Trade Shocks, Population Growth, and Migration: Implications for Mortality Rate Calculations

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Abstract

This paper examines the effect of trade-induced changes in Mexican labor demand on population growth and migration responses at the local level. I exploit cross-municipality variation in exposure to a change in trade policy between the U.S. and China that differentially exposed Mexican municipalities based on their industry structure. In the five years following the change in trade policy, most exposed municipalities exhibit increased population growth, driven by declines in out-migration. Conversely, six to ten years after the plausibly exogenous change in trade policy, exposure to increased trade competition is associated with decreased population growth, driven by declines in in-migration and returned migration rates, and increased out-migration. I show that accounting for changes in population growth and migration response is relevant to analyze the effect of employment shocks on outcomes that are calculated using population estimates, such as mortality rates. I show that results in the recent literature are sensitive to these adjustments.

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1 Introduction

Why, when, and where do individuals decide to migrate? Beyond its intrinsic relevance, the answer to this question has important implications for the estimates of several socioeconomic outcomes. Selective migration in response to an economic shock changes the composition of local labor markets. Consequently, estimated impacts on average economic and health outcomes might reflect both direct treatment effect and a change in outcomes driven by changes in the labor market composition (Greenland et al., 2019; Arthi et al., 2019). Accounting for such compositional effects represents an empirical challenge, especially when individual panel data is not available.

In the first part of this paper, I study how trade-induced changes in Mexican labor demand affect population growth and migration flows at the local level. I exploit cross-municipality variation in exposure to a change in trade policy between the U.S. and China that negatively affected Mexican manufacturing exports to the U.S. market. I find that, in the five years following the change in trade policy, most exposed municipalities exhibit increased population growth, driven by declines in out-migration. These results are not driven by returned migration from the U.S., which also relatively declines in more exposed areas. Conversely, six to ten years after the plausibly exogenous change in trade policy, exposure to increased trade competition is associated with decreased population growth, driven by declines in in-migration and returned migration rates, and increased out-migration. Furthermore, I find heterogeneity in the effects across population groups: the migratory response is driven primarily by less-educated and manufacturing sector workers.

In the second part of the paper, I discuss the implications of sluggish worker reallocation and heterogeneous migration response across subpopulations for estimates of the effects of trade-induced shocks on other socioeconomic and health outcomes. I show that accounting for changes in population growth and migration response is relevant to analyze the effect of employment shocks on outcomes that are calculated using population estimates, such as mortality rates. I calculate mortality rates following three alternative methodologies used in the recent literature, and discuss the implications of reporting results using the different rates. In particular, I use population estimates to compute "crude" mortality rates as in Case and Deaton (2015, 2017), "age-adjusted" mortality rates as in Gelman and Auerbach (2016) and Pierce and Schott (2020), and the difference in the number of deaths in "levels" as in Dell et al. (2019). I find that results of the trade-induced employment shock on mortality are sensitive (in magnitude, sign, and statistical significance) to the way the rate is calculated. This finding is relevant to assess the size of the impact of an employment shock by itself, but also to compare the results to those previously reported in the literature.

My primary empirical approach focuses on a change in trade policy between the U.S. and China that negatively affected Mexican manufacturing exports to the United States. In October 2000, the U.S. granted to China Permanent Normal Trade relations (PNTR), which eliminated potential tariff increases on imports from China. In the U.S., Pierce and Schott (2016) link the decline manufacturing employment after 2000 to the surge in imports of Chinese goods in particular industries affected by PNTR. Given the technological similarity between China and Mexico at the time, the increase in Chinese exports to the U.S. also led to a decrease in demand for Mexican manufacturing products (Hanson et al., 2008; Gallagher and Porzecanski, 2007) and hence a decline in manufacturing employment opportunities in Mexico (Chiquiar et al., 2017; Mendez, 2015; Utar and Torres Ruiz, 2013).[1] Building on Pierce and Schott (2016, 2020), I construct a Mexican municipality measure of exposure to trade competition resulting from the U.S. granting to China PNTR, which differentially exposed regions to increased trade competition via their industry structure. Therefore, Mexican municipalities specializing in industries in which China had an initial comparative advantage were more exposed to this change in trade policy.[2]

[1] Mexico experienced a rapid export-led expansion of its manufacturing sector, an important source of formal employment creation, after its entry into GATT in 1986 and culminated with the signing of NAFTA in 1994. Within NAFTA, Mexico had developed a comparative advantage in the production of labor-intensive goods (Chiquiar et al., 2017; Feenstra and Kee, 2007; Gallagher et al., 2008; Hanson and Robertson, 2008).

[2] Chinese competition affected Mexico directly, through an increase in imports from China, and indirectly, through increased competition in the U.S. market. In related work (Fernandez Guerrico, 2020), I show the effect of both import and export competition on the manufacturing employment rate.

The contribution of this paper is twofold. First, I examine the population response to a local labor demand shock, and second, I explain why accounting for population adjustment matters to measure mortality rates. To the best of my knowledge, this is the first paper studying aggregate population changes as a response to trade competition in Mexico. There are, however, a vast number of studies examining the U.S.-Mexico migration (Caballero et al., 2019, 2018; Kaestner and Malamud, 2014; Mckenzie and Rapoport, 2010; Ibarraran and Lubotsky, 2007; Chiquiar and Hanson, 2005), and migration responses to income shocks (Quiñones, 2019; Angelucci, 2015; Kleemans, 2015; Belot and Hatton, 2012). The closest related paper is on the individual decision to migrate (Majlesi and Narciso, 2018), which finds that individuals living in areas with higher exposure to international competition were more likely to migrate within Mexico between 2002 and 2005.[3]

Moreover, my results contribute to a better understanding of the implications of international trade exposure on mortality, accounting for population adjustment across municipalities (Greenland et al., 2019; Arthi et al., 2019). An extensive literature has investigated the health and mortality consequences of unemployment. Following the seminal contribution by Ruhm (2000), which reports a pro-cyclical fluctuation of mortality in the United States, a series of influential papers study the effect of economic conditions on mortality (Sullivan and Wachter, 2009; Ruhm, 2015; Autor et al., 2019). A more recent strand of literature focuses on deaths of despair—drug overdoses, suicides, and alcohol-related liver mortality—as the main driver of the overall increase in all-cause mortality in the U.S. over the last two decades (Pierce and Schott, 2020; Hollingsworth et al., 2017; Case and Deaton, 2015, 2017). Although prior work discusses how changes in the underlying population may be a potential source of bias, studies often fail to report whether estimation results would have been different, had they calculated mortality rates accounting for the age distribution of the population or separately examining the migration response to an economic shock,

[3] Majlesi and Narciso (2018) use data from the Mexican Family their sample covers 100 municipalities (oversampling rural areas) whereas my sample covers 2,382. Also, the MxFLS baseline year (2002) does not allow to calculate pre-shock industry shares to correctly measure predicted exposure to increased international competition.

something that I document in this paper for the first time.

More broadly, my analysis relates to the literature on heterogeneous migratory responses to local labor market conditions based on workers' skills (Greenland et al., 2019; Notowidigdo, 2019; Utar, 2018; Cadena and Kovak, 2016; Bound and Holzer, 2000), the relative importance of regional mobility compared to sectoral mobility given adjustment costs (Dix-Carneiro and Kovak, 2017; Bartik, 2018; Autor et al., 2014), and the relative importance of out-migration compared to in-migration (Monras, 2018). Finally, this paper also relates to the extensive literature examining the effect of trade liberalization on labor market outcomes in the last two decades (Autor et al., 2013, 2014; Acemoglu et al., 2016; Pierce and Schott, 2016; Dix-Carneiro, 2014), as well as an array of socio-economic outcomes such as marriage and fertility (Autor et al., 2015, 2019), and crime (Dell et al., 2019; Khanna et al., 2019; Dix-Carneiro et al., 2018). Here, using a similar identification strategy, my results contribute to a better understanding of the implications of accounting differential population growth and migration responses when estimating the effect of international competition on a broader set of outcomes.

This paper proceeds as follows. In the next section, I describe the data. Section 3 introduces my source of variation in labor demand and explains my empirical strategy. In Sections 4 and 5, I present the results of increased trade exposure on aggregate population growth and migration responses, respectively. Section 6 discusses the implications of these population changes for analyzing the effects of economic shocks on outcomes that are calculated using population estimates, such as mortality rates. Section 7 concludes.[4]

2 Data

This section describes the data I use to investigate the relationship between international competition, population growth, and migration responses in the first part of the paper. It

[4]In Appendix B, I provide additional supporting evidence on the implications of population adjustments for mortality rate calculations in a self-contained *Comment* inspired in a partial replication of Dell, Feigenberg, and Teshima (2019). I show that the paper's results are sensitive to the mortality rate calculation.

also describes the data I use to calculate mortality rates for the discussion on the implications of population adjustments for mortality rates calculation.

Population growth and migration response across municipalities

Population data comes from the 2000 and 2010 Mexican Census of Population and Housing Units, and the 1995, 2005, and 2010 Intercensal Population and Housing Count collected by the Mexican National Institute of Statistics and Geography (INEGI). First, I use official tabulations of the full-count 2000 and 2010 Mexican Censuses, and the 1995 and 2005 Counts available at INEGI's website to calculate population growth (with gender and age breakdown) at municipality level.

Second, I also use official tabulations of the full-count based on questions included in the 2000, 2005, and 2010 Population Census and Count regarding individuals' location of residence 5 years prior to the survey. This data allows me to observe migration flows over 1995-2000, 2000-2005, and 2005-2010. Following Caballero et al. (2019), I define the returned migration rate as the number of returned migrants to a municipality, divided by the municipality's population in the survey year. Additionally, I use data on migration intensity from the Mexican Population Council (CONAPO), which has information on the percentage of households whose member(s) have emigrated or returned to the US during 1995-2000 and 2005-2010.

Third, I measure internal migration flows. A municipality's out-migration rate between t-5 and t is the number of individuals leaving municipality i as a share of municipality i's population in t-5, while a municipality's in-migration rate in the number of in-migrants as a share of i's population in t-5. The main caveat of using INEGI's tabulations is that they only allow me to calculate in-migration and out-migration rates for each municipality based on individuals state of residence 5 years prior to the survey. Consequently, I do not observe migration rates between municipalities and within states when using INEGI tabulations of the full-counts.

Fourth, because movement across minor administrative divisions (i.e., municipalities or *municipios*) is only available for the long-form survey, I have information for an approximately ten percent sample of the Mexican population for years 2000 and 2010. This data comes from the Integrated Public Use Microdata Series (IPUMS) International, collected by the Minnesota Population Center. I also use IPUMS microdata to explore the heterogeneity in population response across different educational groups and sectors of employment.

Mortality rates across municipalities

I calculate the number of deaths by municipality using administrative registers from the Mexican National Institute of Statistics and Geography (INEGI). This data provides information from all deaths certificates filed in Mexico. Observable demographics include age, gender, and place of residence. Causes of death are classified using the International Classification of Diseases (ICD-10) (NCHS, 2018). I match year by municipality by age by gender death counts to corresponding population estimates from the 2000 and 2010 Mexican Censuses of Population and Housing Units, as well as the 1995 and 2005 Intercensal Population and Housing Counts collected by INEGI.

Cross-municipality exposure to trade

To measure the initial industry employment shares, I use the 1999 Mexican Economic Census (with reference period 1998). I also use data from the 2004 and 2014 Mexican Economic Census (with reference periods 2003 and 2013, respectively) to examine changes in manufacturing employment over the period. Data to compute the tariffs gaps (described in detail in section 3.1) comes from Feenstra et al. (2002). Data on international trade flows is from UN Comtrade. This data is matched to 4-digit time-consistent manufacturing industries in the Mexican Economic Census using the concordance in (Pierce and Schott, 2009, 2016) between UN Comtrade 4-digit Harmonized System (HS) and 4-digit North American Industry Classification System (NAICS, or SCIAN in Spanish). I use the dataset provided by the authors to create 4-digit industry time-invariant family level dataset containing 84 constant manufacturing industries.

3 Empirical Strategy

In this section, I discuss how I construct measures of municipality exposure to the changes in China-U.S. trade policy. I detail the specifications I use to estimate the causal effect of increased international competition on population growth and migration.

3.1 Labor Market Shock in Mexico - PNTR

My primary empirical approach exploits a change in trade policy between the U.S. and China that generated plausible exogenous variation in Mexican export demand from the United States.[5] In 2001, the United States granted China Permanent Normal Trade Relations (PNTR), which reduced uncertainty regarding potential tariff rates on Chinese exports to the United States. Before China's accession to the WTO in 2001, provision of tariffs rates was subject to annual renewal by the U.S. Congress. Hence, Chinese firms faced considerable uncertainty regarding future costs of exporting. Following China's accession to the WTO, the U.S. congress voted to grant NTR rates on a permanent basis. Pierce and Schott (2016) measure the impact of PNTR as the rise in U.S. tariffs on Chinese goods that would have occurred in the event of a failed annual renewal of China's NTR status (i.e., non-NTR tariffs). They define this difference between the observed NTR tariff rates and the potential non-NTR rates in industry j as the "NTR Gap".

$$NTRGap_j = NonNTRRate_j - NTRRate_j \tag{1}$$

[5]The Mexican manufacturing sector experienced a rapid export-led expansion between the years 1986 and 2000, which started with the country's entry into the General Agreement on Tariffs and Trade (GATT) in 1986 and culminated with the signing of North American Free Trade Agreement (NAFTA) in 1994 and its implementation. The export to GDP ratio rose from 14 percent in 1986 to 25 percent in 2000, as Mexico became integrated into the world economy. Manufacturing exports represent 10 percent of merchandise exports over the 1980s, 43.5 percent in 1990, and 85 percent in 2000. Within NAFTA Mexico had developed a comparative advantage in the production of labor-intensive goods (Chiquiar et al., 2017; Feenstra and Kee, 2007; Gallagher et al., 2008; Hanson and Robertson, 2008). Consequently, China's sharp increase in exports to the U.S. following its accession to the WTO in 2001 is particularly relevant for Mexican manufacturing firms, given that nearly half of the manufacturing exports are produced by *maquiladoras*, or export assembly plants, with the U.S. as their export main destination (Utar and Torres Ruiz, 2013).

I use Pierce and Schott (2016) approach to construct a measure of Mexican industries exposure to China receiving PNTR. The intuition behind using this measure is that Mexican municipalities with industries that benefited from NAFTA, developing a comparative advantage and increasing exports to U.S. over 1994-2000, were more negatively affected by the trade liberalization between China and the United States. The change in trade policy between China and the U.S. was not correlated with Mexican pre-existing outcomes at the local level, while the industry-municipality shares predict changes in employment through the changes in the trade policy between third countries.

Figure 1 shows some visual evidence by plotting Mexico's and China's export values in millions USD to the U.S. from 1990 to 2018, by product disaggregated at 2-digit Harmonized System (HS). The vertical lines show the year NAFTA was implemented (1994) and the year in which the U.S. granted Permanent Normal Trade Relations to China (October 2000). The plots show the increase in Mexican exports to the U.S. after NAFTA between 1994-2000, and the increase in China's exports after 2001. The most affected manufacturing sectors (textiles, electronic and mechanical machinery, wood and paper products, leather, footwear and transportation) in Mexico experienced a decrease (or at least a deceleration) in exports to the United States.[6]

Given that my outcomes of interest are at municipality level, I construct a geographically based measure of international competition. I create a municipality level measure of the "NTR Gap" following Pierce and Schott (2020), who compute U.S. county-level exposure to the PNTR. I construct a measure of Mexican municipalities (indirect) exposure to the PNTR as the employment-share-weighted-average of NTR Gaps across manufacturing industries that are subject to tariffs.

$$NTRGap_i = \sum_j \frac{L_{ji}}{L_i} NTRGap_j \tag{2}$$

where L_{ji} represents the employment in industry j in Mexican municipality i and L_i represents

[6] Table A.3 shows the change in U.S. tariffs on imports from Mexico and China between 1990 and 2001.

total employment in municipality i. Data to compute "NTR Gaps" for each industry j using *ad valorem* equivalent tariff rates is provided by Feenstra et al. (2002). I follow (Pierce and Schott, 2016) and use NTR gaps in 1999, immediately preceding the policy change. Industry-level employment by municipality is from the 1999 Mexican Economic Census. There are 2,382 municipalities in my data, spanning the entire country. Across municipalities, the unweighted NTR gap averages 7.8 percent and has a standard deviation of 6.5 percent, with an interquartile range from 2.8 to 10.6 percent. Figure 2 shows the employment-share-weighted-average NTR gaps across 4-digit NAICS industries in Mexico.[7]

I exploit cross-municipality variation in exposure to the PNTR based on their initial industry specialization, by comparing municipalities facing high and low Chinese competition in the U.S. before and after China's accession to the WTO.

3.2 Estimation

In this section, I explain the specifications I use to estimate the effect of exposure international competition and population adjustment, and I discuss the required specification assumptions.

To estimate how exposure to Chinese competition based on municipalities' initial industrial specialization affected population adjustments in Mexico, I start by assuming that:

$$Y_{i,t} = \alpha_i + \delta_t + \beta Z_i * Post_t + t.X_i'\gamma + u_{i,t} \tag{3}$$

where $Y_{i,t}$ is the outcome for municipality i and year t related to population adjustment, Z_i is a measure of labor market changes at municipality level, and $Post_t$=1 [t>2000] is a dummy variable that equals 1 after 2000. α_i and δ_t are unobserved municipality and time effects, respectively, X_i is a trend for municipality i, and $u_{i,t}$ is the error term.

Municipalities more- or less-exposed to international competition differ in level and trend

[7]The average employment-share-weighted NTR gap is 0.26 with a standard deviation of 0.1, and an interquartile range from 0.21 to .32.

before the trade-shock, meaning that any direct comparison of exposed and non-exposed municipalities could be biased. To address pre-existing differences and to be able to explore the within-municipality variation in population growth, I take first differences of the equation above and obtain the regression model I will use throughout the analysis:

$$\Delta Y_{i,t} = \beta_0 + \beta_1 Z_i + X_i' \gamma + \Delta u_{i,t} \tag{4}$$

Equation 4 will estimate the casual effect of Z_i, under the assumption that municipalities more- and less-exposed to the change in China-U.S. trade policy would have had common changes in outcomes in the absence of the trade shock. Because the model is estimated in first differences, the quinquennial-specific models are equivalent to fixed effects regressions.[8] As explained in the previous section, I will use the $NTRGap_i$, defined in Equation 2, as a plausible exogenous measure of labor market changes at municipality level, represented by Z_i in Equation 4. Mexican municipalities with a larger initial share of employment in industries where Chinese exports to the United States increased as a consequence of the PNTR, have higher exposure to international competition.[9]

4 Aggregate Population Effects

To explore aggregate changes in population growth, I use quinquennial (half-decadal) municipality level population data from the Mexican Population Census and Population Counts. I estimate the following equation:

$$\Delta Population_{i,t} = \beta_0 + \beta_1 NTRGap_i + \Delta Population_{i,t-5} + \Delta u_{i,t} \tag{5}$$

where $\Delta Population_{i,t}$ represents the change in the municipalities i's log population between

[8]Estimating 4 as a fixed-effects regression assumes that the errors are serially uncorrelated (Autor et al., 2013).

[9]Table A.4 shows the effect of exposure to the PNTR on the manufacturing employment rate, providing reduced-form evidence of the negative manufacturing employment shock in Mexican municipalities.

years t-5 and t. Following Greenland et al. (2019), I include a control for pre-shock population growth, $\Delta Population_{i,t-5}$, to account for the possibility that more- and less-exposed municipalities experienced differential growth on average throughout this period. This specification differences out any time-invariant municipality treats and controls for pre-trends in population growth.

In Table 1, I analyze the changes in municipalities' log working-age population over 2000-2005 and 2005-2010. In addition to total population counts in Column 1, I present results by gender in Columns 2 and 3. Panel A shows the changes in log working-age population between 2000 and 2005, using Equation 5. An interquartile increase in the NTR gap increased population growth by 0.0123 log points or a 1.2 percent increase. However, Panel B shows that moving a municipality from the 25th to the 75th percentile of exposure is estimated to decrease population growth by 1.6 percent over 2005-2010. The estimate is statistically significant at 1% level.

The results presented in Table 1 imply an increase in log working-age population growth in the short-term (i.e., 2000-2005), followed by a decrease in population growth in the middle-term (i.e., 2005-2010) among municipalities with a higher average NTR gaps (i.e., those more exposed to Chinese competition in the U.S. market).

The aggregate population results presented in this section suggest that the migration response to a labor demand shock might be sluggish (Greenland et al., 2019). As discussed above, there are several plausible reasons. First, the negative economic shock may cause declines in local income that reduce migration in the short term. Second, workers with different skill sets might be more or less mobile. Third, transitions across employers and sectors could be a mechanism by which workers adjust as opposed to regional mobility. Fourth, there could be increased returned migration from the U.S., where the same industry-specific shock took place concurrently. In the next section, I explore migration flows with the aim to provide some more insight into these channels.

5 Migration Responses

I observe migration between 1995-2000 and 2005-2010 based on responses to the 2000 and 2010 Mexican Population Census, and between 2000-2005 based on (a subset of) responses to the 2005 Population Count.[10] Let $Y_{i,5yr,t}$ be the in-migration, out-migration, or returned-migration rate from municipality i between 2000-2005 and 2005-2010, and $Y_{i,5yr,95-00}$ the corresponding migration rates from municipality i between 1995 and 2000. I estimate the change in migration rates as follows:

$$Y_{i,5yr,t} = \beta_0 + \beta_1 NTRGap_i + Y_{i,5yr,95-00} + \mu_i \tag{6}$$

Equation 6 consistently estimates the effect of exposure to international competition if exposure to the PNTR is independent of potential outcomes conditional on the five-year migration rate.

5.1 Returned Migration from the U.S.

In Table 2, I present estimates of the effect of exposure to PNTR on returned migration rates. Returned migrants are defined as individuals living in Mexico during the year t, when the survey took place, but who lived in another country five years before. The returned migration rate is the number of migrants divided by the source's population in the year t-5. Column 1 shows that moving from the 25th to 75th percentile of municipality exposure is estimated to decrease the returned migration rate by 0.02 percentage points for the overall population between 2000-2005 and 0.3 percentage points between 2005-2010. Columns 2 and 3, which present the results for men and women, respectively, imply that the decreased in returned migration is driven by men.

To further explore the migration response to and from the U.S., I use additional data on U.S.-Mexico migration from the Mexican National Population Council (CONAPO). This

[10] Migration data over the period 2000-2005 are not available to calculate all rates.

dataset has information on the percentage of households with migrants to the U.S. and the percentage of households with returned migrants between 1995-2000 and 2005-2010. Table 3 shows that moving a municipality from the 25th to the 75th percentile of exposure to trade competition increased the percentage of households with migrants to the U.S. by 0.31 percentage points over 2005-2010, whereas it decreased the percentage of households with returned migrants by 0.35 percentage points.[11]

5.2 Internal Migration in Mexico

Table 4 estimates Equation 6 using the in-migration rates between 2000-2005 period and the 2005-2010 period as dependent variables in Panels A and B, respectively. I include the in-migration rate during the 1995-2000 period to control for pre-shock migration rates (Greenland et al., 2019; Caballero et al., 2019). Column 1 shows that moving from the 25th to the 75th percentile of municipality exposure is estimated to decrease the overall in-migration rates by 0.05 percentage points over 2000-2005, although this change is imprecisely estimated, and 0.2 percentage points over 2005-2010.

Similarly, Table 5 presents out-migration rates over the same periods. Column 1 in Panel A shows that moving from the 25th to the 75th percentile of municipality exposure to trade is estimated to decrease overall out-migration rates by 0.7 percentage points over 2000-2005. Conversely, Column 1 in Panel B shows an increase in the overall out-migration rate of 1.1 percentage points over 2005-2010. Columns 2 and 3 in Tables 4 and 5 present the estimates for men and women, respectively. Results by gender are similar in magnitude over the period 2005-2010 (Panel B). However, changes in migration rates are larger in magnitude for men over the period 2000-2005.

Tables 4 and 5 present estimation results of the effect Mexican municipalities exposure to increase Chinese competition in the U.S. market on internal migration. As explained in Section 2, the Mexican Population Census and Count only have information on aggregate

[11] Given that there is no data on migration over 2000-2005, the results presented in Table 3 are comparable to those in Panel B of Table 2.

internal migration flows at municipality level to/from other states. Using this data, I am able to calculate in-migration and out-migration rates for each municipality based on individuals state of residence 5 years prior to the survey. Consequently, estimation results could be a lower bound if migration rates between municipalities and within states are relevant.

In order to partially address this data limitation, I use a 10% subsample of the Mexican population who answered the long-form Census surveys (i.e., IPUMS microdata sample). In years 2000 and 2010 these surveys also asked individuals whether they lived in a different municipality within the same state five years before. Table 6 presents the estimates of Equation 6 for the period 2005-2010 using the IPUMS sample. As before, the regression controls for the pre-shock in-migration rate, (i.e., 1995-2000).[12] Panel A shows an interquartile shift in exposure to international competition reduced overall in-migration by 0.2 percentage points over 2005-2010, although imprecisely estimated. The magnitudes of the in-migration estimates from other states (Table 4, Panel B) and from other municipalities (Table 6, Panel A) are very similar.[13]

The IPUMS sample microdata also enables me to explore whether the migration response is driven by particular subpopulations beyond gender. In Columns 4 and 5 of Table 6, I explore variation across educational groups. The dependent variable is the change in the in-migration rate of those without a high-school diploma (Column 4) and those who have completed high-school (Column 5).[14] The decrease in in-migration is driven by individuals with incomplete high-school. Column 4 implies that an interquartile increase in the NTR gap would have reduced in-migration for those without a high-school diploma between 0.4-0.6 percentage points. This estimate is statistically significant at 10% for in Panel A and 1% in Panel B.

Finally, Columns 6 and 7 show the heterogeneous response across sectors of employ-

[12] Information on in-migration from other municipalities is not available in the 2005 Mexican Population Count. The results on Table 6 should be compared to Panel B (i.e., period 2005-2010) in Table 4.

[13] However, the estimates of in-migration from other states using the IPUMS sample, presented in Panel B show an increase of 0.5 percentage points, slightly higher than the aggregate results using the full sample.

[14] Appendix Table A.1 shows that 79% of the Mexican working-age population (i.e., 20-64 years old) had not completed high-school in year 2000.

ment. Column 6 implies significant reductions in in-migration from manufacturing sector workers, of about 1.2 percentage points. The estimates are more than three times larger for manufacturing workers than other sectors.[15]

The heterogeneous response documented in Columns 4 to 7 is consistent with the fact that the PNTR affected the manufacturing sector. Given that repeated cross-section data does not allow me to observe the population response among individuals displaced from their jobs due to the exposure to the trade shock, it is reassuring to observe that the response is driven by populations directly affected by it.

Although the initial decision to explore the effects of trade exposure on aggregate changes in population growth using quinquennial municipality level population counts is driven by data availability (to be able to match aggregate population changes to migration responses), it sheds light on the dynamics of the adjustment process. The fact that the population response to trade shocks may be sluggish and heterogeneous across subpopulations is relevant when analyzing the effects of these shocks on other outcomes. In the next section, I discuss the implications of differential changes in population growth and composition for calculating mortality rates.

6 Discussion

My results thus far suggest dynamic population effects in response to increased municipality level exposure to Chinese competition in the U.S. market. In the five years following the change in trade policy, most-exposed municipalities have increased population growth, driven by declines in out-migration. If find evidence against these results being driven by returned migration from the U.S., which also relatively declines in more exposed areas. In-migration is negative, although imprecisely estimated in this quinquennial. Conversely, six to ten years

[15] Appendix Table A.1 shows that 10% of the Mexican working-age population is employed in the manufacturing sector in year 2000. The male-to-female ratio in the manufacturing sector was 2 in year 2000 (see Appendix Table A.2). According to the 1998 Mexican Economic census 30% of the labor force was employed in manufacturing.

after the plausibly exogenous change in trade policy, exposure to increased trade competition is associated with decreased population growth, driven by declines in in-migration and returned migration rates, and increased out-migration. Thus, my results are consistent with lagged population adjustments that are driven by significant changes in internal migration.

6.1 What are the implications of changes in population growth on mortality rates calculations?

In this section, I discuss to what extent the population changes documented in the first part of the paper matter when analyzing the effect of economic shocks on other outcomes, such as mortality rates, that require population estimates for its definition. Typically, a mortality rate calculation normalizes death counts by the region's underlying population. There are some empirical challenges introduced by migration. First, people might migrate towards regions with better economic opportunities. Consequently, average economic outcomes may reflect both the direct effect of the economic shock and the change in outcomes driven by changes in labor market composition. Second, there might be an heterogeneous effect across population groups based on ages, education, and gender. This type of selective migration might bias mortality results downwards or upwards depending on the type of death and population group.

Prior literature discusses changes in the underlying population as a potential source of bias; however, studies often fail to report whether results would have been different, had they calculated mortality rates accounting for the age distribution of the population or separately examining the migration response to an economic shock, something that I document in this paper for the first time.

The aim of this part of the paper is to provide empirical evidence that estimation results are sensitive to the way mortality rates are calculated. In Section 6.2, I explain three alternative ways to calculate mortality rates used in the recent literature. I calculate crude and age-adjusted mortality rates based on Gelman and Auerbach (2016)'s discussion on potential “age-aggregation bias” in mortality trends in Case and Deaton (2015)’s work at national level in the U.S.. Additionally, I calculate the difference in deaths in “levels” normalized by the population of the initial year as Dell et al. (2019) calculate homicide rates. In Section 6.3, I discuss the implications of these different ways of calculating mortality rates for analyzing national mortality trends over time. In this case, total population growth and aging of population are key to understand the differences. In Section 6.4, I show how the choice to calculate mortality rates affects the interpretation of the results of a trade-induced economic shock on mortality at sub-national level. Related to this, I present a self-contained comment in Appendix D, where I partially replicate a paper by Dell, Feigenberg and Teshima (2019) to show how their results change if I calculate the homicide rate accounting for population changes at municipality level. I also present additional results on overall mortality to complement the analysis.

6.2 What are we *dividing* by?

In this section, I define mortality rates following three alternative approaches used in the recent literature. I use the population estimates to compute crude mortality rates as in Case and Deaton (2015, 2017), age-adjusted mortality rates as in Gelman and Auerbach (2016) and Pierce and Schott (2020), and the difference in the number of deaths in “levels” for two given years, divided by the population in the initial year as in (Dell et al., 2019).

6.2.1 Crude Mortality Rate

The crude mortality rate for a municipality-year is the total number of deaths in municipality i and year t divided by its total population in that year. The difference in crude mortality rates between two relevant periods is then:

$$\Delta CrudeDeathRate_{i,t,t-1} = 100,000 * (\frac{Deaths_{i,t}}{Population_{i,t}} - \frac{Deaths_{i,t-1}}{Population_{i,t-1}}) \tag{7}$$

Comparisons of crude rates can be misleading if the populations being compared have different distributions of other determinants of disease, such as age.

6.2.2 Age-adjusted Mortality Rate

The age-adjusted rate for a municipality is the weighted average of the crude death rates across age categories within a municipality, using the Mexican population shares in those age categories in 2000 as weights.[16] By assigning a standard age distribution to the populations being compared I compute hypothetical summary rates indicating how the overall rates would have compared if the populations had had the same age distribution between periods. This method allows to obtain the differences in mortality that are independent of age differences. The difference in age-adjusted mortality rates between two relevant periods is then:

$$\Delta AgeAdjDeathRate_{i,t,t-1} = 100,000 * \sum_{b=1}^{16} Share_{b,w} * (\frac{Deaths_{i,t,b}}{Population_{i,t,b}} - \frac{Deaths_{i,t-1,b}}{Population_{i,t-1,b}}) \quad (8)$$

6.2.3 "Level" Mortality Rate

The mortality rate calculated in "levels" is the difference in the number of deaths for a municipality-year, divided by the population of the initial year. This way of calculating mortality rates, used by Dell et al. (2019), normalizes the differences in the number of deaths to the population of the initial year, as shown in the following equation:

$$\Delta LevelDeathRate_{i,t,t-1} = 100,000 * \frac{(Deaths_{i,t} - Deaths_{i,t-1})}{Population_{i,0}} \quad (9)$$

[16] I use the following 16 age categories, b: 0 to 4 years, 5 to 9 years...,70 to 75 years..., and greater than 75 years. The population weights associated with these categories, w, are provided in Table A.5. I follow the same approach as Pierce and Schott (2020) to calculate the crude and age-adjusted mortality rates. In the U.S., age-adjusted death rates calculated by National Vital Statistics Reports are based on the 2000 U.S. standard population. This population standard was adopted by the National Center of Health Statistics (NCHS) in 1999, and replaced the 1940 standard population that had been used for more than 50 years. To the best of my knowledge, Mexico has not designated any particular year as population standard. Gelman and Auerbach (2016) show that age-adjusted mortality trends are not sensitive to the age distribution used to normalize the mortality rates.

6.3 Previous Literature: Age-adjusted, Crude, or Levels?

In this section, I briefly summarize how previous work has defined mortality rates to motivate the discussion on how the different approaches matter for comparing results across the literature.

Country-level Analysis - Crude versus Age-adjusted

Case and Deaton (2015) find an increase in all-cause mortality of middle-aged white non-Hispanic men and women in the United States between 1999 and 2013. The authors calculate the crude mortality rates dividing number of the deaths within an age group by the population of the age-group. Gelman and Auerbach (2016) confront these results by showing the existence an "age-aggregation bias" in the mortality trends. The authors argue that the change in the age of the 45-54 year old group explains about half of the change in the mortality rate of this group in the period considered. Opposite to the absolute increase in mortality that Case and Deaton (2015) report, Gelman and Auerbach (2016) find that the mortality rate increase from 1999 to 2005 and then stopped increasing.

The methodology used to calculate the rate matters for the interpretation of mortality trends because changes in the distribution of the population within age groups. Consequently, the method used for calculating mortality rates is particularly relevant when analyzing the effects of differential exposure exogenous policy changes, such as international competition. Given that mortality rates are sensitive to the compositional changes of the population, a shock that affects workers mobility will in all likelihood affect the composition of the population in less and more exposed regions.

The change in the composition of the population and its size will matter when studying the effect of labor market shocks and the workers mobility resulting from it. In the next section, I discuss how the change in the composition of the population might bias results when studying the effects of trade-induced worker displacement at sub-national level.

Sub-national Level Analysis - Age-adjusted versus Levels

To motivate the discussion on the differences between age-adjusted and level mortality rates, I compare to recent papers that use China's entry to the WTO as source of exogenous variation in labor demand. The first paper, Pierce and Schott (2020), finds that U.S. counties more exposed to the change in trade policy between China and the United States exhibit relative increases in deaths of despair driven by drug overdoses in working-age population. The second paper, Dell, Feigenberg, and Teshima (2019), finds that Mexican urban municipalities with higher predicted increases in international competition experience significantly greater increases in the drug-related homicide rate. It goes without saying that deaths caused by overdose and homicide are different outcomes; hence, any comparison in these mortality rates will be different not only in magnitude, but also in terms of the potential mechanisms affecting these outcomes. Nevertheless, the two studies use the same trade shock as a source of exogenous variation for labor demand, over similar periods of time, and in two economies that are highly connected by trade, labor demand, and migration. Therefore, it would be useful to be able to compare the effects found in the literature to understand the impact and magnitude of this shock.[17]

Suppose someone replicates these two papers using a common econometric specification and source of exogenous variation, would we be able to compare the results on different causes

[17]The two papers use the same shock but have slightly different approaches to identifying the causal effects of trade-induced job displacement on mortality. Pierce and Schott study the effect of direct Chinese import competition in the U.S. using the "NTR Gap" as county-level measure of exposure to a change in trade policy. Dell, Feigenberg and Teshima present evidence of the effect of indirect international competition (i.e., increased Chinese competition in the U.S. market for Mexico) exploiting cross-municipality variation in exposure to trade based on initial industry specialization and the predicted change in Chinese exports to the U.S., adapting (Autor et al., 2013) identification strategy. Moreover, using a difference-in-difference identification strategy, Pierce and Schott (2020) find that an interquartile shift in exposure to PNTR is associated with a relative increase in the mortality rate from drug overdoses of 2 to 3 deaths per 100,000 of population in each year after the policy (with a baseline mortality rate of 5 per 100,000 in the year 2000). Using an instrumental variable approach, Dell et al. (2019) find that a one standard deviation decline in manufacturing jobs increases the annual homicide rate by 1 between years 1998-2003 and by 12 per 100,000 between years 1998-2013. Regarding mechanisms, in both papers, the rise in mortality is linked to the deterioration of employment opportunities induced by increased Chinese competition in the U.S. market. However, in Pierce and Schott (2020) job displacement seems to have exacerbated some socioeconomic cumulative disadvantages in vulnerable populations (Case and Deaton, 2015, 2017; Hollingsworth et al., 2017; Browning and Heinesen, 2012), whereas in Dell et al. (2019) the main mechanism is that job loss lowers the opportunity cost of criminal employment (Dix-Carneiro et al., 2018; Khanna et al., 2019).

of death? Not quite. It turns out that these papers calculate mortality rates differently. Pierce and Schott (2020) follow the standard approach in the literature and calculate age-adjusted mortality rate in a county as the weighted average of the crude death rates across age categories within a county using the US population shares in those age categories in 2000 as weights. Dell et al. (2019) calculate the death rate cause by homicides as the difference in the number of homicides in levels normalized by the population of the initial year. This difference is relevant because it prevents us from comparing the impact of the shock on mortality across these two economies. Only one of these papers is actually normalizing the outcome by this change in population, whereas the other paper is taking the differences in number of deaths in levels, and normalizing it by the initial population. Does this affect the results in terms of magnitude and statistical significance of point estimates? Yes.

In the next section, I show that the interpretation of the effects of trade-induced manufacturing job loss in Mexico on mortality differ depending on the the way the mortality rate is calculated. For this empirical application, I focus on overall mortality to provide a general overview of the issue. Then, in Appendix D, I partially replicate Dell et al. (2019) to show that the results on specific causes of death, such as homicides, are also sensitive to the rate calculation.

6.4 Empirical Application

In this section, I illustrate how the population growth and migration response that I document in Sections 4 and 5 matter for the calculation of mortality rates. Figure 3 plots Mexico's overall mortality rates, calculated in the three ways described above, between 1990 and 2015. At national level, crude and age-adjusted mortality rates follow a similar trend in the early 1990s and start diverging in the late 1990s and 2000s.[18] Similarly, Table 7 shows the quinquennial mean changes in overall mortality rates across Mexican municipalities over 1995-2000, 2000-2005, and 2005-2010, which match the periods used for the population anal-

[18]The divergence is driven by the demographic transition (i.e., aging population) that Mexico, as many other middle-income economies has experienced in the last several decades.

ysis in the previous sections.[19] Looking at the unweighed national mortality trend in Figure 3 and the population-weighted mortality rates in Table 7, it is evident that the mortality rate calculations are sensitive to population changes. Given these results, what happens when we estimate the effect of a trade-induced employment shock on mortality?

Table 8 estimates Equation 4 where the dependent variable is the change in municipality i's mortality rate between 2000-2005 in Panel A and 2005-2010 in Panel B, controlling for quinquennial change in the pre-shock mortality rate (i.e., 1995-2000). Panel A shows that, between 2000 and 2005, moving a municipality from the 25th to the 75th percentile of exposure to the PNTR decreased the crude mortality rate by 5.8 deaths per 100,000 population; and decreased the age-adjusted mortality rate by 0.5 deaths per 100,000 population, although imprecisely estimated. However, it increased the mortality rate calculated in levels by 6.8 deaths per 100,000. Panel B shows that, between 2005 and 2010, moving a municipality from the 25th to the 75th percentile of exposure to the PNTR decreased the crude mortality rate by 6.2 deaths per 100,000 population, although imprecisely estimated, the age-adjusted mortality rate by 6.6 deaths per 100,000 population, and the mortality rate calculated in levels by 13.7 deaths per 100,000 population.

Results show that age-adjusted and crude mortality rates, which divide number of deaths by contemporaneous population, decrease in 2000-2005 and 2005-2010. Therefore, any changes in mortality already account for population growth; however, the potential change in the population composition is not accounted for. The age-adjustment goes one step further than the crude rate by fixing the age-distribution to the initial year. On the contrary, calculating the mortality rate in levels does not allow to account neither for differential population growth nor for compositional changes as a result of the employment shock. Therefore, the mortality rate in municipality i could be increasing as a result of more people living there. Recall that Table 1 shows that exposure to the PNTR is associated with increased population growth over 2000-2005, and decreased population growth over 2005-2010. Similarly,

[19] Appendix Table A.7 shows mean changes in the mortality rate from other major causes mentioned in this paper for completeness.

Column 3 in Table 8 shows that the mortality rate in levels increases over the first period and decreases over the second period. Conversely, note that the point estimates of age-adjusted and crude mortality rates are negative in both periods.[20]

Finally, to provide further evidence on the implications of population adjustments when evaluating the effects of a trade-induced employment shock on mortality, in Appendix D, I partially replicate Dell, Feigenberg and Teshima (2019), which explores the effect of increased international competition in the U.S. market on drug-related homicides. The authors calculate the homicide rate in "levels". In Section B.2, I described their 2SLS identification strategy in detail. In Section B.3, I show that their results are sensitive to the way that the homicide rate is defined. Furthermore, using their 2SLS identification strategy I also estimate the effect of the trade-induced job displacement on overall mortality to be able to provide some insights into the size of the impact on overall mortality, compared to homicides.

7 Final Remarks

The results presented in the first part of the paper imply dynamic population effects in response to increased municipality level exposure to Chinese competition in the U.S. market. In the five years following the change in trade policy, most-exposed municipalities have increased population growth, driven by declines in out-migration. If find evidence against these results being driven by returned migration from the U.S., which also relatively declines in more exposed areas. The effect on on-migration is negative, although imprecisely estimated in this quinquennial. Conversely, six to ten years after the plausibly exogenous change in trade policy, exposure to increased trade competition is associated with decreased population growth, driven by declines in in-migration and returned migration rates, and increased out-migration. Thus, my results are consistent with lagged population adjustments that are

[20]For robustness, appendix tables A.6 and A.8 present estimates of Equation 4 of the effect of Mexican municipalities' exposure to international competition on log population growth and changes in overall mortality, respectively. In this case, using $\Delta ICW_{i,t}$, defined in Appendix D, as a measure exposure to international competition per worker in municipality i, which is an alternative source of plausibly exogenous variation to labor market conditions, Z_i in Equation 4.

driven by significant changes in internal migration.

In the second part of the paper, I illustrate how my population results affect the calculation of mortality rates. Results show that age-adjusted and crude mortality rates, which divide number of deaths by contemporaneous population, decrease; however, calculating mortality in levels does not account for population changes. In epidemiology and demography, the standard approach is to use age-adjusted (also referred to age standardized) mortality rates (Ahmad et al., 2001; Klein and Schoenborn, 2001; Murphy et al., 2013).[21] If we follow this approach, looking at Table 8 we would conclude that the effect of exposure to the PNTR on mortality is not statistically significant over 2000-2005 and only marginally significant over 2005-2010. That said, the main objective of this paper is not to argue for or against either of these methodologies, but to make the following two points. First, it is important to be precise in the definition of mortality rates when reporting results because it allows comparisons across the vast literature on (trade-induced) unemployment shocks and mortality. Second, mortality rate calculations are sensitive to population changes.

[21] Age adjustment is also used in mortality statistics reports produced by the World Health Organization, Centers of Disease of Controls and Prevention, and the National Center for Health Statistics.

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8 Tables

Table 1: International Competition and Five-year Changes in Log Working-age Population

	(1) All	(2) Men	(3) Women
PANEL A: $\Delta Log(Population)$ **2000-2005**			
$NTRGap_i$	0.106***	0.133***	0.0853**
	(0.0375)	(0.0411)	(0.0364)
Moving municipality from 25th to 75th pctile	0.0123***	0.0155***	0.0099**
	(0.0044)	(0.0048)	(0.0042)
PANEL B: $\Delta Log(Population)$ **2005-2010**			
$NTRGap_i$	-0.143***	-0.179***	-0.106***
	(0.0434)	(0.0497)	(0.0397)
Moving municipality from 25th to 75th pctile	-0.0166***	-0.0208***	-0.0123***
	(0.0051)	(0.0058)	(0.0046)
Observations	2,382	2,382	2,382

Notes: This table presents estimates of Equation 5 and shows the effect of Mexican municipalities' exposure to international competition on population growth over 2000-2005, in Panel A, and between 2005-2010, in Panel B. The dependent variable is the change in log municipality working-age population. $NTRGap_i$, defined in Equation 2 is a measure of Mexican municipalities exposure to the change in trade policy between the U.S. and China. Column 1 shows changes in log total population, while Columns 2 and 3 present the results for men and women, respectively. The second to last row in each panel presents rescaled estimates to reflect the change in log population for a Mexican municipality at the 75th compared to the 25th percentile of exposure to international competition. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities.

Table 2: International Competition and Five-year Changes in Returned Migration Rates

	(1) All	(2) Men	(3) Women
PANEL A: Returned migration rate from U.S. 2000-2005			
$NTRGap_i$	-0.00188***	-0.00324***	-0.000639
	(0.000676)	(0.00101)	(0.000434)
Moving municipality from 25th to 75th pctile	-0.0002***	-0.0004***	-0.0001
	(0.0001)	(0.0001)	(0.0001)
PANEL B: Returned migration rate from U.S. 2005-2010			
$NTRGap_i$	-0.0222***	-0.0337***	-0.0116***
	(0.00323)	(0.00517)	(0.00168)
Moving municipality from 25th to 75th pctile	-0.0026***	-0.0039***	-0.0014***
	(0.0004)	(0.0006)	(0.0002)
Observations	2,382	2,382	2,382

Notes: This table presents estimates of Equation 6 of the relationship between China receiving PNTR, which increased Mexican municipalities' exposure to Chinese competition in the U.S. market, and returned migration rates between 2000-2005 (Panel A) and 2005-2010 (Panel B). The dependent variable is the returned migration rate from the U.S., $Y_{i,5yr,t}$ in Equation 6. $NTRGap_i$, defined in Equation 2 is a measure of Mexican municipalities (indirect) exposure to the change in trade policy between the U.S. and China. The second to last row presents rescaled estimates to reflect the change in the returned migration rate for a Mexican municipality at the 75th compared to the 25th percentile of exposure to international competition, which is the tariff gap for the average worker of 0.11 percentage points. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities.

Table 3: International Competition and Change in % of Households with Migrants 2005-2010

	(1) % Households with migrants to U.S.	(2) % Households with returned migrants
$NTRGap_i$	2.672**	-3.020***
	(1.317)	(0.713)
Moving a municipality from 25th to 75th pctile	0.3111**	-0.3515***
	(0.1533)	(0.0830)
Observations	2,382	2,382

Notes: This table shows the effect of Mexican municipalities' exposure to international competition in the U.S. market on Mexico-U.S. migration between 2005-2010 with respect to the pre-shock period 1995-2000. The dependent variable is the percentage of households with migrants to the U.S. in Column 1 and the percentage of households with returned migrants from the U.S. in Column 2. Data is from the Mexican Population Council (CONAPO). $NTRGap_i$, defined in Equation 2 is a measure of Mexican municipalities exposure to the change in trade policy between the U.S. and China. The second to last row presents rescaled estimates to reflect the change in returned migration for a Mexican municipality at the 75th compared to the 25th percentile of exposure to international competition, which is the tariff gap for the average worker of 0.11 percentage points. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities.

Table 4: International Competition and Five-year Changes in In-migration Rates

	(1) All	(2) Men	(3) Women
PANEL A: In-migration rate from other states 2000-2005			
$NTRGap_i$	-0.00419	-0.00753	-0.000823
	(0.00706)	(0.00733)	(0.00693)
Moving a municipality from 25th to 75th pctile	-0.0005	-0.0009	-0.0001
	(0.0008)	(0.0009)	(0.0008)
PANEL B: In-migration rate from other states 2005-2010			
$NTRGap_i$	-0.0246***	-0.0298***	-0.0195**
	(0.00928)	(0.00949)	(0.00922)
Moving a municipality from 25th to 75th pctile	-0.0029***	-0.0035***	-0.0023**
	(0.0011)	(0.0011)	(0.0011)
Observations	2,382	2,382	2,382

Notes: This table presents estimates of Equation 6 of the relationship between China receiving PNTR, which increased Mexican municipalities' exposure to Chinese competition in the U.S. market, and in-migration rates between 2000-2005 (Panel A) and 2005-2010 (Panel B). The dependent variable is the in-migration rate to municipality i from municipalities in a different state, $Y_{i,5yr,t}$ in Equation 6. $NTRGap_i$, defined in Equation 2 is a measure of Mexican municipalities (indirect) exposure to the change in trade policy between the U.S. and China. The second to last row presents rescaled estimates to reflect the change in the in-migration rate for a Mexican municipality at the 75th compared to the 25th percentile of exposure to international competition, which is the tariff gap for the average worker of 0.11 percentage points. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities.

Table 5: International Competition and Five-year Changes in Out-migration Rates

	(1)	(2)	(3)
	All	Men	Women
PANEL A: Out-migration rate to other states 2000-2005			
$NTRGap_i$	-0.0626**	-0.0809***	-0.0450*
	(0.0253)	(0.0254)	(0.0257)
Moving a municipality from 25th to 75th pctile	-0.0073**	-0.0094***	-0.0052*
	(0.0030)	(0.0030)	(0.0030)
PANEL B: Out-migration rate to other states 2005-2010			
$NTRGap_i$	0.0979***	0.102***	0.0943***
	(0.0256)	(0.0266)	(0.0249)
Moving a municipality from 25th to 75th pctile	0.0114***	0.0118***	0.0110***
	(0.0030)	(0.0031)	(0.0029)
Observations	2,382	2,382	2,382

Notes: This table presents estimates of Equation 6 of the relationship between China receiving PNTR, which increased Mexican municipalities' exposure to Chinese competition in the U.S. market, and out-migration rates between 2000-2005 (Panel A) and 2005-2010 (Panel B). The dependent variable is the out-migration from municipality i to municipalities in a different state, $Y_{i,5yr,t}$ in Equation 6. $NTRGap_i$, defined in Equation 2 is a measure of Mexican municipalities (indirect) exposure to the change in trade policy between the U.S. and China. The second to last row presents rescaled estimates to reflect the change in the out-migration rate for a Mexican municipality at the 75th compared to the 25th percentile of exposure to international competition, which is the tariff gap for the average worker of 0.11 percentage points. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities.

Table 6: International Competition and Five-year In-migration Rates (IPUMS Sample)

	All	Men	Women	Less than High-school	Completed High-school	Manufacturing Sector	Other Sectors
PANEL A: In-migration rate from other municipalities 2005-2010							
$NTRGap_i$	-0.0207	-0.0268	-0.0153	-0.0368*	0.0421	-0.102***	-0.0104
	(0.0226)	(0.0234)	(0.0224)	(0.0212)	(0.0283)	(0.0365)	(0.0205)
Moving a municipality from 25th to 75th pctile	-0.0024	-0.0031	-0.0018	-0.0043*	0.0050	-0.0119***	-0.0012
	(0.0026)	(0.0027)	(0.0026)	(0.0025)	(0.0033)	(0.0043)	(0.0024)
PANEL B: In-migration rate from other states 2005-2010							
$NTRGap_i$	-0.0433**	-0.0433**	-0.0436**	-0.0547***	-0.0105	-0.103***	-0.0352**
	(0.0183)	(0.0187)	(0.0181)	(0.0186)	(0.0184)	(0.0320)	(0.0157)
Moving a municipality from 25th to 75th pctile	-0.0051**	-0.0051**	-0.0051**	-0.0064***	-0.0012	-0.0120***	-0.0041**
	(0.0021)	(0.0022)	(0.0021)	(0.0022)	(0.0022)	(0.0037)	(0.0018)
Observations	2,382	2,382	2,382	2,382	2,382	2,382	2,382

Notes: This table presents estimates of Equation 6 of the relationship between China receiving PNTR, which increased Mexican municipalities' exposure to Chinese competition in the U.S. market, and in-migration rates between 2005-2010 In Panel A, the dependent variable is the in-migration rate to municipality i from any other municipality in Mexico. In Panel B, the dependent variable is the in-migration rate to municipality i from municipalities in a different state, $Y_{i,5yr,t}$ in Equation 6. $NTRGap_i$, defined in Equation 2 is a measure of Mexican municipalities (indirect) exposure to the change in trade policy between the U.S. and China. The second to last row presents rescaled estimates to reflect the change in the in-migration rate for a Mexican municipality at the 75th compared to the 25th percentile of exposure to international competition, which is the tariff gap for the average worker of 0.11 percentage points. Source: IPUMS International. Data for Panel A is not available for 2000-2005; thus, these results should be compared to those in Panel B of Table 4. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities.

Table 7: Summary Statistics - Mean Changes in Overall Mortality Rate in Mexico

Δ **Total Mortality**	Age-adjusted	Crude	Levels
Δ 1995-2000	-26.02	3.64	31.35
	(79.23)	(79.65)	(78.25)
Δ 2000-2005	-8.56	40.65	61.16
	(55.50)	(68.53)	(59.99)
Δ 2005-2010	4.28	56.53	93.50
	(67.99)	(80.67)	(76.93)
Observations	2,382	2,382	2,382

Notes: This table shows mean changes Mexican municipalities' overall mortality national trend between 1995-2000, 2000-2005, and 2005-2010. I calculate "age-adjusted", "crude", and "levels" mortality rates per 100,000 population as defined in Section 6.2. The observations are weighted by the municipalities' population.

Table 8: International Competition and Mortality

	(1) Crude	(2) Age-adjusted	(3) Levels
PANEL A: Overall Mortality Rate 2000-2005			
$NTRGap_i$	-50.75**	-3.897	58.40**
	(25.33)	(20.87)	(23.90)
Moving a municipality from 25th to 75th pctile	-5.887**	-0.452	6.774**
	(2.9378)	(2.4206)	(2.7719)
PANEL B: Overall Mortality Rate 2005-2010			
$NTRGap_i$	-53.16	-57.00*	-117.6***
	(33.79)	(31.95)	(31.41)
Moving a municipality from 25th to 75th pctile	-6.171	-6.617*	-13.649***
	(3.923)	(3.709)	(3.647)
Baseline rate	445.38	448.25	445.38
Mean Δ 2000-2005	1.59	-48.17	29.79
Mean Δ 2005-2010	56.19	4.11	93.38
Observations	2,382	2,382	2,382

Notes: This table presents estimates of Equation 4 of the relationship between China receiving PNTR, which increased Mexican municipalities' exposure to Chinese competition in the U.S. market, and the overall mortality rate between 2000-2005 (Panel A) and 2005-2010 (Panel B). The dependent variable is the change in the crude (Column 1), age-adjusted (Column 2) and levels (Column 3) mortality rates per 100,000 population in municipality i, as defined in Section 6.2. $NTRGap_i$, defined in Equation 2 is a measure of Mexican municipalities (indirect) exposure to the change in trade policy between the U.S. and China. The second to last row presents rescaled estimates to reflect the change in the mortality rate for a Mexican municipality at the 75th compared to the 25th percentile of exposure to international competition, which is the tariff gap for the average worker of 0.11 percentage points. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities.

9 Figures

Figure 1: Mexican and Chinese Exports to the U.S. (millions USD, 2-digit industries)

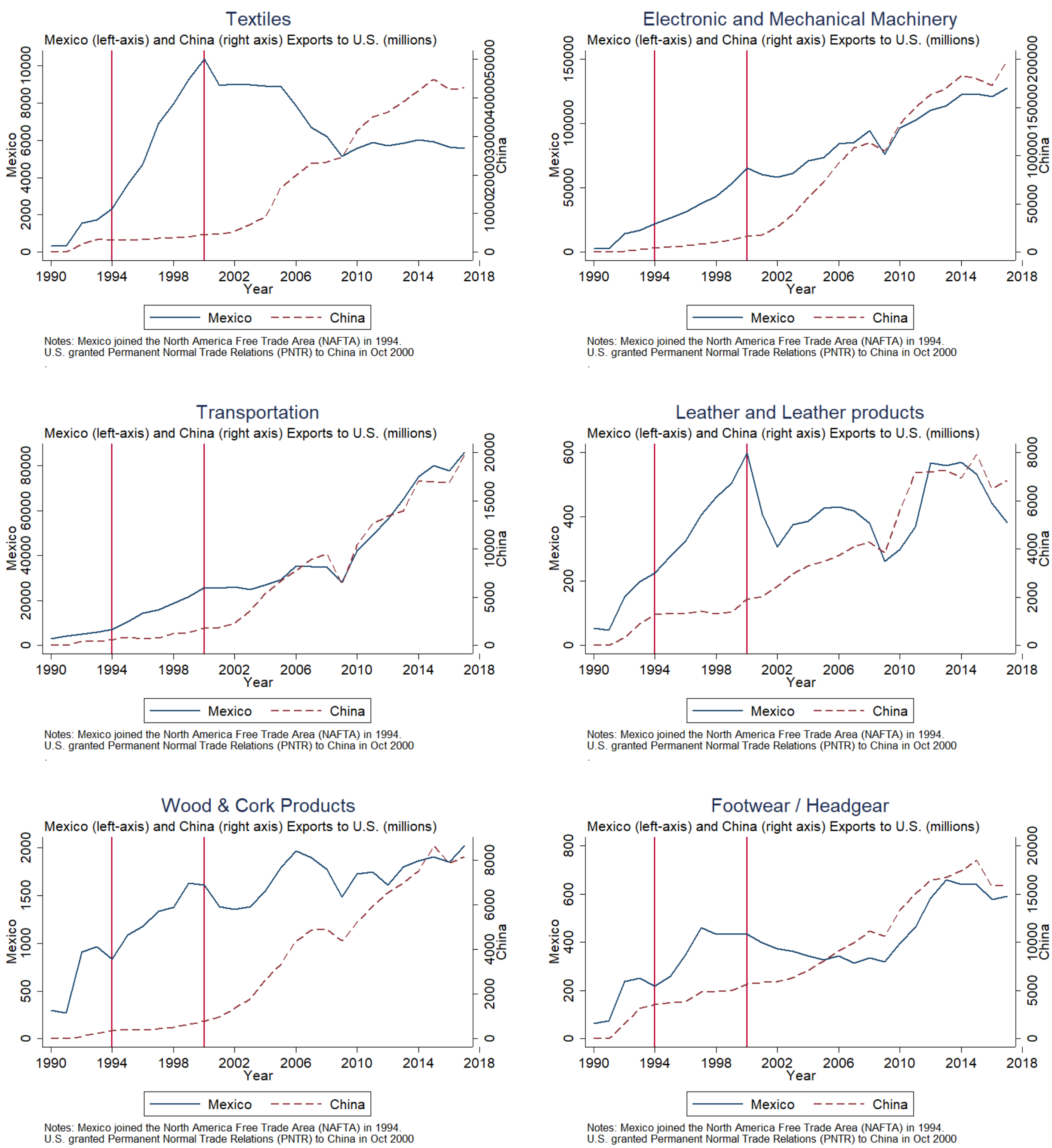


Figure 2: Histogram - Pierce and Schott (2016) measure of exposure

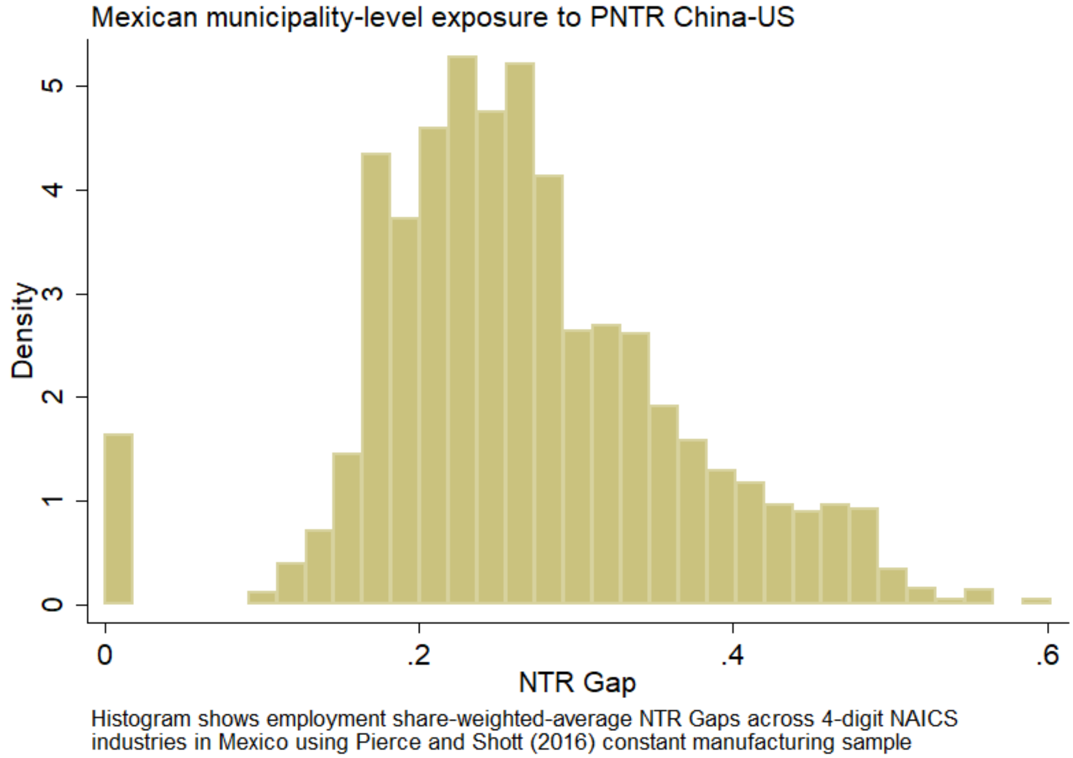
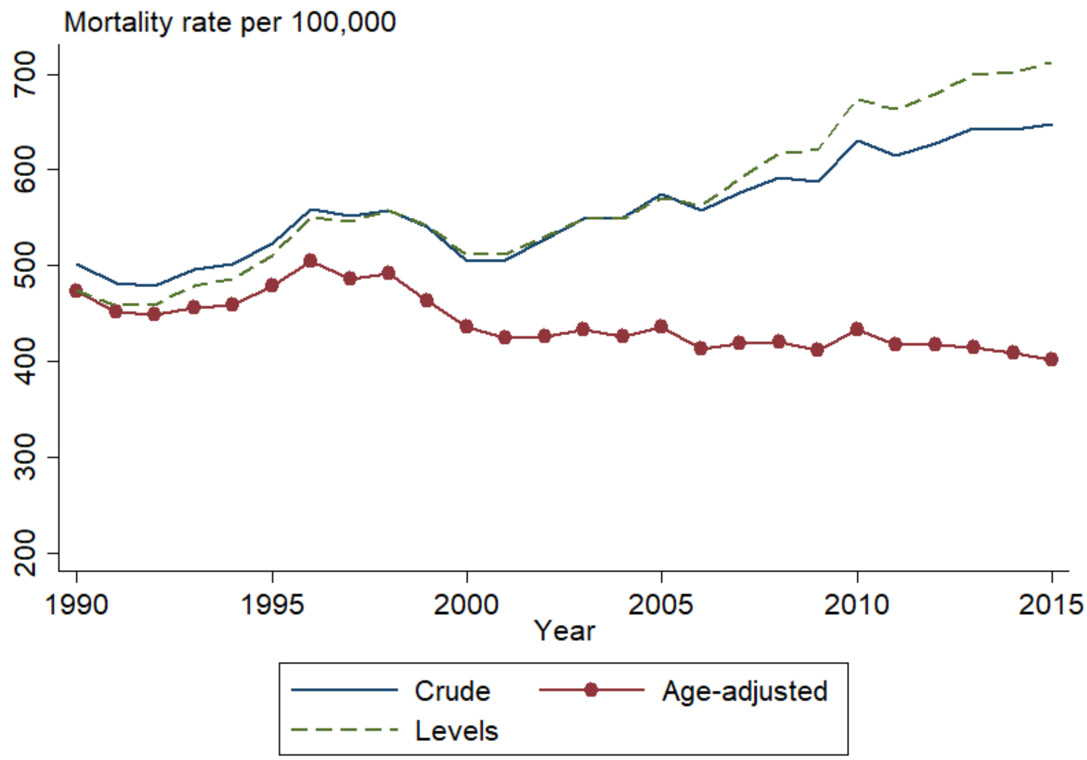


Figure 3: Overall Mortality Rate - Mexico 1990-2015



Mortality Rate	Crude	Age-adjusted	Levels
100,000 x	$\frac{Deaths_{i,t}}{Population_{i,t}}$	$\sum_b Share_{b,2000} \frac{Deaths_{i,t,b}}{Population_{i,t,b}}$	$\frac{Deaths_{i,t}}{Population_{i,2000}}$

Notes: This figure shows the Mexico's overall mortality national trend between 1990 and 2015. I calculate "crude", "age-adjusted", and "levels" mortality rates per 100,000 population as defined in Section 6.2.

A Appendix A: Additional Tables

Table A.1: Summary Statistics - Mexican Population Census 2000 (IPUMS Sample)

	Mean	**Std. Dev.**
Demographics		
Age	36.51	11.99
Men	0.48	0.50
Married	0.73	0.44
Employment-to-Population by main sectors		
Manufacturing	0.10	0.30
Agriculture & mining	0.13	0.34
Services	0.10	0.30
Construction	0.05	0.22
Sales	0.09	0.28
Education		
Less than High School	0.79	0.41
High School Graduate	0.15	0.35
College Graduate	0.06	0.26
Place of residence in 1995		
Different state	0.04	0.20
Different Municipality	0.07	0.25
Different Country	0.01	0.08

Source: IPUMS International and INEGI, 2000 Mexican Population Census. Sample includes working-age individuals (20-64 years old).

Table A.2: Male-to-female ratio by Sector of Employment, 2000

Sector	**Male-to-female ratio**
Agriculture, fishing, forestry	9.3
Mining	7.2
Manufacturing	**2.0**
Electricity, gas and water	6.2
Construction	36.2
Wholesale and retail trade	1.3
Hotels and restaurants	0.9
Transportation, storage and communications	7.8
Financial services and insurance	1.3
Public administration and defense	2.0
Real estate and business services	2.1
Education	0.7
Health and social work	0.6
Other services	5.2
Private household services	0.1

Source: IPUMS international, Mexican Population Census, 2000. Number of observations: 2,750,218. Sample includes working-age individuals (20-64 years old) who are employed.

Table A.3: Mexico's and China's Trade with the U.S., 1990-2001

	Overall	Agriculture	Textiles & Garments	Wood & Paper	Petroleum & plastics	Mining & metals	Machinery & transport	Electronics
US tariffs on imports from Mexico								
1990	4.1	4.4	13	2.2	0.6	2.1	2.5	4.1
2001	0.3	0.8	0.4	0	0.1	0.7	0.1	0.1

	Overall	Agriculture	Textiles & Garments	Wood & Paper	Petroleum & plastics	Mining & metals	Machinery & transport	Electronics
US tariffs on imports from China								
1990	5.8	1.4	13	6.6	2.7	6.4	5.1	5.1
2001	3.6	1.7	10.9	1.3	3.1	4.1	3	1.2

Notes: Table shows 1990 and 2001 U.S. tariffs on imports from Mexico and China Source: Feenstra et al. (2002)

Table A.4: International Competition and Manufacturing Employment

Δ **Manufacturing Employment Rate**		
	1998-2003	**1998-2013**
	(1)	(2)
$NTRGap_i$	-0.0864***	-0.165***
	(0.0210)	(0.0317)
Moving a municipality from 25th to 75th pctile	-0.0101***	-0.0192***
	(0.0024)	(0.0037)
Observations	2,382	2,382

Notes: This table shows the effect of exposure to the PNTR on the municipality manufacturing employment rate. $NTRGap_i$ is defined in Equation 2 is a measure of Mexican municipalities exposure to the change in trade policy between China and the U.S.

Table A.5: Distribution of Mexican Population Across Age Categories in 2000

	Total	Women	Men
Ages 0-4	0.109	0.105	0.113
Ages 5-9	0.115	0.111	0.119
Ages 10-14	0.110	0.106	0.114
Ages 15-19	0.103	0.102	0.103
Ages 20-24	0.093	0.096	0.090
Ages 25-29	0.084	0.086	0.081
Ages 30-34	0.073	0.075	0.071
Ages 35-39	0.065	0.067	0.064
Ages 40-44	0.053	0.054	0.052
Ages 45-49	0.042	0.042	0.041
Ages 50-54	0.034	0.035	0.034
Ages 55-59	0.026	0.027	0.026
Ages 60-64	0.023	0.023	0.022
Ages 65-69	0.017	0.018	0.016
Ages 70-74	0.013	0.013	0.012
Ages 75 +	0.019	0.020	0.018

Notes: Table reports the overall Mexican population weights used to construct the age-adjusted mortality rates. Data is from the 2000 Mexican Population Census.

Table A.6: International Competition and Five-year Changes in Log Working-age Population - (Alternative Measure of Exposure)

	(1) All	(2) Men	(3) Women
PANEL A: $\Delta Log(Population)$ **2000-2005**			
$\Delta ICW_{2000-2005}$	0.00227***	0.00258***	0.00226***
	(0.000873)	(0.000935)	(0.000825)
Moving a municipality from 25th to 75th pctile	0.0072***	0.0082***	0.0072***
	(0.0028)	(0.0030)	(0.0026)
PANEL B: $\Delta Log(Population)$ **2005-2010**			
$\Delta ICW_{2005-2010}$	-0.00228**	-0.00244*	-0.00193*
	(0.00116)	(0.00125)	(0.00109)
Moving a municipality from 25th to 75th pctile	-0.0088**	-0.0094*	-0.0075*
	(0.0045)	(0.0048)	(0.0042)
Observations	2,382	2,382	2,382

Notes: This table presents estimates of Equation 4 of the relationship between Mexican municipalities' exposure to international competition in the U.S. market and log population growth between 2000-2005 in Panel A and 2005-2010 in Panel B. Dependent variable is change in log municipality working-age population. $\Delta ICW_{i,t}$, defined in Equation B.4 is a measure exposure to international competition per worker in municipality i, which is an alternative source of plausibly exogenous variation to labor market conditions, Z_i in Equation 4. Column 1 shows changes in log total population, while Columns 2 and 3 present the results for men and women respectively. The second to last row in each panel presents rescaled estimates to reflect the change in log population for a Mexican municipality at the 75th compared to the 25th percentile of exposure to international competition. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities.

Table A.7: Summary Statistics - Mean Changes in Mortality Rates by cause in Mexico

Δ Internal Causes	Age-adjusted	Crude	Levels
Δ1995-2000	26.72	50.76	74.82
	(64.45)	(68.34)	(65.39)
Δ2000-2005	-5.19	42.16	60.22
	(49.96)	(63.14)	(55.51)
Δ2005-2010	-7.00	42.85	75.20
	(45.29)	(62.94)	(60.87)
Δ External Causes	Age-adjusted	Crude	Levels
Δ1995-2000	-0.04	0.39	4.04
	(25.78)	(24.04)	(24.65)
Δ2000-2005	-3.37	-1.51	0.94
	(21.04)	(20.87)	(20.64)
Δ2005-2010	11.28	13.68	18.30
	(48.09)	(48.09)	(48.48)
Δ Homicides	Age-adjusted	Crude	Levels
1995-2000	-3.05	-2.99	-2.21
	14.30	12.21	12.43
2000-2005	-1.40	-1.13	-0.74
	10.63	9.65	9.62
2005-2010	13.10	13.77	15.14
	42.07	41.53	41.88
Δ Deaths of Despair	Age-adjusted	Crude	Levels
Δ1995-2000	1.21	2.90	4.91
	15.65	14.72	15.09
Δ2000-2005	-2.35	0.87	2.28
	13.67	14.40	14.14
Δ2005-2010	-3.59	-1.26	0.83
	13.58	15.33	15.54
Observations	2,382	2,382	2,382

Notes: This table shows mean changes in the mortality rate by some causes at country level between 1995-2000, 2005-2010, and 2005-2010. I calculate "age-adjusted", "crude", and "levels" mortality rates per 100,000 population as defined in Section 6.2. Internal causes of death, defined as those whose origins lie within the body, explain most of the differences described above between rates. Deaths of despair (i.e., (suicide, overdose, alcohol-related liver disease) and homicides are classified as external causes of death, which are defined as those whose origins are outside the body (e.g., suicide, overdose, accidents, homicides). The observations are weighted by the municipalities' population.

Table A.8: International Competition and Overall Mortality - Alternative Instrument

	(1) Crude	(2) Age-adjusted	(3) Levels
PANEL A: Overall Mortality Rate 2000-2005			
$ICW_{2000-2005}$	-1.407***	-0.297	0.892**
	(0.331)	(0.347)	(0.434)
Moving municipality from 25th to 75th pctile	-4.5160***	-0.9536	2.8637**
	(1.0617)	(1.1126)	(1.3931)
PANEL B: Overall Mortality Rate 2005-2010			
$ICW_{2005-2010}$	0.109	0.123	-0.468
	(0.682)	(0.630)	(0.508)
Moving municipality from 25th to 75th pctile	0.4276	0.4825	-1.8287
	(2.6647)	(2.4633)	(1.9860)
Baseline rate	445.38	448.25	445.38
Mean Δ 2000-2005	1.59	-48.17	29.79
Mean Δ 2005-2010	56.19	4.11	93.38
Observations	2,382	2,382	2,382

Notes: This table presents estimates of Equation 4 of the relationship between Mexican municipalities' exposure to international competition in the U.S. market and changes in overall mortality between 2000-2005 in Panel A and 2005-2010 in Panel B. Dependent variable is change the overall mortality rate define in three alternative ways as explained in Section6.2 (i.e., column 1: crude, column 2: age-adjusted, column 3: levels). $\Delta ICW_{i,t}$, defined in Equation B.4 is a measure exposure to international competition per worker in municipality i, which is an alternative source of plausibly exogenous variation to labor market conditions, Z_i in Equation 4. The second to last row in each panel presents rescaled estimates to reflect the change in the mortality rate for a Mexican municipality at the 75th compared to the 25th percentile of exposure to international competition. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities.

B Appendix B: Comment

Partial Replication of Dell, Feigenberg, and Teshima (2019)

To provide further evidence on the implications of population adjustments for evaluating the effects of a trade-induced employment shock on mortality, in this section, I partially replicate Dell, Feigenberg, and Teshima (2019), which explores the effect of increased international competition in the U.S. market on drug-related homicides.

The main result of the paper that corresponds to the results I replicate in this section is that "*a one standard deviation decline in manufacturing jobs increases the annual homicide rate between 1998 and 2013 by 12 per hundred thousand, whereas the effect between 1998 and 2003 is around 1.*"[22]

The authors define the change in the homicide rate as the difference between annual number of homicides in levels in the relevant years divided by the initial population size.

$$\Delta HomicideRate_{i,t,t-1} = 100,000 * \frac{(Homicides_{i,t} - Homicides_{i,t-1})}{Population_{i,0}} \tag{B.1}$$

A priori, there's no issue in calculating a difference in the number of deaths in levels and normalizing that by the population municipality in the initial year. Moreover, the purpose of this section is not to deny an increase in the absolute number of deaths from homicides in Mexico, which has been well-documented (Velásquez, 2019; Utar, 2019; Basu and Pearlman, 2017; Dell, 2015). However, to the extent that Dell et al. (2019) are reporting a differential increase in the homicide rate in Mexican municipalities that were more exposed to international competition, it is important to at least consider the differential effects on the population composition in these municipalities.

In particular, reporting "crude" and "age-adjusted" mortality rates (using contemporary

[22]Their first stage results are: "A $10,000 USD increase in predicted international competition per worker results in a 0.08 (1998-2013) to 0.97 (1998-2003) standard deviation decline in employment."

annual number of deaths and population) is relevant if researchers are interested in comparing the magnitude of the effects for other causes of death. For example, if municipalities with high initial share of manufacturing employment had a different gender ratio with respect to less exposed municipalities, it would make sense to see larger effects on low-educated males, who may be selected into migrating to these regions before the shock.

B.1 Motivation - Aggregate Trends

Table B.1 shows change in mean mortality rate by major causes in Mexico over a five-year and a fifteen-year period. Did overall mortality decreased or increase in Mexico over 1998-2013? If we follow the standard approach in epidemiology and demography (i.e., calculating age-adjusted mortality rate), overall mortality decreased by 61.55 deaths per 100,000 population between years 1998 and 2013 (Column 2). However, if we look at crude mortality rates, it increased by 84.18 per 100,000 people (Column 4), and if we calculate the difference in deaths in levels normalizing by the initial year we find that the total mortality rate increased by 184.40 deaths per 100,000 population (Column 6). No need to say that these differences are large.

Why are these differences so large? The main reasons are population aging (i.e., demographic transition) and population growth (over a 15 year period). First, crude and age-adjusted mortality rates will differ if the populations we compare are different ages. In other words, the age distribution of the populations we are comparing matters. Second, crude and levels mortality rates will differ if the population grows over time because the denominator in each rate is different. Are these differences present if we explore deaths by specific causes? In rows 2-4 of Table B.1, I show the mean differences for some causes of death: internal causes of death, deaths of despair (suicide, overdose, alcohol-related liver disease), and homicides. Internal causes of death, defined as those whose origins lie within the body, explain most of the differences described above between rates. Deaths of despair and homicides are classified as external causes of death, which are defined as those whose origins are outside the body (e.g., suicide, overdose, accidents, homicides). In the case of external causes of mortality, we could argue that the difference between rates is smaller because population aging matters less. However, the composition of the population being compared and the change in the size of the denominator (i.e., population growth) still are very relevant.

Figure B.1 presents some visual evidence on the country level homicide rate trend over the period 1990-2015, using the three different methodologies (see section 6.2) to calculate the homicide rate. In the figure it is possible to observe the spike in homicides that took place between 2006-2010 in Mexico.

In Section B.2, I describe Dell et al. (2019) identification strategy in detail. In section B.3, I show that their results are not robust to calculating the homicide rate in alternative ways. After examining the main replication results, I estimate the effect of the trade-induced job displacement on *overall mortality* to be able to provide some insights into the size of the impact on overall mortality, compared to homicides. Finally, I also replicate the author's identification strategy using exposure to the PNTR instead of international competition per worker (ICW) as instrumental variable.[23]

B.2 Identification Strategy

Dell et al. (2019) use a 2SLS specification to explore the consequences of trade-induced worker displacement on homicides. The second stage is:

$$\Delta Y_{i,t} = \beta_0 + \beta_1 \Delta L^m_{i,t} + X_i'\gamma + \epsilon_{i,t} \tag{B.2}$$

where $\Delta Y_{i,t}$ is the change in the outcome variable between the initial year (1998) and year

[23] Dell et al. (2019) exploit cross municipality variation in exposure to increase Chinese competition in the U.S. market, using international competition per worker as instrument, following (and adapting to the Mexican context) Autor et al. (2013)'s identification strategy. In this paper, I use Pierce and Schott (2016) measure of exposure instead. The results are robust to the use of either measure of exposure to trade, although point estimates' magnitudes change based on the way to measure each source of variation.

t={2003,2013} in municipality i.[24] $\Delta L^m_{i,t}$ is the change in manufacturing jobs between the initial year and year t in municipality i, normalized by the size of the initial non-agricultural labor force. X'_i includes municipality-level controls (i.e., the share of Manufacturing employment in 1998 and the baseline homicide rate) and state fixed effects. The first stage specification is:

$$\Delta L^m_{i,t} = \beta_0 + \beta_1 \Delta ICW_{i,t} + X'_i\gamma + \epsilon_{i,t} \tag{B.3}$$

where $\Delta L^m_{i,t}$ is the change in manufacturing jobs between 1998 and year t={2003,2013} in municipality i. $\Delta ICW_{i,t}$ is the change in International Competition per Worker faced by Mexican municipality i between the initial year, 1998, and year t={2003,2013}:

$$\Delta ICW_{i,t} = \sum_j \frac{L_{i,j,0}}{L_{j,0}} \frac{\Delta UC_{j,t}}{L_{i,0}} \tag{B.4}$$

where $L_{i,j,0}$ is the manufacturing employment of industry j in municipality i in the initial year, $L_{j,0}$ is the total initial manufacturing employment for industry j, and $L_{i,0}$ is the total initial non-agricultural employment in municipality i. $\Delta UC_{j,t}$ is the predicted change in Chinese exports to the U.S. in industry j between year 1998 and year t.

$$\Delta UC_{jt} = \frac{Exports_{j,0}}{Exports_0} \Delta Exports_t \tag{B.5}$$

where $Exports_{j,0}/Exports_0$ is the value of Chinese exports to the U.S. of industry j goods as a share of the total Chinese exports to the U.S. in the initial year, and $\Delta Exports_t$ is the change in the total value of exports from China to U.S. between the initial year and year t.

I replicate Dell et al. (2019) using a larger sample that includes all rural and non-rural Mexican municipalities available in the Economic Census. The regressions control for the municipalities' initial manufacturing employment share, so the variation in international

[24] The main periods of analysis are 1998-2003 and 1998-2013 given the industry level data available in the Economic Census. The initial period is always 1998, which is the latest year with industry level data before China's accession to the WTO in 2001.

competition is driven by the initial industrial composition. The regressions are weighted by the initial population size.[25] $\Delta L^m_{i,t}$ is the difference between annual manufacturing employment levels in the relevant years divided by the pre-period non-agricultural labor force size, and it is standardized to facilitate the interpretation of the second stage. $\Delta ICW_{i,t}$ is divided by 100,000 to be in units of 100,000 USD.

As shown by Dell et al. (2019) with a subset of 518 urban Mexican municipalities, using predicted Chinese competition in the U.S. as an instrument generates a strong first stage. Table B.2 presents the first stage estimation for a sample of 2,383 municipalities, and for a subsample of non-rural municipalities.[26] A 100,000 usd increase in predicted international competition per worker results in about 0.74 (1998-2013) to a 9.25 (1998-2003) standard deviation decline in employment.[27]

B.3 Results

Table B.3 reports the second stage estimation results. Consistent with the results presented in Dell et al. (2019) for the periods 1998-2003 and 1998-2013 (see Columns 1 and 2 in Panel A of Table 2 on page 50 in their paper), Columns 5 and 6 Table B.3 show that a one standard deviation decline in manufacturing jobs increases the annual homicide rate between 1998 and 2013 by 12 per hundred thousand, whereas the effect between 1998 and 2003 is around 1 in non-rural municipalities (Panel B). The results are not as strong for the full sample (Panel A); the coefficients are smaller in magnitude and marginally significant, though they have

[25] I use population from year 2000 because this is the last year a Population Census took place before China's accession to the WTO. Results don't change using the interpolated population values from 1998 or the labor force size in 1998.

[26] The Mexican Population Census and the intercensal Population Counts classify municipalities by the size of the localities in which more than 50% of the population in that municipalities resides. Rural municipalities: more than 50% of the population lives in localities with less than 2500 inhabitants. Non-rural municipalities are divided in 4 sub-categories: more than 50% of the population resides in localities with 1) Metropolitan (more than 1,000,000), 2) Medium Urban (15k and less than 100k population) 3) Semi-urban (2500 and less than 15k population), 3) Mix cases.

[27] The first stage for the full sample of 2,383 municipalities is consistent with Dell et al. (2019)'s Table 2 Panel B (on page 50 of their paper) results for the subset of 518 non-rural municipalities covered by the Mexican Monthly Survey of Manufacturing Industry (EMIM). Given the similarity in the magnitude and sign of the coefficients for the full sample, results are driven by Urban municipalities.

the same sign.[28]

Crude and age-adjusted homicide rates, reported in Columns 1-4, are similar in magnitude, sign and statistically significance. However, the results differ when comparing crude and age-adjusted against the difference in number of deaths in levels divided by the initial population (in Columns 5 and 6). First, the magnitude of the coefficients is a lot smaller for the crude and age-adjusted mortality rate. Second, the sign is the same with the exception of the point estimates for the 1998-2013 period in the full sample, which are positive. Third, the coefficients are marginally significant only for the sample of non-rural municipalities and the period 1998-2003. However, none of the coefficients are significant in the longer period.

In Table B.4, I present second stage estimates of the effect of job displacement, instrumented with the change in international competition per worker (ICW), on overall mortality.[29] Results in Columns 1-4 show that age-adjusted and crude mortality rates, which divide number of deaths by contemporaneous population, decrease over 1998-2003 and 1998-2013. However, calculating the mortality rate in levels does not allow to account neither for differential population growth nor for compositional changes as a result of the employment shock. Consequently, a one standard deviation decline in the manufacturing employment rate, increases overall mortality over both periods (Columns 5 and 6). Therefore, the mortality rate in levels in municipality i could be increasing as a result of more people living there.[30]

To conclude, the methodology used to calculate the rate matters for the interpretation of mortality trends because changes in the distribution of the population within age groups. Consequently, the method used for calculating mortality rates is particularly relevant when analyzing the effects of differential exposure exogenous policy changes, such as international

[28]In Table B.5, I replicate Columns 1 and 2 in Panel A of Table 2 on page 50 in Dell et al. (2019) using the authors' original data and code.

[29]Table B.6 presents the reduced-form results.

[30]Recall that Table 1 in the main part of the paper shows that exposure to the PNTR is associated with increased population growth over 2000-2005, and decreased population growth over 2005-2010. Similarly, Column 3 in Table 8 shows that the mortality rate in levels increases over the first period and decreases over the second period. Conversely, note that the point estimates of age-adjusted and crude mortality rates are negative in both periods. For robustness, Table B.7 presents estimates of the second stage using the NTR gaps as instrumental variable, and Table B.8 present the corresponding reduced-form results.

competition. Given that mortality rates are sensitive to the compositional changes of the population, a shock that affects workers mobility will in all likelihood affect the composition of the population in less and more exposed regions.

B.4 Tables and Figures

Table B.1: Summary Statistics - Mean Changes in Mortality Rates by Cause in Mexico

	(1)	(2)	(3)	(4)	(5)	(6)
Δ Mortality Rate	**Age-adjusted**		**Crude**		**Levels**	
100,000 x	$\sum_b Share_{b,0}\frac{Deaths_{i,t,b}}{Pop_{i,t,b}} - \frac{Deaths_{i,t-1,b}}{Pop_{i,t-1,b}}$		$\frac{Deaths_{i,t}}{Pop_{i,t}} - \frac{Deaths_{i,t-1}}{Pop_{i,t-1}}$		$\frac{Deaths_{i,t}-Deaths_{i,t-1}}{Pop_{i,0}}$	
	Δ 1998-2003	**Δ 1998-2013**	**Δ 1998-2003**	**Δ 1998-2013**	**Δ 1998-2003**	**Δ 1998-2013**
Total Deaths	-38.25	-61.55	2.39	84.18	26.10	184.40
	(63.16)	(79.93)	(70.29)	(106.12)	(70.14)	(112.00)
Internal causes of death	-28.78	-54.80	9.90	84.56	30.67	172.90
	(57.43)	(69.58)	(65.49)	(97.29)	(65.07)	(98.70)
Deaths of Despair	-2.12	-5.98	-0.56	-2.04	0.45	1.39
	(12.43)	(14.64)	(12.41)	(13.60)	(12.42)	(14.03)
Homicides	-4.96	2.94	-4.43	4.55	-3.89	8.16
	(13.91)	(21.40)	(11.86)	(20.07)	(11.90)	(21.92)

Notes: This table shows mortality rate mean changes in Mexico over 1998-2003 and 1998-2013 with standard deviations shown in parenthesis. The last row shows the mean change in homicides; Columns (5) and (6) are comparable to Dell et al. (2019)'s Table 1 Columns (3) and (4), page 49.

Table B.2: International Competition and Manufacturing Employment - First Stage

	(1)	(2)	(3)	(4)
	All municipalities		Non-rural municipalities	
$\Delta Jobs$	1998-2003	1998-2013	1998-2003	1998-2013
$\Delta ICW_{1998-2003}$	-9.253***		-9.027***	
	(2.014)		(2.172)	
$\Delta ICW_{1998-2013}$		-0.743***		-0.681***
		(0.141)		(0.150)
Observations	2,383	2,383	975	975
R-squared	0.097	0.057	0.197	0.116
First Stage F-stat	21.11	27.73	17.27	20.70

Notes: This Table replicates Dell et al. (2019) first stage using a larger sample of Mexican municipalities. Columns (1) and (2) estimate Equation B.3 using all Mexican municipalities, and Columns (3) and (4) restrict the sample to all non-rural municipalities. In Table B.5 I estimate the first stage using the same sample as the authors. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities. $\Delta Jobs_{it}$ is the difference between annual manufacturing employment levels in the relevant years divided by the pre-period non-agricultural labor force size, and it is standardized to facilitate the interpretation of the second stage. ΔICW_{it} measures the predicted change in international competition per worker during the relevant years. It is divided by 100,000 to be in units of 100,000 USD. Regressions include state fixed effects, and control for the initial share of manufacturing employment. Coefficients should be interpreted as the effect of a 100,000 USD change in predicted international competition per worker on the standarized change in manufacturing employment. For example, a 100,000 USD increase in predicted ICW results in a 9.25 standard deviation decline in employment over 1998-2003.

Table B.3: Trade-Induced Job Displacement and Homicides - Second Stage

	(1)	(2)	(3)	(4)	(5)	(6)
Δ Homicide Rate 100,000 x	**Crude** $\frac{Hom_{i,t}}{Pop_{i,t}} - \frac{Hom_{i,t-1}}{Pop_{i,t-1}}$		**Age-adjusted** $\sum_b Share_{b,0} \frac{Hom_{i,t,b}}{Pop_{i,t,b}} - \frac{Hom_{i,t-1,b}}{Pop_{i,t-1,b}}$		**Levels** $\frac{Hom_{i,t} - Hom_{i,t-1}}{Pop_{i,0}}$	
	Δ 1998-2003	**Δ 1998-2013**	**Δ 1998-2003**	**Δ 1998-2013**	**Δ 1998-2003**	**Δ 1998-2013**
PANEL A: All Municipalities						
$\Delta Jobs_{1998-2003}$	-0.147		-0.132		-0.599**	
	(0.259)		(0.297)		(0.283)	
$\Delta Jobs_{1998-2013}$		1.031		1.309		-8.007*
		(1.937)		(2.099)		(4.577)
Baseline rate	13.98	13.98	14.40	14.40	13.98	13.98
Mean of Dep Var	-4.83	2.85	-6.23	0.62	-4.75	4.35
Observations	2,383	2,383	2,383	2,383	2,383	2,383
PANEL B: Non-Rural Municipalities						
$\Delta Jobs_{1998-2003}$	-0.577*		-0.579*		-1.069***	
	(0.344)		(0.327)		(0.368)	
$\Delta Jobs_{1998-2013}$		-1.120		-1.030		-12.20***
		(1.470)		(1.393)		(3.332)
Baseline rate	13.32	13.32	13.26	13.26	13.32	13.32
Mean of Dep Var	-4.50	3.47	-5.22	1.78	-4.07	7.02
Observations	969	969	969	969	969	969

Notes: This Table replicates Dell et al. (2019) second stage using a larger sample of Mexican municipalities. Panel A estimates Equation B.2 using all Mexican municipalities, and Panel B restricts the sample to all non-rural municipalities. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities. $\Delta Jobs_{it}$ is the difference between annual manufacturing employment levels in the relevant years divided by the pre-period non-agricultural labor force size, and it is standardized to facilitate the interpretation of the second stage. Regressions include state fixed effects, and control for the initial share of manufacturing employment and initial homicide rate (i.e., baseline value of outcomes variable). Coefficients represent the implied effect of a one standard deviation change in manufacturing employment on the change in the *"crude"* (columns 1 and 2), *"age-adjusted"* (columns 3 and 4), and *"level"* (columns 5 and 6) homicide rates per 100,000 population, relative to the sample mean change between relevant years. The first stage shows a negative impact of trade exposure on manufacturing employment (i.e., the first stage coefficients are negative). Hence, to interpret the second stage results as the effect of a decrease in employment, the sign needs to be reversed. In Table B.5, I estimate the second stage using the same sample and homicide rate definition as the authors.

Table B.4: Trade-Induced Job Displacement and Overall Mortality - Second Stage

	(1)	(2)	(3)	(4)	(5)	(6)
Δ Overall Mortality Rate 100,000 x	**Crude** $\frac{Deaths_{i,t}}{Pop_{i,t}} - \frac{Deaths_{i,t-1}}{Pop_{i,t-1}}$		**Age-adjusted** $\sum_b Share_{b,0} \frac{Deaths_{i,t,b}}{Pop_{i,t,b}} - \frac{Deaths_{i,t-1,b}}{Pop_{i,t-1,b}}$		**Levels** $\frac{Deaths_{i,t} - Deaths_{i,t-1}}{Pop_{i,0}}$	
	Δ 1998-2003	**Δ 1998-2013**	**Δ 1998-2003**	**Δ 1998-2013**	**Δ 1998-2003**	**Δ 1998-2013**
PANEL A: All Municipalities						
$\Delta Jobs_{1998-2003}$	9.435***		-0.856		-6.336**	
	(3.309)		(2.302)		(3.176)	
$\Delta Jobs_{1998-2013}$		37.96***		6.214		-89.36**
		(12.27)		(6.819)		(45.00)
Baseline rate	465.92	465.92	478.66	478.66	465.92	465.92
Mean of Dep. Var.	4.50	87.52	-36.94	-60.51	27.83	185.66
Observations	2,382	2,382	2,382	2,382	2,382	2,382
PANEL B: Non-Rural Municipalities						
$\Delta Jobs_{1998-2003}$	11.82***		0.464		-5.819*	
	(4.469)		(2.771)		(3.448)	
$\Delta Jobs_{1998-2013}$		53.33***		12.70		-101.7**
		(15.51)		(10.22)		(44.45)
Baseline rate	460.54	460.54	481.11	481.11	460.54	460.54
Mean of Dep. Var.	6.29	85.85	-33.82	-60.82	34.64	193.40
Observations	969	969	969	969	969	969

Notes: This table replicates Dell et al. (2019) second stage using a larger sample of Mexican municipalities and using Overall Mortality as outcome. Panel A estimates Equation B.2 using all Mexican municipalities, and Panel B restricts the sample to all non-rural municipalities. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities. $\Delta Jobs_{it}$ is the difference between annual manufacturing employment levels in the relevant years divided by the pre-period non-agricultural labor force size, and it is standardized to facilitate the interpretation of the second stage. Regressions include state fixed effects and control for the initial share of manufacturing employment. Coefficients represent the implied effect of a one standard deviation change in manufacturing employment on the change in the *"crude"* (columns 1 and 2), *"age-adjusted"* (columns 3 and 4), and *"level"* (columns 5 and 6) overall mortality rate per 100,000 population, relative to the sample mean change between relevant years. The first stage shows a negative impact of trade exposure on manufacturing employment (i.e., the first stage coefficients are negative). Hence, to interpret the second stage results as the effect of a decrease in employment, the sign needs to be reversed.

Table B.5: Dell et al. (2019) "Table 2 - Job and Violence" partial replication using authors' data, sample, and code

	(1) 1998-2013	(2) 1998-2003
Panel A: Violence		
% $\Delta Jobs$	-11.93***	-0.993***
	(3.295)	(0.344)
Observations	537	537
First Stage F-stat	11.86	13.81
Mean of Dep Var	12.87	-2.68
Homicide type	All	All
Panel B: First Stage		
ΔICW	-0.806***	-9.934***
	(0.234)	(2.674)
Observations	537	537
R-squared	0.241	0.292

This table replicates Columns 1 and 2 of Table 2 in Dell et al. (2019) (page 50) using the authors' original data and code.[31] Dependent variable in Panel A is the change in homicide rate (calculated in "levels"). Dependent variable in Panel B is the percent change in jobs, % $\Delta Jobs$, calculated as the difference in level in manufacturing workers divided normalized by the initial labor force size. ΔICW measures the predicted change in international competition per worker during the relevant years (see text for details). Observations are municipalities weighted by the pre-period non-agricultural labor force size. I followed the authors criteria to restrict the sample to include non-rural Mexican municipalities covered by the Mexican Monthly Survey of Manufacturing Industry (EMIM), which is not publicly available. However, my sample size is slightly larger: 537 municipalities instead of 518.

[31] Authors' code is available here: $https://www.aeaweb.org/articles?id = 10.1257/aeri.20180063$

Table B.6: International Competition and Overall Mortality - Reduced Form

	(1)	(2)	(3)	(4)	(5)	(6)
	Crude		**Age-adjusted**		**Levels**	
	Δ1998-2003	Δ1998-2013	Δ1998-2003	Δ1998-2013	Δ1998-2003	Δ1998-2013
PANEL A: All municipalities						
$\Delta ICW_{1998-2003}$	-0.933***		0.0847		0.627*	
	(0.242)		(0.233)		(0.351)	
$\Delta ICW_{1998-2013}$		-0.346***		-0.0567		0.815**
		(0.0761)		(0.0600)		(0.389)
Moving municipality from	-1.6738	-3.5587	0.1519	-0.5826	1.1241	8.3785
25th to 75th pctile	0.4334	0.7815	0.4186	0.6168	0.6292	3.9958
Baseline rate	465.92	465.92	478.66	478.66	465.92	465.92
Mean Dep. var	4.50	87.52	-36.94	-60.51	27.83	185.66
Observations	2,382	2,382	2,382	2,382	2,382	2,382
PANEL B: Non-rural municipalities						
$\Delta ICW_{1998-2003}$	-1.168***		-0.0458		0.575	
	(0.291)		(0.274)		(0.412)	
$\Delta ICW_{1998-2013}$		-0.460***		-0.110		0.877**
		(0.0872)		(0.0827)		(0.400)
Moving municipality from	-3.1821	-7.1749	-0.1249	-1.7092	1.5669	13.6820
25th to 75th pctile	0.7936	1.3613	0.7469	1.2916	1.1215	6.2356
Baseline rate	460.54	460.54	481.11	481.11	460.54	460.54
Mean Dep. Var.	6.29	85.85	-33.82	-60.82	34.64	193.40
Observations	969	969	969	969	969	969

Notes: This table present reduced-form results of the effect of international competition on overall mortality. ΔICW measures the predicted change in international competition per worker during the relevant years (see text for details). Panel A uses a full-sample Mexican municipalities, and Panel B restricts the sample to all non-rural municipalities. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities. Coefficients represent the implied effect of a one standard deviation change in manufacturing employment on the change in the *"crude"* (columns 1 and 2), *"age-adjusted"* (columns 3 and 4), and *"level"* (columns 5 and 6) overall mortality rate per 100,000 population, relative to the sample mean change between relevant years.

Table B.7: PNTR and Overall Mortality - Second Stage (alternative instrument)

	(1)	(2)	(3)	(4)	(5)	(6)
	Crude		**Age-adjusted**		**Levels**	
	Δ1998-2003	Δ1998-2013	Δ1998-2003	Δ1998-2013	Δ1998-2003	Δ1998-2013
PANEL A: All municipalities						
$\Delta Jobs_{1998-2003}$	-25.62		-60.70		-81.80	
	(44.85)		(65.03)		(83.24)	
$\Delta Jobs_{1998-2013}$		22.22		15.13		24.91
		(20.38)		(12.23)		(17.16)
Baseline rate	465.92	465.92	478.66	478.66	465.92	465.92
Mean Dep. Var.	4.50	87.52	-36.94	-60.51	27.83	185.66
Observations	2,382	2,382	2,382	2,382	2,382	2,382
PANEL B: Non-Rural municipalities						
$\Delta Jobs_{1998-2003}$	-1.303		-17.07		-22.68	
	(32.42)		(27.81)		(30.06)	
$\Delta Jobs_{1998-2013}$		23.20		23.83*		47.54**
		(22.22)		(13.34)		(19.76)
Baseline rate	460.54	460.54	481.11	481.11	460.54	460.54
Mean dep var	6.29	85.85	-33.82	-60.82	34.64	193.40
Observations	969	969	969	969	969	969

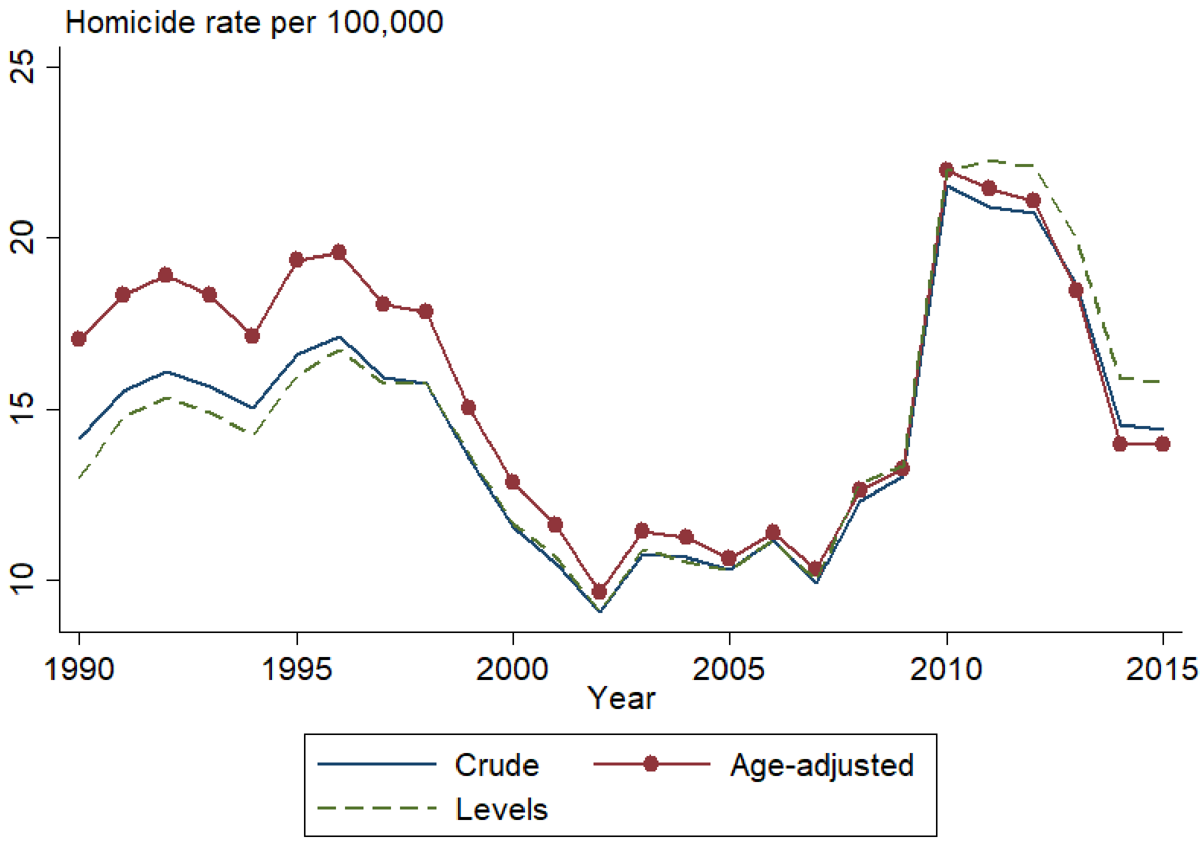
Notes: This table replicates Dell et al. (2019) second stage using a larger sample of Mexican municipalities and using Overall Mortality as outcome. Panel A estimates Equation B.2 using all Mexican municipalities, and Panel B restricts the sample to all non-rural municipalities. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities. $\Delta Jobs_{it}$ is the difference between annual manufacturing employment levels in the relevant years divided by the pre-period non-agricultural labor force size, and it is standardized to facilitate the interpretation of the second stage. The instrumental variable, $NTRGap_i$ is defined in Equation 2 is a measure of Mexican municipalities exposure to the change in trade policy between China and the U.S. Coefficients represent the implied effect of a one standard deviation change in manufacturing employment, instrumented with $NTRGap_i$, on the change in the *"crude"* (columns 1 and 2), *"age-adjusted"* (columns 3 and 4), and *"level"* (columns 5 and 6) overall mortality rate per 100,000 population, relative to the sample mean change between relevant years. The first stage shows a negative impact of trade exposure on manufacturing employment (i.e., the first stage coefficients are negative). Hence, to interpret the second stage results as the effect of a decrease in employment, the sign needs to be reversed.

Table B.8: PNTR and Overall Mortality - Reduced Form (alternative instrument)

	(1)	(2)	(3)	(4)	(5)	(6)
	Crude		**Age-adjusted**		**Levels**	
	Δ1998-2003	Δ1998-2013	Δ1998-2003	Δ1998-2013	Δ1998-2003	Δ1998-2013
PANEL A: All municipalities						
$NTRGap_i$	17.89	-63.13	42.39	-42.97	57.12**	-70.77
	(29.24)	(50.78)	(25.80)	(31.90)	(26.99)	(46.95)
Moving municipality from	2.0828	-7.3482	4.9338	-5.0018	6.6490	-8.2374
25th to 75th pctile	3.4033	5.9108	3.0036	3.7130	3.1414	5.4650
Baseline	465.92	465.92	478.66	478.66	465.92	465.92
Mean Dep. Var.	4.50	87.52	-36.94	-60.51	27.83	185.66
Observations	2,382	2,382	2,382	2,382	2,382	2,382
PANEL B: Non-Rural municipalities						
$NTRGap_i$	1.565	-80.97	20.51	-83.15**	27.25	-165.9**
	(39.86)	(69.55)	(33.33)	(42.09)	(34.06)	(66.37)
Moving municipality from	0.1761	-9.1093	2.3078	-9.3541	3.0657	-18.6647
25th to 75th pctile	4.4841	7.8242	3.7495	4.7356	3.8314	7.4666
Baseline	460.54	460.54	481.11	481.11	460.54	460.54
Mean Dep. Var.	6.29	85.85	-33.82	-60.82	34.64	193.40
Observations	969	969	969	969	969	969

Notes: This table present reduced-form results of the relationship between China receiving PNTR, which increase Mexican municipalities exposure to Chinese competition in the U.S. and overall mortality. $NTRGap_i$ is defined in Equation 2 is a measure of Mexican municipalities exposure to the change in trade policy between China and the U.S. Panel A uses a full-sample Mexican municipalities, and Panel B restricts the sample to all non-rural municipalities. Robust standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Observations are population-weighted municipalities. The second to last row in each panel presents rescaled estimates to reflect the change in the *"crude"* (columns 1 and 2), *"age-adjusted"* (columns 3 and 4), and *"level"* (columns 5 and 6) overall mortality rate per 100,000 population, relative to the sample mean change between relevant years.

Figure B.1: Homicide Rate - Mexico 1990-2015



Homicide Rate	Crude	Age-adjusted	Levels
100,000 x	$\frac{Homicides_{i,t}}{Population_{i,t}}$	$\sum_b Share_{b,2000} \frac{Homicides_{i,t,b}}{Population_{i,t,b}}$	$\frac{Homicides_{i,t}}{Population_{i,1998}}$

Notes: This figure shows the Mexico's homicide national trend between 1990 and 2015. I calculate "crude", "age-adjusted", and "levels" homicide rates per 100,000 population as defined in Section 6.2.