Online Appendix for "Trade Liberalization and Mortality: Evidence from U.S. Counties" by Justin R. Pierce and Peter K. Schott

This online appendix contains additional empirical results and information on data creation referenced in the main text.

A Summary Statistics

Table A.3 reports counties' population-weighted-average death of despair mortality rates for the year 2000, as well as the initial county attributes discussed in the main text.

B Cause of Death Codes

We use proprietary "compressed all-county mortality files" available by petition from the US Centers for Disease Control's National Center for Health Statistics (NCHS). Causes of death are classified by the NCHS based on codes listed in the International Classification of Diseases (ICD), where version 10 of the ICD codes (ICD-10) is used for years 1999 to 2013 and version 9 (ICD-9) of the ICD codes is used for years 1990 to 1998.[18] NCHS recodes the ICD causes of death into classification systems of varying levels of aggregation. We use the NCHS 282 cause recodes for the years 1990 to 1998 and the NCHS 358 cause recodes for the years 1999 to 2013. The following codes are used to define the three categories of deaths of despair considered in this paper:

- Suicide:

[18] The "blue form" instructions for completing the cause of death section of a death certificate are available at http://www.cdc.gov/nchs/data/dvs/blue_form.pdf. Death certificates note both county of residence and county of work. We focus on the former, and note that 81 percent of deaths occur in the deceased's county of residence.

  - NCHS 282 Cause Recodes (1990-1998): 33700-34400
  - NCHS 358 Cause Recodes (1999-2013): 424-431

- Drug Overdoses
  - NCHS 282 Cause Recodes (1990-1998): 31700, 35300
  - NCHS 358 Cause Recodes (1999-2013): 420, 443

- Alcohol-Related Liver Disease[19]
  - NCHS 282 Cause Recodes (1990-1998): 24200
  - NCHS 358 Cause Recodes (1999-2013): 298

Case and Deaton (2015) highlight a substantial rise in deaths due to suicide, poisoning – which primarily consists of drug overdoses – and chronic liver disease among middle-aged whites starting in 1999. In Figure A.4, we use the above CDC death codes to replicate these trends and extend them backwards in time. As indicated in the figure, the weighted-average rates of suicide and ARLD across counties are more or less flat during the 1990s but begin increasing around the time of the change in US trade policy in the year 2000, particularly for suicide. Deaths due to drug overdose, by contrast, are increasing before 2000, but exhibit an inflection point around that time.

Table A.4 reports the overall US mortality rates for major external and internal causes of death in 2000. Internal causes account for more than 90 percent of the 2.4 million deaths in that year, with the three leading causes being cancer (neoplasm), circulatory disease and respiratory ailments. Suicide, drug overdose and ARLD account for 29,416, 14,160 and 12,126 deaths, or approximately 10, 5 and 4 per 100,000.

C NTR Gap

Figure A.5 reports the distribution of NTR gaps across four-digit SIC industries, counties and CUMAs. Relative to the distribution across industries, the distributions for counties and

[19] We do not consider other forms of liver disease which might be classified as deaths of despair given difficulties associated with how they are tracked by the CDC over time.

CUMAs are shifted towards the left, reflecting the fact that most workers in most areas are employed outside goods-producing sectors.[20]

D Control Variables

NTR Rates: counties' labor-share-weighted US import tariff rates, NTR_{ct}, are computed as in Equation 2, except that the US NTR tariff rate for industry j (in percent) is used in place of the NTR gap for industry j. We find that the distribution of NTR_{ct} across our sample period declines during the late 1990s due to implementation of tariff reductions agreed upon during the Uruguay Round.[21]

MFA Exposure: As discussed in greater detail in Khandelwal et al. (2013), the MFA and its successor, the Agreement on Textile and Clothing (ATC), grew out of quotas imposed by the United States on textile and clothing imports from Japan during the 1950s. Over time, the MFA evolved into a broader institution that regulated the exports of clothing and textile products from developing countries to the United States, European Union, Canada and Turkey. Bargaining over these restrictions was kept separate from multilateral trade negotiations until the conclusion of the Uruguay Round in 1995, when an agreement was struck to eliminate the quotas over four phases. On January 1, 1995, 1998, 2002 and 2005, the United States was required to remove textile and clothing quotas representing 16, 17, 18 and the remaining 49 percent of their 1990 import volumes, respectively. Relaxation of quotas on Chinese imports did not occur until it became a member of the World Trade Organization in 2001; as a result, its quotas on the goods in the first three phases were relaxed in early 2002 and its quotas on the goods in the fourth phase were relaxed as scheduled in 2005. The order in which goods were placed into a particular phase was chosen by the United States.

Computation of counties' exposure to elimination of the MFA proceeds in three steps. First, we follow Khandelwal et al. (2013) in measuring the extent to which MFA quotas

[20]The distribution for industries in Figure A.5 omits SIC industries that are not subject to import tariffs.

[21]NTR tariff rates from Feenstra et al. (2002) are unavailable after 2001 and so are assumed constant after that year. Analysis of analogously computed "revealed" tariff rates from public US trade data during this interval in Pierce and Schott (2016) suggests this is an reasonable assumption that avoids having to make do with the smaller set of industries for which "revealed" rates are available.

in industry j and phase p were binding as the average fill rate of the industry's constituent import products in the year before they were phased out, $FillRate_{jp}$.[22] Specifically, for each phase, we measure an industry's exposure to MFA expiration as its average quota fill rate in the year prior to the phase's expiration. Industries with higher pre-expiration average fill rates faced more binding quotas and are therefore more exposed to the end of the MFA. Second, we compute counties' labor-share-weighted-average fill rate across industries for each phase, $FillRate_{cp}$, using a version of Equation 2. Finally, the county-year variable of interest, $MFA\,Exposure_{ct}$, cumulates the calculated fill rates as each phase of expiration takes place. This measure of exposure to the MFA rises over time, as quotas for additional products are removed, by phase.

Changes in US Export Opportunities: As part of its accession to the WTO, China agreed to institute a number of policy changes that could have influenced US manufacturing employment and thereby mortality, including liberalization of its import tariff rates and reductions of production subsidies, which might increase export opportunities for US manufacturers. Following Pierce and Schott (2016) we use product-level data on Chinese import tariffs from 1996 to 2005 from Brandt et al. (2017) to compute the average change across those years in Chinese import tariffs across products within each US industry. For production subsidies, we use data from the Annual Report of Industrial Enterprise Statistics compiled by China's National Bureau of Statistics (NBS) to calculate the change in subsidies provided to responding firms from 1998 to 2005.[23] For both changes in Chinese import tariff rates and production subsidies, we compute the labor-share-weighted average of this change across the industries active in each US county as in Equation 2, and then interact these variables with a full set of year dummies (excluding 1990).

Demographics: Our baseline specifications control for interactions of a post-PNTR indicator variable with four initial-year (i.e., 1990) county attributes: the percent of the popu-

[22] As discussed in Brambilla et al. (2010), fill rates are defined as actual imports divided by allowable imports under the the quota. MFA products for which there were no restrictions on imports (i.e., there were no quotas), have fill rates of zero.

[23] The NBS data encompass a census of state-owned enterprises (SOEs) and a survey of all non-SOEs with annual sales above 5 million Renminbi (~$600,000). The version of the NBS dataset available to us from Khandelwal et al. (2013) spans the period 1998 to 2005. Following Girma et al. (2009) and Aghion et al. (2015) we use the variable "subsidy" in this dataset and compute the change in the subsidies to sales ratio for each SIC industry between 1998 and 2005 using concordances provided by Dean and Lovely (2010).

lation without any college education, median household income, percent of population that are veterans and percent of population that is foreign-born.[24] These variables allow for the possibilities, respectively, that changes in technology unrelated to the trade liberalization might have replaced less-educated workers with technology disproportionately during the 2000s, that high-income households gained better access to medical care after the 2000s, perhaps due to health insurance provided by their employers, that an increase in suicide and opioid misuse might be the result of military experience associated with post-9/11 wars in Afghanistan and Iraq (Kemp and Bossarte (2012); Bauerlein and Campo-Flores (2016)), and that foreign-born individuals may have different propensities for deaths of despair than native-born individuals. These attributes, summarized in Table A.3, are obtained from the US Census Bureau's 1990 Decennial Census.[25] As noted in the table, the means and standard deviations across counties are 55 and 11 percent (share of population with no college education), 40 and 11 thousand dollars (median household income), 14 and 3 percent (percent of population that are veterans), and 8 and 9 percent (percent of population that is foreign born), respectively.

Manufacturing Share: Another means of controlling for counties' exposure to automation and competition from low-wage foreign workers is to include their initial share of employment that is in manufacturing. To the extent that areas with high NTR gaps had spuriously high manufacturing employment in the 1990s, this covariate also helps control for declines in manufacturing employment during the 2000s that are driven by mean reversion. On the other hand, because manufactured goods represent the vast majority of products exposed to PNTR, NTR gaps and manufacturing employment shares are highly correlated. As a result, inclusion of both exposure to PNTR and counties' manufacturing share may make it less likely to find an effect for either.

Table A.5 in the online appendix reports the results of OLS regressions of counties' NTR gaps on the control variables discussed in this section. As indicated in the table, counties with higher NTR gaps have greater exposure to the MFA, have higher import tariffs across

[24]We use initial rather than contemporaneous levels of these variables as the latter may be affected by the change in policy.

[25]These data can be downloaded from the Dexter Data Extractor from the University of Missouri, available at http://mcdc.missouri.edu/.

the goods they produce, are exposed to larger reductions in Chinese imports tariffs and subsidies, have lower household incomes in 1990, have lower share of population with a college education in 1990, have lower shares of foreign-born population and have a higher share of the population that are veterans in 1990.

E Other Publicly Available Data

This section notes the sources of the other publicly available datasets used in the analysis.

E.1 Disability

Disability payments by county-year are from the BEA Regional Economic Accounts website (linecode 2120), and are deflated using the personal consumption expenditures deflator. Disabled workers counts are from the Social Security Administration, available for download at https://www.ssa.gov/policy/docs/statcomps/oasdi_sc/2017/index.html.

E.2 County Business Patterns

Employment by county-industry are available from the US County Business Patterns database at http://www.census.gov/econ/cbp/download/. We follow Autor et al. (2013) in imputing employment for cells where only a range of employment is reported and use data from the 1990 County Business Patterns.

E.3 SEER Population Data

Population estimates from the National Cancer Institute's Surveillance, Epidemiology, and End Results Database are available at http://seer.cancer.gov/popdata/download.html.

F CUMA-Level Results

While our primary analysis uses counties as the level of observation, we also calculate mortality rates across groups of counties with larger populations, therefore potentially decreasing the amount of noise that can be present in mortality rates for sparsely populated counties. As noted in the main text, we refer to these areas as CUMAs. In Figures A.6, A.7, and A.8 of this appendix, we report the analogues of Figures 1, 2 and 3 of the main text. As indicated by a comparison of the two groups of figures, results are similar.

G Migration

This section examines the potential role of domestic migration on the estimated relationship between exposure to PNTR and mortality from deaths of despair.

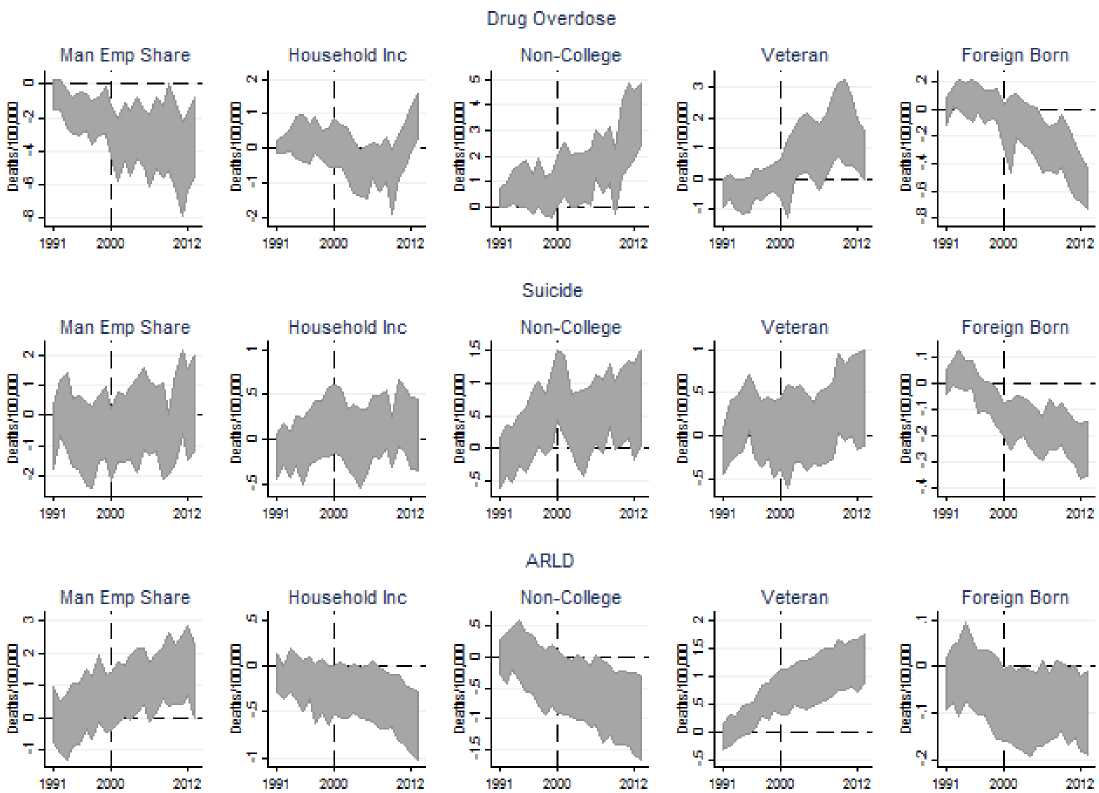
County-level mortality rates could, in principle, be influenced by two types of selective out-migration. The first would be migration based on age, e.g., if younger workers are more likely to move in response to a labor market shock than older workers. Examining both population changes and migration, Greenland et al. (2016), for example, find that areas with greater exposure to PNTR experience relative reductions in population and relatively larger out-migration, especially among the young, though most of the out-migration occurs with a lag of 7 to 10 years. Such movement might bias our results downwards or upwards depending on whether younger workers are more or less likely to suffer deaths of despair. On the other hand, the SEER population data we use to calculate age-adjusted mortality rates track population changes by age, race, and gender, at an annual level, and therefore can reasonably be expected to reflect changes in the population of young people that might affect the mortality rates we compute. In addition, the Census population data upon which the SEER population data are based include explicit adjustments to account for migration.[26]

A second type of selective out-migration that might influence our results involves differential movement of workers within age groups. If those least likely to suffer deaths of despair are more likely to migrate in response to the change in US trade policy, our results will be overstated, and *vice versa.* We do not have any data that allows us to address this issue directly. In either case, our finding that age-adjusted mortality rates increase within counties

[26] While Arthi et al. (2017) discuss potential errors in inter-censal population estimates, these issues are less of a concern once the estimates have been revised to reflect the information in subsequent censuses, which has occurred for the years 1990 to 2010, nearly our entire period of analysis. While data for 2011 to 2013 will not undergo this revision process until the 2020 Census is released, accuracy of inter-censal population estimates is less of a concern in the years immediately following a Census (Phipps et al. (2005).

more exposed to PNTR is evidence of important distributional implications of changes in trade policy. Moreover, because overall deaths of despair increase substantially over the period we examine (Figure A.4; Case and Deaton (2015)), it is clear that the data do not simply reflect a reshuffling of population, and therefore mortality, across counties.

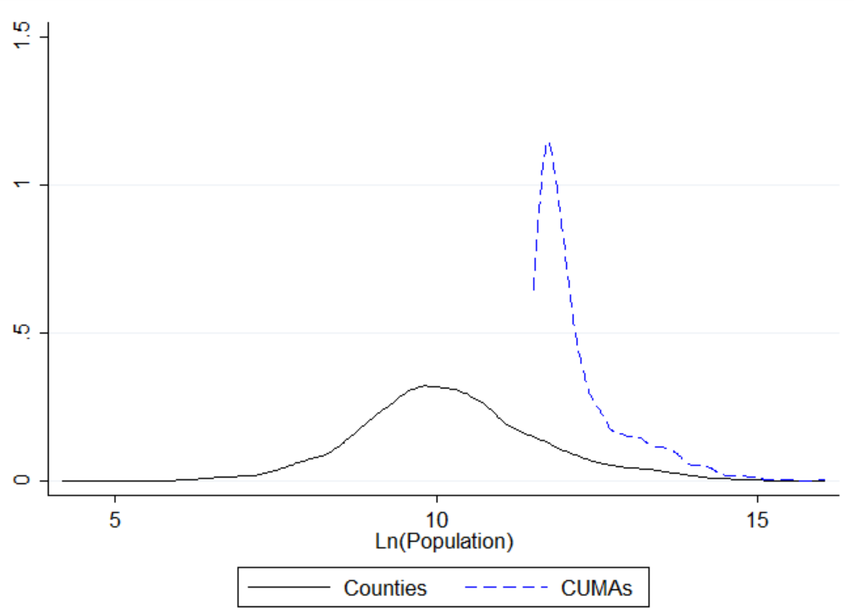
Figure A.1: Implied Impact of Interquartile Shifts in Counties' Initial Attributes



Source: Authors' calculations based on U.S. Centers for Disease Control (CDC) data. Figure displays the 95 percent confidence intervals of the estimated impact of an interquartile shift in the noted initial county attribute with respect to the noted causes of death among the full sample (all races, genders and ages). Y-axis is in units of deaths per 100,000 population. Each row presents the results of a separate population-weighted estimation of equation 3. Confidence intervals are based on robust standard errors adjusted for clustering at the state level.

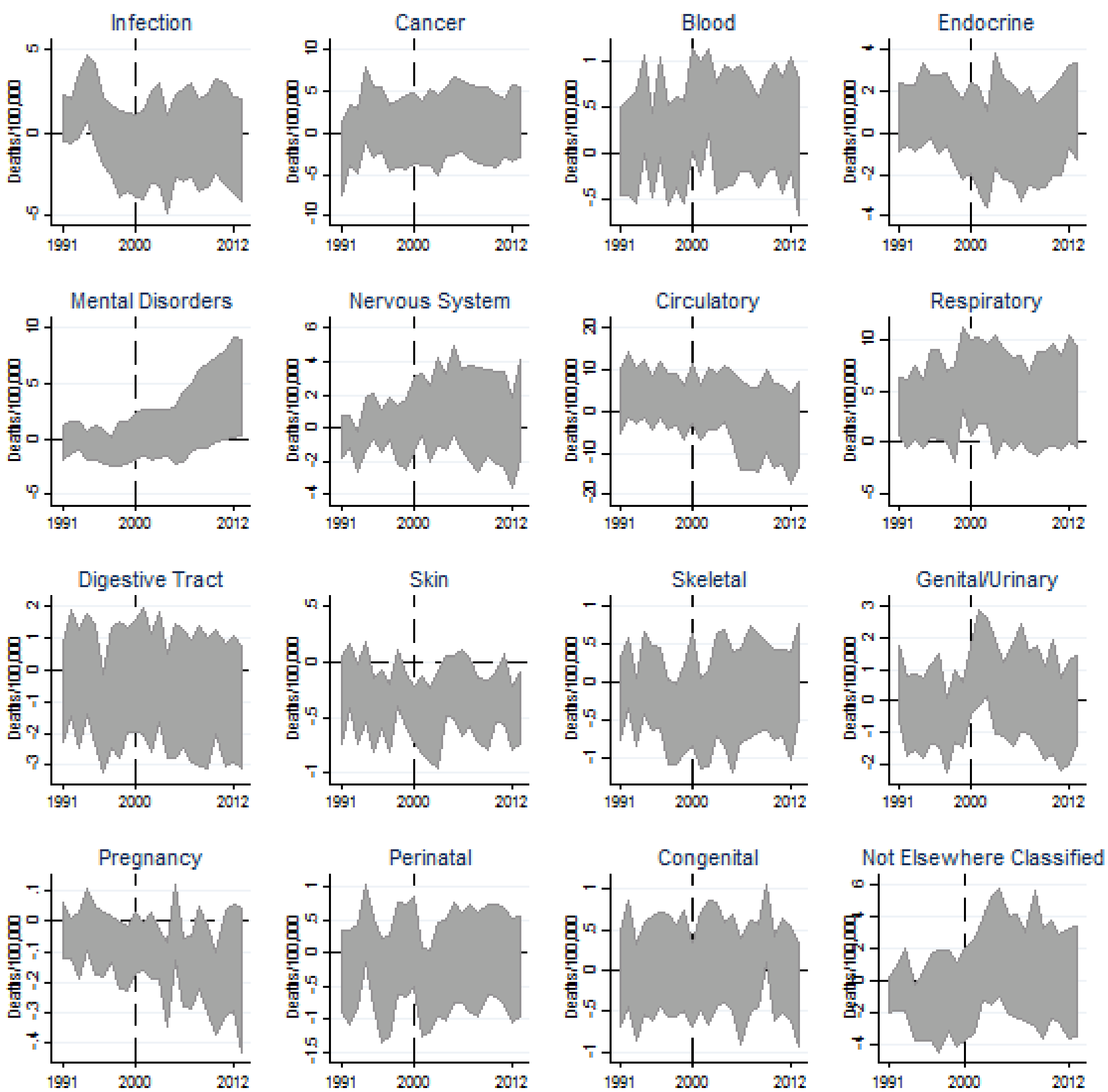
Appendix Tables and Figures

Figure A.2: Population Distribution Across Counties and CUMAs



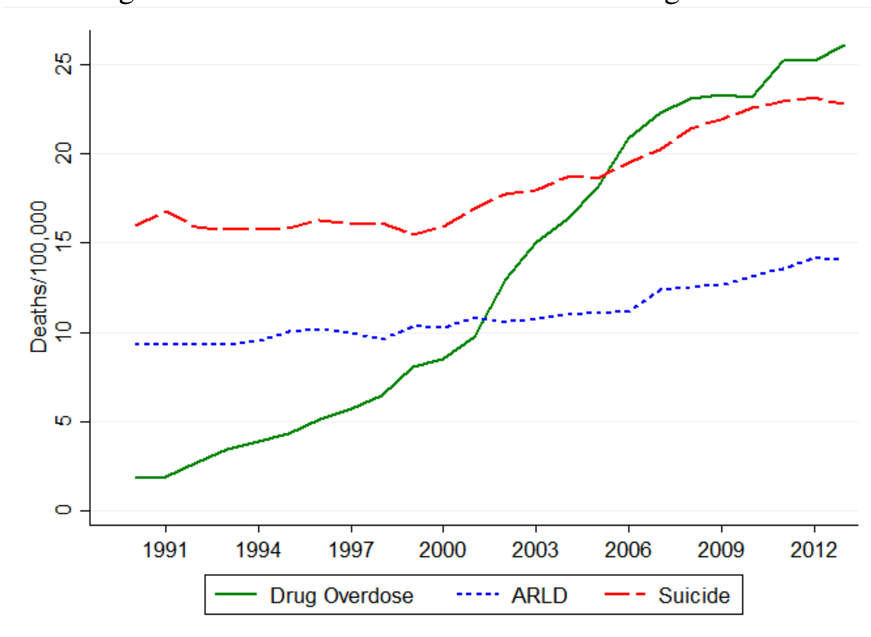
Source: Authors' calculations based on data from the U.S. Census Bureau and the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) Program. Figure displays distribution of employment across noted geographic units. As discussed in the main text, CUMAs are groups of counties based on Public Use Microdata Areas (PUMAs). Figure represents data for 3122 counties and 950 CUMAs.

Figure A.3: Implied Impact of PNTR on Internal Causes of Death



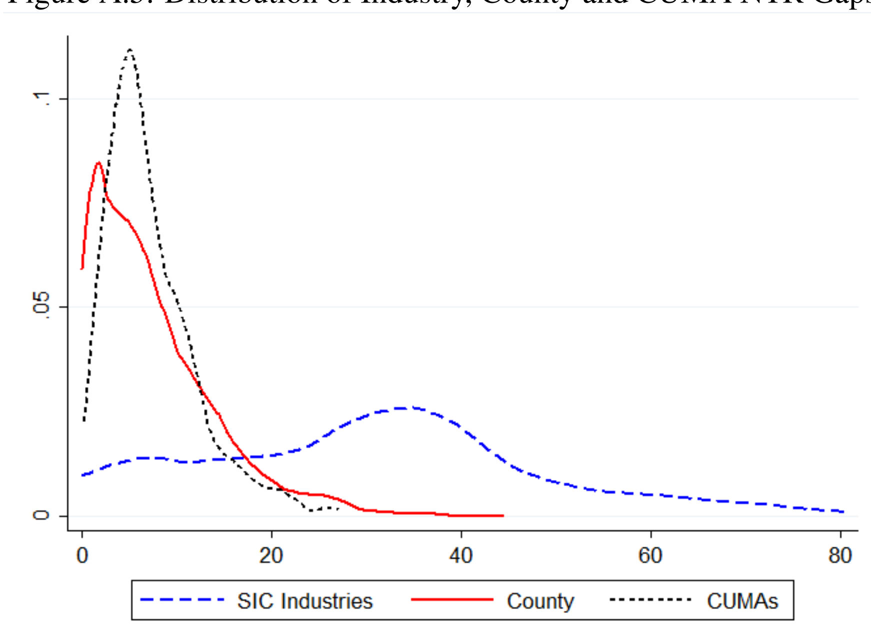
Source: Authors' calculations based on U.S. Centers for Disease Control (CDC) data. Figure displays the 95 percent confidence interval of the implied impact of an interquartile shift in counties' exposure to PNTR on major internal cause of death categories, e.g., cancer or diseases of the respiratory system. Each panel presents the results of a separate population-weighted estimation of equation 3. Confidence intervals are based on robust standard errors adjusted for clustering at the state level.

Figure A.4: Crude Death Rates for Whites Aged 45-54



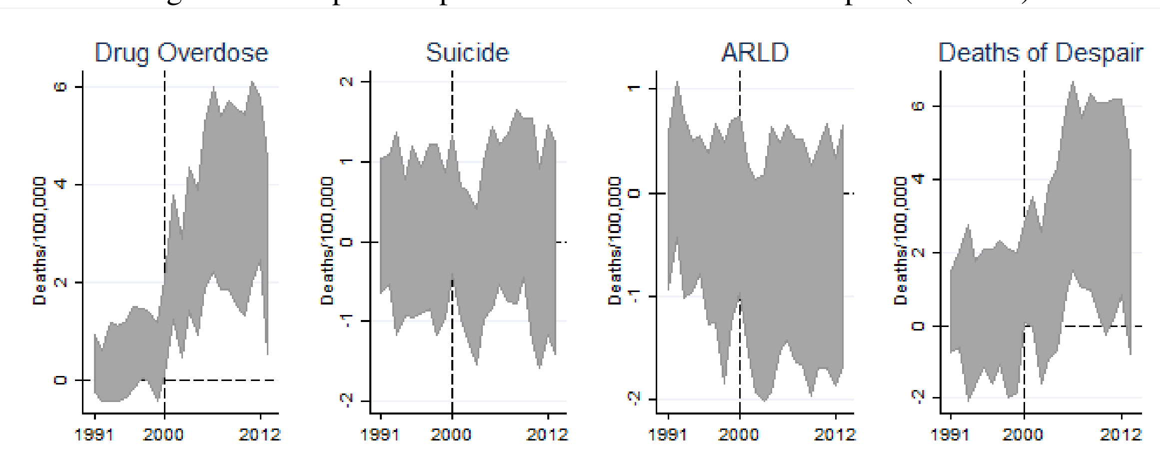
Source: U.S. Centers for Disease Control (CDC). Figure displays the crude death rate for three causes of death across all counties of the United States for whites aged 45 to 54.

Figure A.5: Distribution of Industry, County and CUMA NTR Gaps



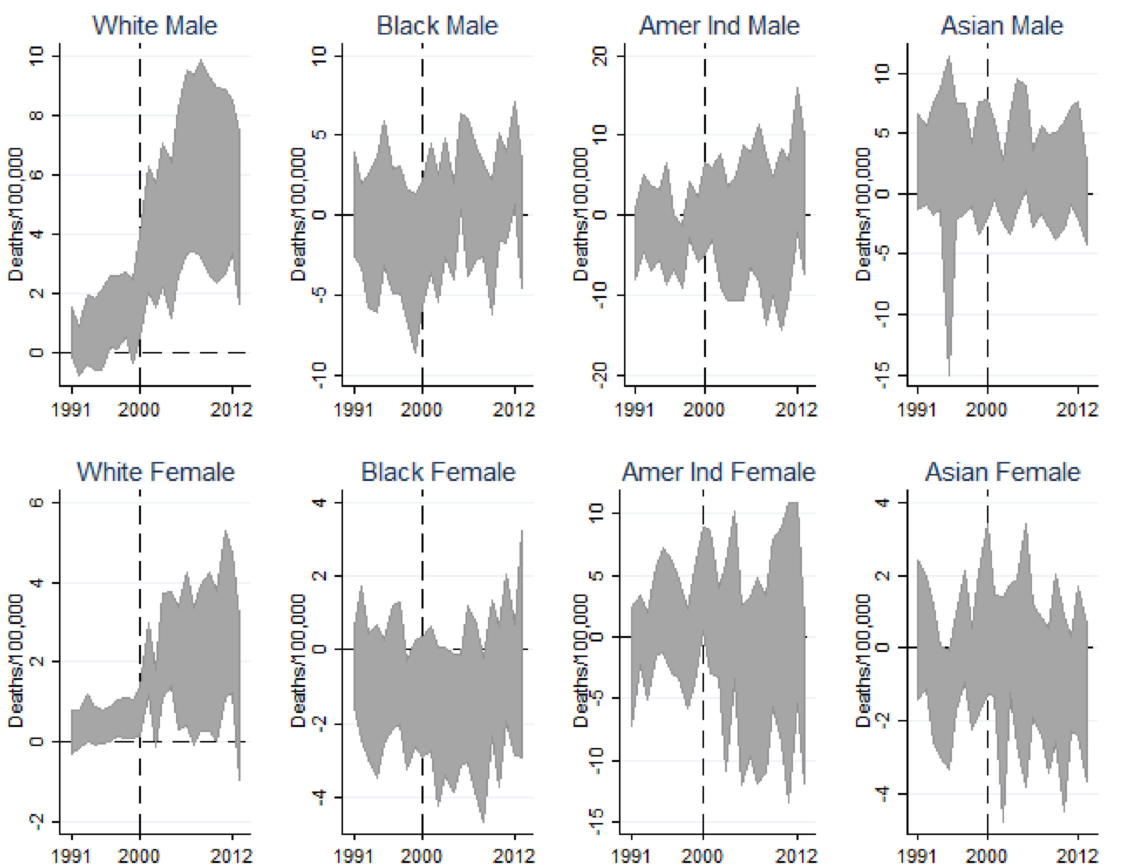
Source: Authors' estimates based on data from Feenstra, Romalis and Schott (2002) and the U.S. Census Bureau's 1990 County Business Patterns. Figure displays distributions of NTR gaps across SIC industries, counties and groups of counties based on Public Use Microdata Areas (PUMAs) referred to as CUMAs in the main text.

Figure A.6: Implied Impact of PNTR on Deaths of Despair (CUMAs)



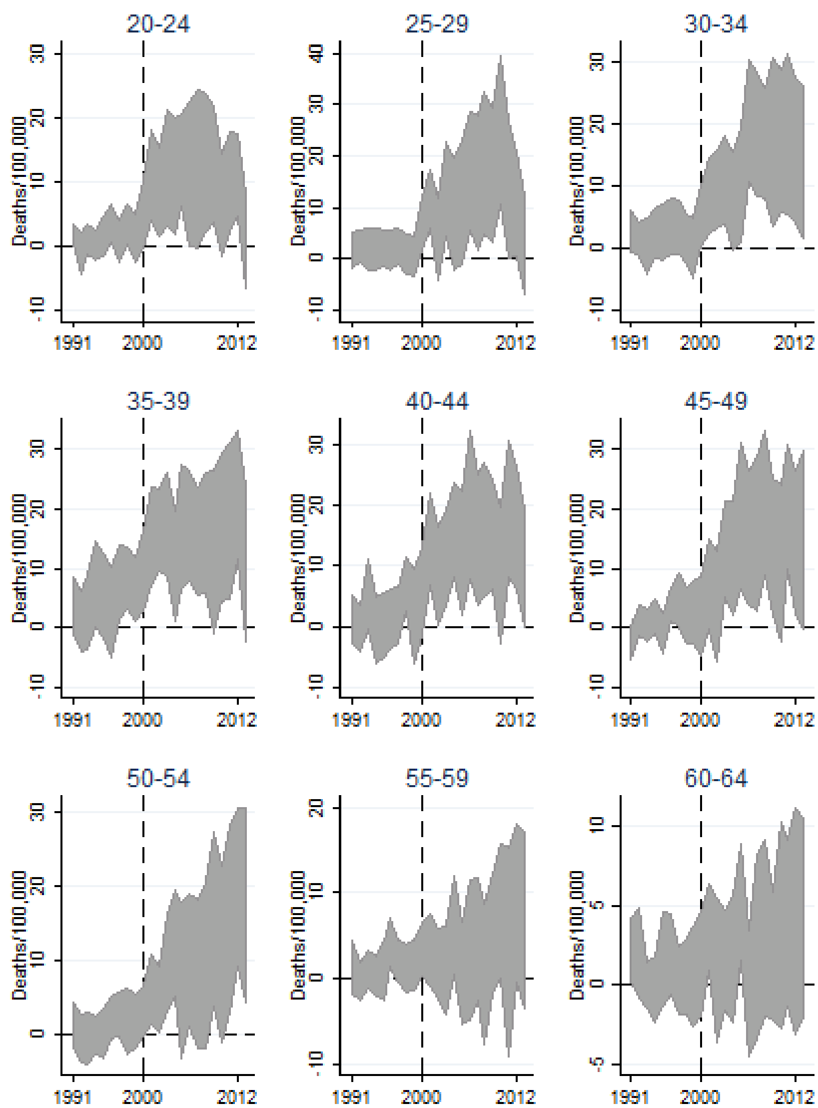
Source: Authors' calculations based on U.S. Centers for Disease Control (CDC) data. Figure displays the 95 percent confidence intervals of an interquartile shift in CUMAs' exposure to PNTR on noted cause of death. Y-axis is in units of deaths per 100,000 population. Each panel presents the results of a separate population-weighted estimation of equation 3 on death rates for fatal drug overdose, suicide, alcohol-related liver disease (ARLD) and overall fatalities from these deaths of despair. The population weighted average death rate across CUMAs of these causes of death, in deaths per 100,000 population, are 5, 10, 4 and 20. Each regression has 22,800 observations across 950 CUMAs and R-squares ranging from 0.68 to 0.76. Confidence intervals are based on robust standard errors adjusted for clustering at the state level.

Figure A.7: Implied Impact of PNTR on Drug Overdose Deaths, by Gender and Race (CUMAs)



Source: Authors' calculations based on U.S. Centers for Disease Control (CDC) data. Figure displays the 95 percent confidence interval of the implied impact of an interquartile shift in CUMAs' exposure to PNTR on drug overdose mortality for males (top panel) and females (bottom panel), by racial category. Each panel presents the results of a separate population-weighted estimation of equation 3. The population weighted average death rate across counties for fatal drug overdoses among white males and females is 7 and 3 per 100,000 population. Each regression has 22,800 observations across 950 CUMAs. Confidence intervals are based on robust standard errors adjusted for clustering at the state level.

Figure A.8: Implied Impact of PNTR on White Drug Overdose Deaths, by Age (CUMAs)



Source: Authors' calculations based on U.S. Centers for Disease Control (CDC) data. Figure displays the 95 percent confidence interval of the implied impact of an interquartile shift in CUMAs' exposure to PNTR on drug overdose mortality for whites by noted five-year age category. Each panel presents the results of a separate population-weighted estimation of equation 3. Each regression has 22,800 observations across 950 CUMAs. Confidence intervals are based on robust standard errors adjusted for clustering at the state level.

Table A.1: Distribution of US Population Across Age Categories in 2000

Age	Population	Share
Under 1 year	3,855,956	0.0137
1-4 years	15,322,337	0.0543
5-14 years	41,101,548	0.1457
15-19 years	20,294,955	0.0719
20-24 years	19,116,667	0.0678
25-29 years	19,280,263	0.0683
30-34 years	20,524,234	0.0727
35-39 years	22,650,852	0.0803
40-44 years	22,517,991	0.0798
45-49 years	20,219,527	0.0717
50-54 years	17,779,447	0.0630
55-59 years	13,565,937	0.0481
60-64 years	10,863,129	0.0385
65-69 years	9,523,909	0.0338
70-74 years	8,860,028	0.0314
75-79 years	7,438,619	0.0264
80-84 years	4,984,540	0.0177
85 and over	4,262,472	0.0151
Total	282,162,411	1.0000

Source: the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) Program and authors' calculations. Table reports the overall U.S. population weights associated with the age categories used in our baseline results. Data are for the year 2000.

Table A.2: Share of Whites and Males Among Occupations in Manufacturing, 1999

Occupation	Male	White	White-Male	Total
Managerial, Professional	70.8	90.4	.	100
Technical, Sales, Admin, Service	49.6	86.3	.	100
Precision Production	83.0	85.5	.	100
Operators, Fabricators, Laborers, Other	67.0	78.9	.	100
Total	68.0	84.3	58.4	100
Total in Population	49.0	81.9	40.3	100

Source: U.S. Bureau of Labor Statistics and authors' calculations. Table displays the share of manufacturing workers in 1999 that are male or white, by occupation within manufacturing. "." represents unavailable data.

Table A.3: Summary Statistics

	County			CUMA		
Variable	Obs	Mean	SD	Obs	Mean	SD
Age-Adjusted Death Rate (2000)						
Overall	3122	861	113	950	862	110
Deaths of Despair	3122	20	8	950	20	7
Drug Overdose	3122	5	4	950	5	4
Suicide	3122	10	5	950	10	4
ARLD	3122	4	3	950	4	3
NTR Gap (1999)	3122	6	4	950	16	23
Median Household Income (1990)	3122	40	11	950	40	10
Percent No College (1990)	3122	55	11	950	55	11
Percent Veteran (1990)	3122	14	3	950	14	3
Percent Foreign Born (1990)	3122	8	9	950	8	9
Percent Manufacturing Employment (2000)	3122	20	11	950	20	10

Source: U.S. Centers for Disease Control (CDC), the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) Program, the U.S. Cenus Bureau and authors' calculations. Table summarizes distribution of noted attributes across counties and CUMAs, weighted by population, where the year in parentheses notes the year for which the attribute is measured. Death rates are expressed per 100,000 population. Median household income is in thousands of dollars. Summary statistics for the NTR gap in this table differ from those reported in the main text, which represent unweighted averages and standard deviations.

Table A.4: Average Death Rates by Major Causes of Death

	Total Deaths	Crude Rate
External causes of death		
Suicide	29,416	10
Drug Overdose	14,160	5
Other (e.g., motor vehicle accidents, falls, crime)	108,560	39
Total External	152,136	54
Internal causes of death		
Infectious or Parasitic Diseases (e.g., septicemia)	59,122	21
Neoplasms (i.e., cancer)	567,242	202
Diseases of the Blood (e.g., anemia)	9,337	3
Endocrine, Nutritional and Metabolic Diseases (e.g., diabetes)	94,456	34
Mental (e.g., dementia)	46,040	16
Diseases of the Nervous System (e.g., Alzheimers, Parkinsons)	91,182	32
Diseases of the Circulatory System (e.g., AMI, hypertension)	943,068	336
Diseases of the Respiratory System (e.g., pneumonia, influenza)	231,253	82
Diseases of the Digestive System (e.g., liver failure)	84,136	30
Diseases of the Skin	3,756	1
Diseases of the Skeletal System (e.g., arthritis)	13,775	5
Diseases of the Genitourinary System (e.g., renal failure)	54,604	19
Pregnancy and Childbirth	404	0
Conditions Arising in the Perinatal Period	14,097	5
Congenital Malformations and Abnormalities	10,631	4
Not elsewhere classified	31,954	11
Total Internal	2,255,057	803
Total	2,407,193	857

Source: U.S. Centers for Disease Control (CDC), the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) Program, the U.S. Cenus Bureau and authors' calculations. Table summarizes distribution of noted attributes across counties and CUMAs, weighted by population, where the year in parentheses notes the year for which the attribute is measured. Death rates are expressed per 100,000 population. Median household income is in thousands of dollars.

Table A.5: NTR Gap versus County Attributes

	NTR Gap_c	NTR Gap_c	NTR Gap_c	NTR Gap_c	NTR Gap_c	NTR Gap_c	NTR Gap_c	NTR Gap_c	NTR Gap_c
MFA Exposure_c	6.911***								
	0.17								
2000 NTR_c		4.411***							
		0.067							
$\Delta\text{Chinese Tariffs}_c$			-1.577***						
			0.024						
$\Delta\text{Chinese Subsides}_c$				-40.060***					
				4.582					
1990 Median HHI_c					-0.079***				
					0.013				
$\text{1990 Percent No College}_c$						0.252***			
						0.01			
$\text{1990 Percent Veteran}_c$							-0.588***		
							0.041		
$\text{1990 Percent Foreign Born}_c$								-0.414***	
								0.032	
$\text{1990 Percent Manufacturing Employment}_c$									0.347***
									0.003
Observations	3,122	3,122	3,122	3,122	3,122	3,122	3,122	3,122	3,122
R-squared	0.35	0.58	0.58	0.02	0.01	0.18	0.06	0.05	0.77

Notes: Table reports the results of county-level OLS regression of the 1999 NTR gap (in percent) on county attributes. First covariate is the labor share-weighted average fill rate of the MFA products produced in the county. Second covariate is the labor share-weighted average NTR tariff rate of the goods produced in the county. Third and fourth covariates are the labor share-weighted average 1996 to 2005 change in Chinese import tariffs and the 1998 to 2005 change in Chinese production subsidies across the industries active in the county. Fifth through eighth covariates are counties' median household income, percent of residents without college education, percent of residents who are veterans in 1990 and percent of population that is foreign-born. Final covariate is the percent of employment in manufacturing. Results for the regression constant are suppressed. Standard errors are reported below coefficients. *, ** and *** signify statistical significance at the 10, 5 and 1 percent level.