EMPLOYMENT AND DRUG-RELATED MORTALITY

by

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The following individuals read and discussed the thesis submitted by student Trung Minh Pham, and they evaluated the student's presentation and response to questions during the final oral examination. They found that the student passed the final oral examination.

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ABSTRACT

In the last two decades, there has been a downturn in labor force participation. One research approach to explain the downturn is death by despair—a recent topic in economics on pain and preventable deaths caused by alcohol, drugs and suicide. This thesis hopes to add to the death by despair literature by exploring the effect of employment on drug-related mortality through empirical investigation across 17 demographic groups—accounting for age, education, gender, and race—from 2011 to 2018, and covering all 50 US states along with the District of Columbia. Different estimations of population (demographic groups, gender and state total) are used to explore the subtleties for each demographic group. Under the employment-to-population ratios using state total populations and logarithm considerations of employment, empirical results mostly align with existing literature; that is, increases to employment lowers mortality rate. The main approach of this thesis is the use of Bartik shift-share instruments to account for reverse causality of mortality on employment. Through this method, we find that demographic groups respond differently to the national average growth rate versus local growth rates of employment. This thesis aims to contribute to the literature with an example of how the Bartik instrument may be applied to identify differences between local and national employment growth rates and associated mortality.

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LIST OF ABBREVIATIONS

2SLS	Two-stage least squares
AMM	Adult medical marijuana
ASEC	Annual Social and Economic Supplement
BED	Business Employment Dynamics
BLS	Bureau of Labor Statistics
CDC	Centers for Disease Control and Prevention
CPS	Current Population Survey
LAUS	Local Area Unemployment Statistics
LED	Local Employment Dynamics
LEHD	Longitudinal Employer-Household Dynamics
MCD	Multiple Causes of Death
NAICS	North American Industry Classification System
OLS	Ordinary least squares
PDMP	Prescription drug monitoring program
QWI	Quarterly Workforce Indicator

CHPATER 1: INTRODUCTION

The focus of this thesis is employment and drug-related mortality, which represents a shock to the labor supply. The specific focus on drugs narrows the focus of this thesis to the death by despair subject in economics. Death by despair is a broad collection of recent research literature in economics, all of which is generally associated with mortality related to alcohol, drugs, and suicides that are perceived as preventable. Case and Deaton (2015) started the conversation with a qualitative study highlighting an increase in morbidity of middle-age (45 to 54) non-Hispanic Whites in the US related to an "epidemic of pain, suicide, and drug overdoses" (p. 15081). They noted that there is a widening of income inequality and slowdown of real median earnings growth for the aforementioned demographic group. In a follow-up descriptive study, Case and Deaton (2017) found that males born in 1970 or later were more likely to experience negative outcomes in terms of drug overdoses, marriage (they were not or had never married), and labor force detachment than older generations. These findings were more severe for males than for females.

With regard to the economy as a whole, the death-by-despair narrative helps to explain the drastic decline in labor force participation. According to US BLS data, prime-age (25 to 54) male participation in the labor force has been in steady decline since the 1940s. This has been substituted by an increase in female prime-age workforce participation. By early year 2000, however, labor force participation was declining for both genders.

Krueger (2017) speculated that the cause for the decline in labor force participation may have to do with physical disability and pain. According to US Census CPS data, between 2009 and 2017 some 33.7% of males not in the labor force reported having some kind of disability. Based on the American Time Use Survey Well-Being Module data, Krueger (2017) also reported that 43% of prime-age males and 31% of prime-age females who are not in the labor force reported their health status as being "fair" or "poor." For males, this figure was 2.6 times higher than that of unemployed males (those currently not working, but are actively seeking work and are available for work) and 3.5 times higher than employed males. They also reported an average pain rating of 1.96, based on a scale of 1 to 6, and stated they spent 53.2% of their day in pain. Moreover, 43.5% reported the use of pain medication on the previous day. For the past two decades, pain has been on the rise and prime-age males have been resorting to opioids (prescription analgesics and others) to alleviate pain. These evidences support that pain may be a cause for abstaining from labor force participation.

With pain as the underlying cause and opioid usage as the observable outcome and proxy for pain, the death-by-despair narrative has also been called the "opioid epidemic" or "opioid crisis." Much literature exists relating to this aspect of the subject. Schnell (2017) focused on the opioid primary legal and secondary illegal markets, and found overprescribing behavior among physicians in the US. Powell, Pacula, and Jacobsen (2018) researched marijuana legislation, and found that states with legal access to marijuana had fewer opioid overdose deaths. Currie, Jin, and Schnell (2019) found a weak relation between opioid prescriptions and employment. Ruhm (2019) found that declines in local (county-level) economic conditions correlated with an increase in mortality rates for all drug-related deaths. From 2010 to 2015, the demographic of males aged 20 to 39 saw an upward skew of illicit opioid deaths substituting opioid analgesic deaths. Regarding public policies and death by despair, Dow et al. (2020) found no significant relations between minimum wages or earned-income tax credit policies and "at-risk" demographic groups. Maclean, Horn, and Cantor (2020) examined supply and demand for substance abuse treatment. They found that the admission rates for all drugs did not vary across the business cycle. These examples serve to provide an overview of a problem related to pain and drug abuse behavior that may adversely affect the labor market.

In this thesis, the aim is to find evidence for the impact of employment on non-homicide, drug-related (overdose poisoning) mortality. Although mortality represents a permanent exit from the labor force, analysis is complicated by the issue of reverse causality. That is, drug-related mortality may have an influence on the employment outcomes of surviving workers. Our use of employment data for all 50 states and the District of Columbia helps to avoid a matching problem of accounting for employers replacing lost workers. However, the possibility remains that mortality may create job openings that surviving workers could fill. In this case, an increase in mortality would lead to an increase in employment. At the same time, deceased workers cannot by definition work, so we observe a smaller labor supply.

We can attempt to adjust for this reverse causality in two methods. First, we lag the employment variables with the crude rate of mortality (per 100,000 population) as the dependent variable. Second, we then include control variables and fixed effects, and remove the period lag (of one year) for a more elaborate instrumented specification. We repeat this process for all 17 demographic groups—accounting for age, gender, race, and educational attainment.

In accordance with the existing literature on the topic of death by despair, we hypothesize that a downturn in macroeconomic conditions—represented by a proxy decrease in employment—contributes to despair mortality, especially for males and less educated demographic groups. We control for the complex effects of reverse causality by using the Bartik shift-share instrument to project national employment growth rate average onto local shares of employment. This way, we are able to better measure the effects of employment on non-homicide drug-related mortality.

Our results for employment-to-population ratio using state total population and logarithm transformation of employment are largely consistent with the existing literature. We find that increases in the employment level would decrease the crude rate of mortality for less educated demographic groups and all workers under the age of 55. We also find that average national employment growth rates differ from local conditions. This is especially true for our considerations of demographic groups by educational attainment. This difference between the national average and local employment growth rates may compromise the integrity of our instrument by violating one of its assumptions, as explained below. In this regard, we can state that national trends may better reflect existing findings in the literature than employment growth rates at the local level.

Our results for the employment-to-population ratios using state demographic group population specification are ambiguous and are herein included for full disclosure.

The rest of this thesis comprises the following: Chapter 2 describes the Bartik shift-share instrument; Chapter 3 explains the methods behind the empirical investigation; Chapter 4 presents the data we use; and Chapter 5 outlines the regression results. Lastly, Chapter 6 discusses the findings and implications of this thesis, and presents a conclusion.

CHAPTER 2: BARTIK SHIFT-SHARE INSTRUMENT

The Bartik instrument is a specific type of shift-share analysis that combines a local share with an exogenous shifter. This is to control for the reverse causality problem in some cases of economic analysis. The instrument was proposed by Bartik (1987) as a critique of the Rosen-Freeman approach to the marginal bid function and choice of instrument, outlined by Rosen (1974) and Freeman (1979). Bartik (1991) used the shift-share instrument in a more formalized manner with the interaction between national industry employment growth rate averages and local metropolitan statistical area employment shares to address the problem that important local (metropolitan statistical area) determinants may be endogenously determined by business growth.

Blanchard and Katz (1992) referred to the instrument as a “mix variable” and point out that “the assumption [is] that each of the state’s [Standard Industrial Classification] two-digit industries had the same employment growth rate as the national average employment growth rate for that sector” (p. 61). This assumption is a problem for using this instrument in most contexts. For example, few states have a strong presence of NAICS Sector 21 (mining, quarrying, and oil and gas extraction), so national data relating to this sector is often not relevant at the local level.

Therefore, in this thesis, we also violate this assumption that the local and national growth rates are synonymous. It is uncertain how severe the consequence of the violation is as other researchers have used the Bartik instrument without commenting on the assumption of homogeneity mentioned by Blanchard and Katz (1992). Certainly, in the context of this thesis, the instrument guarantees the exogeneity of our employment variable. Local drug-related mortality does not have an influence on the average national growth rate of employment. That is, unless a state were to have a large-enough population for its employment rates to influence national employment average growth rates estimated from 19 NAICS 2-digit sectors. We do not believe this to be the case.

The traditional approach to using this shift-share instrument by Bartik (1991) and Blanchard and Katz (1992) could be defined simply as a weighted sum,

$$w_{jt} = \sum_{s \in sector} w_{sjt-1} \cdot g_{st},$$

of the share of employment w at location j in the previous period, $t - 1$, and the national employment growth rate g of a sector s to determine local weighted employment estimates in the current period. As a side note, Bartik (1991) considered up to eight periods to evaluate cumulative effects.

A variation of the shift-share instrument from Card (2001, 2009) assumes a constant elasticity of substitution between local and migrant workers to shift local shares of migrant workers with national immigration rates. In this context, the instrument for migration m is defined as a weighted average,

$$m_{jt} = \sum_{o \in origin} \frac{m_{ojt=0}}{m_{ot=0}} \cdot \frac{\Delta m_{ot}}{p_{jt-1}},$$

for the share of migrants from origin o at location j in reference period $t = 0 < t$ and the shifter is the national number of new arrivals Δm_{ot} divided by the local population in the preceding period p_{jt-1}.

More recently, some researchers have suggested a switch from the use of growth rate shifters to industry share shifters. In a working paper, Goldsmith-Pinkham, Sorkin, and Swift (2019) suggested that instead of using the national growth rate, *k-1* industry shares should be used as the instruments. Moreover, these instruments should be used in tandem with Rotemberg (1983) weights for overidentified specifications (from the exactly identified submodels). On the other hand, Adão, Kolesár, and Morales (2020) noted that the use of Rotemberg weights was only necessary if the shares were to be exogenous to the base equation. Adão, Kolesár, and Morales also further relaxed the assumptions of this instrument to allow for the employment of any individual sector to not be "too large" at the national level in the initial period ($t = 0$). We mention these recent critiques calling for amendments to the Bartik instrument as a precaution that there may be other errors associated with our use of the instrument in this thesis.

For the purpose of our instrumented regressions, validity of an instrument depends on whether the instrument is uncorrelated with the local shock to labor supply and is relevant to the employment variables of interest. In this thesis, the national growth rate of employment within specific economic sectors is used to shift the local (state) share of employment. In short, our use of the instrument is to satisfy rudimentary assumptions of exogeneity to the base regression functions and correlated with the endogenous independent variable (employment).

Our use of the Bartik instrument is inspired by a working paper by Currie, Jin, and Schnell (2019), whose design followed a basic presentation of the traditional shift-share instrument in Goldsmith-Pinkham, Sorkin, and Swift (2019),

$$Bartik_{jt} = \sum_{s} w_{jst=0} \cdot g_{st}.$$

The instrument is a sum of the local share of employment w in a reference period $t = 0$ with the national employment growth rate g of a sector s as the shifter. This is similar to the original method commented upon above. Fixing the shares to an initial period instead of a preceding period enables cross-sectional comparison of the labor market shock period. (For this thesis, that shock period is 2011 to 2018.)

CHAPTER 3: METHODS

For this thesis, we explore the effects of employment on drug-related mortality for specific demographic groups at the state level (including the District of Columbia, and hereafter referred to as "states" in aggregate) for the period 2011 to 2018. For each demographic group, we conduct regression analyses with respect to the state's demographic group population (employed and not employed), the state's total population, and the natural log of employment count.

From the regressions of employment-to-population ratios using demographic group population on crude mortality rate (death count per 100,000 population), we can address the effect on mortality of an increase in the percentage of the demographic group employed. Under this specification, our variable of interest exhibits an employment-to-population ratio exceeding 100% in some situations. Whether this error in our data is due to the US Census QWI including out-of-state employees in its employment counts, or whether the US Census CPS ASEC otherwise misrepresents the population data for each state, is uncertain.

Since the estimates for this specification sometimes include employment-to-population ratios greater than 100%, we use employment-to-population ratios with state total population and log of employment counts as additional checks. In this specification of employment-to-population using state total employment, the variable of interest is the percentage of employed persons of a demographic group in the state's total population. Without limiting the percentage to only a given demographic group, our empirical results allow for a broader interpretation of the demographic group with respect to the rest of the population.

The regressions with natural log of employment on the crude mortality rate allow for a similar interpretation as for the employment-to-population ratio using the state demographic group population. Using these linear-logarithmic regressions, we can examine how a 1% increase in the count of employed persons of a demographic group affects the crude mortality rate of that demographic group. The results of these empirical estimations permit us to compare to specification employment-to-population ratio with state demographic group populations. We note here that this is not a robustness check of our analyses.

Under each specification, we conduct five OLS regressions and one instrumented regression using the Bartik instrument to obtain an accurate estimation of the effect of employment on mortality. These are explained and defined as follows.

First, the simplest approach to accounting for reverse causality is to lag the variable of interest (employment) and regress on the crude mortality rate. For the employment-to-population ratios using state demographic group populations, the regressions are

$$Mortality_{ijt} = \beta_0 + \beta_1 \frac{Employment_{ijt-1}}{Population_{ijt-1}} + \epsilon_{ijt}, \quad (1)$$

where the crude mortality rate of demographic group *i* of state *j* in year *t* is regressed with a one-year lag of the employment-to-population ratio, and ϵ is the error term. This simple regression contains only one variable and provides a straightforward understanding from the coefficient β_1—the effect of employment-to-population ratio on mortality.

When we change the employment specification to use the state total population ratio, the population in the denominator of the above equation (1) becomes $Population_{jt-1}$. Each demographic group of any given state has the same state total population. We adjust the crude mortality rate dependent variable to use state total population as well.

For the linear-logarithmic specification, the regression from equation (1) becomes

$$Mortality_{ijt} = \beta_0 + \beta_1 \ln Employment_{ijt-1} + lnPopulation_{jt-1} + \epsilon_{ijt}. \qquad (2)$$

These regressions highlight the effect of a 1% increase in employment of a demographic group on the crude mortality rate of that demographic group. Here, we include the log of state total population as a control variable. The crude mortality rates of the linear-log regressions use state total populations. In the results section below, the OLS1 columns show the empirical findings of equations (1) and (2).

From the simple OLS, we include control variables to minimize unobservable characteristics of each state. Equation (1) becomes

$$Mortality_{ijt} = \beta_0 + \beta_1 \frac{Employment_{ijt-1}}{Population_{ijt-1}} + \boldsymbol{X}_{jt}\boldsymbol{\gamma} + \epsilon_{ijt}, \qquad (3)$$

and equation (2) becomes

$$Mortality_{ijt} = \beta_0 + \beta_1 \ln Employment_{ijt-1} + \boldsymbol{X}_{jt}\boldsymbol{\gamma} + \epsilon_{ijt}. \qquad (4)$$

$\boldsymbol{X}$ is a matrix of control variables (including the log of population for equation (4) regressions) and $\boldsymbol{\gamma}$ is a vector of corresponding coefficients. In this thesis, the control variables are the unemployment rate, the net number of establishment births, the percentage of female adults aged 25 and older, the percentage of White adults aged 25 and older, the percentage of college graduates, the percentage of persons in poverty, and legislation variables for prescription drug monitoring and medical marijuana. The results of equations (3) and (4) are below under the OLS2 columns.

From equations (3) and (4), we include fixed effects to better account for state characteristics (such as culture) that our control variables may not be able to adequately account for. For these regressions, we no longer lag the variable of interest (employment) because in one set of regressions we include only entity fixed effects (for states), while in the next we add time fixed effects for 2012 to 2018. When time is controlled for, there is no longer a need to lag the variable of interest. Equation (3) becomes

$$Mortality_{ijt} = \beta_1 \frac{Employment_{ijt}}{Population_{ijt}} + \boldsymbol{X}_{jt}\boldsymbol{\gamma} + state_j + \epsilon_{ijt}, \tag{5}$$

with the inclusion of entity fixed effects, and

$$Mortality_{ijt} = \beta_1 \frac{Employment_{ijt}}{Population_{ijt}} + \boldsymbol{X}_{jt}\boldsymbol{\gamma} + state_j + time_t + \epsilon_{ijt}, \tag{5'}$$

with the inclusion of time fixed effects. Equation (4) becomes

$$Mortality_{ijt} = \beta_1 \ln Employment_{ijt} + \boldsymbol{X}_{jt}\boldsymbol{\gamma} + state_j + \epsilon_{ijt}, \tag{6}$$

with the inclusion of entity fixed effects, and

$$Mortality_{ijt} = \beta_1 \ln Employment_{ijt} + \boldsymbol{X}_{jt}\boldsymbol{\gamma} + state_j + time_t + \epsilon_{ijt}, \tag{6'}$$

with the inclusion of time fixed effects. Equations (5) and (6) correspond to OLS3. Likewise, equations (5’) and (6’) correspond to OLS4.

One additional consideration we make to the control variables concerns legislation. Not every state has implemented prescription drug monitoring and medical marijuana laws. For states that have implemented such policies, the years of implementation are different. To determine whether these policies may have any influence on employment, we must consider them as binary and trend variables. In OLS2, OLS3 and OLS4, we regress with policy variables as binary. $AMM_{jt} = 1$ if the state has an adult medical marijuana law and 0 if not. Similarly, $PDMP_{jt} = 1$ if the state has a prescription drug monitoring program and 0 if otherwise. In OLS5 and 2SLS we regress with the two variables as trends with the year implemented as 0 and increasing sequentially (for example, up to the 79th year for California). The results of OLS4 and OLS5 are comparisons of the differences between evaluation of the policy variables as binary figures versus trends.

As we noted above, there is a reverse causality concern as to whether the shock of mortality influences the employment decisions of surviving workers. To account for this, we use the Bartik shift-share instrument to apply the national average employment growth rate to local shares of employment. For our empirical investigation of the period 2011 to 2018, we use employment counts of base year 2010 as the "share" portion and the average growth rate of US employment since 2010 as the "shift." What makes this method a Bartik instrument is the fact that we use the weighted sum by NAICS 2-digit sectors. Formally, our instrument is defined as

$$Bartik_{ijt} = \sum_{s \in sector} Employment_{sijt=2010} \cdot \frac{USEmployment_{sijt}}{USEmployment_{sijt=2010}}.$$

This instrument is used in the first-stage regression on employment,

$$\frac{Employment_{ijt}}{Population_{ijt}} = \alpha_1 \frac{Bartik_{ijt}}{Population_{ijt}} + \boldsymbol{X}_{jt}\boldsymbol{\gamma} + state_j + time_t + \omega_{ijt}, \qquad (7)$$

for the employment-to-population ratio with state demographic group population. Again, when considering state total population, the regressions use $Population_{jt}$ in the denominator instead of $Population_{ijt}$. The first-stage regressions for the log of employment are

$$\ln Employment_{ijt} = \alpha_1 \ln Bartik_{ijt} + \boldsymbol{X}_{jt}\boldsymbol{\gamma} + state_j + time_t + \omega_{ijt}, \qquad (8)$$

with the population variable included in $\boldsymbol{X}$. To make a distinction from the main empirical estimations, we denote the error term in the first-stage of 2SLS regressions as ω. Control variables and fixed effects are included appropriately.

First-stage results are not presented in this thesis. For all three specifications, the first-stage results for the employment variables are positive. We can interpret the second-stage results without needing to change the signs (positive or negative) of the coefficients. With regards to statistical significance of our first-stage results for 51 regressions, 50 have F-statistics greater than 10. The exception is the demographic group of males with some college education under the specification of state total population ratio, which has $F = 5.90$. As for t-test considerations, we have 50 results that are statistically significant at the 5% level or higher and one statistically significant at the 10% level. This is for the demographic group of females with less than high school education under the state total population ratio specification. With respect to econometric evaluation, our Bartik instruments are valid. Please note that the second-stage (instrumented) regressions essentially have the same functional forms as equation (5') for state demographic population ratios, as equation (5') but for the use of $Population_{jt}$ for state total population ratios, and as equation (6') for the logarithm specification.

Complete validity of the instrument, however, may not hold as our findings may violate the assumption that the US employment growth rate is the same as local employment growth rates. The 2SLS results differ greatly from the OLS5 results: in coefficient magnitude, for total employment on total crude mortality rate, and in sign reversal, for the specific demographic groups. These findings suggest that the national growth rate differs from local employment growth rates. In other words, while the Bartik instrument is valid in that it is exogenous (i.e., the national average employment growth rate is not affected by the local shock of drug-related mortality) and relevant to the local share of employment, we violate the instrument's inherent assumption of trend similarities. The consequence of violating this assumption is that our results no longer reflect local changes to employment and may misestimate the effects of employment on mortality.

CHAPTER 4: DATA

For the purpose of this thesis, demographic groups are defined by age, gender, race, and education. Age-wise, “young workers” are 19 to 24, “prime-age workers” are 25 to 54, and “older workers” are 55 or older. Race includes non-Hispanic Whites (hereafter referred to as “Whites”) and non-Hispanic Blacks (hereafter referred to as “Blacks”) and White Hispanics (hereafter referred to as “Hispanics”). Educational attainment levels include: less than high school; high school only; some college with no degree; and college graduate or advance degree. In total, this thesis looks at 17 demographic groups.

Non-homicide drug-related (poisoning overdose) mortality (hereafter referred to as “mortality”) data are obtained from the Centers for Disease Control and Prevention, from the WONDER MCD 1999 to 2019 dataset. These counts are based on death certificates issued at the county level. The publicly available data for drug/alcohol induced causes that we use in this thesis suppresses the death counts in some instances. In this regard, the results of this thesis may not accurately reflect the impact of employment on mortality.

Age, gender, and race are the only options available for selection. As we do not have data that considers the educational attainment of the deceased, for regressions on education, we use total death counts by gender to estimate the effect of educational attainment of workers on mortality. The descriptive statistics for mortality counts are given in Table 4.1 below.

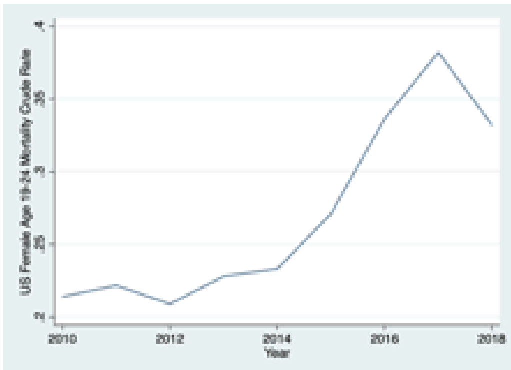
Table 4.1 Summary Statistics of Mortality Counts of Demographic Groups

Variable:	N	Mean	Standard Deviation	Minimum	Maximum
Female					
Total	453	372.011	371.2988	11	1740
Age 18 to 24	257	29.89883	21.65527	10	142
Age 25 to 54	452	259.6416	248.9702	11	1282
Age 55 and older	423	102.7872	110.7551	10	705
Male					
Total	455	645.156	714.1679	15	3702
Age 18 to 24	348	64.27586	54.84528	10	287
Age 25 to 54	455	463.0527	503.4462	15	2800
Age 55 and older	429	141	171.8894	10	1253
Race					
White	452	841.4314	834.1585	10	4465
Black	301	159.4983	159.5558	10	829
Hispanic	225	149.9156	213.9739	10	1249

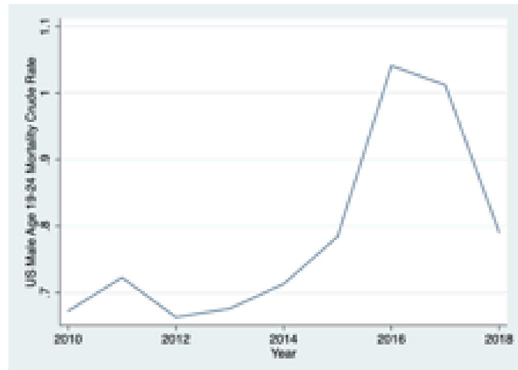
Notes: These mortality counts are from the CDC, WONDER MCD 1999 to 2019 at the state level for the above categories: age, gender, and race. The classification of death is non-homicide drug poisoning overdose. All counts below 10 are suppressed for privacy reasons.

The number of observations **N** in the Table 4.1 above covers the period 2010 to 2018. Our regressions cover 2011 to 2018 and use 2010 as the base year. Therefore, we have fewer than 408 observations. On a related note, the suppression of publicly available CDC mortality data conceals all counts under 10. Therefore, in this thesis, we do not know if values less than 10 are suppressed or are zero. Consequently, this may lead to fewer observations in our empirical estimations.

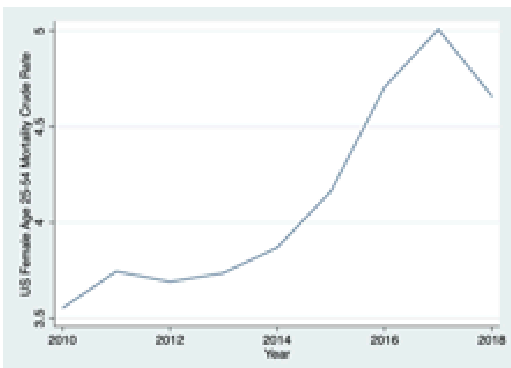
The following figures present aggregations of mortality rates per 100,000 population of the US for nine demographic groups, based on Table 4.1. The first six (Figure 4.1a) show age groups for both genders, while the last three (Figure 4.1b) show race. Graphically, younger adults (age 54 and under) and White adults showed comparatively lower mortality rates between 2010 and 2018. At the same time, both figures below also show that these demographic groups have been abstaining from employment. As there is no educational attainment consideration for mortality count, there is no US educational attainment mortality equivalent for Figure 4.2c. We observe that, overall, fewer people are working and mortality is lowering.



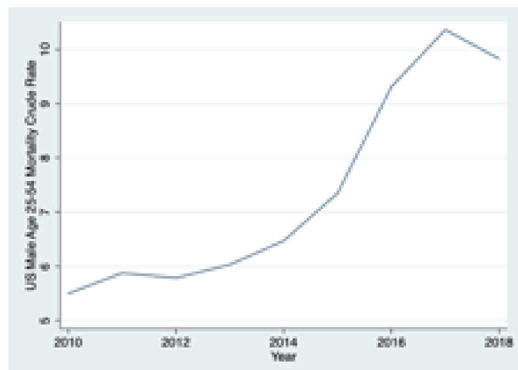
US Female Young Adults Mortality



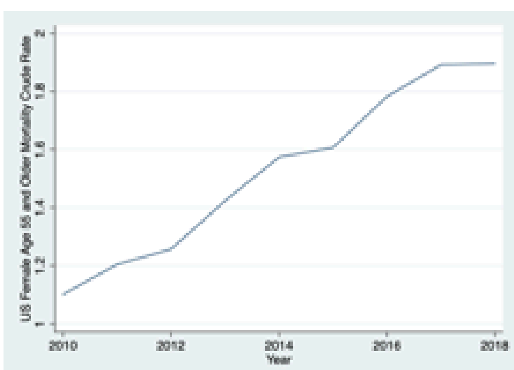
US Male Young Adults Mortality



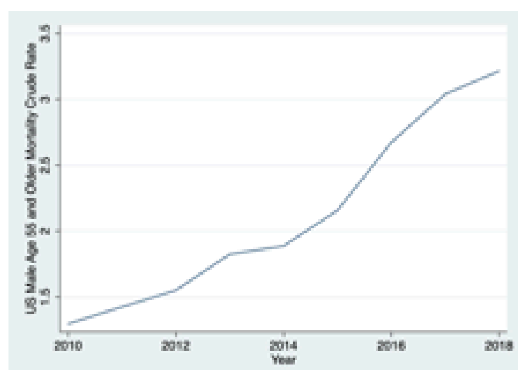
US Female Prime Age Adults Mortality



US Male Prime Age Adults Mortality

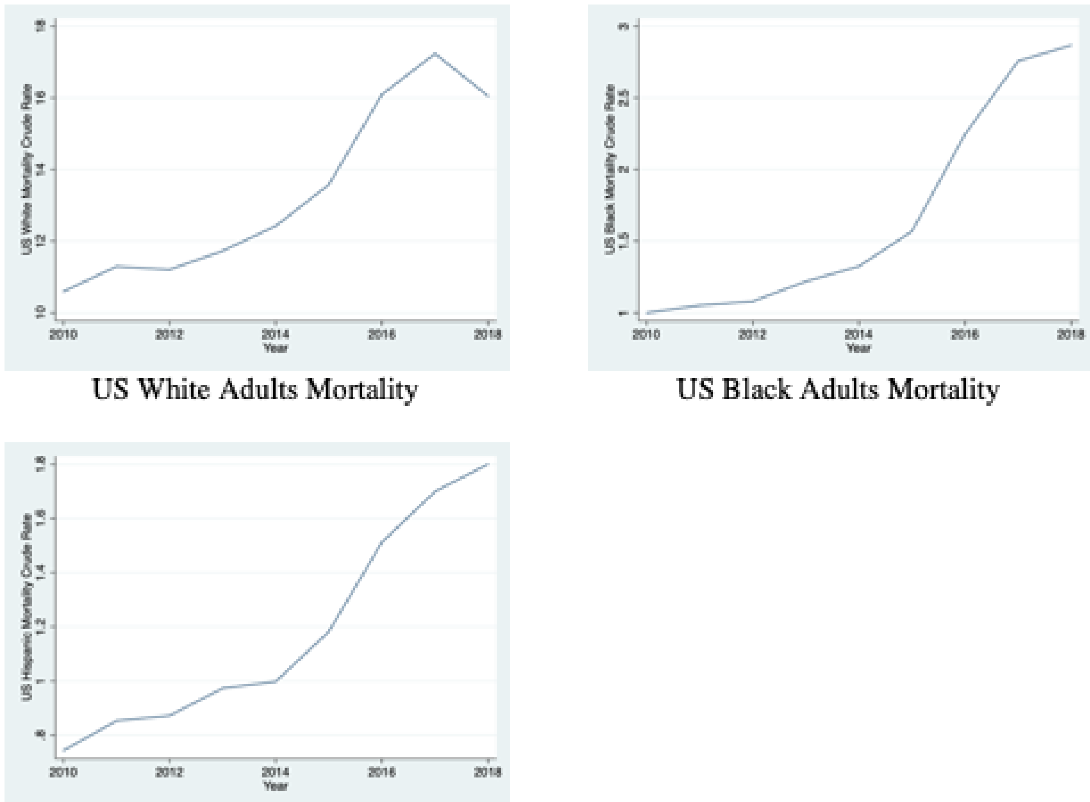


US Female Older Adults Mortality



US Male Older Adults Mortality

Figure 4.1a US Crude Mortality Rates, 2010-2018



US White Adults Mortality

US Black Adults Mortality

US Hispanic Adults Mortality

Figure 4.1b US Crude Mortality Rates, 2010-2018

The employment counts from the US Census QWI we use in this thesis are stable counts of persons who were employed for the entire quarter. This data is retrieved from the LED Extraction Tool. These are workers counted on the first and last days of a given quarter. These counts are often for employment for the full quarter, though not necessarily full-time employment (for example, substitute teachers). The QWI data is from employers at the county level recording the number of employees by age, race, ethnicity, and educational attainment as part of the LED Partnership under the LEHD program. We use 2010 as the base year, $t = 0$, because that is the start of the most complete counts of stable quarterly employment. Even so, we are missing some estimates. Massachusetts is missing counts for the first quarter of 2010. Alaska is missing counts for 2016 to 2018. Arkansas and Mississippi are both missing counts for 2018. We average the counts accordingly for each state by year. All counts of educated workers are for persons aged 25 and older because the census marks the educational attainment of younger workers as undefined. Whether race and gender data also exclude workers who are 24 years old or younger is unknown. Table 4.2, below, shows the summary statistics for employment counts.

Aggregating the counts of Table 4.2 up to national level, we derive Figures 4.2a, 4.2b and 4.2c, corresponding to age, race, and educational attainment, respectively. For a comparison of employment and mortality, Figure 4.1a corresponds to 4.2a and 4.1b corresponds to 4.2b.

Table 4.2 Summary Statistics of Employment Counts of Demographic Groups

Variable:	N	Mean	Standard Deviation	Minimum	Maximum
Female					
Young workers	454	110,083.1	118,460.3	9,175	657,852.5
Prime-age	454	773,938.8	853,701.5	68,617	4,894,203
Older workers	454	263,660	281,831.2	23,806.25	1,720,185
Male					
Young workers	454	101,528.3	111,385.6	8,874.5	632,672.5
Prime-age	454	790,849.7	891,297.4	76,529.25	5,208,165
Older workers	454	263,167.1	288,052.3	25,096.25	1,820,881
Race					
White	454	1,553,622	1,365,981	85,634.25	6,085,123
Black	454	274,398.3	325,608.4	1,243.75	1,338,389
Hispanic	454	289,163.5	700,058	2,604.75	4,600,726
Female					
Less than high school	454	119,895.6	175,273.5	5,553.25	1,169,566
High school	454	263,907.4	259,923.1	27,098.5	1,365,084
Some college	454	344,802.2	361,756	35,752	2,039,318
College graduate or higher	454	308,993.4	352,790	22,844.25	2,040,420
Male					
Less than high School	454	146,250.4	207,498.5	8,908	1,358,040
High school	454	289,049.7	281,294.5	34,934.5	1,509,033
Some college	454	314,942.2	343,498.7	31,556.75	2,027,007
College graduate or higher	454	303,774.6	36,1806.3	21,572	2,134,966

Notes: These stable employment counts are from the US Census QWI. The counts of young workers are for persons aged 19 to 24. For educational attainment, we have counts for persons aged 25 and older because all persons aged 24 and younger are marked as undefined. We do not know the ages of our employment counts by race. All quarterly counts, when available, are averaged annually.

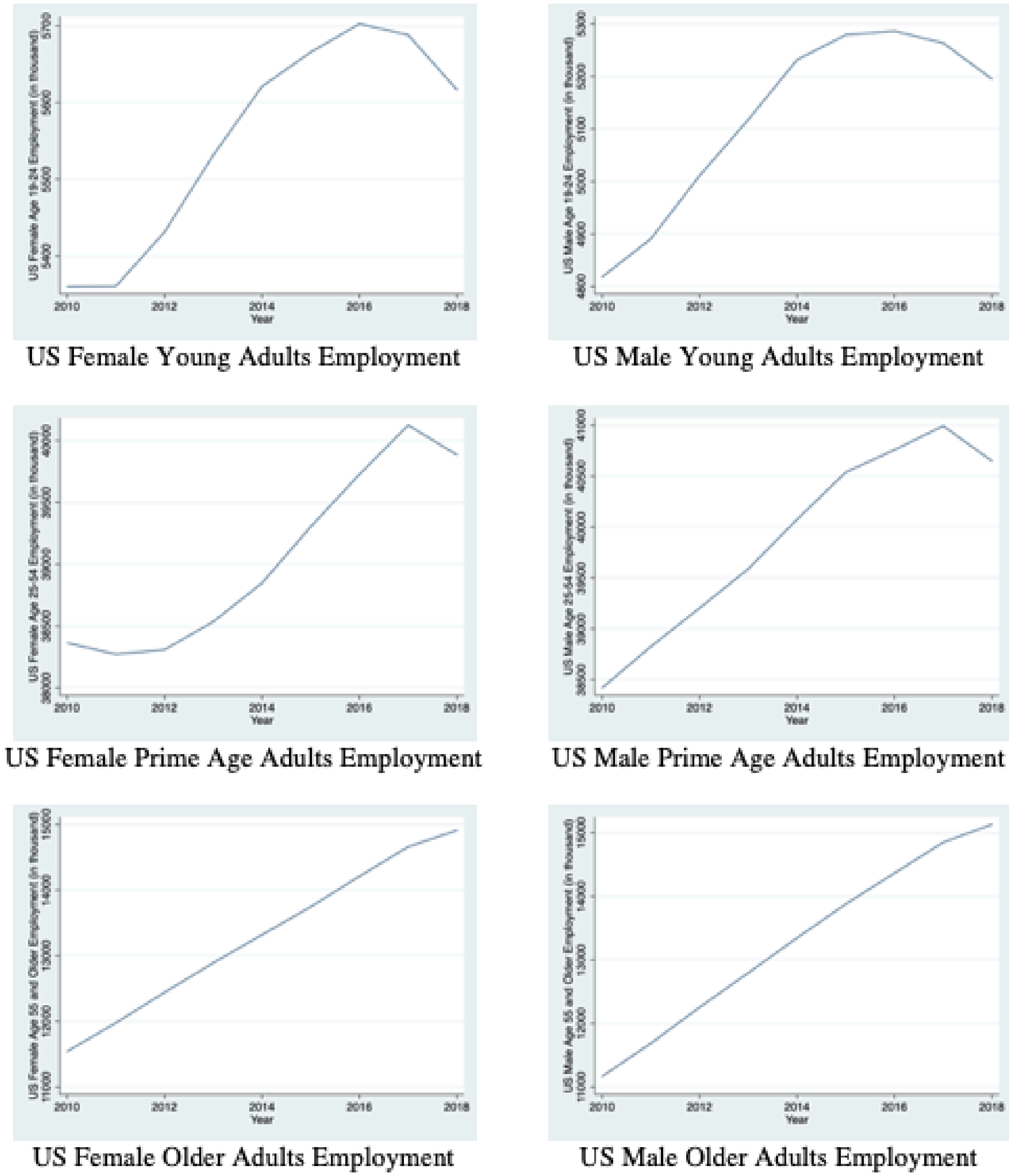
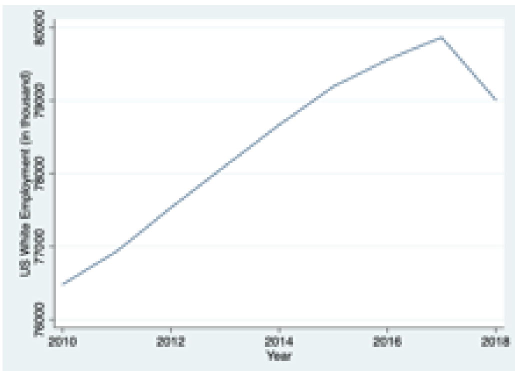


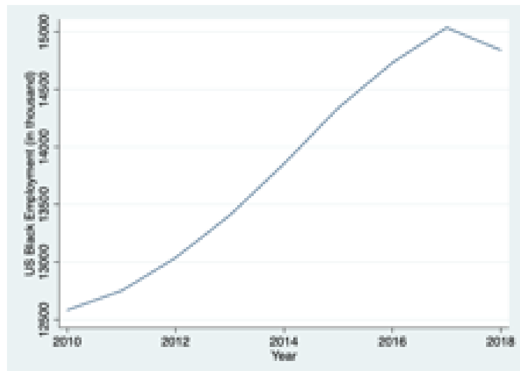
Figure 4.2a US Employment Counts, 2010-2018

The trends in Figure 4.2a are similar to Figure 4.1a. Both show that older workers have been working more and also have higher mortality than younger workers at the national level. Racially, we observe a decline in Black employment counts after 2017, which does not match the increase in the mortality rate (Figure 4.1b) for the same period.

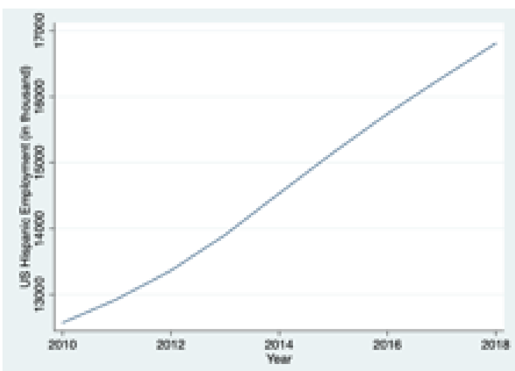
Hispanic employment is fairly consistent, unlike the mortality rates. We note again that mortality counts from the CDC MCD dataset are suppressed, which may result in an incorrect observation of mortality. From what we can observe graphically, the overall trends are similar for employment and mortality.



US White Adults Employment



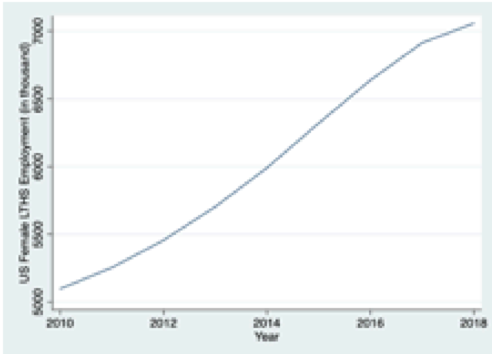
US Black Adults Employment



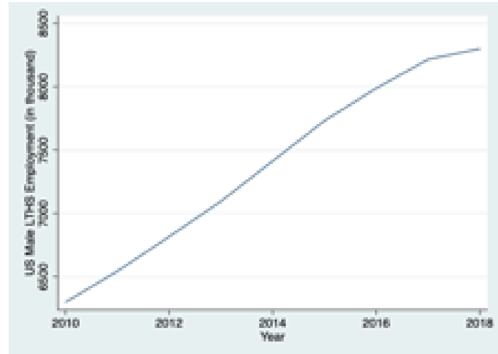
US Hispanic Adults Employment

Figure 4.2b US Employment Counts, 2010-2018

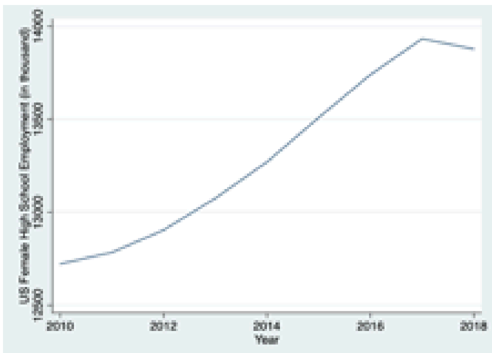
We include Figure 4.2c for an observation that employment trends are similar across the demographic groups. There is an upward trend with a decline after 2017. Only young workers have an earlier decline after 2016.



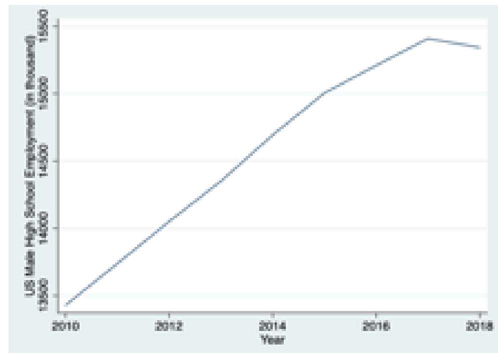
US Female LTHS Employment



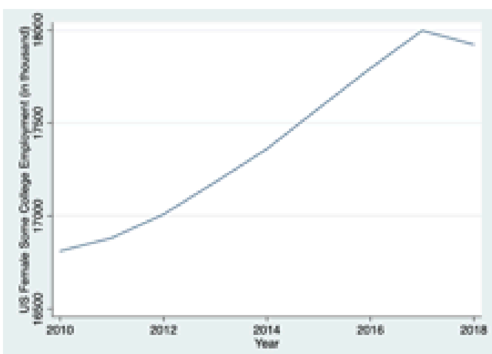
US Male LTHS Employment



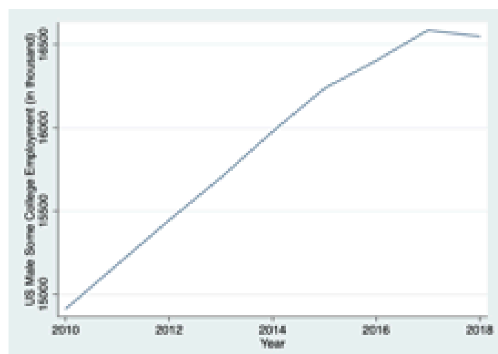
US Female High School Employment



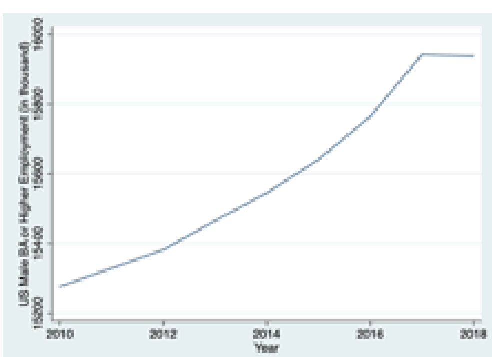
US Male High School Employment



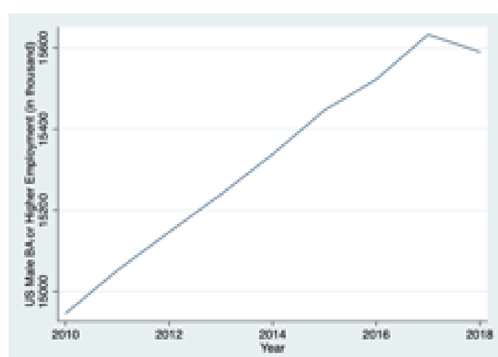
US Female Some College Employment



US Male Some College Employment



US Female BA or Higher Employment



US Male BA or Higher Employment

Figure 4.2c US Employment Counts, 2010-2018

As noted above, this thesis uses two population estimates. Estimates of demographic group populations are from the US Census CPS ASEC dataset: the data files we use are from the Center for Economic and Policy Research. State total population estimates are from data tables of the US Census Income and Poverty in the United States. All of our variables of state demographic characteristics (in percentages) are based on these two estimates of population. The poverty count we use is for persons whose reported incomes are below 100% of the federal level of poverty. Our percentages in the state total population of females, Whites, and persons with a Bachelor's degree or higher (all from CPS ASEC) are for people aged 25 or older.

For our economic control variables, we use the unemployment rate and the net number of establishment births. Our unemployment rate data is from US BLS LAUS. We take the annual average of the monthly unemployment rate of each state for every year for our variable. Our net number of establishment births are the annual average of the quarterly difference between the number of establishment births and the number of establishment deaths. Our quarterly establishment counts are from the US BLS BED dataset.

To control for some legislation, we use two policy variables from the Prescription Drug Abuse Policy System of the National Institute on Drug Abuse. For medical marijuana laws (AMM) authorizing legal use for adult patients, we assign a value of 1 if the state has such legislation in a given year and 0 if otherwise. We code prescription drug monitoring program (PDMP) legislation in the same way. To test whether these policies have a progressive influence to our employment variables, we also code AMM and PDMP as trends. For these trend variables, we assign the first year the policy is enacted as 0 and increase sequentially for subsequent years. We find the results of our employment variables do not differ greatly between the use of policy variables as binary figures or trends.

Table 4.3 Summary Statistics of Mortality Counts of Demographic Groups

Variable:	N	Mean	Standard Deviation	Minimum	Maximum
Economic					
Unemployment rate	459	6.057	2.205	2.433	13.5
Net establishment births	459	1,652.996	4,928.11	-10,522	60,286
Demographic					
Total population (in thousands)	459	6,184.961	7,008.709	550	39,247
Percent of female	459	39.149	1.616	33.661	43.854
Percent of Whites	459	55.146	12.474	15.097	78.471
Percent of educated	459	22.263	5.402	11.831	49.406
Percent of poverty	459	13.341	3.521	5.457	25.734
Legislation					
PDMP	459	15.471	17.101	0	79
AMM	459	3.595	5.628	0	22

Notes: Our unemployment rate data is the annual average of monthly estimates from the US BLS LAUS. Our net establishment births are calculated based on the quarterly numbers of establishment births and deaths from the US BLS BED. We use the annual average of the quarters. Our state total population data is from the US Census Income and Poverty in the United States. We calculate our estimates of adult percentages using the state total population data and US Census CPS ASEC weighted counts of survey responses for females, Whites, and persons with a Bachelor’s degree or higher. Our percentage of persons in poverty is from the US Census Income and Poverty in the United States. Our poverty data is for people whose incomes are below the 100% poverty federal level. Our legislation variables are from the Prescription Drug Abuse Policy System.

CHAPTER 5: RESULTS

Table 5.1 shows the empirical results of employment on mortality for the aggregate (not distinguishing between demographic groups). These results consider the state total population ratio specification and serve to summarize the overall effects of employment on mortality. Without distinguishing between demographic groups, we find that an increase in employment level tends to increase the mortality rate. OLS1 is the simplest regression, corresponding to equation (1), and uses $population_{jt-1}$. OLS2 keeps the employment variable lagged by one period and includes control variables based on equation (3). OLS3 switches to fixed effects without any lag (using $population_{jt}$) based on equation (5). OLS4 incorporates time fixed effects. OLS5 switches from policy binary variables to policy trend variables. 2SLS estimates the employment-to-population ratio with the projection of the US average employment growth rate on local shares of employment. The panel beneath the coefficients summarizes the different types of empirical regressions.

(Please note that only Table 5.1 breaks down the findings of independent variables. The tables afterwards only show the empirical results of the employment variables for each demographic group. The panels under the demographic tables (in 5.2a, 5.2b, 5.3a, 5.3b, 5.4a and 5.4b) specify the regressions. These panels are the same as the one before the notes panel in Table 5.1.)

From the results in Table 5.1, we can see that the coefficients of employment-to-population ratio are mostly positive. The only exception is OLS2 (-0.228, $p < 0.05$).

Though these positive results are not statistically significant, they are baffling as they suggest that an increase in employment contributes to an increase in mortality. For example, looking at OLS5 in Table 5.1, we note that a 1% increase in the percentage of employed persons in a given state and year would increase the crude mortality rate by 0.09 per 100,000 population. Given how small the observed counts of mortality are (Table 4.1), this estimate is appropriate.

Changes to results from OLS4 to OLS5 suggest that the treatment of policy variables as a binary factor versus a trend do have an effect. The result of PDMP in OLS5, though not statistically significant, hints that the longer the legislation has been in place, the more likely it is to reduce mortality. Though we observe positive coefficients for AMM variables, our findings do not suggest that legislation authorizing adult medical marijuana use may contribute to a higher mortality rate in a state. To address such a question, we would have to control for pain.

The results of the two policy variables across the different demographic groups are fairly consistent with what we show in Table 5.1. Differences between the demographic groups and the aggregation are that: 1) PDMP is sometimes statistically significant, and 2) AMM has a negative coefficient for young workers, but is not statistically significant. (These results are not presented in this thesis.)

For 2SLS, the first-stage F-statistic is 7.74. This is an indication that the Bartik instrument may not be ideal for an empirical estimation at the aggregate level. As noted above, in Chapter 3, the F-statistic results of first stages are much better for the demographic groups (with the exception of males with some college education under the state total population ratio specification), so the instrument may still be useful for the evaluation of demographic groups. While our use of the instrument may have removed the endogeneity of mortality on employment, the dissimilarity between employment growth rates at the local level and the national average means that the results of 2SLS reflect the projection of the national growth rate on local employment rather than local economic conditions.

The positive sign of the aggregate employment coefficients (except for OLS2) contradicts the existing literature on the subject of death by despair. In fact, most of our regression results for the demographic groups also tend to be positive. We believe these contradictory findings are due to our observations of employment and mortality counts. Regarding employment, we do not control for job quality or work-related injuries. As for mortality, our data does not specify which drugs caused the overdose deaths. To this extent, our findings in this thesis cannot provide a conclusive answer to why the effect of employment on mortality for the aggregate and for many demographic groups is positive.

Based on two existing studies noted above, Currie, Jin, and Schnell (2019) and Ruhm (2019), we can suppose that we are observing greater mortality due to income demand. Currie, Jin, and Schnell found only a weak relation between employment and opioid prescriptions. Ruhm found that, after 2010, there had been an increase in mortality related to illicit opioids. Prescription opioids are more accessible through health insurance programs. Illicit opioids, such as heroin, are not. If pain has been increasing for the last two decades, as suggested by Krueger (2017), then people require pain relievers. Working is a way to obtain income to purchase painkillers, legal or illegal, and the effects of that may be what we observe in this thesis.

Table 5.1 Results of Total Employment on Total Mortality Rate

	OLS1	OLS2	OLS3	OLS4	OLS5	2SLS
Employment-to-population ratio	0.0368 (0.104)	-0.228* (0.108)	0.695 (0.916)	0.348 (0.876)	0.0915 (0.930)	1.951 (2.651)
Unemployment rate		-1.21*** (0.168)	-0.738 (0.448)	0.260 (0.589)	-0.208 (0.642)	-0.475 (0.825)
Net establishments		-0.00004 (0.00004)	-0.0001 (0.00005)	-0.00006 (0.00004)	-0.000083 (0.000044	-0.00001 (0.0002)
Percentage of female adults		1.833*** (0.324)	-0.265 (0.637)	-0.0980 (0.703)	0.130 (0.740)	2.819* (1.205)
Percentage of White adults		0.148** (0.0456)	-0.0884 (0.191)	0.0861 (0.197)	0.0196 (0.220)	-0.0229 (0.242)
Percentage of educated adults		0.207 (0.126)	0.573* (0.228)	0.197 (0.211)	0.274 (0.257)	-1.863 (2.358)
Percentage of poverty		0.273 (0.147)	-0.337 (0.187)	0.0228 (0.166)	0.0169 (0.189)	-0.131 (0.752)
PDMP binary		2.185 (1.219)	3.824 (3.344)	5.251 (3.342)		
AMM binary		1.496* (0.758)	4.701** (1.623)	4.806** (1.557)		
PDMP trend					-1.163 (0.638)	0.0625 (0.0832)
AMM trend					0.571 (0.417)	0.195 (0.389)
N	401	401	398	398	398	398
$\bar{R}^2$	-0.002	0.307	0.462	0.532	0.491	n/a
Lagged	Yes	Yes	No	No	No	No
X	No	Yes	Yes	Yes	Yes	Yes
Entity effects	No	No	Yes	Yes	Yes	Yes
Year effects	No	No	No	Yes	Yes	Yes
Policy binary	No	Yes	Yes	Yes	No	No
Policy trends	No	No	No	No	Yes	Yes

Notes: Standard errors are in parentheses. * denotes significance at 5% level. ** denotes significance at 1% level. *** denotes significance at 0.1% level. The variable of interest is employment-to-population ratio. This table of results show all variables used in this thesis. Subsequent tables rely on the panel immediately above to indicate the regression that produced the result.

In the following section, we break down the findings for the demographic groups under different employment specifications. Tables 5.2a and 5.2b show the regression results of employment-to-population ratios using state demographic group populations. Tables 5.3a and 5.3b show the results with the state total population ratio specification. Tables 5.4a and 5.4b show the results with the log of employment for each demographic group with log of state total population as a control variable. These tables only present the results of the employment variable from each regression and all of them may be interpreted as an increase in the mortality rate given a 1% increase in employed population under each specification (within the state demographic group, within the state total population, and within the employment count itself). The headings, OLS1 through OLS5 and 2SLS, and the panel beneath the coefficients indicate the type of empirical regression and control variables for each set of regression results. The layout matches the results in Table 5.1 above.

In discussing the findings of this thesis below, we focus more on the regression results of OLS4, OLS5 and 2SLS because those are the most accurate. OLS1 and OLS2 regressions are biased because they do not distinguish between different states and years. OLS3 regressions do not have time fixed effects. The presentation of OLS1 through OLS3 are to demonstrate the progressive approach of our empirical investigations. They show how the inclusions and changes to control variables affect our variables of interest (employment).

As noted above, our employment-to-population ratios using state demographic group population exceed 100% in some cases. In this regard, what we observe in Table 5.2a, statistically significant as they are, may not be accurate. We include these regression results to disclose our different approaches to answering the question of employment on mortality in this thesis.

The purpose of this specification is to demonstrate the effect of employment on mortality for the population of a given demographic group in a state and year. We believe the demographic groups may have different attitudes towards mortality. This specification would identify those differences.

From the OLS5 results in Table 5.2a, we observe that more employment leads to more mortality for every demographic group in every state in every year. This contradicts the existing literature. Switching to 2SLS, we have sign changes (positive to negative) for workers aged 25 to 54 and two races. These highlight that the national average employment growth rates for these demographic groups is different from the local economic conditions. If what we are observing were the removal of endogeneity, the results in Tables 5.3a and 5.4a would be similar; that is, sign changes from positive to negative between OLS5 and 2SLS. The fact that we do not consistently observe these sign changes means our results in Table 5.2a are biased.

Table 5.2a Results of Demographic Population Ratio Specification

	OLS1	OLS2	OLS3	OLS4	OLS5	2SLS
Female						
Age 19-24	0.184**	-0.0841	0.119*	0.0969	0.0998	0.130
	(0.0637)	(0.0529)	(0.0506)	(0.0494)	(0.0522)	(0.0806)
Age 25-54	-0.281***	-0.349***	0.404**	0.383**	0.387**	-0.376**
	(0.0517)	(0.0648)	(0.150)	(0.134)	(0.144)	(0.143)
Age ≥ 55	0.286***	0.233***	0.331***	0.335***	0.333***	0.289***
	(0.0242)	(0.0314)	(0.0350)	(0.0334)	(0.0345)	(0.0281)
Male						
Age 19-24	0.314**	0.0567	0.512***	0.478***	0.458***	0.413**
	(0.0964)	(0.0964)	(0.0976)	(0.0942)	(0.0803)	(0.141)
Age 25-54	-0.344*	-0.447**	0.368	0.537	0.623	-0.274
	(0.141)	(0.141)	(0.360)	(0.365)	(0.390)	(0.281)
Age ≥ 55	0.328***	0.244***	0.320***	0.321***	0.315***	0.306***
	(0.0250)	(0.0336)	(0.0344)	(0.0276)	(0.0257)	(0.0304)
Race						
White	0.083	-0.0491	0.547	0.431	0.442	-0.475
	(0.0536)	(0.0510)	(0.275)	(0.257)	(0.281)	(0.277)
Black	-0.117*	-0.0744	0.701**	0.597**	0.453**	-0.0424
	(0.0533)	(0.0514)	(0.239)	(0.168)	(0.140)	(0.311)
Hispanic	2.711***	1.489**	0.358**	0.407***	0.461***	0.660**
	(0.605)	(0.495)	(0.117)	(0.110)	(0.125)	(0.253)
Lagged	Yes	Yes	No	No	No	No
X	No	Yes	Yes	Yes	Yes	Yes
Entity effects	No	No	Yes	Yes	Yes	Yes
Year effects	No	No	No	Yes	Yes	Yes
Policy binary	No	Yes	Yes	Yes	No	No
Policy trends	No	No	No	No	Yes	Yes

Notes: Standard errors are in parentheses. * denotes significance at 5% level. ** denotes significance at 1% level. *** denotes significance at 0.1% level. The variable of interest is employment-to-population ratio. Each coefficient presented is for the variable of interest, employment-to-population ratio, here with respect to state demographic population. Each variable is a separate regression, hence, N and $\bar{R}^2$ are omitted.

The results in Table 5.2b use male and female adult (aged 25 or older) populations for the crude mortality rates and employment-to-population ratios. Therefore, the results align more with educational attainment on mortality rate for each gender than necessarily for the education of the demographic group. For example, the result for females with less than high school education in OLS5 is as follows: for a 1% increase in employment of females with less than high school education, in comparison to all females aged 25 or older, we estimate a mortality rate decrease of 0.003 of that demographic group per 100,000 population of females age 25 or older. (Please note: in Table 5.2b, we use the populations of males and females aged 25 or older for calculations of crude mortality rate and employment-to-population ratios; and in Table 5.3b, we use state total populations.) The interpretations of the results of other education demographic groups are similar. In OLS3 through OLS5, the only sign changes are females with less than high school education (OLS3 to OLS4) and males with only high school education (OLS4 to OLS5). Neither are statistically significant. Between OLS5 and 2SLS, we can further observe the differences between the national average growth rate and local growth as five of the variables show sign changes and the female LTHS shows a more-than tenfold increase. Altogether, we observe local labor conditions may affect mortality rates differently from the national average.

Table 5.2b Results of Demographic Population Ratio Specification

	OLS1	OLS2	OLS3	OLS4	OLS5	2SLS
Female						
LTHS	0.0146	-0.0335	0.0235	-0.00418	-0.00279	-0.0309
	(0.0239)	(0.0274)	(0.0254)	(0.0267)	(0.0269)	(0.0411)
High school	-0.0446	-0.354***	0.0812	0.0513	0.0426	-0.432***
	(0.0368)	(0.0437)	(0.0872)	(0.0713)	(0.0747)	(0.0780)
Some college	0.00407	-0.0974	0.0263	0.0240	0.0411	-0.168
	(0.042)	(0.0527)	(0.0571)	(0.0463)	(0.0608)	(0.105)
BA or higher	0.0652	-0.180*	0.0123	0.0710	0.0784	-0.0842
	(0.0577)	(0.0701)	(0.0941)	(0.0760)	(0.0917)	(0.135)
Male						
LTHS	0.0506	-0.0527	0.0948*	0.0500	0.0410	-0.0601
	(0.0493)	(0.0488)	(0.0470)	(0.0481)	(0.0500)	(0.0731)
High school	-0.144	-0.696***	-0.144	-0.0897	0.0385	-0.975***
	(0.106)	(0.115)	(0.193)	(0.197)	(0.214)	(0.194)
Some college	0.509***	0.303**	0.0607	0.0812	0.116	0.216
	(0.112)	(0.103)	(0.176)	(0.164)	(0.186)	(0.178)
BA or higher	-0.0435	0.0359	0.361	0.400*	0.312	0.369
	(0.122)	(0.130)	(0.184)	(0.158)	(0.178)	(0.265)
Lagged	Yes	Yes	No	No	No	No
X	No	Yes	Yes	Yes	Yes	Yes
Entity effects	No	No	Yes	Yes	Yes	Yes
Year effects	No	No	No	Yes	Yes	Yes
Policy binary	No	Yes	Yes	Yes	No	No
Policy trends	No	No	No	No	Yes	Yes

Notes: Standard errors are in parentheses. * denotes significance at 5% level. ** denotes significance at 1% level. *** denotes significance at 0.1% level. The variable of interest is employment-to-population ratio. Each coefficient presented is for the variable of interest, employment-to-population ratio, here with respect to demographic population. Each variable is a separate regression, hence, N and $\bar{R}^2$ are omitted.

The results of our switch to state total population ratios are in Tables 5.3a and 5.3b. These findings better reflect the notion of death by despair through negative coefficients. Under this specification, we observe that 2SLS results involving age is a small fraction of what we observe in OLS5. That is, the national growth rate averages projected onto local shares of employment produces much smaller coefficient magnitudes than the estimates using local growths of demographic employment-to-population ratios.

We only observe this same effect for the Black demographic group. The differences between the national average and local growth rates are very pronounced for the three races we consider in this thesis. Results in Tables 5.2a and 5.4a are similarly mixed.

Returning to the consideration of the state total population ratio specification, we find that the Bartik instrument assumption that the national growth rate is the same as the local growth rates holds (no sign change) for demographic groups that account for age and for Black and Hispanic races. The changes in statistical significance of results in Table 5.3a are less important than the consistent decrease in coefficient magnitude and same sign (positive or negative) between OLS5 and 2SLS. These consistencies provide evidence that the Bartik instrument may be statistically valid to remove endogeneity of mortality on employment for age groups.

Table 5.3a Results of State Total Population Ratio Specification

	OLS1	OLS2	OLS3	OLS4	OLS5	2SLS
Female						
Age 19-24	0.277**	0.0370	-0.464	-0.469	-0.694*	-0.00331
	(0.0879)	(0.102)	(0.316)	(0.317)	(0.331)	(0.0029)
Age 25-54	-0.143***	-0.221***	-0.297	-0.271	-0.443	-0.090**
	(0.0425)	(0.0606)	(0.316)	(0.350)	(0.387)	(0.0300)
Age ≥ 55	0.140	0.110	0.514	0.0234	0.122	0.0128
	(0.0862)	(0.104)	(0.294)	(0.342)	(0.317)	(0.0120)
Male						
Age 19-24	0.454**	0.350*	-0.806	-0.947	-1.183*	-0.00278
	(0.157)	(0.177)	(0.514)	(0.554)	(0.521)	(0.005)
Age 25-54	-0.235	-0.344**	-1.052	-0.126	-0.898	-0.0669
	(0.129)	(0.118)	(1.096)	(1.137)	(1.180)	(0.0542)
Age ≥ 55	0.990***	0.637**	1.375**	0.479	0.504	0.0547
	(0.256)	(0.223)	(0.508)	(0.805)	(0.773)	(0.0404)
Race						
White	0.0171***	-0.00794	0.580	1.111	0.903	-0.269*
	(0.00247)	(0.00722)	(0.911)	(0.897)	(0.971)	(0.109)
Black	-0.00391	-0.00848	2.311	1.292	4.350*	0.0702
	(0.0185)	(0.0341)	(1.276)	(2.075)	(2.029)	(0.0774)
Hispanic	0.0379**	0.0779***	0.592	0.551	0.168	0.136*
	(0.0123)	(0.0123)	(0.321)	(0.348)	(0.411)	(0.0675)
Lagged	Yes	Yes	No	No	No	No
X	No	Yes	Yes	Yes	Yes	Yes
Entity effects	No	No	Yes	Yes	Yes	Yes
Year effects	No	No	No	Yes	Yes	Yes
Policy binary	No	Yes	Yes	Yes	No	No
Policy trends	No	No	No	No	Yes	Yes

Notes: Standard errors are in parentheses. * denotes significance at 5% level. ** denotes significance at 1% level. *** denotes significance at 0.1% level. The variable of interest is employment-to-population ratio. Each coefficient presented is for the variable of interest, employment-to-population ratio, here with respect to state total population. Each variable is a separate regression, hence, N and $\bar{R}^2$ are omitted.

The results for education demographic groups are fairly similar between Tables 5.2b and 5.3b. This is understandable because the employment-to-population ratios for the regressions in Table 5.3b (state total population) is roughly less than half of the same employment-to-population ratios in Table 5.2b (state male or female adult population). Most notably, we observe increases in coefficient magnitudes for OLS results in Table 5.3b. As for more subtle differences, we see sign changes for males with less than high school education and males with a Bachelor's degree or higher. Neither of these, however, are statistically significant.

Table 5.3b Results of State Total Population Ratio Specification

	OLS1	**OLS2**	**OLS3**	**OLS4**	**OLS5**	**2SLS**
Female						
LTHS	-0.0686	1.125**	3.539	-2.523	-1.913	-0.0282
	(0.260)	(0.359)	(2.114)	(4.005)	(4.728)	(0.0339)
High school	0.317	-0.914**	0.928	0.501	0.426	-0.107***
	(0.209)	(0.326)	(2.019)	(2.130)	(2.406)	(0.0166)
Some college	-0.597**	-1.275***	3.935	4.293*	4.505	-0.0638*
	(0.215)	(0.251)	(1.987)	(2.051)	(2.429)	(0.0325)
BA or higher	-0.244*	-0.563**	-0.151	0.242	0.0896	-0.0223
	(0.107)	(0.174)	(0.891)	(1.065)	(1.277)	(0.0311)
Male						
LTHS	0.711	1.212	5.750	-4.272	-9.742	-0.0519
	(0.754)	(0.708)	(4.203)	(6.798)	(7.636)	(0.0637)
High school	0.0622	-1.284**	2.436	3.079	0.560	-0.207***
	(0.415)	(0.438)	(3.789)	(3.993)	(4.064)	(0.0419)
Some college	-1.343*	-1.672***	6.572*	8.067**	6.863*	0.0827
	(0.607)	(0.464)	(2.903)	(2.770)	(3.152)	(0.0570)
BA or higher	0.579*	0.386	-5.241	-3.425	-3.353	0.0820
	(0.280)	(0.402)	(4.101)	(4.695)	(5.033)	(0.0552)
Lagged	Yes	Yes	No	No	No	No
X	No	Yes	Yes	Yes	Yes	Yes
Entity effects	No	No	Yes	Yes	Yes	Yes
Year effects	No	No	No	Yes	Yes	Yes
Policy binary	No	Yes	Yes	Yes	No	No
Policy trends	No	No	No	No	Yes	Yes

Notes: Standard errors are in parentheses. * denotes significance at 5% level. ** denotes significance at 1% level. *** denotes significance at 0.1% level. The variable of interest is employment-to-population ratio. Each coefficient presented is for the variable of interest, employment-to-population ratio, here with respect to total population. Each variable is a separate regression, hence, N and $\bar{R}^2$ are omitted.

We now switch focus to the logarithm specification of demographic employment counts. Here, we use state total population as a control variable and for the calculations of demographic mortality rates. This is our alternative to the employment-to-population ratios using the state demographic populations (Tables 5.2a and 5.2b). The logarithmic transformation of the employment count for a given demographic group allows us to interpret how a percentage change to the employment count may affect the mortality rate of that demographic group. Given this transformation, the results in Tables 5.4a and 5.4b require a scalar transformation of 0.01 for meaningful interpretation.

For example, a 1% increase in female workers aged 19 to 24 under OLS5 results in a 0.011 decrease in the mortality rate of that group per 100,000 population of any given state and year. At first glance, this may be deceptively smaller than the results above. From Table 4.2, we know that 1% of the average number of female workers aged 19 to 24 (young workers) in our sample is approximately 1,100.8 people. This is small. From Table 4.3, we know that the average total population is 6,184,961. Therefore, the average percent of young female workers in the population of our sample is 1.78%. Of course, this is on average, but is adequate to demonstrate that a 1% change for an interpretation using Table 5.3a (for example, -0.694 for OLS5 females aged 19 to 24 demographic group) is necessarily much larger (2.78%) than a 1% change we observe under the logarithmic specification of Table 5.4a.

In Table 5.4a, we see more negative coefficients than in Table 5.2a. Only the White demographic group persists with negative coefficients for OLS4 and OLS5. Though the overall results are not statistically significant, the negative coefficients do align with death by despair literature—an increase in employment decreases the likelihood of drug abuse to the point of death by overdose. The 2SLS results are mixed. They are consistent for all female age groups and for prime-age males. We have sign reversals for all three race groups and the other two male age groups. Only three results are statistically significant (prime-age females, black race and Hispanic race).

Under this specification is the only time we observe OLS results for Hispanic workers being negative. Tables 5.2a and 5.3a both show positive coefficients for Hispanic workers; that is, an increase in the percentage of Hispanic workers in a state leads to an increase there in the mortality rate of Hispanics. These findings align with the income demand argument. Our negative coefficients in the OLS results here (Table 5.4a) suggest that an increase in the Hispanic employment count would lead to a decrease in the Hispanic mortality rate. (The only OLS exception is OLS2, which, although statistically significant, does not account for minute differences between states.) Here, in OLS3 through OLS5, we observe that more employment opportunities at the state level may benefit the Hispanic demographic group. The positive national trend result of 2SLS, however, still supports the income demand argument.

To some extent, we observe that the Black demographic group also possesses positive coefficients in the previous two specifications (Tables 5.2a and 5.3a) for OLS3 through OLS5. For 2SLS, we observe negative coefficients for the Black demographic group only under the state demographic population ratio specification. In this regard, we can apply an analysis similar to that used for the Hispanic demographic group. The greater coefficient magnitudes we observe here may be indicative that the Black demographic group would benefit more than other demographic groups in our sample from more employment opportunities at the local level.

Table 5.4a Results of Natural Log of Employment Specification

	OLS1	OLS2	OLS3	OLS4	OLS5	2SLS
Female						
Age 19-24	-0.127***	0.108	-0.815	-0.816	-1.097*	-0.0479
	(0.0232)	(0.163)	(0.515)	(0.487)	(0.484)	(0.365)
Age 25-54	-0.0145	-4.734***	-5.625	-3.010	-4.849	-5.505*
	(0.102)	(1.094)	(3.837)	(4.188)	(4.506)	(2.424)
Age ≥ 55	-0.173***	-0.483	2.311	-0.950	-0.586	-1.249
	(0.0368)	(0.313)	(1.442)	(2.091)	(1.952)	(0.678)
Male						
Age 19-24	-0.0754*	0.566*	-1.315	-1.348	-1.771*	0.449
	(0.0318)	(0.272)	(0.863)	(0.897)	(0.872)	(0.621)
Age 25-54	0.204	-4.240*	-16.50	-1.956	-12.19	-2.791
	(0.232)	(2.022)	(15.16)	(15.15)	(15.96)	(3.894)
Age ≥ 55	-0.0563	2.102**	1.419	-5.098	-5.517	0.878
	(0.0937)	(0.703)	(4.737)	(6.623)	(7.130)	(1.353)
Race						
White	-0.116***	-0.277	-4.577	9.052	2.770	-10.95
	(0.0290)	(0.180)	(24.42)	(22.73)	(24.03)	(7.139)
Black	0.0627	0.127	-3.831	-12.27*	-27.32	1.438**
	(0.0508)	(0.120)	(4.806)	(5.561)	(14.13)	(0.526)
Hispanic	-0.0483*	0.302***	-0.832	-3.016	-3.105	2.125***
	(0.0194)	(0.0399)	(0.841)	(1.783)	(2.298)	(0.543)
Lagged	Yes	Yes	No	No	No	No
X	No	Yes	Yes	Yes	Yes	Yes
Entity effects	No	No	Yes	Yes	Yes	Yes
Year effects	No	No	No	Yes	Yes	Yes
Policy binary	No	Yes	Yes	Yes	No	No
Policy trends	No	No	No	No	Yes	Yes

Notes: Standard errors are in parentheses. * denotes significance at 5% level. ** denotes significance at 1% level. *** denotes significance at 0.1% level. The variable of interest is employment-to-population ratio. Each coefficient presented is for the variable of interest, employment-to-population ratio, here with the natural log of employment with population as a control variable in $\boldsymbol{X}$. Each variable is a separate regression, hence, N and $\bar{R}^2$ are omitted.

Interestingly, the results of the White demographic group are generally positive under OLS regressions and negative when the national shifters are applied in 2SLS. These findings indicate that an increase in the national average employment growth rate benefits the White demographic overall. Local economic conditions, on the other hand, may adversely affect mortality outcomes for Whites. This thesis, however, does not cover why the White and non-White demographic groups exhibit opposite outcomes at the local state level versus the national average.

Regarding educational attainment, we continue observe trend differences between OLS5 and 2SLS. This may well be due to different employment opportunities at the local level in comparison with the national average. Though the trends are different, we do observe that demographic groups with high school education or less showing negative coefficients more often than the more educated demographic groups. The positive coefficients (though not statistically significant) of these less educated demographic groups could imply that these workers are experiencing more pain than other education demographic groups. They may also have inelastic income demand, which leads to a greater likelihood of drug overdose.

Table 5.4b Results of Natural Log of Employment Specification

	OLS1	OLS2	OLS3	OLS4	OLS5	2SLS
Female						
LTHS	0.108	3.555***	7.559*	-6.138	-5.137	2.561
	(0.121)	(0.756)	(2.944)	(5.711)	(6.969)	(1.752)
High school	0.207	-4.701**	-1.992	-2.010	-4.517	-7.267*
	(0.141)	(1.724)	(7.636)	(7.179)	(7.390)	(3.203)
Some college	0.101	-9.271***	17.59	17.55	17.78	-11.20***
	(0.142)	(1.617)	(12.29)	(11.46)	(12.90)	(3.160)
BA or higher	0.0332	-5.437***	0.681	3.271	2.467	-4.498*
	(0.135)	(0.947)	(5.987)	(6.550)	(7.482)	(2.240)
Male						
LTHS	0.547	5.711***	15.59	-3.058	-11.36	3.855
	(0.281)	(1.709)	(9.368)	(14.13)	(15.65)	(3.535)
High school	0.652*	-3.924	5.833	11.01	-7.112	-8.167
	(0.327)	(2.925)	(18.12)	(17.43)	(19.65)	(4.983)
Some college	0.456	-7.913**	34.97	39.42*	31.29	-9.466
	(0.318)	(2.936)	(18.79)	(19.02)	(21.20)	(5.261)
BA or higher	0.661*	0.0347	-12.41	0.647	0.642	5.073
	(0.286)	(2.150)	(21.87)	(23.89)	(25.48)	(4.826)
Lagged	Yes	Yes	No	No	No	No
X	No	Yes	Yes	Yes	Yes	Yes
Entity effects	No	No	Yes	Yes	Yes	Yes
Year effects	No	No	No	Yes	Yes	Yes
Policy binary	No	Yes	Yes	Yes	No	No
Policy trends	No	No	No	No	Yes	Yes

Notes: Standard errors are in parentheses. * denotes significance at 5% level. ** denotes significance at 1% level. *** denotes significance at 0.1% level. The variable of interest is employment-to-population ratio. Each coefficient presented is for the variable of interest, employment-to-population ratio, here with the natural log of employment with population as a control variable in ***X***. Each variable is a separate regression, hence, N and $\bar{R}^2$ are omitted.

Though the classification of "some college with no degree" is technically more educated than "only high school education" and "less than high school education", in the context of economics, all three categories are considered "less educated." Our results for educational attainment of workers on mortality are often not statistically significant. They do, however, tend to have negative coefficients. This finding is in keeping with the existing literature; that is, less-educated workers are more at risk of drug-related mortality than more-educated workers (those who have a Bachelor's degree or higher).

That being said, the findings in this thesis for males with a Bachelor's degree or higher are ambiguous under all three specifications. Between OLS4, OLS5 and 2SLS, only OSL4 in Table 5.2b is statistically significant. However, as noted above, these results may be overestimating the effect of employment on group male mortality. OLS4 and OLS5 in Table 5.3b are the only negative coefficients. With the exception of 2SLS in Table 5.2b, the national average is very different from local employment growth rates. Though we have other results that are not statistically significant, the educated male demographic is the only one to show no discernable pattern. The situation may be that there is no relation between employment and mortality for males with a Bachelor's degree or higher.

In a broad comparison of the two genders, this thesis finds that the empirical results for females tend to have smaller coefficient magnitudes than their male counterparts and are more likely to have negative coefficients. This is true for both local (OLS) results and national averages (2SLS). Our findings for females align with existing literature more often than with the other demographic groups in this thesis.

CHAPTER 6: DISCUSSION & CONCLUSION

Death by despair is one narrative to explain the decline in labor force participation in the US over recent decades. In this thesis, we seek to contribute to the literature on the topic in economics by exploring the impact of employment on drug-related mortality for 17 different demographic groups. We consider three specifications of employment for these demographic groups: employment-to-population ratio using state demographic population, employment-to-population ratio using the state total population, and logarithmic transformation of employment counts. We investigate these aspects empirically by gradually including more variables to control for characteristics at the state level, time-invariant entity fixed effects, and time fixed effects for macroeconomic conditions that indiscriminately affect all observations. We then switch from OLS to 2SLS to address potential reverse causality of drug-related mortality on employment.

Our instrument of choice is a Bartik shift-share method that combines the national average growth rate with the local shares of employment. An assumption of this instrument is that the national average employment growth rate for each sector is the same (or nearly the same) as the employment growth rates of the local (state) economy. In our analysis, we are able to uphold this assumption for most demographic groups under our three specifications. Where we fail to do so, we remark that local economic conditions differ from the national average. For the instances where we succeed with upholding the similarity assumption, we find that the national trend results in smaller coefficient magnitudes than the local employment growth rates.

We have an additional concern with exogeneity regarding the Bartik shift-share instrument. Although we use a weighted sum with 19 NAICS 2-digit sectors, our national shifters may be influenced by states that have adequately large populations and employment levels in any given sector. As our empirical investigation is at the state level, more populated states like California and Texas may affect the national employment growth rate shifters of our demographic groups. If our shifters are biased, we are unable to identify the employment variables in this thesis.

With respect to the death-by-despair literature in economics, we find mixed results. Our most robust regression results use the state demographic population ratio specification. These findings, however, overestimate the influence of employment on mortality and positively correlate employment and mortality. Our other two specifications do not produce strong results, but the coefficients we observe are in keeping with existing literature. Under the state total population ratio specification, we observe that workers between ages 19 and 54 for both genders experience lower mortality rates given better economic conditions (in other words, there are more jobs). Older workers—perhaps due to a greater demand for income or disregard for personal health—show a positive correlation between employment and mortality. For our race demographic groups, we find that the national averages deviate from local employment growth rates. This is especially true for Whites. Under the log of employment specification, we observe that national shifters may be completely different from local economic conditions for Black and Hispanic demographic groups. As for educational attainment, we find less-educated demographic groups (those with only high school education or less) would benefit from more employment. Our results for females also tend to have smaller coefficient magnitudes and negative coefficients (in line with death-by-despair literature) than our results for males. Our results for demographic groups with more education (those with some college education but no degree and those with a Bachelor's degree or higher) tend to be positive. These findings suggest that employment leads to greater mortality rates for these demographic groups. We find that males are more affected than females.

From the findings in this thesis, we have sufficient evidence to suggest that there are differences between local economic conditions and the national average. Consequently, there is no one-size-fits-all policy to address the issue of death by despair. Projecting national employment growth rates onto local shares of employment yields empirical outcomes that align with the existing literature. At the local level (OLS), we find results that suggest improvements to the macroeconomy may not benefit everyone. In this respect, local policies may be more suitable for addressing the needs of local populations than national policies.

Extensions to this thesis need to take into consideration data, methodology, and related questions. With regard to data, our investigation uses state-level information and the mortality counts for all drugs. An investigation at the county level with more transparent causes of death could better identify the impact of employment on opioid-related mortality (a proxy in existing literature for despair). Our employment-to-population ratios using state demographic group populations sometime have employment-to-population ratios that exceed 100%. As such, we are unable to adequately explore how the percentage of employment for a given demographic group affects the mortality of that group. Regarding employment estimations and the Bartik shift-share instrument, using higher order NAICS classifications (e.g., subsector level or industry level) could create a better instrument. Additionally, this thesis uses a very basic version of the Bartik instrument—national growth rate shifter. More recent literature suggests to consider using national industry share shifters. Lastly, there should be a consideration of labor substitution between demographic groups.

Though the results of this thesis are mixed, we hope that we shine some light on the death-by-despair literature in economics with an example of how to apply the Bartik shift-share instrument for empirical investigation. The instrument is a straightforward method to address the endogeneity problem of reverse causality between the dependent variable and the variable of interest. A concern we have in this thesis is that the shifters at the national level may be projecting a different employment growth rate that does not adequately reflect the lower-level state economic conditions. This can be further explored in additional research.

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