Can Exports Be Pain Relievers? The Effect of Exports on Workplace Safety and Health

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Abstract

This study examines the effect of exports on worker safety and health in the US. We use foreign countries' unilateral liberalization as an instrument to capture the demand shocks on US exports. Our two-stage estimates with establishment fixed effects suggest that a $1,000 increase in exports per worker decreased the workplace injury rate by a significant 0.7%, which implies an annual reduction of about 55,000 injuries among manufacturing workers. The reduction in injuries is more salient among establishments with lower injury rates, indicating an increase of inequality in working conditions. The improvement in working conditions might come from more investment in advanced equipment and better compliance of safety and health regulations. While workplace injuries decreased, workers' self-reported health deteriorated with export expansion, likely to be a result of increased work intensity.

Keywords: workplace safety; health and health behaviors; export expansion

JEL Codes: F16, J28.

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1 Introduction

Over the last two decades, international trade expansion has had a profound impact on the US economy. Numerous studies examined the effect of trade expansion on employment and wages (e.g., imports: Acemoglu et al. (2016); Autor et al. (2013, 2014); Hakobyan and McLaren (2010), exports: Costa et al. (2016); Dauth et al. (2014); Feenstra et al. (2019); Liang (2021)). However, it is less clear how trade expansion affects workers' safety and health. Workplace injuries are prevalent and expansive. US workers experience about 2.8 million workplace injuries annually (Bureau of Labor Statistics, 2018), costing 206 billion dollars on wage and productivity losses, medical expenditures, and administrative expenses (National Safety Council, 2015). Particularly, the manufacturing workers have long been suffering from higher than national average workplace injury rates.

This study evaluates the effect of exports on the workplace injuries of US manufacturing workers and seeks to provide possible explanations for the contradictory findings of the previous studies. To identify the causal impact of exports on workplace injuries, we construct an instrumental variable on exports utilizing trade liberalization of emerging markets. The recent liberalization of the emerging economies created positive demand shocks on US exports and was primarily unilateral. Thus, these idiosyncratic demand increases in are arguably exogenous to the determinants of working conditions in a given US manufacturing establishment. We construct a shift-share instrumental variable, exploiting the differences in the initial industry composition of each local labor market. We provide a series of tests on the validity of our identification strategies, following recent developments in the literature (Goldsmith-Pinkham et al., 2020; Borusyak et al., 2022).

We create a unique panel of manufacturing establishments by matching an establishment-level panel dataset on workplace injury rates to commuting-zone-level measures of US export exposures. We obtain injury rate data from the OSHA Data Initiative (ODI), collected by the Occupational Safety and Health Administration (OSHA). The data include approximately 80,000 establishments per year from 1996 to 2011, covering the whole manufacturing sector and the non-manufacturing industries with average injury rates higher than the national average. We link the observations across years based on establishment names and street addresses. The analysis sample covers about 521,000 establishment-year observations among nearly 115,000 unique manufacturing establishments. The panel of establishments enables us to include establishment fixed effects in the empirical model, which estimates changes in workplace safety within establishments.

We find that export expansion significantly reduced workplace injuries. Our two-stage estimate with establishment fixed effect finds that a $1,000 increase in US exports per worker decreased the injury case rates by a significant 0.7%. The decrease persisted five years after the export expansion and was more salient among establishments with low injury rates, suggesting that export expansion increased the inequality of working conditions in the manufacturing sector. The effect is robust to a variety of the controls on demographic characteristics, import penetration, regional shocks, and other commuting zone specific trends and is similar using commuting zone level and industry level measures on export exposure.

We explore a few possible mechanisms through which export expansion may affect working conditions for manufacturing workers. Theoretically, the effect of exports on workplace injuries is ambiguous. Workplace injuries and illnesses are affected by a complex combination of firms' production technology, compliance of safety regulations, and workers' training and effort. Investment in safety can be conceptualized as one of the inputs in the production process, similar to labor and capital (Kniesner and Leeth, 2014).

First, export expansion created positive demand shocks on firms, which could release the financial constraint on investment (Cohn and Wardlaw, 2016). Increasing investments in equipment and technology may allow firms to provide more resources facilitating workplace safety (Kniesner and Leeth, 2014). We find that export expansion is associated with higher level of capital stock, equipment expenditures, and plant structure investment, which could contribute to the decrease in injuries. Second, export expansion might allow firms to invest in resources that improve the compliance of safety and health regulations. We find that export expansion is associated with fewer employee complaints on working conditions. The results suggest that the improvement in working conditions might be achieved through better health and safety regulation compliance. Lastly, export expansion increased labor demand, which might increase working hours and work intensity, causing more workplace injuries. We find that export expansion is associated with an insignificant increase in hours per worker.

To our knowledge, this is the first study to provide evidence on the impact of exports on US worker safety. From 1996 to 2011, US exports increased more than 100 percent, from 625 billion dollars to 1,482 billion dollars. Our estimates suggest that the export expansion was associated with an annual reduction of approximately 55,000 injuries among manufacturing workers. With the median estimate on the value of a statistical injury being $69,393 (Viscusi and Aldy, 2003), the reduction in injuries implies a cost decrease of about 3.83 billion dollars annually.

Two closely related studies that examine the effect of exports on working conditions are Tanaka (2020) and Hummels et al. (2018). In line with our findings, Tanaka (2020) finds that export expansion in the garment industry in Myanmar was associated with improved working conditions. This study differs from Tanaka (2020) in several ways. Firstly, workplace safety standards and the associated costs of reducing injuries vary greatly across countries. We provide evidence in the context of the US, where the workplace safety standards and the costs of reducing injuries are much higher than those in many developing countries. Secondly, we use the injury rate as a direct measure of workplace safety, while Tanaka (2020) approximates workplace safety using self-reported safety practices by managers, which might be subject to reporting bias. Lastly, we find that the injury reduction was likely due to higher firm investments in equipment and better compliance of safety regulations, whereas Tanaka (2020) suggests that the improvement was likely driven by buyers' pressures to comply with international labor standards.

Hummels et al. (2018) utilized Danish matched firm-worker data and find that export expansion led to more injuries, contrary to the findings of this study. They suggest that the increase in injuries was a result of more stress and pressure on workers in firms experiencing export expansion. However, their study specifically focused on stress and depression-related hospitalization, which represent a small subset of workplace injuries and are relatively rare, ranging from 0.005 to 0.02 per 100 workers. In contrast, our measure includes all recordable workplace injuries, which occur more frequently at a rate of 9.8 cases per 100 workers annually. Our results suggest that exports improve overall workplace safety through more capital investment and better compliance with safety regulations.

This study adds to a burgeoning literature studying the effect of demand shocks on worker safety and health. Several prior studies examined the effect of increasing import competition on worker safety and health. Export shocks are likely to affect workplace safety differently from import shocks as export intensive industries tend to differ from import intensive ones and also tend to be more capital intensive (Appendix Figures A1). In addition to export measures, we include import measures in our model and find that imports were associated with lower workplace injury rates. Our establishment-level analysis complements Lai et al. (2022), which utilized industry-level data to demonstrate that import competition reduced injury rates by displacing dangerous jobs. Others found that import competition led to higher workplace injury rates among small establishments (McManus and Schaur, 2016), more hospitalizations (Adda and Fawaz, 2020), worse mental health (Colantone et al., 2019; Lang et al., 2019), and more fatal drug overdoses (Pierce and Schott, 2020).

Other previous studies have utilized alternative sources of demand shocks to study their impact on workplace safety. Fan et al. (2020) analyzed input tariff shocks and found that worker health was adversely affected through increased working hours. Boone and Van Ours (2006) and Boone et al. (2011) studied the economic cycle as a source of demand shock and found that recessions were associated with fewer workplace accidents, mostly driven by workers under-reporting moderate injuries. Similarly, Ruhm (2000) found that recessions were associated with fewer fatalities. Charles et al. (2019) exploited variations in global commodity prices and discovered that positive price shocks were associated with higher workplace injury rates.

This paper also adds to the broad literature discussing the effect of export expansion on a series of important outcomes, including human capital investment (Blanchard and Olney, 2017; Edmonds et al., 2010), job flows and labor market transitions (Goldberg and Pavcnik, 2003; McCaig and Pavcnik, 2018; Erten and Leight, 2021), pollution (Bombardini and Li, 2020), and inequality (Attanasio et al., 2004; Verhoogen, 2008).

2 Methodology

2.1 Local Labor Market Measures

The empirical objective of this paper is to estimate the impact of exports on workplace injury rates at the establishment level. The main specification is as follows,

$$\ln \text{Injury}_{ict} = \alpha + \beta \text{XPW}_{ct} + \delta_i + \mu_t + \epsilon_{ict}, \tag{1}$$

where the dependent variable ($\ln \text{Injury}_{ict}$) is the log of the injury rate of establishment i in commuting zone (CZ) c and year t. XPW_{ct} indicates the total exports per manufacturing worker in commuting zone c in year t. We include establishment fixed effects (δ_i) to control for time-invariant establishment-specific unobservables. We also include year fixed effects (μ_t) to adjust for macroeconomic shocks that affect all manufacturing establishments in the same year.

Following the broad literature on the impact of trade on local labor markets, we construct the export performance measure at the commuting zone level as follows,

$$\text{XPW}_{ct} = \sum_{j=1}^{J} \frac{X_{jt}}{\text{Emp}_{jt_0}} \frac{\text{Emp}_{cjt_0}}{\text{Emp}_{ct_0}} \tag{2}$$

where X_{jt} represents the total exports in industry j in year t; Emp_{jt_0} measures the employment in industry j from the initial year t_0; and the ratio $\frac{\text{Emp}_{cjt_0}}{\text{Emp}_{ct_0}}$ is the share of workers in industry j in each commuting zone c in year t_0.

2.2 Instrumental Variable Approach

Equation 1 might be subject to endogeneity bias as there might be unobserved determinants of supply or demand shocks affecting both exports and working conditions. For example, a labor-saving technology could simultaneously decrease injury rates and increase exports simultaneously. Whereas a labor-augmenting technology may lead to an increase in both injury rates and exports. Thus, to overcome these endogeneity concerns, we create an instrumental variable that purges out variation coming from the US domestic productivity shocks. Inspired by the work of Hummels et al. (2014) and Aghion et al. (2018), we construct an instrumental variable that captures foreign demand shocks on US exported products. Our demand-shock instrument for US exports (X_{jt}) in each industry j in year t is defined as,

$$\text{XIV}_{jt} = \sum_{s \in j} \sum_{n=1}^{N} \frac{X_{st_0}^{US \rightarrow n}}{X_{st_0}^{US \rightarrow World}} \cdot M_{st}^{n \leftarrow World}, \tag{3}$$

where $\frac{X_{st_0}^{US \rightarrow n}}{X_{st_0}^{US \rightarrow World}}$ represents the share of US exports to country n in total US exports of product s in the initial period t_0, and this part captures the importance of foreign destination market n to the US for selling product s. The time-varying $M_{st}^{n \leftarrow World}$ is the imports of country n from the world for its product s in year t, capturing the demand of each product from each markets.

To construct the instrument, we use countries that experienced recent trade liberalizations (Wacziarg and Welch, 2008).[1] Many of the recent liberalizations are unilateral and plausibly exogenous to economic conditions of advanced economies (Goldberg and Pavcnik, 2016). For instance, India's trade liberalization occurred as a results of IMF interventions that dictated the pace and scope of the reforms. Similar stories exist for many candidate countries in our sample.

Figure 1 presents the correlation between the US exports and the demand-shock instrument at the four-digit SIC industry level. Each dot indicates an industry-by-year observation and the line is fitted by an OLS regression. The exports and the instrument, normalized by the industry's total production, are highly correlated and the relationship is not driven by a particular industry.[2]

To construct the instrument on exports at the commuting zone level, for each product, we first sum across countries to get the product level demand shocks on US exports at the six-digit Harmonized Commodity Description and Coding System (HS) level. We then map each manufacturing product s into a specific manufacturing industry j at the four-digit Standard Industrial Classification (SIC) level. We use the crosswalk files created by Autor et al. (2013) and Pierce and Schott (2012) to create a comparable export-weighted concordance table and match each six-digit HS level exports to a four-digit SIC industry. Lastly, we project the industry level demand shocks to commuting zone level to calculate the instrument, which is,

[1] The selected countries that have unilaterally implemented liberalizations are Bangladesh, Brazil, China, Columbia, Czech Republic, Ecuador, Egypt, India, Indonesia, Mexico, New Zealand, Paraguay, Philippines, Poland, Romania, Sri Lanka, Tunisia, Turkey, and Vietnam. Appendix Table A1 presents the year of uninterrupted openness of these economies. To select countries that have recently liberalized their economies, we utilized the Sachs-Warner (1995) criteria. This classification considers a country to be closed if it satisfies at least one of the following criteria: (i) average tariff rates of 40% or more, (ii) non-tariff barriers covering 40% or more of trade, (iii) a black market exchange rate at least 20% lower than the official exchange rate, (iv) a state monopoly on major exports, and (v) a socialist economic system (as defined by Kornai 1992). The list of countries was then finalized using updated data from Wacziarg and Welch (2008), which employ the same classification standards.

[2] Borusyak et al. (2022) suggest that the validity in a shift-share instrumental variable relies on the assumption of idiosyncratic shocks across many industries.

$$\text{XPWIV}_{ct} = \sum_{j=1}^{J} \frac{\text{XIV}_{jt}}{\text{Emp}_{jt_0}} \frac{\text{Emp}_{cjt_0}}{\text{Emp}_{ct_0}}. \tag{4}$$

The correlation between exports per worker and the instrument at the commuting zone level is shown in Figure 2. Each dot in the figure represents a commuting zone by year observation, and the line is fitted by an OLS regression. The instrument is strongly correlated with export exposure at the commuting zone level. In Appendix Table A6 and A7, we also show that results are not driven by a particular HS product or country.

The coefficient, β, in equation 1 reflects the association between the export volume per worker and workplace injury rate at the commuting zone level. The 2SLS estimates on XIV reflect the causal effect of a $1,000 increase in exports per worker on the workplace injury rates. The validity of the shift-share instrument relied on the assumption that conditional on establishment fixed effects and year fix effects, the instrument, $XPWIV_ct$, is unrelated to other time-varying establishment specific determinants of injury rate that would be captured in the residual of the regression. The identification assumption might be violated if export expansion tends to happen in products concentrated in certain commuting zones with certain baseline characteristics, and these characteristics have a direct impact on injury rates. For example, in commuting zones with a larger share of routine-based employment, and if more routine-based employment is linked to certain products and trend of injury rates, the 2SLS results would be biased. In Appendix, we provided a series of tests on the validity of our instrument.

3 Data and Sample

The main analysis sample is constructed by linking establishment-level injury data and individual-level health and health behavior data to commuting zone level trade exposures. The data on workplace injury rates are from the OSHA Data Initiative (ODI). The ODI is an annual survey on workplace injuries among around 80,000 establishments from 1996 to 2011. The survey covered establishments in all industries in the manufacturing sector and for the non-manufacturing sectors, the survey covered those with average injury rates higher than the national average. The establishments were sampled each year from those with 40 or more employees in 46 states.[3]

Three measures of injury rates were calculated, including the total case rate (TCR), the case rate on injuries involving days away from work, days with restricted work activities or transferred to another job (DART), and the case rate on injuries involving days away from work only (DAFWII).[4] The case rates are calculated as the number of workplace injuries per 100 full-time equivalent employees. We exclude establishments reporting total case rates higher than 100 cases per 100 full-time equivalent employees (0.05% of the analysis sample).[5] We also exclude establishments in non-manufacturing industries and establishments from Alaska, Hawaii, and the District of Columbia. About half of the manufacturing establishments with 40 or more employees were surveyed each year. Thus, establishments were typically surveyed multiple times during the analysis period, but not every year. Establishments with multiple surveys during the analysis period are linked based on the establishment names and street addresses. We use the zip codes of establishments to assign establishments to commuting zones, later matched to measures to trade flows.[6]

The establishment-level panel data on injury rates and individual level data on health outcomes are matched to measures of trade flows at the commuting zone level. The country-product level trade data are from the UN Comtrade Database, which pro-

[3]In 1996 and 1997, only establishments with 60 or more employees were included. States did not participate in ODI 2011 include Alaska, Oregon, South Carolina, Washington, Wyoming, and District of Columbia.

[4]DAFWII was collected from 2002 to 2011.

[5]A small number of establishments reported very large number on injuries. While OSHA takes multiple steps to ensure the data collected is accurate, OSHA does not believe the data for the establishments with the highest rates on this file are accurate in absolute terms (https://www.osha.gov/pls/odi/establishment_search.html).

[6]Although ODI contains information on SIC industry code, about 10% of establishments did not report their SIC code. Additionally, some SIC codes are inconsistent over time. Thus, we focus our analysis at the local labor market level. In Appendix Table A2, we report the results using export exposure measured at the industry level (equation 3), and the estimates are very similar to those in Table 3.

vides bilateral import and export volumes at the six-digit product level for each country; and the United States International Trade Commission (USITC), which provides the US import and export volumes at the six-digit HS product level.[7] We use the commuting zone level employment composition data from County Business Patterns (CBP) to transform our industry-level measures to the commuting zone level.[8]

To examine the potential channels through which exports might affect working conditions, we construct measures on investment, employment, and compliance of safety regulations. The NBER-Center for Economic Studies Manufacturing Industry Database (NBER-CES) provides annual industry level data on output, employment, payroll, working hours, and various investment accounts (total capital, equipment, and plant structures) for all manufacturing industries at the four-digit SIC level. Date on compliance of safety and health regulations are retrieved from OSHA's Integrated Management Information System (IMIS). The IMIS includes the history of all closed OSHA inspections since 1984. We focus on three types of inspections: inspections on fatalities and severe accidents, inspections on employee complaints, and programmed inspections conducted based on industries, locations, or specific hazards. For each inspection, we calculate the number of violations on safety and health regulations , and the total financial penalties on these violations. A lower number of violations or financial penalties would suggest an improvement in workplace safety compliance and health regulations.

Table 1 presents the summary statistics of the main analysis sample. The analysis sample on workplace injury rates includes about 521,000 observations among about 115,000 unique manufacturing establishments. Figure 3 presents the geographic variation of the exports per worker at the commuting zone level in 1996 and 2011, the first and the last year of the analysis period. The total US exports increased by 108% during the analysis period, totaling $1.5 trillion in 2011. States in the south and west accounted for

[7]The UN Comtrade database can be accessed at http://comtrade.un.org. The USITC data can be accessed at https://dataweb.usitc.gov/.

[8]All measures of trade flows are converted to 2011 US dollar value using the Personal Consumption Expenditure (PCE) deflator.

a larger share of the US exports growth than other regions, and experienced an average 200% increase during our sample period. The analysis sample on worker health and health behavior includes about 2.5 million observations from 1996 to 2011.

4 Result

4.1 Baseline Results

We first examine the relationship between export expansion and workplace injury rate. Table 2 presents the baseline estimates. Columns (1), (3), and (5) present the OLS estimates of our baseline model (Equation 1). We consider three measures of injury rate: the total case rate (TCR), which includes any workplace injuries, DART, which include injuries involving days away from work, days with restricted work activities, or days transferred to a new position, and DAFWII, which include injuries involving days away from work. The outcomes are log of each injury rate measure, per 100 full-time equivalent workers. The model includes establishment fixed effects to control for time-invariant establishment specific characteristics, and year fixed effects to control for time-variant macroeconomic shocks. Standard errors, presented in parentheses, are always clustered at the state level (Cameron and Miller, 2015). [9] Larger exports per worker were associated with lower injury rates, but the estimated coefficients were small and mostly statistically insignificant.

To identify the causal effect of export expansion on workplace injuries, we construct an instrument for US exports using the demand shocks from the foreign countries' unilateral liberalizations. Table 2, Columns (2), (4), and (6) present the 2SLS estimates, with establishment and year fixed effects.[10] The estimate shows that a $1,000 increase in exports per worker decreased the total case rate (TCR) by 0.7%, statistically significant at 10% level

[9] Appendix Table A3 shows estimates with standard errors clustered at the commuting zone level. The results are similar to those in Table 3.

[10] The first-stage estimates are presented in Table A4. The instrument is strongly correlated with the export volumes per worker.

((Column (2)). The OLS estimates are smaller and not statistically significant, which implies that the OLS results may be biased by omitted unobservables affecting both exports and workplace injuries. For example, an unobserved demand shock might increase the export and drive up the injury rate through higher work intensity, which would lead to the OLS estimates to bias upward.

A common concern for using the total case rate (TCR) to measure workplace safety is under-reporting. To alleviate this concern, we examine the effect of export expansion on relatively severe injuries, DART and DAFWII, which are less likely to be under-reported compared to mild cases with no losses of workdays. DART includes injuries involving days away from work, days with restricted work activities or transferred to another job. DAFWII includes only cases involving losses of workdays. If the results are driven by the under-reporting of less severe injuries, the effect on DART and DAFWII is expected to be smaller than the effect on total case rate. A $1,000 increase in exports per worker was associated with a 1.0% decrease in DART case rate and a 0.5% decrease in DAFWII case rate (Table 2, Columns (4) and (6)). The estimates on DAFWII include fewer observations as data on DAFWII were only collected from 2002 to 2011. Overall, the effect of export expansion on DART and DAFWII is similar to that on TCR, suggesting that the reduction in injury rates is unlikely to be driven by underreporting.

In summary, our results show that export expansion reduced workplace injuries significantly. During the analysis period, the US manufacturing exports increased from $613 billion in 1996 to $1,277 billion in 2011, which is an average of $5,880 per worker per year. Our estimates suggest that a $1,000 increase in exports per worker is associated with a 0.7% decrease in workplace injuries. With the average case rate of 9.8 injuries per 100 full-time equivalent workers and an average of 13.7 million manufacturing workers, the implied total reduction in injuries was 55,261 per year. The studies on the value of a statistical injury present a median estimate of $69,393 per injury in 2016 dollar value (Viscusi and Aldy, 2003). Thus, the injury reduction from export expansion was associated with a cost saving of $3.83 billion per year.

4.2 Robustness to Baseline Results

To test the robustness of our IV results, we augment our main specification by including additional control variables. Table 3 presents the estimates with additional control variables. Column (1) presents the baseline results with 2SLS estimates, same as those in Table 2, Columns (2), (4), and (6)). Column (2) adds control variables on demographic characteristics of each commuting zone, including the share of population that is female, Black, Hispanic, and with college education.[11] Column (3) includes additional control variables on costs of workers' compensation, measured as the log of the maximum weekly workers' compensation benefit amount and the log of total Workers' Compensation costs by state and year.[12] Previous literature has documented that the costs of Workers' compensation affect workplace injury reports (Fortin and Lanoie, 2000; Meyer et al., 1995). The results are robust to the inclusion of these additional control variables.

During the analysis period from 1996 to 2011, US exports increased dramatically by 108 percent. At the same time, imports from other trading partners increased by 136 percent, mostly from China's accession to the World Trade Organization (WTO) in 2001. One concern on the results from the baseline model is that exports and imports within each commuting zone might be correlated. Import competition, which created negative demand shocks, could affect workplace safety as well (McManus and Schaur, 2016; Lai et al., 2022). Omitting the import penetration may bias the estimates on the effect of exports on workplace injuries.

We address this concern by directly controlling for the import penetration from China in our baseline model. Table 3, Column (4) presents the estimates adding the im-

[11] The data on the demographic characteristics are from Census.

[12] The data on the maximum weekly workers compensation rate is from the Social Security Administration, which can be accessed at https://secure.ssa.gov/poms.nsf/lnx/0452150045. The data on total Workers' Compensation costs are collected by the National Academy of Social Insurance, which can be accessed at https://www.nasi.org/research/workers-compensation/.

port penetration from China, from NAFTA, and from the rest of the world, as control variables. The import measures are instrumented following Autor et al. (2013) using imports from in eight other countries including Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland. Additionally, in Appendix Table A5, we presented the coefficients on imports. The sign of the coefficients on imports are consistent with those in Lai et al. (2022). Controlling for import competition does not change the magnitude or the significance level of the baseline results. Additionally, we test if our results are sensitive to any region specific shocks and find that the results are robust to additionally controlling for region by year fixed effects (Table 3, Column (5)).

We conduct a number of robustness checks validating the Bartik identification strategy. First, we test the assumption that the results are not solely driven by the initial characteristics of a specific product sector or a destination country that is independent of export expansion (Appendix Table A6 and A7). Additionally, we include commuting zone specific treads interacted with the initial employment characteristics of commuting zones (Appendix Table A8) and the initial share of manufacturing employment interacted with year fixed effects (Appendix Table A9). Overall, we find these additional controls have limited impact on the estimated coefficients.

4.3 Dynamic Effect and Distributional Effect

To examine the dynamic effects of exports on injury rates over time, we include leads and lags of the exports per worker in the baseline model. Specifically, we estimate the equation, following the approach developed by Schmidheiny and Siegloch (2019):

$$lnInjury_{ict} = \alpha + \sum_{j \neq -1} \pi_j * XPW_{ct} + \beta * X_{ict} + \delta_i + \mu_t + \epsilon_{ict}. \tag{5}$$

XPW_{ct} represents the difference in the total exports per manufacturing worker in commuting zone c between year t and the previous year. Event time $j = -1$ is omitted to normalize the estimates of pi_j, to zero in that period. The model includes establishment fixed effects $delta_i$ and year fixed effects mu_t. The model also includes a full set of control variables, X_ict, which is the same as those included in our most saturated model (Table 3, Column (5)).

Consistently with the baseline results, we find that the export expansion decreased workplace injury rates, and this effect became larger over time. The estimated coefficients are presented in Table 4, and the graphical evidence is presented in Figure A2. Specifically, a $1,000 increase in exports per worker over five years was associated with a 0.9% decrease in TCR, a 1.7% decrease in DART, and a 1.2% decrease in DAFWII. The coefficients on periods prior to the liberalizations are mostly small and insignificant (the coefficients on leads of DAFWII are positive and significant, likely to be driven by the fact that DAFWII data are only available after 2002, which is after many countries' liberalization), which confirms that the effect is not driven by a pretend of workplace injury rate over time.

The baseline results suggest that export expansion improved the workplace safety in the manufacturing sector. To explore whether the result are driven by relatively dangerous or safe establishments, Figures 4 presents estimates on the distributional effect of exports on TCR. Each figure presents the estimated effect of exports on injury rate quantiles using the specification of Equation 1. The dots indicate the point estimates on establishments with case rates below the 20th, 40th, ... , 100th percentile, and the lines indicate the corresponding 95% confidence interval. The largest decrease appeared among establishments with injury rates below the 20th percentile, corresponding to a TCR of 2.16 cases or lower. Overall, establishments with lower injury rates showed the largest decrease in injuries when facing export expansion. The results imply export expansion might contribute to an increase in working condition inequality in the manufacturing sector.

4.4 Mechanisms

We explore three potential channels on how export expansion could impact the workplace safety. First, the positive demand shock might alleviate firm's financial constraints and lead to more capital and equipment investment. We find that industries experiencing larger export expansion possessed higher total capital stock, equipment expenditures, and plant structures investment per establishment.[13] With a $1,000 increase in exports per worker, the capital stock increased by 3.7 thousand dollars per worker (3.5%), the equipment increased by 2.9 thousand dollars per worker (4.0%), and plant structures increased by 0.8 thousand dollars per worker (2.6%) per establishment (Table 5, Columns (1) to (3)).

Second, the demand shock might directly affect the working hours of employees in manufacturing. Increasing working intensity is found to affect the workers' safety and health negatively (Spurgeon et al. (1997)). Column (4) of Table 5 shows that export expansion was associated with an insignificant increase in the weekly production hours per worker (0.02 hours per week, 0.07%). The results do not support the hypothesis that workers work longer hours when faced with export expansion.[14]

Lastly, export expansion might enable firms to invest more resources to comply with workplace safety and health standards. We examined the effect of export expansion on the inspections, violations, and financial penalties per worker (Table 6). We find that export expansion decreased the number of fatalities and severe accidents. With a $1,000 increase in exports per worker, the number of fatalities and severe accidents decreased by a significant 3% (Table 6, Column (2)). Additionally, export expansion also led to fewer employee complaints about workplace safety, and the associated violations and penalties. We find that the number of inspections triggered by employee complaints decreased by 4.7%

[13] The data are from the NBER-CES Manufacturing Industry Database, prepared by Becker et al. (2013)

[14] Additional analysis indicates that the positive demand shock on exports led to an increase in employment, number of establishments, and employment per establishment. In response to the export shock, firms opted to hire more workers rather than increasing the working hours.

with a \$1,000 increase in exports per worker, while the associated violations decreased by 6.2% and penalties decreased by 6.9%. The programmed inspections, conducted based on OSHA's programs targeting specific industries, occupations, and safety hazards, show insignificant changes. In summary, the results provide suggestive evidence an improvement in the compliance of workplace health and safety regulations.

5 Conclusion

This is the first study to examine the effect of exports on worker safety and health in the US. We find that export expansion was associated with a significant decrease in workplace injury rates. In five years, the injuries decreased by 1.5% with a \$1,000 increase in exports per worker. The reduction in injuries was more salient among establishments with lower injury rates.

We explore three mechanisms: first, we find that export expansion led to more investment in capital and equipment, which might contribute to the improvement of workplace safety. Second, we find that export expansion was associated with fewer severe accidents and employee complaints, suggesting an improvement in compliance with workplace safety and health regulations. Lastly, we find that export expansion had an insignificant impact on working hours per worker, but led to worse self-reported physical and mental health.

Overall, our estimates imply that the export expansion during in the late 1990s and early 2000s were associated with an annual reduction of about 55,000 injuries among manufacturing workers, accounting for a cost saving of about 3.83 billion dollars per year. The US exports expansion has slowed down since the late 2010s, due to many reasons, including the interruption of supply chains due to covid-19 and US-China trade war since 2018. Our results suggest that workplace injuries could be an unexpected cost of these interruptions.

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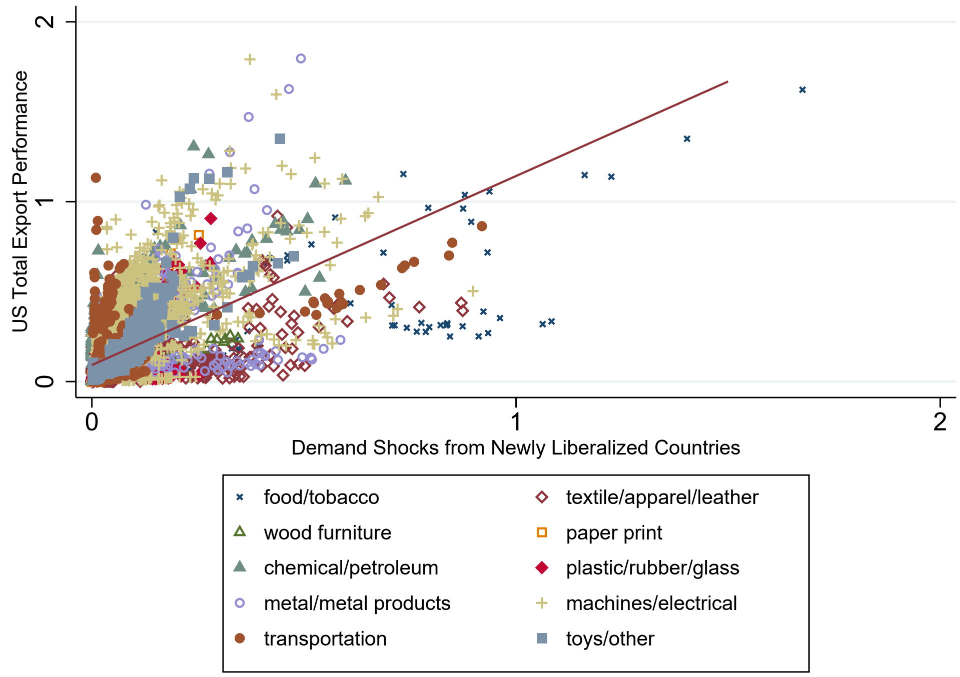
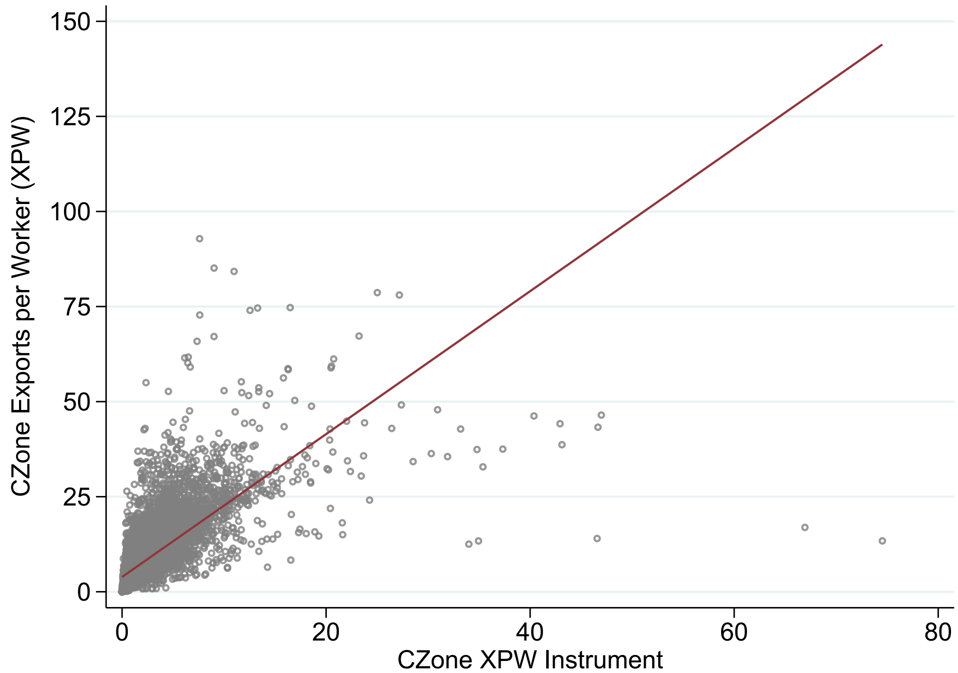
Figures and Tables

Figure 1: US Export and the Demand Shock Instrument



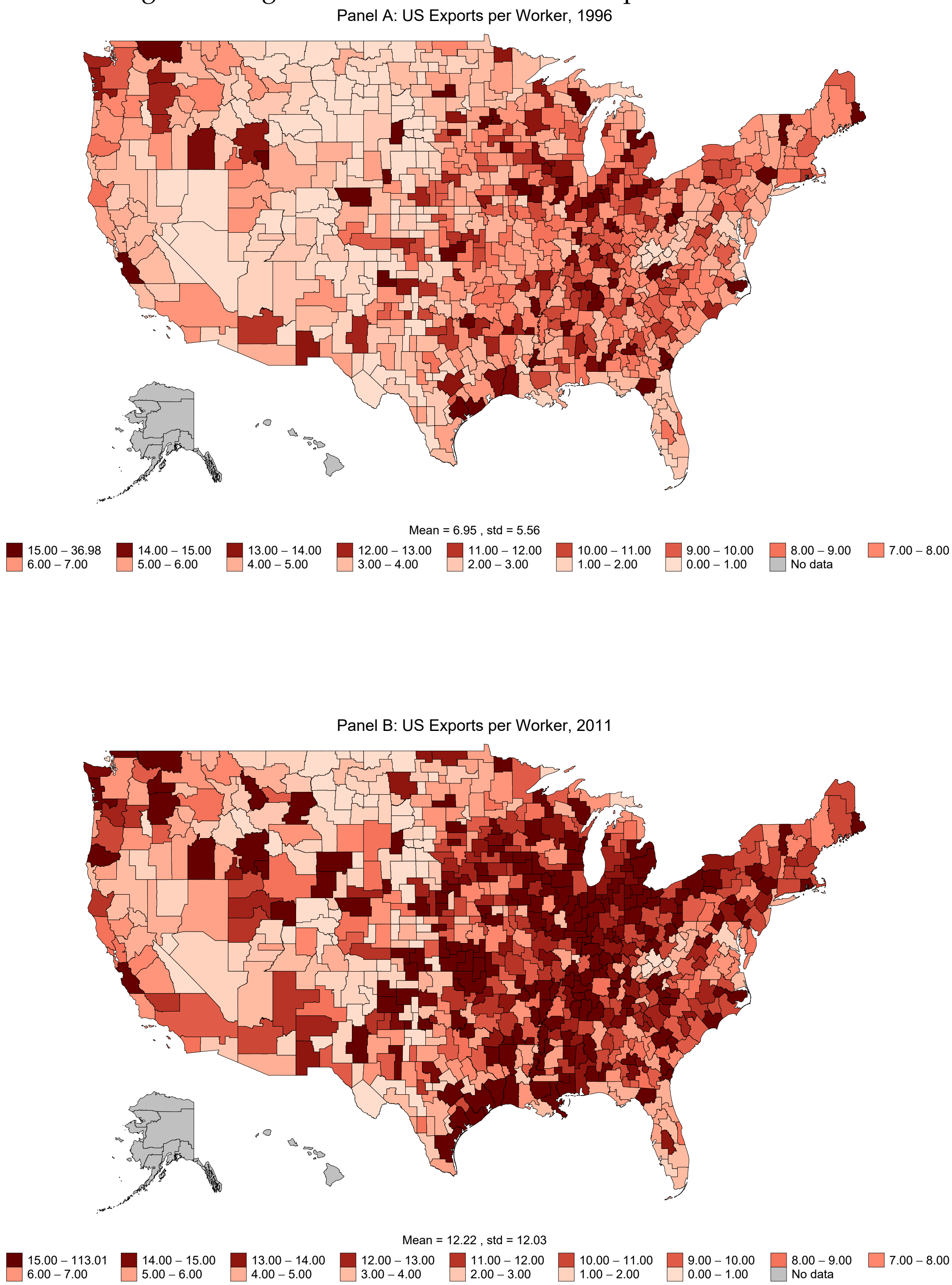
Note: Each dot in the figure indicates a four-digit SIC industry by year observation. Y-axis represents the US total export performance, measured by the total exports for each industry as a share of that industry's total production. X-axis shows the demand shock instrument constructed based on newly liberalized countries' import, normalized by the initial industry's production. Coefficient = 1.05, standard error=0.01, $R^2 = 0.78$.

Figure 2: First Stage Correlation between Exports per Worker and the Instrument on Exports



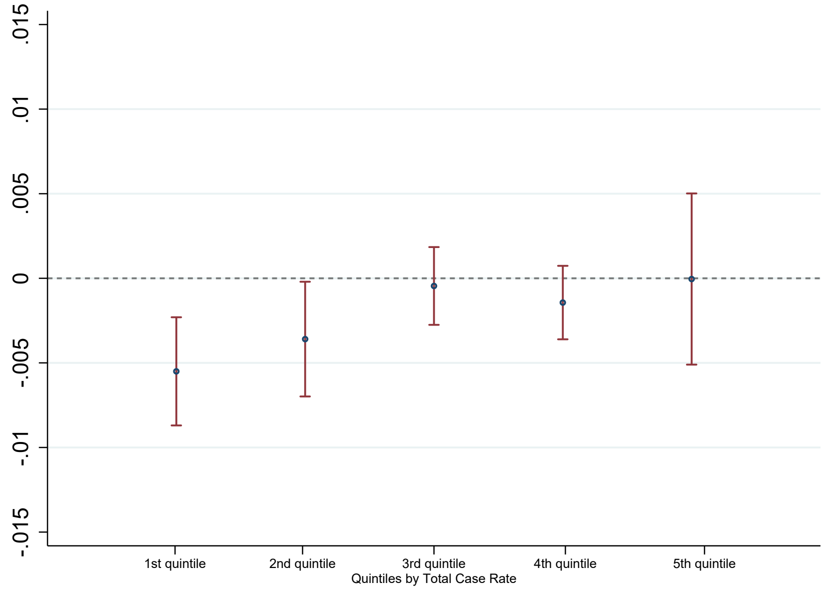
Note: The figure presents the results of the first stage correlation at the commuting zone level. The x-axis is the instrument on exports and y-axis is the exports per worker (in $1000). Each dot represents a commuting zone by year observation and the line is fitted by an OLS regression. Coefficient = 1.88, standard error=0.264, $R^2 = 0.518$. Standard errors are clustered at the state level.

Figure 3: Regional Variation in U.S. and Export Performance



Note: The figures show the exports per worker (in $1,000) at the commuting zone level in 1996 and 2011.

Figure 4: Distributional Effects of Exports on ln(TCR)



Note: The outcome is log of the total case rate (TCR). The dots indicate the point estimates, and lines indicate the 95% confidence intervals. The standard errors are clustered at the state level. 1st quintile to 5th quintile indicate establishments with total case rate between 0th percentile and 20th percentile to those between 80th percentile and 100th percentile.

Table 1: Summary Statistics

	mean	sd	min	max	N
Establishment-Level Injury Rates					
Total Case Rate (TCR)	9.80	9.56	0.00	100.00	521,273
Days away, Job Restrictions, and Transfer (DART)	5.13	5.74	0.00	98.85	521,273
Days away from Work (DAFWII)	2.08	3.13	0.00	97.11	310,588
Trade Performance					
Export Performance per Worker (XPW)	8.39	7.48	0.00	113.01	11,552
Instrument for Export Performance	2.47	2.95	0.00	74.53	11,552
Import Penetration per Worker (IPW)	2.18	2.41	0.00	60.09	11,552
Instrument for Import Penetration	1.81	1.82	0.00	33.75	11,552
Expenditure Investment and Production Measures					
Total Capital Stock (kUSD per worker)	104.53	46.91	0.00	818.05	11,552
Equipment Expenditure (kUSD per worker)	73.07	34.52	0.00	614.48	11,552
Plant Structures Investment (kUSD per worker)	31.47	12.84	0.00	204.72	11,552
Weekly Produciton Hours (per worker)	29.54	2.50	0.00	40.79	11,552
Enforcement Measures					
Total Number of Inspections per 1,000 workers	31.73	87.75	0.00	1966.00	15,162
Toal Number of Violations per 1,000 workers	139.80	407.39	0.00	10655.00	15,162
Total Number of Serious Violations per 1,000 workers	77.31	205.91	0.00	4679.00	15,162
Total Amount of Penalties per worker (USD)	118.44	517.58	0.00	33438.91	15,162

Note: The establishment-level injury rate data are from the OSHA Data Initiative (ODI). The trade variables are from UN Comtrade Database and the US International Trade Commission, measured as thousand USD per worker. The investment measures are from NBER-Center for Economic Studies Manufacturing Industry Database. The CZone-level enforcement data are from OSHA's Integrated Management Information System (IMIS), normalized by per 100 workers.

Table 2: The Impact of Exports on Injury Rates, Baseline

Dependent Variable:	ln(TCR)		ln(DART)		ln(DAFWII)	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
XPW	-0.001	-0.007*	-0.002	-0.010**	-0.002**	-0.005**
	(0.001)	(0.004)	(0.002)	(0.005)	(0.001)	(0.003)
Establishment FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap Weak IV F-Stats		15.833		15.833		50.196
Observations	521,273	521,273	521,273	521,273	310,588	310,588

Note: Table reports results of OLS and 2SLS regressions. Dependent variables are log of indicated injury measures in establishment i at commuting zone c in year t. TCR is the total injury case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as the number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. Standard errors in parentheses are clustered at the state level. * $p < .10$, ** $p < .05$, *** $p < .01$

Table 3: The Impact of Exports on Injury Rates with Controls

	(1)	(2)	(3)	(4)	(5)
	Panel A: ln(TCR)				
XPW	-0.007*	-0.007*	-0.007*	-0.007*	-0.007**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Kleibergen-Paap Weak IV F-Stats	15.833	15.014	15.040	14.426	13.652
Observations	521,273	521,273	521,273	521,273	521,273
	Panel B: ln(DART)				
XPW	-0.010**	-0.009*	-0.009*	-0.009**	-0.009**
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
Kleibergen-Paap Weak IV F-Stats	15.833	15.014	15.040	14.426	13.652
Observations	521,273	521,273	521,273	521,273	521,273
	Panel C: ln(DAFWII)				
XPW	-0.005**	-0.005*	-0.004*	-0.006**	-0.006**
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Kleibergen-Paap Weak IV F-Stats	50.196	46.547	45.717	22.104	22.830
Observations	310,588	310,588	310,588	310,588	310,588
Establishment FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	Yes	Yes	Yes
Worker Compensation Controls	No	No	Yes	Yes	Yes
Import Competition Measures	No	No	No	Yes	Yes
Region by Year FE	No	No	No	No	Yes

Note: Table reports estimates of 2SLS regressions. Dependent variables are log of indicated injury measures for each establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as the number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. Column (1) reports the baseline 2SLS regression with establishment and year fixed effects, and Columns (2) to (5) are estimated with additional controls. Demographic controls include a set of time-varying county-specific demographic characteristics of population (the share of population that was female, Black, Hispanic, and with college education). Workers' Compensation controls include the log of the maximum Workers' Compensation cash benefit amount and the log of total Workers' Compensation costs in each state. Import competition controls contain three measures: the imports from China, from NAFTA, and from the rest of the world, all at the commuting zone level. Imports from China is instrumented using imports from in eight other countries including Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland. The region by year fixed effects include four regions: Northeast, Midwest, South, and West. Standard errors in parentheses are clustered at the state level.

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 4: The Impact of Exports on Injury Rates with Controls

	(1) ln(TCR)	(2) ln(DART)	(3) ln(DAFWII)
3 years lead	0.0004	0.0008	0.0017***
	(0.0006)	(0.0008)	(0.00066)
2 years lead	-0.0002	-0.0001	0.0008**
	(0.0003)	(0.0004)	(0.0003)
0 year lag	-0.0003	-0.0005	-0.0013***
	(0.0003)	(0.0004)	(0.00036)
1 year lag	-0.0012*	-0.0022**	-0.0031***
	(0.0006)	(0.0008)	(0.0009)
2 years lag	-0.0025***	-0.0044***	-0.0048***
	(0.00095)	(0.0014)	(0.0013)
3 years lag	-0.0043***	-0.0079***	-0.0072***
	(0.0014)	(0.0019)	(0.0018)
4 years lag	-0.0064***	-0.011***	-0.0095***
	(0.0019)	(0.0029)	(0.0024)
5 years lag	-0.0093***	-0.017***	-0.012***
	(0.0024)	(0.0036)	(0.0026)
Observations	521,273	521,273	310,588

Note: Table reports estimates of 2SLS regressions. Dependent variables are log of indicated injury measures for each establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as the number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the change in kUSD exports per worker at commuting zone c from the period, including leads up to three years and lags from one year to five years. The year before unilateral liberalizations are omitted. Standard errors in parentheses are clustered at the state level.
* $p < .10$, ** $p < .05$, *** $p < .01$

Table 5: Exports, Capital Investment, and Production Intensity

	(1) Total Capital Stock (kUSD)	(2) Equipment Expenditure (kUSD)	(3) Plant Structure Investment (kUSD)	(4) Production Hours (Per Week)
	All measures are in per worker			
XPW	3.695***	2.891***	0.804***	0.021
	(0.907)	(0.646)	(0.287)	(0.016)
Dependent Variable Mean	104.535	73.070	31.465	29.539
Commuting Zone FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	11,552	11,552	11,552	11,552

Note: Table reports estimates of 2SLS regressions. Dependent variables are log of indicated per worker measures in each commuting zone c in year t. The main data are drawn from NBER-CES Manufacturing Industry Database during 1996 to 2011 (prepared by Becker et al. (2013)). *Total capital stock* is the combination of capital expenditures on equipment and plant structures. *Expenditure equipment* covers capital expenditures for machinery, computers, hardware, and peripheral data processing equipment. *Plant structures investment* includes capital expenditure for buildings, and other structures. We project each industry-level measures to the commuting zone level using the local employment composition. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. Standard errors in parentheses are clustered at the state level. All regressions are weighted by the share of national population of each commuting zone in the initial period. Commuting zone and year fixed effects are included in all regressions.

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 6: Exports and Working Conditions

Inpection Type:	(1) Total	(2) Accident	(3) Complaint	(4) Program
	Panel A: ln(Number of Inspections per Worker)			
XPW	-0.0234	-0.0316*	-0.0474**	-0.0234
	(0.0227)	(0.0188)	(0.0219)	(0.0266)
	Panel B: ln(Number of Violations per Worker)			
XPW	-0.0351	-0.0298	-0.0621**	-0.0373
	(0.0279)	(0.0261)	(0.0301)	(0.0323)
	Panel C: ln(Current Penalty per Worker)			
XPW	-0.0360	-0.0393	-0.0695*	-0.0252
	(0.0397)	(0.0339)	(0.0375)	(0.0418)
Commuting Zone FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	15,162	15,162	15,162	15,162

Note: Table reports estimates of 2SLS regressions. The data are from OSHA's Integrated Management Information System (IMIS), from 1991 to 2011. *Accident* refers to inspections on fatalities and severe accidents with three or more hospitalizations. *Complaint* refers to inspections on employee complaints. *Program* refers to programmed inspections conducted based on industries, locations, or specific hazards. Dependent variables are log of indicated enforcement measures per worker at commuting zone c in year t. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. Standard errors in parentheses are clustered at the state level. Commuting zone and year fixed effects are included in all regressions.

* $p < .10$, ** $p < .05$, *** $p < .01$

Appendix

We conduct a number of robustness checks validating the Bartik identification strategy. First, we test the assumption that the results are not solely driven by the initial characteristics of a specific industry or product sector that is independent of export expansion (Goldsmith-Pinkham et al., 2020). In Appendix Table A6, we test the sensitivity of the results to the exclusion of individual HS section when constructing the instrument. Column (1) presents the baseline results, same as the 2SLS estimates in Table 2. Columns (2) to (6) present results with instruments constructed excluding each individual HS section, including food processing, textile and apparel, chemicals, transportation, and electronic. Overall, the results are similar to the baseline estimates.

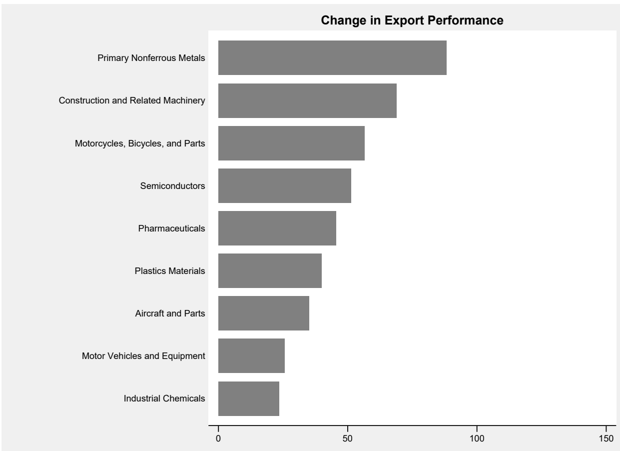
We provide additional sensitivity tests on whether the results are driven by specific export destination countries in Appendix Table A7. Similar to Appendix Table A6, Column (1) presents the baseline results, same as the 2SLS estimates in Table 2. Columns (2) exclude Mexico, which has been the country accounting for the largest share of US exports and signed the bilateral free trade agreement (the North American Free Trade Agreement) in 1994, in constructing the instrument on exports. Columns (3) to (6) exclude China, central American countries (Brazil, Paraguay, Colombia, Ecuador), emerging markets in Europe (Czech Republic, Egypt, Poland, Romania, Tunisia, Turkey), and Southeast Asian countries (Bangladesh, India, Indonesia, Philippines, Sri Lanka) respectively. The results are similar to the baseline estimates and confirm that the effect is not driven by specific sectors or destination countries.

Appendix Table A8 presents the results including commuting zone specific trends based on the initial share of manufacturing employment, the initial share of skilled manufacturing employment, or the initial share of routine-based employment (Columns (2) to (4)).[15] Column (5) includes all three commuting zone specific trends. This is to address

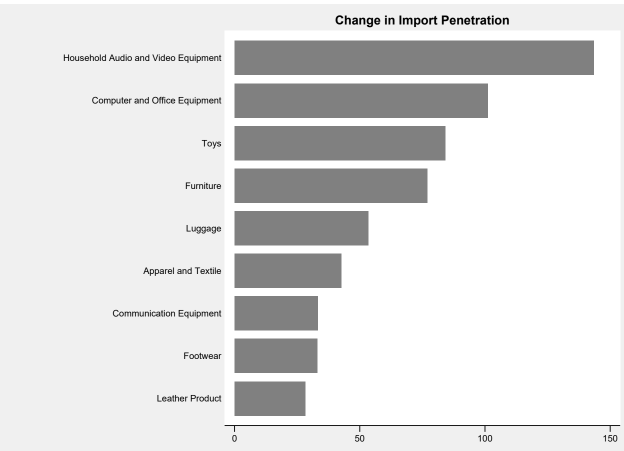
[15]The data on the initial share of manufacturing employment and the share of skilled manufacturing employment (measures as workers with college or above degrees) are from the 1990 Census. The data on the share of routine-based employment are from Autor and Dorn (2013).

any potential trend in workplace safety that is correlated with the initial characteristics of jobs in each commuting zone. Appendix Table A9 further controls the initial share of manufacturing employment, interacted with year fixed effects. This specification is to address the potential concern that the results might be driven by unobserved time-varying factors associated with the export exposure of the manufacturing sector in each commuting zone. Overall, we find these additional controls have limited impact on the estimated coefficients.

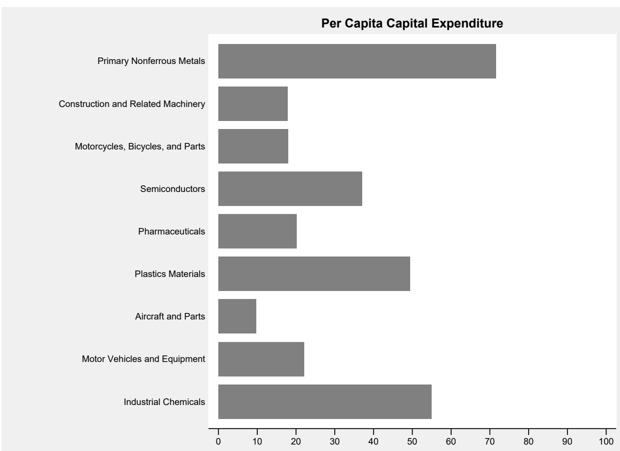
Figure A1: Import-Penetrated vs. Export-Oriented Industries



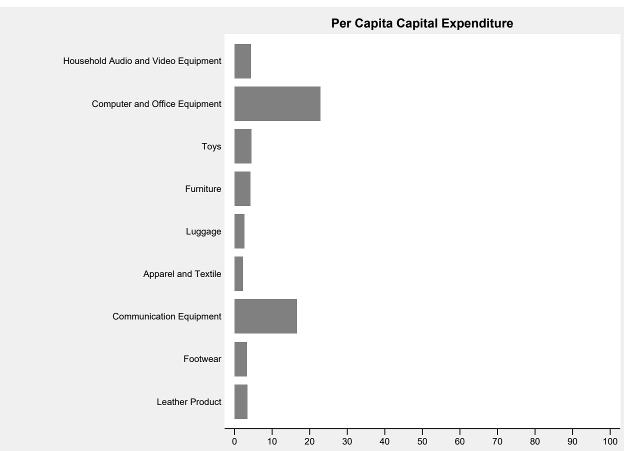
(a) Export-Intensive



(b) Import-Intensive



(c) Export-Intensive

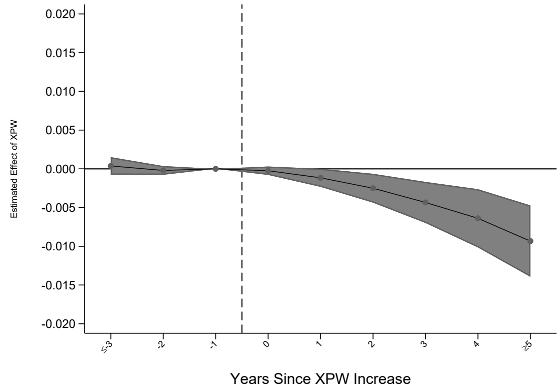


(d) Import-Intensive

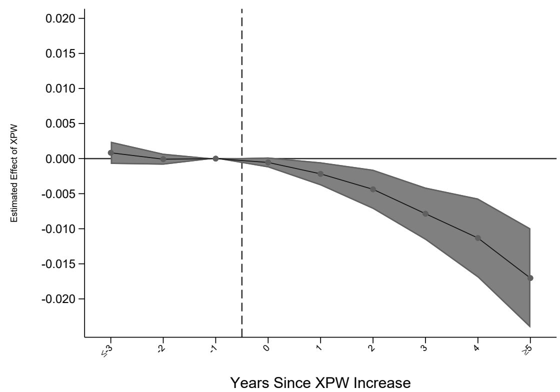
Note: The figures show the differences in export-intensive and import-intensive industries. Data are taken from the NBER-Center for Economic Studies Manufacturing Industry Database (NBER-CES), with calculations by authors. Export performance represents the total exports for each industry as a share of that industry's total production, showing how important the foreign market is for a certain industry's production capacity. Similarly, import penetration is defined as imports from China divided by initial industrial production.

Figure A2: Dynamic Treatment Effects at the Establishment Level

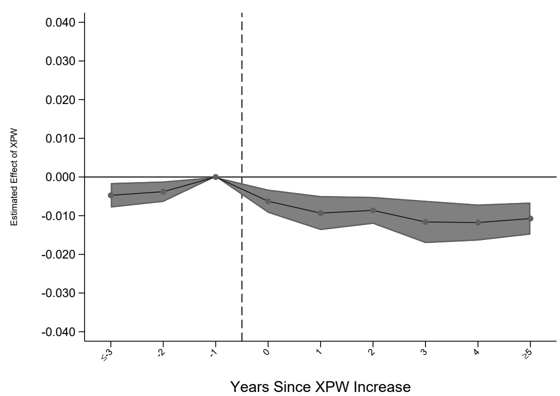
Panel (a): ln(TCR)



Panel (b): ln(DART)



Panel (c): ln(DAFWII)



Note: Dependent variables are log of indicated injury measures in establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as number of cases per 100 full-time equivalent employees. The dots show the estimates, and the shaded area shows the 95% confidence intervals. Independent variable (XPW) is the change in kUSD exports per worker at commuting zone c from the previous period, including leads up to three years and lags from one year to five years. The years before unilateral liberalizations are omitted. Standard errors in parentheses are clustered at the state level.

Table A1: Trade Liberalization Dates

Country	Year Uninterrupted Openness Began
Bangladesh	1996
Brazil	1991
China[a]	2001
Colombia	1990
Czech Republic	1990
Ecuador	1991
Egypt	1998
India	1991
Indonesia	1993
Mexico	1986
New Zealand	1986
Paraguay	1989
Philippines	1981
Poland	1990
Romania	1992
Sri Lanka	1991
Tunisia	1989
Turkey	1989
Vietnam	1986

Note: The list includes countries used in constructing the instrument on export expansion. The dates are from (Wacziarg and Welch, 2008). [a]Although China's Opening-Up Policy launched in 1978, its integration into the world's economy mainly occurred since its WTO accession (Amiti et al., 2010)

Table A2: The Impact of Exports on Injury Rates with Controls, Industry-Level Analysis

	(1)	(2)	(3)	(4)	(5)
			Panel A: ln(TCR)		
ln(Export Performance)	-0.0570*	-0.0575*	-0.0569*	-0.0568*	-0.0677**
	(0.0325)	(0.0321)	(0.0319)	(0.0319)	(0.0294)
Kleibergen-Paap Weak IV F-Stats	217.6	216.6	215.9	217.4	219.3
Observations	400,206	400,206	400,206	400,206	400,206
			Panel B: ln(DART)		
ln(Export Performance)	-0.0462	-0.0475*	-0.0465*	-0.0469*	-0.0501*
	(0.0279)	(0.0275)	(0.0271)	(0.0269)	(0.0260)
Kleibergen-Paap Weak IV F-Stats	284.7	282.9	282.8	283.7	285.4
Observations	400,206	400,206	400,206	400,206	400,206
			Panel C: ln(DAFWII)		
ln(Export Performance)	-0.0538	-0.0456	-0.0465	-0.0482	-0.0354
	(0.148)	(0.147)	(0.148)	(0.149)	(0.147)
Kleibergen-Paap Weak IV F-Stats	413.4	409.3	410.1	409.5	406.2
Observations	244,088	244,088	244,088	244,088	244,088
Establishment FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	Yes	Yes	Yes
Worker Compensation Controls	No	No	Yes	Yes	Yes
Import Competition Measures	No	No	No	Yes	Yes
Region by Year FE	No	No	No	No	Yes

Note: Table reports estimates of 2SLS regressions. Dependent variables are log of indicated injury measures for each establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as the number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. Column (1) reports the baseline 2SLS regression with establishment and year fixed effects, and Columns (2) to (5) are estimated with additional controls. Demographic controls include a set of time-varying county-specific demographic characteristics of population (the share of population that was female, Black, Hispanic, and with college education). Workers' Compensation controls include the log of the maximum Workers' Compensation cash benefit amount and the log of total Workers' Compensation costs in each state. Import competition controls contain three measures: the imports from China, from NAFTA, and from the rest of the world, all at the commuting zone level. The region by year fixed effects include four regions: Northeast, Midwest, South, and West. Standard errors in parentheses are clustered at the state level.

* $p < .10$, ** $p < .05$, *** $p < .01$

Table A3: Robustness: The Impact of Exports on Injury Rates with Controls, Alternative Clustering of Standard Errors at the Commuting Zone Level

	(1)	(2)	(3)	(4)	(5)
			Panel A: ln(TCR)		
XPW	-0.007*	-0.007*	-0.007*	-0.007*	-0.008*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Kleibergen-Paap Weak IV F-Stats	15.833	15.014	15.040	39.007	35.137
Observations	521,273	521,273	521,273	521,273	521,273
			Panel B: ln(DART)		
XPW	-0.010**	-0.009*	-0.009*	-0.009**	-0.010**
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)
Kleibergen-Paap Weak IV F-Stats	15.833	15.014	15.040	39.007	35.137
Observations	521,273	521,273	521,273	521,273	521,273
			Panel C: ln(DAFWII)		
XPW	-0.005*	-0.005*	-0.004	-0.006*	-0.006*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Kleibergen-Paap Weak IV F-Stats	50.196	46.547	45.717	54.406	55.592
Observations	310,588	310,588	310,588	310,588	310,588
Establishment FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	Yes	Yes	Yes
Worker Compensation Controls	No	No	Yes	Yes	Yes
Import Competition Measures	No	No	No	Yes	Yes
Region by Year FE	No	No	No	No	Yes

Note: Standard errors in parentheses are clustered at the commuting zone level. Table reports estimates of 2SLS regressions. Dependent variables are log of indicated injury measures for each establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as the number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. Column (1) reports the baseline 2SLS regression with establishment and year fixed effects, and Columns (2) to (5) are estimated with additional controls. Demographic controls include a set of time-varying county-specific demographic characteristics of population (the share of population that was female, Black, Hispanic, and with college education). Workers' Compensation controls include the log of the maximum Workers' Compensation cash benefit amount and the log of total Workers' Compensation costs in each state. Import competition controls contain three measures: the imports from China, from NAFTA, and from the rest of the world, all at the commuting zone level. The region by year fixed effects include four regions: Northeast, Midwest, South, and West.

* $p < .10$, ** $p < .05$, *** $p < .01$

Table A4: First-Stage Results

	(1)	(2)	(3)	(4)	(5)
XPW Instrument	1.053***	1.041***	1.040***	1.087***	1.084***
	(0.265)	(0.269)	(0.268)	(0.174)	(0.183)
Establishment FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	Yes	Yes	Yes
Worker Compensation Controls	No	No	Yes	Yes	Yes
Import Competition Measures	No	No	No	Yes	Yes
Region by Year FE	No	No	No	No	Yes
Kleibergen-Paap Weak IV F-Stats	15.833	15.014	15.040	39.007	35.137
Observations	521,273	521,273	521,273	521,273	521,273

Note: Table reports first-stage results of columns (1) and (5) in Table 3. Dependent variable (XPW) is exports per worker in kUSD.Independent variable (XPW) is export instrument. Column (1) reports the baseline 2SLS regression with establishment and year fixed effects, and Columns (2) to (5) are estimated with additional controls. Demographic controls include a set of time-varying county-specific demographic characteristics of population (the share of population that was female, Black, Hispanic, and with college education). Workers' Compensation controls include the log of the maximum Workers' Compensation cash benefit amount and the log of total Workers' Compensation costs in each state. Import competition controls contain three measures: the imports from China, from NAFTA, and from the rest of the world, all at the commuting zone level. The region by year fixed effects include four regions: Northeast, Midwest, South, and West. Standard errors in parentheses are clustered at the state level.
* $p < .10$, ** $p < .05$, *** $p < .01$

Table A5: The Impact of Exports on Injury Rates with Controls

	(1)	(2)	(3)	(4)	(5)
			Panel A: $ln(TCR)$		
XPW	-0.007*	-0.007*	-0.007*	-0.007*	-0.007**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
IPW (CHN)				-0.006	-0.010**
				(0.004)	(0.004)
Kleibergen-Paap Weak IV F-Stats	15.833	15.014	15.040	14.426	13.652
Observations	521,273	521,273	521,273	521,273	521,273
			Panel B: $ln(DART)$		
XPW	-0.010**	-0.009*	-0.009*	-0.009**	-0.009**
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
IPW (CHN)				-0.006	-0.012**
				(0.005)	(0.005)
Kleibergen-Paap Weak IV F-Stats	15.833	15.014	15.040	14.426	13.652
Observations	521,273	521,273	521,273	521,273	521,273
			Panel C: $ln(DAFWII)$		
XPW	-0.005**	-0.005*	-0.004*	-0.006**	-0.006**
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
IPW (CHN)				-0.003	-0.003
				(0.005)	(0.005)
Kleibergen-Paap Weak IV F-Stats	50.196	46.547	45.717	22.104	22.830
Observations	310,588	310,588	310,588	310,588	310,588
Establishment FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	Yes	Yes	Yes
Worker Compensation Controls	No	No	Yes	Yes	Yes
Import Competition Measures	No	No	No	Yes	Yes
Region by Year FE	No	No	No	No	Yes

Note: Table reports estimates of 2SLS regressions. Dependent variables are log of indicated injury measures for each establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as the number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. Column (1) reports the baseline 2SLS regression with establishment and year fixed effects, and Columns (2) to (5) are estimated with additional controls. Demographic controls include a set of time-varying county-specific demographic characteristics of population (the share of population that was female, Black, Hispanic, and with college education). Workers' Compensation controls include the log of the maximum Workers' Compensation cash benefit amount and the log of total Workers' Compensation costs in each state. Import competition controls contain three measures: the imports from China, from NAFTA, and from the rest of the world, all at the commuting zone level. Imports from China is instrumented using imports from in eight other countries including Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland. The region by year fixed effects include four regions: Northeast, Midwest, South, and West. Standard errors in parentheses are clustered at the state level.

* $p < .10$, ** $p < .05$, *** $p < .01$

Table A6: Robustness Checks: Dropping one HS Section at a time

	(1) Baseline	(2) No Food Processing	(3) No Textile & Apparel	(4) No Chemicals	(5) No Transportation	(6) No Electronics
			Panel A: ln(TCR)			
XPW	-0.008**	-0.007**	-0.008**	-0.019***	-0.008**	-0.006*
	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)
Kleibergen-Paap Weak IV F-Stats	35.137	34.956	34.669	27.940	23.282	31.834
Observations	521,273	521,273	521,273	521,273	521,273	521,273
			Panel B: ln(DART)			
XPW	-0.010**	-0.009**	-0.010**	-0.021***	-0.009**	-0.008**
	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)
Kleibergen-Paap Weak IV F-Stats	35.137	34.956	34.669	27.940	23.282	31.834
Observations	521,273	521,273	521,273	521,273	521,273	521,273
			Panel C: ln(DAFWII)			
XPW	-0.006**	-0.005**	-0.006**	-0.008**	-0.006***	-0.005**
	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)
Kleibergen-Paap Weak IV F-Stats	55.592	55.098	54.473	52.669	34.515	53.526
Observations	310,588	310,588	310,588	310,588	310,588	310,588
Establishment and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note: Column (1) shows the baseline results. Columns (2) to (6) presents results with instruments constructed excluding each individual HS section, including food processing, textile and apparel, chemicals, transportation, and electronic. Dependent variables are log of indicated injury measures in establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. The models include establishment and year fixed effects, and a full set of control variables as in Table 3, Column (5). Standard errors in parentheses are clustered at the state level.
* $p < .10$, ** $p < .05$, *** $p < .01$

Table A7: Robustness Checks: Dropping one Country at a time

	(1) Baseline	(2) No Mexico	(3) No China	(4) No Mercosur	(5) No EU	(6) No ASEAN
			Panel A: ln(TCR)			
XPW	-0.008**	-0.012***	-0.012***	-0.011***	-0.011***	-0.011***
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Kleibergen-Paap Weak IV F-Stats	35.137	187.356	191.880	236.383	226.090	168.361
Observations	521,273	521,273	521,273	521,273	521,273	521,273
			Panel B: ln(DART)			
XPW	-0.010**	-0.009***	-0.009***	-0.008***	-0.008***	-0.008***
	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Kleibergen-Paap Weak IV F-Stats	35.137	187.356	191.880	236.383	226.090	168.361
Observations	521,273	521,273	521,273	521,273	521,273	521,273
			Panel C: ln(DAFWII)			
XPW	-0.006**	-0.005	-0.005	-0.005	-0.005	-0.005
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Kleibergen-Paap Weak IV F-Stats	55.592	126.412	127.616	136.173	131.325	93.076
Observations	310,588	310,588	310,588	310,588	310,588	310,588
Establishment and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note: Column (1) shows the baseline results. Column (2) excludes exports to Mexico when calculating the XPW, Column (3) excludes China, Column (4) excludes Central American countries (Brazil, Paraguay, Colombia, Ecuador), Column (5) excludes emerging markets in Europe (Czech Republic, Egypt, Poland, Romania, Tunisia, Turkey), and Column (6) excludes Southeast Asia countries (Bangladesh, India, Indonesia, Philippines, Sri Lanka). Dependent variables are log of indicated injury measures in establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. The models include establishment and year fixed effects, and a full set of control variables as in Table 3, Column (5). Standard errors in parentheses are clustered at the state level.
* $p < .10$, ** $p < .05$, *** $p < .01$

Table A8: Robustness Checks: Additional Controls

	(1)	(2)	(3)	(4)	(5)
			Panel A: TCR		
XPW	-0.007*	-0.007***	-0.006***	-0.005***	-0.006***
	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)
Kleibergen-Paap Weak IV F-Stats	15.833	19.456	43.398	10.521	21.905
Observations	521,273	521,273	521,273	521,273	521,273
			Panel B: DART		
XPW	-0.010**	-0.009***	-0.009***	-0.008***	-0.009***
	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)
Kleibergen-Paap Weak IV F-Stats	15.833	19.480	43.398	10.515	21.916
Observations	521,273	521,273	521,273	521,273	521,273
			Panel C: DAFWII		
XPW	-0.005**	-0.007***	-0.006***	-0.005**	-0.005***
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Kleibergen-Paap Weak IV F-Stats	50.196	69.086	100.260	12.130	93.499
Observations	310,588	310,588	310,588	310,588	310,588
Establishment FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Mfg. Empl. Trend	No	Yes	No	No	Yes
Skilled Mfg. Empl. Trend	No	No	Yes	No	Yes
Routine. Empl. Trend	No	No	No	Yes	Yes

Note: Table reports estimates of 2SLS regressions with additional controls. Dependent variables are log of indicated injury measures for each establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. All columns include establishment and year fixed effects. Column (2) to (4) include three commuting zone specific trends: "Mfg. Empl. Trend" is the commuting zone specific trend on the initial manufacturing employment share; Skilled "Mfg. Empl. Trend" is the trend on the initial share of college-above manufacturing employment, and "Routine Empl. Trend" is trend on the initial share of routine-based employment. Column (5) includes all three trends. Standard errors in parentheses are clustered at the state level.
* $p < .10$, ** $p < .05$, *** $p < .01$

Table A9: Robustness Checks: Initial Share of Manufacturing Employment Interacted with Year Fixed Effects

	(1)	(2)	(3)	(4)	(5)
			Panel A: ln(TCR)		
XPW	-0.004	-0.004	-0.004	-0.005	-0.007*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Kleibergen-Paap Weak IV F-Stats	12.122	12.037	12.149	32.946	30.047
Observations	521,273	521,273	521,273	521,273	521,273
			Panel B: ln(DART)		
XPW	-0.006	-0.006	-0.005	-0.007*	-0.008**
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Kleibergen-Paap Weak IV F-Stats	12.122	12.037	12.149	32.946	30.047
Observations	521,273	521,273	521,273	521,273	521,273
			Panel C: ln(DAFWII)		
XPW	-0.005*	-0.005**	-0.004*	-0.006**	-0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Kleibergen-Paap Weak IV F-Stats	35.101	34.351	34.538	42.880	44.146
Observations	310,588	310,588	310,588	310,588	310,588
Establishment FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	Yes	Yes	Yes
Worker Compensation Controls	No	No	Yes	Yes	Yes
Import Competition Measures	No	No	No	Yes	Yes
Region by Year FE	No	No	No	No	Yes

Note: Table reports estimates of 2SLS regressions. Dependent variables are log of indicated injury measures for each establishment i at commuting zone c in year t. TCR is the total case rate, DART is the case rate on injuries involving days away from work, job restrictions, and job transfer, and DAFWII is the case rate on injuries involving days away from work only, all measured as number of cases per 100 full-time equivalent employees. Independent variable (XPW) is the kUSD exports per worker at commuting zone c in year t. Column (1) reports the baseline 2SLS regression with establishment and year fixed effects, and Columns (2) to (5) are estimated with additional controls. Demographic controls include a set of time-varying county-specific demographic characteristics of population (the share of the county population that was female, Black, Hispanic, and college educated). Worker compensation controls include the log of maximum worker compensation and the log of total worker compensation in each state.Import competition controls contain three measures: the imports from China, from NAFTA, and from the rest of the world, all at the commuting zone level. Standard errors in parentheses are clustered at the state level.
* $p < .10$, ** $p < .05$, *** $p < .01$