estimate that a one percentage point increase in top-tier wage growth results in 0.21 fewer male and 0.16 fewer female overdoses per 100,000. Additionally, male overdose rates are affected by middle-tier wage growth rates in metro counties and the effect is 3 times as large as the top-tier effect (estimate -0.64). There is no significant relationship between middle-tier wage growth rates for women and overdoses, nor are there significant relationships between bottom-tier wage growth rates and overdoses for either gender.

Effects by race

Table 5 contains regression results for models of white and black overdose rates. Case and Deaton (2015; 2017) find sharp rises in overall mortality for low-educated whites between 1999-2014, but black mortality rates continued to decline, suggesting factors influencing overdose deaths affect black and white populations differently. We find differential labor market effects on black and white overdose rates, consistent with these previous findings.

In Panel A, we find that bottom-tier employment growth rates influence white overdose rates in both metro and nonmetro counties, such that a one percentage point increase in bottom-tier employment growth rates result in 0.23 and 0.36 fewer white overdose deaths per 100,000 in nonmetro and metro counties, respectively. We find no significant relationships between employment growth rates and black overdose death rates in nonmetro counties. In metro

counties, we find that white overdoses drive the results we find for the full population, such that a one percentage point increase in top-tier employment growth rates increase the white overdose rate by 0.12 people per 100,000, while a one percentage point decrease in bottom-tier employment growth decrease the overdose rates by 0.36 people. We again find no significant relationships between employment growth rates and the black overdose rate, although a similar—if less distinct—pattern akin to that among whites is apparent in the estimated coefficients (positive effects of top-tier growth and negative effects of bottom-tier growth).

Turning to the wage growth results in Panel B, we find that in nonmetro counties, only wage growth rates in bottom-tier industries affect the white overdose rate. We estimate that a one percentage point increase in wage growth in bottom-tier industries decreases the white overdose rate by 0.4 deaths per 100,000 or 4% in the average county. For black populations, we estimate large, negative and statistically significant relationships between aggregate wage growth (-1.7), as well as between top- (-0.67) and bottom-tier (-1.2) industry wage growth. Note that while we report results for black overdose rates in nonmetro counties, the relatively small numbers of black residents in many rural counties render the overdose rates very sensitive to small changes in the number of black deaths due to overdose[5]. Hence, these results should be interpreted with caution.

In metro counties, we find strong relationships between wage growth rates and overdose rates among whites. We estimate that a one percentage point increase in aggregate wage growth rates result in 0.54 fewer white overdose deaths per 100,000, and that one percentage point increases in top- and middle-tier industry wage growth rates result in 0.2 and 0.45 reductions in

[5] Standard deviations for black overdose rates in nonmetro areas are roughly 6-8 times larger than those for whites, males, and females.

white overdose death rates, respectively. Among blacks in metro counties, we find no evidence of statistically significant relationships between wage growth rates and overdose rates.

4. Conclusion

The pattern of results we discuss above paint an interesting picture, providing empirical evidence to support some popular media narratives, and evidence against others. In general, we find that having employment growth in bottom-tier industries protects against increasing overdose deaths in both metro and nonmetro counties. The protective effects of bottom-tier growth appear especially important for males, and for whites. This finding generally aligns with the popular press story of predominantly white workers without economic opportunity having turned to drug misuse as a means of coping. However, the strongest effects of bottom-tier employment growth can be found in metro counties, rather than in the rural areas that are usually portrayed.

Nonmetro counties, by contrast, appear better protected by wage growth in bottom-tier industries – a fact that appears true for men, women, blacks and whites alike. This suggests that in rural areas, local economic conditions are not affecting overdose rates primarily through work availability, but rather through wage growth – a factor that affects those with work more than those who are unemployed. This finding is a new piece of the story and suggests that the unemployment rate may not fully capture the macroeconomic conditions that are important predictors of overdose.

We also uncover two additional unexpected results. To explain these findings, we appeal to a framework where changes in employment or wage growth rates affect the overdose rate through two channels: direct and indirect. Direct channels predominate when employment or wage changes in a particular tier of industries influence overdose rates of workers in industries in that tier. This may occur if declines in employment or wage growth lead to negative psychological effects for workers in those sectors, leading to increased overdose rates. Indirect

channels may be present when changes in employment or wage growth in a particular tier of industries indirectly affect the overdose death rate of those outside of those industries. This may occur if, for instance, top tier wage growth affected overdose rates of those employed in lower-tier industries because of inequality. We cannot test explicitly for direct or indirect mechanisms since we cannot observe overdose rates by industry. However, to help parse these different channels, we rely on the now well-established fact that overdose rates have grown much more for those with less education – who are much more likely to work in bottom-tier industries – than those with more education.

The first unexpected finding is that in metro counties, there is no evidence that wage growth in bottom-tier industries decreases overdose rates, but rather that middle- and (to a lesser extent) top-tier wage growth do. Male and white overdose rates drive these relationships. Because the vast majority of those who die from a drug overdose have a high-school degree or less, we would expect larger effects in the bottom-tier. One possibility is that these relationships reflect indirect effects, whereby growth in top-tier industries harms bottom tier workers by changing their labor market outcomes, or enhancing community resources. Another potential explanation stems from the fact that in creating our wage tiers, we are only able to sort industries and not occupations. It could be that many high and middle-pay industries employ lower-skill workers, especially in metro counties, and that wage growth in these industries directly affects low-skill workers.

The second surprising finding is that top-tier employment growth causes more overdose deaths in metro counties, and among males in nonmetro counties. One possible explanation is that employment growth in top-tier industries indirectly harms lower-educated workers by compromising their labor market opportunities – either decreasing wages, or changing the nature

of jobs available to such workers. However, we do not find a strong correlation between employment growth in the top tier and lower-tier employment or wage growth. Another possibility is that increasing job availability indirectly harms low-tier industry workers by increasing inequality of opportunity (Lillard et al. 2015; Pickett and Wilkinson 2015).

A third hypothesis is that increased employment opportunities in better-compensated sectors increased access to employer-provided health insurance, thereby increasing access to prescription opioids. Powell, Liccardo and Taylor (2016) show that the introduction of Medicare Part D, which dramatically increased insurance rates for older Americans, led to an influx of prescription opioids in affected areas; this, in turn, created spillovers that increased the overdose rate among younger Americans. An access to insurance story could therefore directly increase overdose rates for workers in top-tier industries through their own access, or have increased overdoes rates for workers in other tiers by increasing the overall supply of prescription opioids in a county. The fact that the association between top-tier wage growth and overdose rates is only present for whites also aligns with this theory. There is a substantial literature demonstrating that underrepresented groups suffer disproportionately from unrelieved pain for a variety of reasons (Shavers et al. 2010). One recent study showed blacks are half as likely to receive prescription opioids upon discharge from emergency departments (Singhal, Tien, and Hsia 2016). If black populations had less access to prescription drugs than whites because of discrimination in prescribing practices or other cultural reasons (Gaskin et al. 2006), we would expect an expansion of health coverage from top-tier employment growth to have only increased white overdose rates.

Our results are consistent with other investigations of labor market influences on overdose rates (Rhum 2015; Hollingsworth et al. 2017) in that we find relationships between

macroeconomic conditions and overdose rates. One important difference, however, is that our analyses show that using aggregate measures mask important nuance, nuance that becomes clear when we break measures down by wage tier. Like Pierce and Schott (2017), we find that workers at the low end of the wage distribution are disproportionately affected by changes to wage and employment growth in nonmetro areas.

Another important difference is that our use of the Bartik-style instrument appears important in estimating effects. In naive regressions where we use standard employment growth and wage growth measures without the Bartik adjustment, we find significant results in nearly all of our specifications, even the aggregate measure models that generally produce null effects when we use the Bartik instrument (Appendix Table A1). This suggests the presence of unobservable local characteristics that influence the relationship between employment growth and overdose death rates, which threaten to bias our results if we did not account for them.

Our study suffers from several limitations. Firstly, we only examine the relationships between macroeconomic conditions and aggregate drug overdoses, without examining deaths due to opioid overdoses in particular. Furthermore, by focusing on deaths only, we are missing a large portion of drug misuse, including, recreational use, addiction, admittance to a treatment facility, non-Emergency Room (ER) overdoses that do not result in death, and ER admissions that do not result in death. Hollingsworth et al. (2017) find effect sizes associated with ER visits that are an order of magnitude larger than the effects on mortality.

Additionally, we are unable to test for the causal mechanisms that connect macroeconomic conditions in each industry tier to the overall overdose rate because we do not have overdose death rate by industry. Furthermore, because we can only group industries, and not occupations, by average pay, it is difficult to distinguish whether our estimated effects reflect

direct or indirect relationships with overdose rates. Despite these limitations, our results add to the growing literature intended to explain the meteoric rise in drug overdoses in the United States.

References

Acemoglu, D. and Restrepo, P., 2017. Robots and Jobs: Evidence from US labor markets. NBER working paper # 23285.

Arkes, J. 2007. Does the Economy Affect Teenage Substance Use? *Health Economics*, 16, (1), pp. 19–36.

Alpert, Abby, David Powell, and Pacula, (2017). "Supply-Side Drug Policy in the Presence of Substitues: Evidence from the Introduction of Abuse-Deterrent Opioids". NBER Working Paper # 23031.

Autor, David, H. and Dorn, D., 2013. The growth of low-skill service jobs and the polarization of the US labor market. The American Economic Review, 103(5), pp.1553-1597.

Autor, David, H., Dorn, D. and Hanson, G.H., 2013. The China syndrome: Local labor market effects of import competition in the United States. The American Economic Review, 103(6), pp.2121-2168.

Baily, M.N. and Bosworth, B.P., 2014. US manufacturing: Understanding its past and its potential future. *The Journal of Economic Perspectives*, *28*(1), pp.3-25.

Bartik, Timothy J. 1991. *Who benefits from state and local economic development policies?* Kalamazoo, MI:W.E. Upjohn Institute for Employment Research.

Betz, M.R., Partridge, M.D., Farren, M. and Lobao, L., 2015. Coal mining, economic development, and the natural resources curse. *Energy Economics*, *50*, pp.105-116.

Buchmueller, Thomas and Colleen Carey. 2017. "The Effect of Prescription Drug Monitoring Programs on Opioid Utilization in Medicare," NBER # 23148.

Carpenter, Christopher, Chandler McClellan, and Daniel Rees. 2016. Economic Conditions, Illicit Drug Use, and Substance Use Disorders in the United States. *NBER Working Paper Series, No. 22051*.

Case, A. and Deaton, A., 2015. Rising morbidity and mortality in midlife among white non-Hispanic Americans in the 21st century. Proceedings of the National Academy of Sciences, 112(49), pp.15078-15083.

Case, A. and Deaton, A., 2017. Mortality and morbidity in the 21st century. Brookings Papers on Economic Activity, pp.23-24.

Centers of Disease Control. 2013. *Prescription Drug Overdose Data & Statistics guide to ICD-9-CM and ICD-10 Codes: Prescription Drug Overdose State Health Department Training and Technical*. Assistance Meeting Version 1.3 – Revised August 12th, 2013

Dorfman, J., Partridge, M.D. and Galloway, H., 2011. Are high-tech employment and natural amenities linked: answers from a smoothed Bayesian spatial model. *Spatial Economic Analysis, 6*(4), pp.397-422.

Freeman, Donald G. 1999. A Note on 'Economic Conditions and Alcohol Problems. *Journal of Health Economics*, 18(5), pp. 661–670.

Frijters, Paul, David W. Johnston, Grace Lordan, and Michael A. Shields. 2013. Exploring the Relationship Between Macroeconomic Conditions and Problem Drinking as Captured by Google Searches in the US. *Social Science & Medicine*, 84, pp. 61–68.

Gaskin, D.J., Briesacher, B.A., Limcangco, R. and Brigantti, B.L., 2006. Exploring racial and ethnic disparities in prescription drug spending and use among Medicare beneficiaries. *The American journal of geriatric pharmacotherapy*, *4*(2), pp.96-111.

Gruber, Jonathan and Michael Frakes. 2006. Does Falling Smoking Lead to Rising Obesity? *Journal of Health Economics*, 25(2), pp. 183–197.

Hari, Johann. 2017. "What's Really Causing the Prescription Drug Crisis?" LA Times, January 12, 2017.

Hollingsworth, A., Ruhm C.J., and Simon, K. 2017. Macroeconomic Conditions and Opioid Abuse. NBER Working Paper # 23192.

Katz, Josh (2017). "Drug Deaths in America are Rising Faster than Ever." *The New York Times.* June 5, 2017. Available at: https://www.nytimes.com/interactive/2017/06/05/upshot/opioid-epidemic-drug-overdose-deaths-are-rising-faster-than-ever.html?mcubz=0

Kolata, G. and Cohen, S., 2016. Drug overdoses propel rise in mortality rates of young whites. *New York Times*, *16*.

Krueger, Alan (2017). "Where Have All the Workers Gone? An Inquiry into the Decline of the US Labor Force Participation Rate," *Brookings Papers on Economic Activity.*

Lillard, D.R., Burkhauser, R.V., Hahn, M.H., and Wilkin, R. 2015. Does early-life income inequality predict self-reported health in later life? Evidence from the United States. *Social Science & Medicine*, 128, pp.347-355

Lobao, L., Zhou, M., Partridge, M. and Betz, M., 2016. Poverty, place, and coal employment across Appalachia and the United States in a new economic era. *Rural Sociology*, *81*(3), pp.343-386.

Mishel, L., Gould, E. and Bivens, J., 2015. Wage stagnation in nine charts. *Economic Policy Institute*, *6*.

National Center for Health Statistics. Compressed Mortality File, 1999-2014 (machine readable data file and documentation, CD-ROM Series 20, No. 2T) as compiled from data

provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Hyattsville, Maryland. 2015.

Partridge, M.D., Rickman, D.S., Ali, K. and Olfert, M.R., 2008. Employment growth in the American urban hierarchy: long live distance. *The BE Journal of Macroeconomics*, *8*(1).

Pickett, K.E., and Wilkinson, R.G. 2015. Income inequality and health: A causal review. *Social Science & Medicine*, 128, pp. 316-326.

Pierce, J.R. and Schott, P.K., 2016. Trade Liberalization and Mortality: Evidence from U.S. Counties. NBER working paper # 22849.

Powell D., Pacula, R.L., and Taylor, E. 2016. How Increasing Medical Access to Opioids Contributes to the Opioid Epidemic: Evidence from Medicare Part D. *NBER Working Paper 21072*

Quinones, Sam. 2015. "Dreamland: The true tale of America's opiate epidemic," Bloomsburry Publishing, USA.

Rembert, Mark, Michael R. Betz, Bo Feng, and Mark D. Partridge. 2017. *Taking measure of Ohio's opioid crisis*. Swank Program in Rural-Urban Policy, 27 pages

Ruhm, C. J. 2000. Are Recessions Good for Your Health? *The Quarterly Journal of Economics*, 115(2), pp. 617–650.

Ruhm, C.J., 2015. Recessions, healthy no more?. *Journal of health economics*, *42*, pp.17-28.

Ruhm, C. J. and William E. Black. 2002. Does Drinking Really Decrease in Bad Times*?*,*Journal of Health Economics*, 21(4), pp. 659–678.

Rupasingha, A., Liu, Y. and Partridge, M., 2015. Rural bound: Determinants of metro to non-metro migration in the United States. *American Journal of Agricultural Economics*, *97*(3), pp.680-700.

Schnell, M. and Currie, J., 2017. Addressing the opioid epidemic: Is there a role for physician education?. *American Journal of Health Economics*, pp.1-37.

Shavers, V.L., Bakos, A. and Sheppard, V.B., 2010. Race, ethnicity, and pain among the US adult population. *Journal of Health Care for the Poor and Underserved*, *21*(1), pp.177-220.

Singhal, A., Tien, Y.Y. and Hsia, R.Y., 2016. Racial-ethnic disparities in opioid prescriptions at emergency department visits for conditions commonly associated with prescription drug abuse. *PloS one*, *11*(8), p.e0159224.

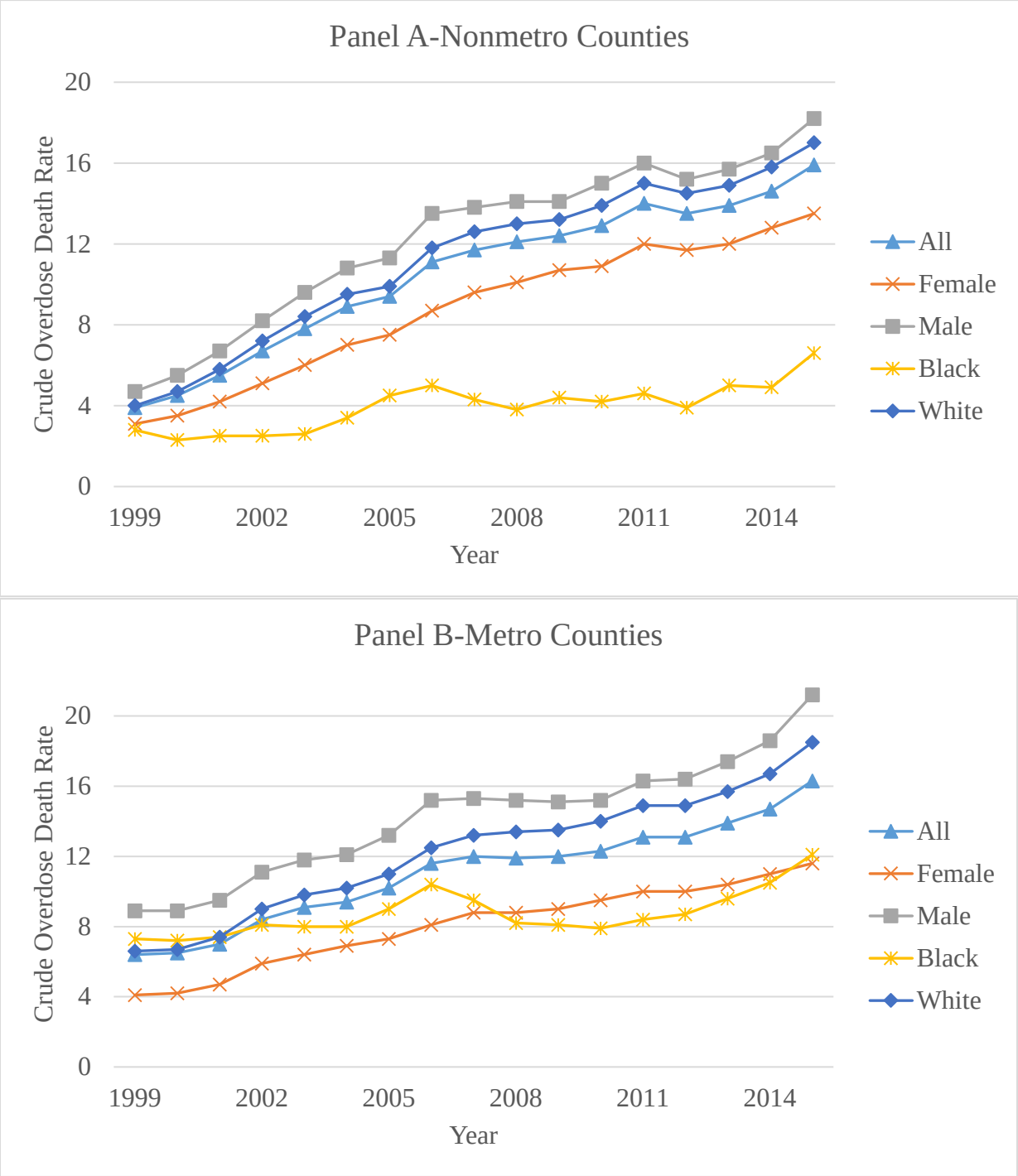
Snyder, S.E., 2016. Urban and rural divergence in mortality trends: A comment on Case and Deaton. *Proceedings of the National Academy of Sciences*, *113*(7), pp.E815-E815.

Tsvetkova, A., Partridge, M. and Betz, M., 2017. Entrepreneurial and Employment Responses to Economic Conditions across the Rural-Urban Continuum. *The ANNALS of the American Academy of Political and Social Science*, *672*(1), pp.83-102.

Tsvetkova, A. and Partridge, M.D., 2016. Economics of modern energy boomtowns: do oil and gas shocks differ from shocks in the rest of the economy?. *Energy Economics*, *59*, pp.81-95

Xu, Xin. 2013. The Business Cycle and Health Behaviors. *Social Science & Medicine*, 77(1), pp. 126–136.

FIGURE 1—CRUDE OVERDOSE DEATH RATES BY RACE AND GENDER 1999-2014



Source: CDC WONDER Compressed Mortality Files 1999-2015

FIGURE 2—CHANGE IN COUNTY OVERDOSE RATE BY GENDER AND RACE 2001-2014

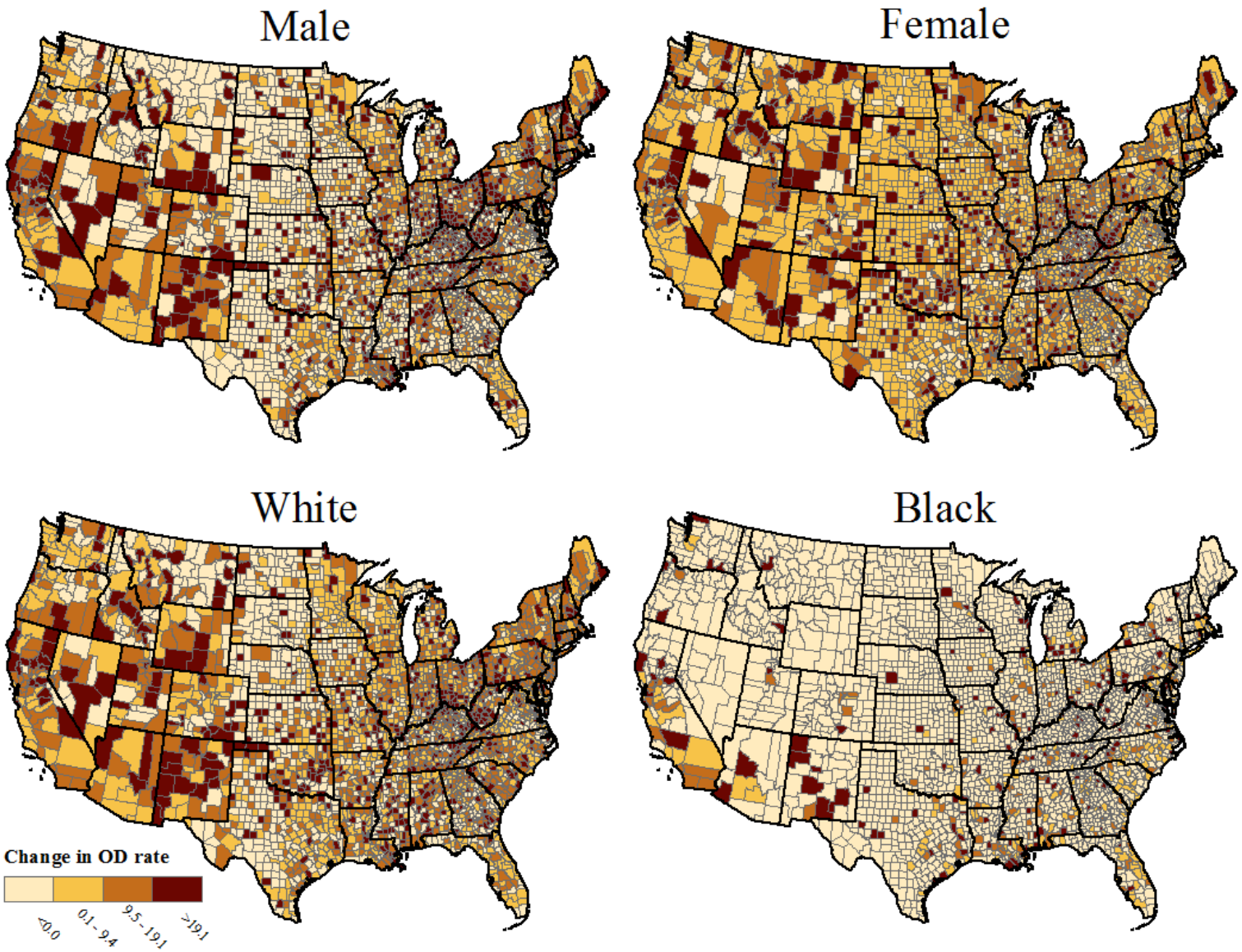


TABLE 1-SUMMARY STATISTICS OF KEY VARIABLES

Nonmetro Counties

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
OD rate-all	26,311	10.11	12.23	0.00	194.46
OD rate-male	26,311	11.67	17.08	0.00	245.70
OD rate-female	26,311	8.84	14.21	0.00	284.09
OD rate-white	26,311	10.87	13.43	0.00	204.08
OD rate-black	26,311	4.87	63.43	0.00	4545.46
Employment growth	26,311	0.10	4.76	-74.55	309.09
Bartik employment growth	26,311	0.06	1.71	-14.54	12.10
Top-tier employment growth	26,311	-0.08	2.59	-60.95	13.54
Middle-tier employ. growth	26,311	-0.06	1.86	-17.71	5.64
Bottom-tier employ. growth	26,311	0.28	1.62	-14.49	14.97
Wage growth	26,311	0.75	8.58	-91.69	1193.07
Bartik wage growth	26,311	0.32	1.25	-3.71	7.05
Top-tier wage growth	26,311	0.60	1.66	-10.17	9.47
Middle-tier wage growth	26,311	0.41	1.23	-4.58	7.14
Bottom-tier wage growth	26,311	0.12	1.29	-6.49	8.90

Metro Counties

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
OD rate-all	13,649	11.53	8.20	0.00	127.06
OD rate-male	13,649	14.14	11.33	0.00	154.39
OD rate-female	13,649	9.31	8.47	0.00	133.33
OD rate-white	13,649	12.76	9.05	0.00	112.79
OD rate-black	13,649	7.24	43.23	0.00	3030.30
Employment growth	13,649	0.61	3.44	-49.38	61.18
Bartik employment growth	13,649	0.12	1.77	-12.45	4.45
Top-tier employment growth	13,649	-0.25	2.43	-44.33	8.73
Middle-tier employ. growth	13,649	-0.04	1.89	-13.90	5.03
Bottom-tier employ. growth	13,649	0.49	1.70	-13.71	8.96
Wage growth	13,648	0.29	2.92	-27.70	73.69
Bartik wage growth	13,649	0.28	1.24	-3.50	10.88
Top-tier wage growth	13,649	0.57	1.61	-7.51	7.74
Middle-tier wage growth	13,649	0.38	1.18	-3.62	4.34
Bottom-tier wage growth	13,649	0.04	1.29	-4.13	11.25

TABLE 2--INDUSTRY TIER SHARE OF TOTAL COUNTY EMPLOYMENT 2014

Nonmetro				
	Mean	Standard Dev.	Min	Max
Top-tier	17.99	9.75	1.59	100.00
Middle-tier	38.10	8.33	4.83	82.40
Bottom-tier	43.95	9.63	3.52	83.95
Metro				
	Mean	Standard Dev.	Min	Max
Top-tier	19.64	7.68	3.41	56.89
Middle-tier	36.20	6.80	3.90	75.17
Bottom-tier	44.16	7.34	13.83	88.46

TABLE 3-- THE EFFECT OF EMPLOYMENT AND WAGE GROWTH ON OVERDOSE RATES

Panel A—Employment growth

	Nonmetro				Metro			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Employment growth rate	-.029	-.062			-.051	-.17*		
	(-0.34)	(-0.71)			(-0.49)	(-1.66)		
Top-tier employment growth rate			.053	.048			.12**	.11**
			(1.27)	(1.15)			(2.36)	(2.24)
Middle-tier employment growth rate			-.097	-.13*			.16	.037
			(-1.32)	(-1.72)			(1.54)	(0.34)
Bottom-tier employment growth rate			-.13	-.14*			-.35***	-.4***
			(-1.56)	(-1.67)			(-3.49)	(-4.11)
County FE	X	X	X	X	X	X	X	X
Year FE	X	X	X	X	X	X	X	X
Controls		X		X		X		X
Observations	26,311	26,311	26,311	26,311	13,649	13,649	13,649	13,649

Panel B—Wage growth

	Nonmetro				Metro			
Wage growth rate	-.084	-.13			-.41***	-.39***		
	(-0.58)	(-0.90)			(-2.83)	(-2.75)		
Top-tier wage growth rate			.032	.018			-.19***	-.18***
			(0.45)	(0.26)			(-3.50)	(-3.37)
Middle-tier wage growth rate			-.051	-.044			-.64***	-.39*
			(-0.42)	(-0.36)			(-3.05)	(-1.90)
Bottom-tier wage growth rate			-.32**	-.35**			.14	.088
			(-2.28)	(-2.55)			(0.99)	(0.64)
County FE	X	X	X	X	X	X	X	X
Year FE	X	X	X	X	X	X	X	X
Controls		X		X		X		X
Observations	26,311	26,311	26,311	26,311	13,649	13,649	13,649	13,649

t-statistics in parenthesis; *p<0.10, **p<0.05, ***p<0.01; Controls include total employment, poverty rate, median household income, and log of population; robust standard errors are estimated for all models;

TABLE 4-- THE EFFECT OF EMPLOYMENT AND WAGE GROWTH ON OVERDOSE RATES BY GENDER

Panel A—Employment growth

	Nonmetro				Metro			
	Male		Female		Male		Female	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Employment growth rate	-.042		-.1		-.34**		-.017	
	(-0.33)		(-1.05)		(-2.28)		(-0.20)	
Top-tier employment growth rate		.1*		-.0044		.11		.12***
		(1.66)		(-0.10)		(1.55)		(2.76)
Middle-tier employment growth rate		-.18		-.085		.07		-.0022
		(-1.59)		(-1.01)		(0.47)		(-0.02)
Bottom-tier employment growth rate		-.18		-.13		-.65***		-.18**
		(-1.38)		(-1.27)		(-4.52)		(-2.23)
County FE	X	X	X	X	X	X	X	X
Year FE	X	X	X	X	X	X	X	X
Controls	X	X	X	X	X	X	X	X
Observations	26,311	26,311	26,311	26,311	13,649	13,649	13,649	13,649

Panel B—Wage growth

	Nonmetro				Metro			
Wage growth rate	.14		-.4**		-.49**		-.31**	
	(0.66)		(-2.21)		(-2.37)		(-2.55)	
Top-tier wage growth rate		.16		-.11		-.21***		-.16***
		(1.48)		(-1.41)		(-2.66)		(-3.10)
Middle-tier wage growth rate		.13		-.23		-.64**		-.15
		(0.70)		(-1.54)		(-2.15)		(-0.94)
Bottom-tier wage growth rate		-.39**		-.32**		.24		-.054
		(-2.16)		(-2.08)		(1.18)		(-0.48)
County FE	X	X	X	X	X	X	X	X
Year FE	X	X	X	X	X	X	X	X
Controls	X	X	X	X	X	X	X	X
Observations	26,311	26,311	26,311	26,311	13,649	13,649	13,649	13,649

t-statistics in parenthesis; *p<0.10, **p<0.05, ***p<0.01; robust standard errors estimated for all models

TABLE 5-- THE EFFECT OF EMPLOYMENT AND WAGE GROWTH ON OVERDOSE RATES BY RACE

Panel A—Employment growth

	Nonmetro				Metro			
	White		Black		White		Black	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Employment growth rate	-.094		.15		-.14		-.084	
	(-0.95)		(0.38)		(-1.12)		(-0.43)	
Top-tier Employment growth rate		.052		-.2		.12**		.082
		(1.11)		(-0.86)		(2.06)		(0.86)
Middle-tier Employment growth rate		-.13		.13		-.012		-.33
		(-1.55)		(0.31)		(-0.09)		(-1.47)
Bottom-tier Employment growth rate		-.23**		.22		-.36***		-.083
		(-2.26)		(0.58)		(-3.11)		(-0.51)
County FE	X	X	X	X	X	X	X	X
Year FE	X	X	X	X	X	X	X	X
Controls	X	X	X	X	X	X	X	X
Observations	26,311	26,311	26,311	26,311	13,649	13,649	13,649	13,649

Panel B—Wage growth

	Nonmetro				Metro			
Wage growth rate	-.052		-1.7***		-.54***		-.16	
	(-0.30)		(-2.58)		(-3.27)		(-0.45)	
Top-tier wage growth rate		.076		-.67*		-.2***		.021
		(0.93)		(-1.70)		(-3.22)		(0.13)
Middle-tier wage growth rate		-.027		-.011		-.45**		-.39
		(-0.18)		(-0.02)		(-1.99)		(-1.08)
Bottom-tier wage growth rate		-.4***		-1.2***		-.021		-.15
		(-2.59)		(-2.63)		(-0.13)		(-0.53)
County FE	X	X	X	X	X	X	X	X
Year FE	X	X	X	X	X	X	X	X
Controls	X	X	X	X	X	X	X	X
Observations	26,311	26,311	26,311	26,311	13,649	13,649	13,649	13,649

t-statistics in parenthesis; *p<0.10, **p<0.05, ***p<0.01; robust standard errors estimated for all models

Appendix

TABLE A1—REGRESSIONS WITHOUT BARTIK-STYLE ADJUSTMENT IN EMPLOYMENT AND WAGE GROWTH

Panel A—Employment growth

	All	Male	Female	White	Black
	(1)	(2)	(3)	(4)	(5)
Employment growth rate	-.11***	-.13***	-.088***	-.095***	-.065
	(-5.03)	(-3.74)	(-5.33)	(-3.27)	(-1.20)
County FE	X	X	X	X	X
Year FE	X	X	X	X	X
Controls	X	X	X	X	X
Observations	40,218	40,218	40,218	40,218	40,218

Panel B—Wage growth

	All	Male	Female	White	Black
Wage growth rate	.0099*	.014*	.0055	.0092*	.024
	(1.78)	(1.82)	(1.22)	(1.69)	(1.17)
County FE	X	X	X	X	X
Year FE	X	X	X	X	X
Controls	X	X	X	X	X
Observations	40,218	40,218	40,218	40,218	40,218

APPENDIX TABLE A2—INDUSTRIES BY WAGE TIER

Top-tier Industries

NAICS	Industry Name
2111	Oil And Gas Extraction
2121	Coal Mining
2122	Metal Ore Mining
2131	Support Activities For Mining
2211	Electric Power Generation, Transmission And Distribution
2212	Natural Gas Distribution
2362	Nonresidential Building Construction
2372	Land Subdivision
3111	Animal Food Manufacturing
3112	Grain And Oilseed Milling
3121	Beverage Manufacturing
3122	Tobacco Manufacturing
3221	Pulp, Paper, And Paperboard Mills
3241	Petroleum And Coal Products Manufacturing
3251	Basic Chemical Manufacturing
3252	Resin, Synthetic Rubber, And Artificial Synthetic Fibers And Filaments Manufacturing
3253	Pesticide, Fertilizer, And Other Agricultural Chemical Manufacturing
3254	Pharmaceutical And Medicine Manufacturing
3255	Paint, Coating, And Adhesive Manufacturing
3256	Soap, Cleaning Compound, And Toilet Preparation Manufacturing
3259	Other Chemical Product And Preparation Manufacturing
3274	Lime And Gypsum Product Manufacturing
3311	Iron And Steel Mills And Ferroalloy Manufacturing
3312	Steel Product Manufacturing From Purchased Steel
3313	Alumina And Aluminum Production And Processing
3314	Nonferrous Metal (Except Aluminum) Production And Processing
3331	Agriculture, Construction, And Mining Machinery Manufacturing
3332	Industrial Machinery Manufacturing
3333	Commercial And Service Industry Machinery Manufacturing
3335	Metalworking Machinery Manufacturing
3336	Engine, Turbine, And Power Transmission Equipment Manufacturing
3339	Other General Purpose Machinery Manufacturing
3341	Computer And Peripheral Equipment Manufacturing
3342	Communications Equipment Manufacturing
3343	Audio And Video Equipment Manufacturing
3344	Semiconductor And Other Electronic Component Manufacturing
3345	Navigational, Measuring, Electromedical, And Control Instruments Manufacturing

3346	Manufacturing And Reproducing Magnetic And Optical Media
3353	Electrical Equipment Manufacturing
3359	Other Electrical Equipment And Component Manufacturing
3361	Motor Vehicle Manufacturing
3363	Motor Vehicle Parts Manufacturing
3364	Aerospace Product And Parts Manufacturing
3365	Railroad Rolling Stock Manufacturing
3369	Other Transportation Equipment Manufacturing
3391	Medical Equipment And Supplies Manufacturing
4234	Professional And Commercial Equipment And Supplies Merchant Wholesalers
4235	Metal And Mineral (Except Petroleum) Merchant Wholesalers
4236	Electrical And Electronic Goods Merchant Wholesalers
4242	Drugs And Druggists' Sundries Merchant Wholesalers
4243	Apparel, Piece Goods, And Notions Merchant Wholesalers
4246	Chemical And Allied Products Merchant Wholesalers
4247	Petroleum And Petroleum Products Merchant Wholesalers
4248	Beer, Wine, And Distilled Alcoholic Beverage Merchant Wholesalers
4251	Wholesale Electronic Markets And Agents And Brokers
4811	Scheduled Air Transportation
4812	Nonscheduled Air Transportation
4821	Rail Transportation
4831	Deep Sea, Coastal, And Great Lakes Water Transportation
4832	Inland Water Transportation
4861	Pipeline Transportation Of Crude Oil
4862	Pipeline Transportation Of Natural Gas
4869	Other Pipeline Transportation
4883	Support Activities For Water Transportation
5112	Software Publishers
5122	Sound Recording Industries
5151	Radio And Television Broadcasting
5152	Cable And Other Subscription Programming
5171	Wired Telecommunications Carriers
5172	Wireless Telecommunications Carriers (Except Satellite)
5174	Satellite Telecommunications
5179	Other Telecommunications
5182	Data Processing, Hosting, And Related Services
5191	Other Information Services
5211	Monetary Authorities-Central Bank
5222	Nondepository Credit Intermediation
5223	Activities Related To Credit Intermediation
5231	Securities And Commodity Contracts Intermediation And Brokerage
5232	Securities And Commodity Exchanges
5239	Other Financial Investment Activities

5241	Insurance Carriers
5242	Agencies, Brokerages, And Other Insurance Related Activities
5251	Insurance And Employee Benefit Funds
5259	Other Investment Pools And Funds
5324	Commercial And Industrial Machinery And Equipment Rental And Leasing
5331	Lessors Of Nonfinancial Intangible Assets (Except Copyrighted Works)
5411	Legal Services
5413	Architectural, Engineering, And Related Services
5415	Computer Systems Design And Related Services
5416	Management, Scientific, And Technical Consulting Services
5417	Scientific Research And Development Services
5418	Advertising, Public Relations, And Related Services
5511	Management Of Companies And Enterprises
5611	Office Administrative Services
5622	Waste Treatment And Disposal
6211	Offices Of Physicians
6215	Medical And Diagnostic Laboratories
7112	Spectator Sports
7114	Agents And Managers For Artists, Athletes, Entertainers, And Other Public Figures
9011	Federal Government, Civilian
9029	State Government, Excluding Education And Hospitals

Middle-tier Industries

NAICS	Industry Name
1131	Timber Tract Operations
2123	Nonmetallic Mineral Mining And Quarrying
2213	Water, Sewage And Other Systems
2361	Residential Building Construction
2371	Utility System Construction
2373	Highway, Street, And Bridge Construction
2379	Other Heavy And Civil Engineering Construction
2382	Building Equipment Contractors
3113	Sugar And Confectionery Product Manufacturing
3114	Fruit And Vegetable Preserving And Specialty Food Manufacturing
3115	Dairy Product Manufacturing
3119	Other Food Manufacturing
3132	Fabric Mills
3133	Textile And Fabric Finishing And Fabric Coating Mills
3161	Leather And Hide Tanning And Finishing
3162	Footwear Manufacturing
3211	Sawmills And Wood Preservation
3212	Veneer, Plywood, And Engineered Wood Product Manufacturing
3222	Converted Paper Product Manufacturing

3231	Printing And Related Support Activities
3261	Plastics Product Manufacturing
3262	Rubber Product Manufacturing
3271	Clay Product And Refractory Manufacturing
3272	Glass And Glass Product Manufacturing
3273	Cement And Concrete Product Manufacturing
3279	Other Nonmetallic Mineral Product Manufacturing
3315	Foundries
3321	Forging And Stamping
3322	Cutlery And Handtool Manufacturing
3323	Architectural And Structural Metals Manufacturing
3324	Boiler, Tank, And Shipping Container Manufacturing
3325	Hardware Manufacturing
3326	Spring And Wire Product Manufacturing
3327	Machine Shops; Turned Product; And Screw, Nut, And Bolt Manufacturing
3328	Coating, Engraving, Heat Treating, And Allied Activities
3329	Other Fabricated Metal Product Manufacturing
3334	Ventilation, Heating, Air-Conditioning, And Commercial Refrigeration Equipment Manufacturing
3351	Electric Lighting Equipment Manufacturing
3352	Household Appliance Manufacturing
3362	Motor Vehicle Body And Trailer Manufacturing
3366	Ship And Boat Building
3372	Office Furniture (Including Fixtures) Manufacturing
3379	Other Furniture Related Product Manufacturing
3399	Other Miscellaneous Manufacturing
4231	Motor Vehicle And Motor Vehicle Parts And Supplies Merchant Wholesalers
4232	Furniture And Home Furnishing Merchant Wholesalers
4233	Lumber And Other Construction Materials Merchant Wholesalers
4237	Hardware, And Plumbing And Heating Equipment And Supplies Merchant Wholesalers
4238	Machinery, Equipment, And Supplies Merchant Wholesalers
4239	Miscellaneous Durable Goods Merchant Wholesalers
4241	Paper And Paper Product Merchant Wholesalers
4244	Grocery And Related Product Merchant Wholesalers
4249	Miscellaneous Nondurable Goods Merchant Wholesalers
4411	Automobile Dealers
4412	Other Motor Vehicle Dealers
4431	Electronics And Appliance Stores
4541	Electronic Shopping And Mail-Order Houses
4841	General Freight Trucking
4842	Specialized Freight Trucking
4851	Urban Transit Systems

4881	Support Activities For Air Transportation
4882	Support Activities For Rail Transportation
4885	Freight Transportation Arrangement
4911	Postal Service
4921	Couriers And Express Delivery Services
4931	Warehousing And Storage
5111	Newspaper, Periodical, Book, And Directory Publishers
5121	Motion Picture And Video Industries
5221	Depository Credit Intermediation
5311	Lessors Of Real Estate
5312	Offices Of Real Estate Agents And Brokers
5313	Activities Related To Real Estate
5323	General Rental Centers
5412	Accounting, Tax Preparation, Bookkeeping, And Payroll Services
5414	Specialized Design Services
5612	Facilities Support Services
5615	Travel Arrangement And Reservation Services
5619	Other Support Services
5621	Waste Collection
5629	Remediation And Other Waste Management Services
6114	Business Schools And Computer And Management Training
6115	Technical And Trade Schools
6117	Educational Support Services
6212	Offices Of Dentists
6213	Offices Of Other Health Practitioners
6214	Outpatient Care Centers
6219	Other Ambulatory Health Care Services
6221	General Medical And Surgical Hospitals
6222	Psychiatric And Substance Abuse Hospitals
6223	Specialty (Except Psychiatric And Substance Abuse) Hospitals
7113	Promoters Of Performing Arts, Sports, And Similar Events
8112	Electronic And Precision Equipment Repair And Maintenance
8113	Commercial And Industrial Machinery And Equipment (Except Automotive And Electronic) Repair And Maintenance
8132	Grantmaking And Giving Services
8139	Business, Professional, Labor, Political, And Similar Organizations
9026	Education And Hospitals (State Government)
9036	Education And Hospitals (Local Government)
9039	Local Government, Excluding Education And Hospitals
9999	Unclassified Industry

Bottom-tier Industries

NAICS	Industry Name

1110	Crop Production
1120	Animal Production
1132	Forest Nurseries And Gathering Of Forest Products
1133	Logging
1141	Fishing
1142	Hunting And Trapping
1151	Support Activities For Crop Production
1152	Support Activities For Animal Production
1153	Support Activities For Forestry
2381	Foundation, Structure, And Building Exterior Contractors
2383	Building Finishing Contractors
2389	Other Specialty Trade Contractors
3116	Animal Slaughtering And Processing
3117	Seafood Product Preparation And Packaging
3118	Bakeries And Tortilla Manufacturing
3131	Fiber, Yarn, And Thread Mills
3141	Textile Furnishings Mills
3149	Other Textile Product Mills
3151	Apparel Knitting Mills
3152	Cut And Sew Apparel Manufacturing
3159	Apparel Accessories And Other Apparel Manufacturing
3169	Other Leather And Allied Product Manufacturing
3219	Other Wood Product Manufacturing
3371	Household And Institutional Furniture And Kitchen Cabinet Manufacturing
4245	Farm Product Raw Material Merchant Wholesalers
4413	Automotive Parts, Accessories, And Tire Stores
4421	Furniture Stores
4422	Home Furnishings Stores
4441	Building Material And Supplies Dealers
4442	Lawn And Garden Equipment And Supplies Stores
4451	Grocery Stores
4452	Specialty Food Stores
4453	Beer, Wine, And Liquor Stores
4461	Health And Personal Care Stores
4471	Gasoline Stations
4481	Clothing Stores
4482	Shoe Stores
4483	Jewelry, Luggage, And Leather Goods Stores
4511	Sporting Goods, Hobby, And Musical Instrument Stores
4512	Book, Periodical, And Music Stores
4521	Department Stores
4529	Other General Merchandise Stores
4531	Florists

4532 Office Supplies, Stationery, And Gift Stores
4533 Used Merchandise Stores
4539 Other Miscellaneous Store Retailers
4542 Vending Machine Operators
4543 Direct Selling Establishments
4852 Interurban And Rural Bus Transportation
4853 Taxi And Limousine Service
4854 School And Employee Bus Transportation
4855 Charter Bus Industry
4859 Other Transit And Ground Passenger Transportation
4871 Scenic And Sightseeing Transportation, Land
4872 Scenic And Sightseeing Transportation, Water
4879 Scenic And Sightseeing Transportation, Other
4884 Support Activities For Road Transportation
4889 Other Support Activities For Transportation
4922 Local Messengers And Local Delivery
5321 Automotive Equipment Rental And Leasing
5322 Consumer Goods Rental
5419 Other Professional, Scientific, And Technical Services
5613 Employment Services
5614 Business Support Services
5616 Investigation And Security Services
5617 Services To Buildings And Dwellings
6111 Elementary And Secondary Schools
6112 Junior Colleges
6113 Colleges, Universities, And Professional Schools
6116 Other Schools And Instruction
6216 Home Health Care Services
6231 Nursing Care Facilities
6232 Residential Mental Retardation, Mental Health And Substance Abuse Facilities
6233 Community Care Facilities For The Elderly
6239 Other Residential Care Facilities
6241 Individual And Family Services
6242 Community Food And Housing, And Emergency And Other Relief Services
6243 Vocational Rehabilitation Services
6244 Child Day Care Services
7111 Performing Arts Companies
7115 Independent Artists, Writers, And Performers
7121 Museums, Historical Sites, And Similar Institutions
7131 Amusement Parks And Arcades
7132 Gambling Industries
7139 Other Amusement And Recreation Industries
7211 Traveler Accommodation

7212	Rv (Recreational Vehicle) Parks And Recreational Camps
7213	Rooming And Boarding Houses
7223	Special Food Services
7224	Drinking Places (Alcoholic Beverages)
7225	Restaurants And Other Eating Places
8111	Automotive Repair And Maintenance
8114	Personal And Household Goods Repair And Maintenance
8121	Personal Care Services
8122	Death Care Services
8123	Drycleaning And Laundry Services
8129	Other Personal Services
8131	Religious Organizations
8133	Social Advocacy Organizations
8134	Civic And Social Organizations
8141	Private Households
9012	Federal Government, Military