Local labor market effects of the 2002 Bush steel tariffs

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Abstract

President Bush imposed safeguard tariffs on steel in early 2002. Using US input-output tables and a generalized difference-in-difference methodology, we analyze the local labor market employment effects of these tariffs depending on the local labor market's reliance on steel as an input and as part of local production. The tariffs did not boost local steel employment but substantially depressed local employment in steel-consuming industries for many years after Bush removed the tariffs. The tariffs also led to a persistent exit of steel-intensive manufacturing establishments, suggesting a role for plant-level fixed entry costs in translating the temporary shock into persistent outcomes.

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1 Introduction

Economists, policy makers and the public usually think of tariffs and protection as synonyms. After all, governments often promote tariffs as a way to protect a domestic industry from foreign competition. However, domestic firms in other industries suffer from tariffs on the imports they use as intermediate inputs. The unprecedented breadth and scale of the Trump administration's tariffs, in particular on intermediate inputs (Bown (2019)), brought this to the front of the public discussion. Stories spread through the media highlighting situations like the reduced global competitiveness of US boat manufacturers who rely on aluminum or mass layoffs at US steel pipe manufacturers who rely on steel as their key input.

However, these are not new issues. Similar issues were very topical when President George W. Bush imposed "safeguard" tariffs on steel in 2002. After years of unsuccessfully pressing the Clinton administration to impose these safeguard tariffs, the steel industry unexpectedly and successfully persuaded the Bush administration to start the safeguard tariff process within six months of taking office in January 2001 (Devereaux et al. (2006)). An influential analysis by Francois and Baughman (2003) on behalf of the Consuming Industries Trade Action Coalition (CITAC) concluded that the Bush steel tariffs cost 200,000 jobs even though only 197,000 workers were employed in the entire steel-producing industry.[1] Yet, as pointed out by Cox and Russ (2018), there are no prior academic analyses of the Bush steel tariffs.[2] To the best of our knowledge, ours is the first paper to fill this gap in the literature.

We analyze the impact of the Bush steel tariffs on employment in steel-consuming (i.e. downstream) industries and the steel-producing industry. Our main analysis uses a generalized difference-in-difference methodology in a local labor markets setting. In June 2001, President Bush asked the US International Trade Commission (USITC) to investigate the imposition of steel safeguard tariffs. In October 2001, the USITC concluded imports were a substantial cause of serious injury to the steel industry and recommended safeguard tariffs. In March 2002, President Bush imposed 8-30% tariffs on over 170 steel products. These temporary tariffs were set to last for three years but President Bush removed them in December 2003 after a November 2003 WTO ruling against their WTO-legality. Based on the input-output structure of the US economy and the industrial employment composition of US local labor markets, we construct measures for US commuting zones (CZs) that reflect the *protection* they received for their steel-producing industry and their *vulnerability* based

[1] See, e.g., articles in Politico, The New York Times, The Financial Times, The Wall Street Journal, The Atlantic, The Economist, The Washington Post, and The Conversation.

[2] Francois and Baughman (2003) use a bi-variate OLS regression with 36 monthly observations that regresses monthly US employment in steel-consuming industries on the two independent variables of a steel producer price index and overall manufacturing employment.

on their use of steel as an input. After controlling for various factors, including time-varying CZ-level exposure to the China shock and contemporaneous steel anti-dumping duties, our difference-in-difference approach essentially checks whether changes in CZ-level employment outcomes between the pre- and post-Bush steel tariff periods (first difference) are related to differences in the local exposure of CZs to the Bush steel tariffs (second difference).

We have four main results. First, the Bush steel tariffs had large negative short-run effects on local steel-consuming employment without any notable effects on local steel industry employment. We alternatively think of the steel-consuming industry as the entire manufacturing sector or the most steel-intensive subset of industries within manufacturing. Following little evidence of notable pre-trends in the share of local employment in steel-consuming industries during the 1993-2000 pre-Bush steel tariff period, we find statistically significant effects once the Bush steel tariff process starts in 2001 and these effects grow substantially before removal of the tariffs at the end of 2003.

Second, the negative effects on downstream employment are highly persistent. They remain stable until the end of our sample period in 2008 which is a full five years after the Bush steel tariffs ended in December 2003. In part to measure economic significance, we also confirm the large magnitude of the China shock on the manufacturing share of employment. In turn, even in 2008, the impact of vulnerability to the Bush steel tariffs in our main analysis is about 30-40% as large as the China shock. Using the kind of long difference specification common in the China shock literature, we show that vulnerability to the Bush steel tariffs can explain about 24% of the 2000-2007 decline in the US manufacturing share of employment (compared to 40% for the China shock). Given stakeholders expected the tariffs would likely last at most three years and potentially far less, these magnitudes could even understate the effect of permanent tariffs. Ultimately, our results emphasize the negative downstream employment effects of tariffs levied on key inputs and downplay the potential positive effects for the protected industry.

Third, the impact of important macroeconomic shocks during the 2000s shapes the response of local labor markets in the face of their vulnerability to the Bush steel tariffs. The impact of vulnerability was notably weaker in local labor markets seeing a construction boom driven by the 2000s house price bubble or specializing in industries standing to benefit from the historic 2000s surge in military expenditure.[3] Analogously, the impact of vulnerability was notably stronger in local labor markets specializing in the auto sector where US employment fell 30% between 2000 and 2008. Overall, the impact of vulnerability was weaker (stronger) if a local labor market was seeing expansion (contraction) of another key sector.

Fourth, we present evidence for a potential mechanism explaining the persistent effects

[3]As s share of US GDP, military expenditure grew over 40% between 2000 and 2008 from 3.1% to 4.4%.

of vulnerability to the Bush steel tariffs: plant-level fixed entry costs. If an existing plant's revenue stream covers its expense stream but would not also cover the fixed entry cost, a temporary negative shock can cause the plant to shut down without subsequent entry by itself or another plant. That is, temporary shocks can lead to a persistent reduction in the number of plants, and in turn employment, that would not happen in the absence of fixed costs. Although sometimes very close to the 10% level of statistical significance, our results show that vulnerability to the Bush steel tariffs reduces the CZ-level share of establishments (or share of manufacturing establishments) that are highly steel-intensive. This is consistent with plant-level fixed entry costs translating temporary tariffs into persistent effects.

Our paper closely relates to three distinct strands of the literature. The closest strand investigates the effects of trade policy on downstream industries. While ours is the first academic analysis on the employment effects of the Bush steel tariffs, the most closely related paper is a subsequent paper by Cox (2022). Despite the methodological differences between her industry-level analysis and our local labor market analysis, the results are very complementary. Using the firm-level tariff exemption process to Trump's national security tariffs on steel, Cox (2022) constructs a novel and highly disaggregated input-output mapping from steel products to downstream industries. Her main result is that the Bush steel tariffs decreased US exports of downstream industries and this decline persisted for many years after the Bush steel tariffs ended. She also confirms that downstream steel-intensive industries experienced persistent employment declines following the Bush steel tariffs with little effect on steel industry employment.

Most closely related to our paper in the strand of the literature on Trump's trade war tariffs is Flaaen and Pierce (2024).[4] Like us, they analyze the impact of tariffs on employment outcomes using a difference-in-difference approach with time-varying treatment effects. Different to our analysis, their main analysis is a monthly industry-level analysis but they still find a sizable role for tariffs reducing industry-level employment through increasing the cost of the industry's intermediate inputs. In an extension, they investigate how county-level unemployment responds to a county's vulnerability based on the local industry use of inputs hit by Trump's tariffs. Apart from looking at a different historical policy episode than Flaaen and Pierce (2024), our CZ-level analysis focuses on local manufacturing and within-manufacturing employment outcomes rather than their local but aggregate unemployment outcome. Moreover, Flaaen and Pierce (2024) only have 18 months of data after the tariffs come into effect and the tariffs are still in effect at the end of their sample period. In contrast,

[4]Handley et al. (2024) emphasize the negative effect of tariffs on intermediate inputs for export sales. They found that exported US goods with intermediate inputs highly exposed to Trump's trade war tariffs effectively faced ad valorem tariffs of up to 4% on their exports. Other recent papers focus on tariff pass through to US consumers (e.g. Amiti et al. (2019); Fajgelbaum et al. (2020); Cavallo et al. (2021)).

our analysis looks at both the short-run effects when the Bush steel tariffs are in effect and the medium-to-long run changes up to 5 years after the steel tariffs ended.

Two recent papers have also focused on the adverse employment effects of tariffs but through temporary trade barriers on intermediate inputs. Bown et al. (2021) find that US anti-dumping (AD) duties against China over the 1998-2016 period cost nearly 2 million jobs in downstream industries. Barattieri and Cacciatore (2023) find that employment in downstream industries falls by 0.5% points following a 1% point increase in the share of imports subject to AD and countervailing (CV) duties in upstream industries.[5] Like us, Barattieri and Cacciatore (2023) also find little evidence that tariffs boosted employment in industries protected by the tariffs. However, neither paper analyzes the effect of safeguard tariffs. Yet, the MFN nature of safeguard tariffs (i.e. these tariffs apply to imports from all countries) rather than the discriminatory nature of AD and CV duties (i.e. these tariffs apply only to imports from specified countries) gives policy importance to understanding the effects of safeguard tariffs. Moreover, as the recent public and policy discussion in the US has indicated, the employment impacts of the Bush steel tariffs are crucial for an overall understanding of real world implications of trade policy.

The second closely related strand of the literature explores factors that shape the response of local labor markets to shocks. Bloom et al. (2019) and Autor et al. (2021) show the negative marginal effect of the Chinese shock is stronger for CZs with lower human capital or greater initial specialization in the industries more exposed to the China shock. Charles et al. (2016, 2019) show local labor market declines in manufacturing employment during the 2000s are weaker (stronger) when the CZ is more (less) exposed to the early-mid 2000s house price bubble driven construction boom and stronger (weaker) upon the subsequent bust in the housing bubble and construction. From their analysis, we infer that the ability of a local labor to deal with a negative shock is shaped by how other key sectors of the local economy are expanding or contracting due to other simultaneous shocks. In addition to showing how this general insight emerges due to the house price bubble led construction boom, we show how it emerges due to the enormous increase in military expenditure and enormous decline of the auto sector during the 2000s.

The third closely related strand of the literature establishes the persistent labor market effects of trade shocks. Dix-Carneiro and Kovak (2017) show this in the context of 1990s Brazilian local labor markets where unilateral tariff liberalization led to worse earnings and employment outcomes for at least 10 years after the liberalization. They present substantial evidence that persistence can stem from a reverse agglomeration process: slow regional adjustment of capital and, in turn, sluggish labor demand dynamics amplify initial negative

[5] Barattieri and Cacciatore (2023) also show their results are robust to including safeguard tariffs.

local labor demand shocks over time. Autor et al. (2021) show persistence in the negative US local labor effects of the China shock through 2019, a decade after the plateau of Chinese import growth. While these studies emphasize persistence effects of *permanent* trade shocks, our results emphasize the persistent effects of *temporary* trade shocks.

However, we are not the first to document persistent effects of temporary trade shocks. Juhász (2018) shows persistence in the French level of technology and economic development due to temporary protection afforded by a trade blockade during the Napoleonic Wars. Persistent effects on exports by domestic firms has been documented by Xu (2022) due to the 1866 London banking crisis, Choi and Levchenko (2024) due to South Korean industrial policy of the 1960s-1970s, and Cox (2022) due to the Bush steel tariffs. Further, Cox (2022) builds a novel model, and presents supporting calibration evidence, showing how destination-specific fixed entry costs imply that temporary tariffs can generate a persistent decline in exports. Our result showing a persistent reduction in the share of establishments that are highly steel-intensive is consistent with this kind of mechanism whereby the temporary input tariff hike may lead firms to exit all markets. Thus, our results complements the evidence presented by Cox (2022) that fixed entry costs can help rationalize the broad persistent effects following removal of the Bush steel tariffs.

The rest of the paper proceeds as follows. Section 2 describes the institutional background of the steel industry and the Bush safeguard tariffs. Section 3 presents industry-level impacts of the tariffs. Sections 4 and 5 present our local labor market analysis. Section 6 concludes.

2 Institutional background

A key issue for our analysis is whether the timing of the Bush steel tariffs is exogenous. If not, differential CZ-level changes in labor market outcomes between more and less exposed CZs around the time of the Bush steel tariffs could reflect factors other than the Bush steel tariffs. However, we argue exogeneity is plausible for two reasons. First, the steel industry was undergoing a large-scale and long-term restructuring process during the 1980-2010 period and was constantly demanding protection. Second, despite unsuccessfully pushing the Clinton administration for safeguard tariffs over many years, the situation changed quickly and unexpectedly under the Bush administration in 2001. We briefly expand on these points, drawing heavily from Read (2005) and Devereaux et al. (2006).

The US steel industry experienced a transformative restructuring between 1980 and 2010. Historically, so-called "integrated" steel mills converted raw steel inputs into basic finished steel products at large-scale using very capital-intensive outdated technologies. However, the 1980s and 1990s saw the emergence of mini-mills that converted scrap metal into niche steel products on a smaller scale using less capital intensive but more advanced technologies. By the late 1990s, mini-mills had up to 40% market share in some steel products, dozens of inefficient integrated mills had closed, and the steel industry labor force had fallen over 50%.

However, problems persisted. US integrated mills had smaller scale than foreign competitors. Industry consolidation was hampered by generous wages and soaring "legacy" costs – health, pension, and severance benefits – of integrated mills. And global factors, including low-price foreign competition and global excess steel capacity, presented ongoing challenges.

These challenges led to continued steel industry demand for protection. Beginning in 1969, US presidents consistently protected the US steel industry.[6] In the 1992-2002 period, mainly under the Clinton administration, nearly 300 8-digit HS products received anti-dumping (AD) duties and nearly 60% were steel products. But, AD duties only impose tariffs on steel imports from specified countries. Hence, the steel industry began pushing for safeguard tariffs – which hit imports from all countries – during the Clinton administration.

The Clinton administration seriously considered steel safeguard tariffs. But, although sympathetic towards US steel workers, President Clinton saw the tariffs as a blemish on his free-trade achievements. After years of unsuccessful pressure, the steel industry's chances of safeguard tariffs with the new Bush administration in 2001 seemed low. President Bush's electoral campaign emphasized free trade, and neither the steel unions nor key politicians in the Congressional Steel Caucus had strong relationships with the Bush administration.

However, things changed quickly and unexpectedly. By May 2001, less than four months after taking office, the Bush administration was seriously considering safeguard tariffs. On June 5 2001, President Bush announced he would ask the USITC to investigate steel safeguard tariffs. By October 2001, the USITC recommended tariffs on a wide range of steel products. Given the Bush administration initiated the safeguard investigation, it was fully expected that President Bush would impose safeguard tariffs. He did so in March 2002 and broadly followed the recommendations of the USITC report by imposing tariffs of 8%-30% on more than 170 8-digit HS steel products.[7]

Unlike many tariff shocks and reforms analyzed in the literature, the Bush steel tariffs were temporary. To conform with WTO rules, US legislation caps safeguard tariff duration at four years. While the USITC recommended four years, President Bush implemented the

[6] President Nixon negotiated voluntary export restraints that began in 1969. President Carter allowed a limited amount of imports when sold above a certain price during the 1970s and early 1980s. In the 1980s and 1990s, Presidents Reagan and George H. Bush oversaw a reestablishment of voluntary export restraints. After they expired under President George H. Bush, anti-dumping duties became the standard form of steel industry protection.

[7] In practice, larger tariffs were associated with larger imports. Splitting the 170 products into three categories of (i) 8% or 13% tariffs, (ii) 15% tariff, and (iii) 30% tariff, then average 1998 imports rise by 30% from groups (i) to (ii) and from groups (ii) to (iii).

tariffs for a planned period of three years. However, countries challenged the WTO legality of the tariffs almost immediately and US stakeholders understood an even shorter duration was likely.[8] In part due to heavy impending EU retaliation, President Bush removed the tariffs after barely 18 months in December 2003 once the US lost their appeal at the WTO to the July 2003 ruling that the tariffs were illegal.[9]

3 Impact of Bush tariffs on steel prices and imports

Our research question revolves around the employment effects of the Bush steel tariffs. Any such effect should arise directly from the effect of the Bush steel tariffs on the price of steel in the US and, in turn, indirectly from the effect of the Bush steel tariffs on US steel imports. Thus, we begin by analyzing the evolution of steel prices and the level of steel imports during the period surrounding the Bush steel tariffs.

We first present data on the evolution of monthly US steel prices in the late 1990s and early 2000s. We hand-collected tariff-inclusive prices paid by US steel-consuming firms from the industry magazine *Purchasing* and obtained industry-specific producer price indices from the US Bureau of Labor Statistics (BLS) that reflect steel prices received by US producers.[10] Given the availability of these data, we focus on the period January 1998 through September 2003 and four prominent types of steel hit by the Bush steel tariffs: hot-rolled (HR) sheet, cold-rolled (CR) sheet, hot-dipped galvanized (HD) sheet, and cold-finished (CF) bar.

Both data sources paint a consistent story: steel prices paid by US buyers and received by US producers generally fell in the late 1990s and early 2000s but increased dramatically following the Bush steel tariffs. Within 6 months of implementation, panel (a) of Figure 1 shows steep increases in the price paid by US steel-consuming firms for HR, CR, and HD galvanized steel sheet (60-80%) and CF bar (20%). Although smaller, panel (b) shows steep price increases received by US steel producers for HR and CR sheet (20-40%) and HD galvanized sheet and CF bar (5-15%). Despite retreat in late 2002 and early 2003, prices remained elevated by 10-20% in September 2003 relative to their pre-Bush tariff levels.

Standard international trade theory says the tariff will largely pass through to prices paid

[8]According to Devereaux et al. (2006, p.100), "[M]any observers claimed that since every safeguards measure challenged in the WTO to that point had been declared illegal, the Bush administration knew full well that the 201 action eventually would be rejected by the organization. However, the almost two years likely needed for the dispute settlement process to reach any conclusion would give the tariffs ample time to block steel imports to the clear benefit of the domestic steel industry."

[9]Although the EU consistently threatened retaliatory tariffs, eventually on a list of US exports worth more than $2 billion, it agreed to wait until the conclusion of the US appeal at the WTO (Devereaux et al. (2006)).

[10]The data from *Purchasing* comes from surveying a large number of firms. They stopped reporting these data in September 2003.

by US buyers of steel and received by US producers of steel if (tariff-exclusive) prices received by foreign exporters remain relatively stable. Evidence of such stability would suggest the price increases in Figure 1 reflect the Bush steel tariffs. To this end, we exploit the fact that the USITC did not impose tariffs on many steel products it investigated. In turn, among steel products investigated by the USITC, we can analyze whether the evolution of steel prices differed between those hit and those not hit by tariffs.

Specifically, we use the sample of steel products investigated by the USITC and estimate the following difference-in-difference specification:

$$\ln p_{kht} = \boldsymbol{\theta} \ln(1+\tau_h) \times \mathbf{Year}_t + \varphi d^{AD}_{kht} + \gamma_{kt} + \gamma_{kh} + \varepsilon_{kht} \quad (1)$$

where p_{kht} is the (tariff-exclusive) unit value received by exporter k for HS8 product h in year t, τ_h is the Bush steel tariff imposed on HS8 product h, $\mathbf{Year}_t$ is a vector of year dummies (with 2000 as the omitted base year). We control for steel anti-dumping (AD) duties d^{AD}_{kht} and include fixed effects γ_{kt} and γ_{kh}.[11] ε_{kht} is the error term.

Figure 2 shows the results. In panel (a), the 2001-2003 point estimates θ_t say the tariff-exclusive price of steel products hit with Bush steel tariffs fell after 2000 relative to the price change for steel products not hit with Bush steel tariffs. Although statistically significant at the 5% level in some years, the lower bound of the 95% confidence interval never falls below -0.65, strongly suggesting that foreign exporters suffered less than full incidence of the tariff but that any effect was temporary and gone by 2004. In turn, and consistent with panel (a) of Figure 1, US steel-consuming industries bore a significant share of the tariff incidence. Panels (b) and (c) split the sample according to the median 1998 exporter-HS8 import share and qualitatively confirm the results of panel (a) for exporter products above and below the median import share. Overall, panels (a)-(c) of Figure 2 support the notion from Figure 1 that the Bush steel tariffs substantially increased prices for US steel-consuming firms.

Turning to the evolution of steel imports, standard international trade theory suggests the origin of steel consumed in the US should shift away from foreign producers facing the tariff and towards producers not facing the tariff. Importantly, producers not facing the tariff include both US producers as well as Free Trade Agreement partners and developing countries specifically exempted from the tariffs by President Bush.[12] We thus analyze the effect on imports by comparing, on one hand, the change in imports between 2000 and some other year for countries hit with the Bush steel tariffs and, on the other hand, the analogous

[11]Our later AD variables at the industry- and CZ-level aggregate from this exporter-product-time AD duties variable d^{AD}_{kht}.

[12]The exemption for some developing countries was on a product-by-product basis.

change in imports for countries exempt from the Bush steel tariffs.[13] We implement this idea through the following triple-difference specification:

$$\ln y_{jht} = \boldsymbol{\theta} \ln(1+\tau_h) \times 1\left(\text{nonExempt}_{jh}\right) \times \mathbf{Year}_t + \varphi d_{kht}^{AD} + \gamma_{ht} + \gamma_{jt} + \gamma_{jh} + \varepsilon_{jht} \tag{2}$$

where y_{jht} is either the (tariff-exclusive) value or quantity of imports and $1\left(\text{nonExempt}_{jh}\right)$ indicates whether country j is non-exempt from the Bush tariff on product h.

Panels (d)-(e) of Figure 2 show the results. If one interpreted the 2002-2003 point estimates in panel (d) as contemporaneous tariff elasticities, each 1% increase in the tariff leads to respective import declines of around 2%-4% in 2002 and 2003. Such magnitudes fit well with the range of elasticities in the literature. Moreover, the nearly identical point estimates for the response of import value and import quantity again suggest the minimal impact of the tariffs on tariff-exclusive prices received by exporters.

Ultimately, the large pass through of the Bush steel tariffs to tariff-inclusive US importer prices and the steep fall in US steel imports combined with the plausibly exogenous timing of the Bush steel tariffs are strong advantages for studying the Bush steel tariff shock.

4 Local labor market analysis: Methodology and data

4.1 Empirical methodology

We use a generalized difference-in-difference specification to analyze the impact of the Bush steel tariffs on local labor market outcomes. Letting c index commuting zones (CZs) and t index years in our sample period 1993-2008,

$$y_{ct} = \alpha + \boldsymbol{\beta} \boldsymbol{B}_c \times \mathbf{Year}_t + \delta \boldsymbol{X}_{ct} + \gamma_c + \gamma_{st} + \varepsilon_{ct}. \tag{3}$$

Here, y_{ct} represents a labor market outcome. Our main outcomes are (i) the manufacturing share of employment and (ii) the steel-intensive manufacturing share of employment. We also look at (iii) the non-steel-intensive manufacturing share of employment and (iv) the employment-to-working-age population ratio with the difference between employment and working-age population reflecting those unemployed or not in the labor force. Finally, we look at (v) the share of employment in steel production industries.

$\boldsymbol{B}_c = [V_c \; P_c]$ is a vector of time-invariant measures of CZ exposure to the Bush steel

[13] To the extent that steel is a homogeneous product, the tariff exclusive price received by foreign exporters of a given good is the same regardless of whether the exporter is exempted from the tariffs. Hence our difference-in-difference specification in equation (1). Nevertheless, the tariff discrimination between exporters still induces a shift in the composition of domestic consumption across exporters.

tariffs. V_c is a measure of *vulnerability* to using steel as an intermediate input and P_c is a measure of *protection* for steel production.[14] $\mathbf{Year}_t$ is a vector of year dummies that allows the treatment effects $\boldsymbol{\beta} = (\boldsymbol{\beta}_{1993}, ..., \boldsymbol{\beta}_{1999}, \boldsymbol{\beta}_{2001}, ..., \boldsymbol{\beta}_{2008})$ to vary over time. Given Bush announced the USITC steel safeguard tariff investigation in June 2001 and the USITC handed down their report recommending steel safeguard tariffs in October 2001, we specify 2000 as the omitted base year. Thus, our time-varying treatment effects are always measured relative to 2000. These time-varying effects allow for differential pre-trends that depend on a CZ's exposure to the Bush steel tariffs. They also allow the effects to emerge immediately or slowly after implementation of the steel tariffs and to persist throughout the sample period or reverse themselves after removal of the steel tariffs in late 2003.

$\boldsymbol{X}_{ct}$ is a vector of time-varying CZ-level controls while γ_c and γ_{st} are, respectively, CZ and state-year fixed effects. The CZ fixed effects control for time-invariant CZ variables including initial demographic and socioeconomic characteristics as well as economic characteristics such as a CZ's historical dependence on manufacturing, steel production, and steel consumption (e.g. initial employment shares in these sectors). The state-year fixed effects control for time-varying shocks at the state-level which could include business cycle fluctuations or the evolution of demographic and socioeconomic factors.

4.2 Data

The data we use fall largely into three categories. First, we obtain input-output (IO) data from the 1997 IO tables provided by the US Bureau of Economic Analysis (BEA). Second, we obtain annual county-by-industry employment data from Eckert et al. (2021) who take County Business Patterns data and concord the industry dimension in each year to NAICS 2012. We concord their data to the 1997 NAICS system used by the BEA in their IO tables and, when relevant, to commuting zones (CZs).[15] Unless otherwise noted hereafter, a NAICS industry is an industry in the NAICS 1997 system used by the BEA in their 1997 IO tables. Third, we obtain Bush steel tariff data from Presidential Proclamation 7529, anti-dumping duties data from the Global Antidumping Database - 1980's-2015 hosted by The World Bank and originally developed by Chad Bown, and US trade flow data from the USITC DataWeb. Appendix D.2 provides a detailed description of the data construction.

[14] As specified in equation (3), we always include both V_c and P_c in our regressions.

[15] The US Census Bureau provides concordances from NAICS 2012 to earlier versions of NAICS, including NAICS 1997. With their IO tables, the BEA provides a concordance from NAICS 1997 to their own version of NAICS 1997 used in their 1997 IO tables. David Dorn provides a concordance from counties to 1990 CZs on his website.

4.2.1 Steel and the input-output structure of the US economy

President Bush imposed steel tariffs on 171 8-digit HS products. These concord to four 6-digit NAICS industries: Iron and Steel Mills (331111), Steel Wire (331222), Metal Valve Manufacturing (332910), and Lighting Fixture Manufacturing (335120). We use the 1997 IO tables to measure how much each 6-digit NAICS industry j uses each 6-digit NAICS Bush steel tariff industry i (or any other industry) as an input. Specifically, the *direct requirement* measures industry j's purchases of industry i as an input per $1 of industry j output, and the *total requirement* measures this and the indirect amount of industry i embedded in other inputs used by industry j per $1 of industry j output.[16]

Table 1 summarizes the direct and total requirement data. Panel A lists the top intermediate inputs in terms of the average total requirement per $100 of output across all other industries. The top four intermediate inputs are outside manufacturing but are much more aggregate 2- or 3-digit NAICS industries. The fifth most important intermediate input and the most important manufacturing input is one of the four Bush steel tariff products: Iron and Steel Mills. On average, another industry uses $2.65 of this steel per $100 of its output either directly or embedded in its other inputs. For the remaining top five manufacturing inputs, other industries use $1.45-$2.08 of them, on average, per $100 of output. The next most important input hit with Bush steel tariffs is Metal Valve Manufacturing with an average usage by other industries of $0.37 per $100 of output and this places it in the top 10% of manufacturing inputs and the top 20% of all inputs in the economy. Overall, steel is a very important input in the economy and this includes steel with Bush steel tariffs.

Panel B of Table 1 shows the industries that most depend on Bush steel tariff industries. Usage in panel B is defined as the sum, per $100 of the using industry's output, of the total or direct requirement across the Bush steel tariff industries.[17] Four 3-digit NAICS codes account for 25% of all 6-digit NAICS codes but 81% of 6-digit NAICS codes among the top 100 industries in terms of total requirement usage: the manufacturing of primary metals, fabricated metals, machinery, and transportation equipment. Indeed, the former two 3-digit codes house the six most steel-intensive industries in the economy, using $23-$40 of tariffed

[16] To be clear, the total requirement represents both the direct requirement and all of the indirect requirements through the Leontief inverse of the IO matrix. That is, the total requirement of steel for a using industry j is not simply its direct steel requirement plus the direct steel requirement in its non-steel inputs k. It also includes the direct steel requirement in the inputs embedded in the non-steel inputs k, and so on along the IO chain.

[17] On average across the 12 6-digit NAICS industries in panel B, the direct requirement is 88% of the indirect requirement. In turn, among industries heavily using steel, the ranking of industries who most rely on steel is very similar regardless of whether input usage is defined as total or direct requirements. However, this is not true for the economy as a whole. Conditional on using steel directly, which includes more than 90% of 6-digit NAICS industries, the median industry's direct requirement is only 25% of its total requirement and this share varies from 5% at the 25th percentile to 68% at the 75th percentile.

steel per \$100 of output. And, the most steel-intensive industries within the latter two 3-digit codes use \$11-\$18 of tariffed steel per \$100 of output. Ultimately, many manufacturing industries rely heavily on the steel hit with Bush steel tariffs as an intermediate input.

4.2.2 CZ-level exposure to Bush steel tariffs

We construct two CZ-level measures of exposure to the Bush steel tariffs. First, V_c captures a CZ's vulnerability to the Bush steel tariffs through its reliance on local production that uses steel as an input. Second, P_c captures the protection afforded to a CZ's steel production and follows the definition of local protection used recently by Blanchard et al. (2024) and Lake and Nie (2023). Each measure aggregates industry-level Bush steel tariff duties that would be collected on the pre-Bush tariff level of imports using the CZ's (time-invariant) employment composition. For each Bush steel tariff industry i, industry-level protection P_i is simply these Bush steel tariff duties per industry i worker. For each steel-using industry j, its vulnerability V_j reflects these additional Bush steel tariff duties paid on the steel embodied in its inputs per industry j worker.

We begin by calculating the Bush steel tariff duties that would be collected on the pre-Bush tariff volume of imports in 1998. Aggregating across the set $H(i)$ of 8-digit HS products h hit with Bush steel tariffs that map to 6-digit NAICS steel industry i, these duties (in thousands of dollars) are

$$d_i = \sum_{h \in H(i)} \tau_h IM_h \tag{4}$$

where τ and IM denote, respectively, the Bush steel tariff and 1998 imports (in thousands of dollars). Industry-specific protection for steel industry i is then simply duties per worker:

$$P_i = \frac{1}{L_i} d_i \tag{5}$$

where L_i denotes 1998 industry i employment. To measure the per-worker burden of Bush steel tariff duties paid by a steel-consuming industry j, we allocate the Bush steel duties d_i collected on imports of each Bush steel tariff industry i across all steel-consuming industries according to their share of economy-wide steel i usage in the 1997 IO tables:

$$V_j = \frac{1}{L_j} \sum_i \frac{s_{ij}}{\sum_j s_{ij}} d_i \tag{6}$$

where s_{ij} denotes industry j's total requirement in absolute terms (i.e. not per \$1 of output) of steel i as an input. Thus, industry-specific protection for steel industry i represents the duties (in thousands of dollars) collected per steel industry worker and industry-specific vulnerability for steel-consuming industry j represents the additional steel input duties paid (in thousands of dollars) per steel-consuming worker.

Although our CZ-level analysis will aggregate these industry-level measures of protection and vulnerability, Borusyak et al. (2022) show an important equivalence result. They show the point estimate for the CZ-level "shock" can be obtained from either a CZ-level regression or an industry-level regression which has transformed the CZ-level data to industry-level data and instruments the transformed CZ-level shock with the observed industry-level shock. This leads to the insight that CZ-level identification can be interpreted as resting on quasi-random assignment of shocks across industries and does not require exogeneity of the CZ-level employment composition. It also leads to additional insights regarding the structure of variation underlying the shocks, the clustering of standard errors, and tests that help understand the plausibility of quasi-random shock assignment.

Intuitively, Borusyak et al. (2022) argue that two conditions should be met for the structure of the shocks to provide meaningful variation for identifying their impact. First, there is sufficient variation in the magnitude of the shock across industries. Second, the employment distribution cannot be overly concentrated in a few industries. Appendix B shows that the input-output structure of the US economy generates substantial variation across steel-consuming industries in additional Bush steel tariff duties paid per worker, V_j, and also shows a relatively dispersed employment distribution across steel-consuming industries. These features allow us to view the impact of vulnerability to the Bush steel tariffs through the lens of the Borusyak et al. (2022) identification framework.

However, there is little variation across few industries in Bush steel tariff duties per worker P_i because Bush steel tariffs only apply to four 6-digit NAICS steel industries. Thus, we hesitate to view local protection from the Bush steel tariffs through the Borusyak et al. (2022) identification framework. Instead, causally interpreting the impact of local protection on the steel-production employment share more reliably rests on exogeneity of the CZ employment composition with respect to the steel-production employment share. We return to this point later when discussing our local protection results.

CZ-level analyses typically cluster observations geographically, e.g. at the state-level, when calculating standard errors. This ignores that CZs with very similar industrial employment compositions, and hence correlated local vulnerability to the Bush steel tariff, may be scattered across different states. However, the equivalence result of Borusyak et al. (2022) provides a natural solution: the "equivalent" industry-level regression allows standard errors clustered by industry. Appendix B assesses the appropriate clustering in our context and ultimately suggests exposure-robust clustering that aggregates our 467 6-digit NAICS industries into 61 3-digit sub-sectors.

To help assess plausibility of quasi-random industry-level vulnerability, panel A of Table 2 investigates systematic correlation with 1998 industry-level characteristics that could also drive differential labor market outcomes. We consider four sets of characteristics.[18] First, the capital share of investment and the high-tech share of investment proxy for an industry's level of technology. Second, skill intensity (defined as the ratio of non-production employment to production employment) and the capital-to-labor ratio proxy for an industry's factor intensity. Third, the capital and labor share of either output or value-added proxy for an industry's factor payments. Finally, log TFP and log TFP growth proxy for an industry's productivity and productivity growth. We normalize vulnerability and industry characteristics so that each has zero mean and unit variance. In turn, the panel A regression point estimates are the raw correlation between vulnerability and an industry characteristic. These point estimates uniformly display a very low correlation, always below 0.08, and never achieve conventional levels of statistical significance when clustering by NAICS sub-sector.

We now aggregate our industry-specific measures of protection and vulnerability to the CZ level using 1998 CZ-level employment shares. That is,

$$V_c = \sum_j \frac{L_{jc}}{L_c} V_j \tag{7}$$

$$P_c = \sum_j \frac{L_{jc}}{L_c} P_j. \tag{8}$$

Panel (a) of Figure 3 shows the spatial distribution of CZ-level vulnerability V_c to the Bush steel tariffs. Following from the notable variation of industry-level vulnerability V_j and dispersion of industry-level employment L_j, panel (a) illustrates substantial spatial variation in local vulnerability V_c. The Rust Belt states of Michigan, Indiana and Ohio are particularly vulnerable but this vulnerability stretches down a corridor through Kentucky, Tennessee, Alabama, and Mississippi. Other pockets of vulnerability are scattered across the US.

Panel (b) illustrates local protection P_c. About 50% of CZs have $P_c = 0$ because they have zero employment in the Bush steel tariff industries. The CZs receiving most protection are scattered across the US, with the largest cluster in the Rust Belt areas of eastern Michigan, eastern Ohio, and western Pennsylvania. Although positive, the correlation between vulnerability V_c and protection P_c of 0.37 is relatively weak. Given our estimation strategy uses state-year fixed effects, panels (c)-(d) illustrate vulnerability and protection after removing state fixed effects and this generates a lot more variation across the US.[19]

[18] Except for the capital and high-tech share of investment from Acemoglu et al. (2016), all industry characteristics from the NBER-CES Manufacturing Database (Becker et al. (2013)).

[19] Because vulnerability and protection, V_c and P_c, are time invariant, removing state-year fixed effects is equivalent to removing state fixed effects.

Finally, panel B of Table 2 investigates systematic correlation between vulnerability and CZ-level characteristics that reflect the 1990 composition of a CZ's workforce. Again normalizing vulnerability and CZ characteristics so that each has zero mean and unit variance, the regression point estimates are the raw correlation between vulnerability and a CZ characteristic. Although still relatively weak correlations of 0.20-0.35, more vulnerable CZs have statistically significant lower shares of college educated workers and foreign born workers, as well as larger shares of their 1990 workforce employed in routine occupations. We take multiple steps to guard against these CZ characteristics confounding the impact of the Bush steel tariffs. First, our CZ fixed effects control for these 1990 CZ characteristics. Second, our baseline controls $\boldsymbol{X}_{ct}$ include these 1990 CZ characteristics interacted with year dummies so that they can affect local labor market outcomes in a time-varying manner. Third, our state-year fixed effects control for the evolution of state-level changes in demographic and socio-economic characteristics.

4.2.3 Employment outcomes

Our analysis focuses on two CZ-level employment variables, each expressed as a share of time-varying CZ employment. First, manufacturing employment covers the 2-digit NAICS sectors 31, 32 and 33. Second, we define steel-intensive manufacturing industries as the 6-digit NAICS manufacturing industries with a direct requirement in at least one of the four Bush steel tariff industries above \$7.50 per \$100 of output. There are 35 of these industries (see Table 1 for a snapshot) that cover about 13% of US manufacturing employment. Apart from the non-steel-intensive manufacturing share of employment, we also consider two additional variables. First, the steel-production share of employment covers the four Bush steel tariff industries. Second, the employment-to-working-age population ratio is an inverse measure of non-employment that includes unemployed workers and those not in the labor force.[20]

Appendix figures A.1 and A.2 show, respectively, the evolution of these employment share variables at the national and CZ levels. After 2000, the US employment share for manufacturing, steel-intensive manufacturing, and steel-production all fell to around 80% of their 2000 values with particularly rapid declines in the 2001-2003 window. Although this continued the pre-2000 decline for the manufacturing and steel-production employment shares, the steel-intensive manufacturing employment share was quite stable before 2000. At the national level from 1993 to 2008, the manufacturing employment share fell 6% points from 17.1% to 11.1%, the steel-intensive manufacturing employment share fell 0.5% points from 2.0% to 1.5%, and the steel-production employment share fell 0.11% points from 0.29% to 0.18%. Thus, roughly speaking, the manufacturing employment share is an order of

[20]County-level working age population data, defines as people 15-64 years of age, comes from SEER.

magnitude larger than the steel-intensive manufacturing employment share, which is an order of magnitude larger than the steel-production employment share.

At the CZ-level, panels (a)-(b) of appendix Figure A.2 show that the early 2000s declines in the manufacturing and steel-intensive manufacturing employment shares are heavily concentrated in the eastern half of the US. In fact, these employment shares actually increase in the top 20%-40% of CZs and these are concentrated in the western half of the US. Comparing this spatial variation in employment shares with the spatial variation in local vulnerability illustrated in Figure 3 reveals a negative correlation, especially in the Rust Belt states of Michigan, Indiana and Ohio, and is suggestive of our later results.

Panel (c) shows the decline in steel-production employment is concentrated in western Pennsylvania, eastern Michigan, and north-eastern Ohio. Although Figure 3 also shows these areas are the most dependent on employment in the Bush steel tariff industries, the correlation between local protection P_c and employment is not as visually obvious as that between local vulnerability and employment.

4.2.4 Other important trade shocks during Bush steel tariff time period

A key concern for identifying the impact of the Bush steel tariffs is that other confounding shocks may happen simultaneously. The most natural candidate is rising Chinese import competition during the 2000s, given the influential literature documenting its importance. Another candidate is the overlap of steel AD duties. Thus, we construct CZ-level measures of exposure to these shocks. We briefly describe their construction here, but return to a more detailed description of their relationship with the Bush steel tariff shock in Section 5.3.

We construct time-varying local vulnerability to steel AD duties V_{ct}^{AD} and and local protection from steel AD duties P_{ct}^{AD} using equations (4)-(8).[21] Following Autor et al. (2013), our time-varying measure of local imports per worker (IPW) from China aggregates time-varying industry-specific imports (in thousands of 1998 dollars) using time-invariant 1998 CZ employment weights:

$$IPW_{ct} = \sum_j IPW_{jt} \frac{L_{jc}}{L_c} = \sum_j \frac{\sum_{h \in H(j)} IM_{ht}}{L_j} \frac{L_{jc}}{L_c}. \tag{9}$$

We also construct the canonical instrument for IPW_{ct} that replaces US imports from China

[21]Given AD tariffs are exporter-product specific, we construct steel AD duties d_it in equation (4) using time-varying tariffs and 1998 imports at the exporter-product level. We define steel AD duties as those HS products in Chapters 72 (Iron and Steel) and 73 (Articles of Iron and Steel).

IM_{ht} with Chinese exports to other high-income countries IM_{ht}^{Other}:[22]

$$IPW_{ct}^{IV} = \sum_j \frac{\sum_{h \in H(j)} IM_{ht}^{Other}}{L_j} \frac{L_{jc}}{L_c}. \tag{10}$$

5 Bush steel tariffs and local labor markets: Results

5.1 Baseline results

Standard international trade theory suggests steel tariffs should reduce production of goods that use steel as a key intermediate input, but boost the production of steel. If employment is positively correlated with production, employment should fall in steel-consuming industries but rise in steel-production industries.

We begin with a parsimonious specification to illustrate the core relationship between the Bush steel tariffs and CZ employment. Given the correlation between 1990 CZ characteristics and local vulnerability documented in Section 4.2.2, the controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics interacted with year dummies. Shortly we will expand these controls to include Chinese import competition and exposure to steel AD tariffs. All figures illustrating our results cover 1993-2000 before the Bush steel tariff process began, 2001-2003 that finishes with President Bush removing the steel tariffs in December 2003, and post-2003 after removal of the tariffs. To facilitate comparison between different dependent variables and different shocks, all figures report standardized coefficients.

Figure 4 presents the parsimonious results. Panels (a)-(b) show the impact of vulnerability to the Bush steel tariffs on our two primary outcomes: the manufacturing employment share and the steel-intensive manufacturing employment share. Neither panel suggests notable concerns regarding pre-trends: the pre-period point estimates are generally statistically insignificant, substantially smaller in absolute value than the post-period point estimates, and any pre-trends push in the opposite direction of the post-period point estimates.

The point estimates are negative and statistically significant once the Bush steel tariff process begins in 2001 and grow substantially in 2002. Panels (a)-(b) show modestly negative standardized coefficients in 2001 of, respectively, -.021 and -.055 for manufacturing and steel-intensive manufacturing. But, these coefficients grow substantially to -.053 and -.133 in 2002. As expected, the standardized coefficients are larger in the steel-intensive manufacturing sector. A CZ with a one standard deviation higher vulnerability to the Bush steel tariffs has a 0.133 standard deviation larger decline (or smaller increase) in the steel-intensive

[22] These countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Sweden and Spain. We obtain Chinese imports into these countries from COMTRADE via the World Bank's WITS database.

manufacturing employment share between 2000 and 2002 but only a .053 standard deviation larger decline (or smaller increase) in the manufacturing employment share.

Perhaps surprisingly, these negative effects persist after removal of the Bush steel tariffs in 2003. Indeed, the impacts grow substantially with respective standardized coefficients reaching -.097 and -.185 in 2008. These effects are economically meaningful. As a benchmark and as we discuss in more detail in Section 5.3, the standardized coefficient for the impact of Chinese import competition on the manufacturing employment share when including it as a control in equation (3) is 0.175. Thus, the effect of the Bush steel tariff shock is more than half as large as that of the China shock on the CZ-level manufacturing employment share. And, the size of the Bush tariff shock on the steel-intensive manufacturing employment share is larger than that of the China shock on the manufacturing employment share.

The vast recent literature on local labor market shocks has emphasized the surprising lack of prompt within-CZ employment reallocation from industries facing trade shocks to other industries and, in turn, an increase in the share of non-employed workers that either become unemployed or leave the labor force. Panels (a)-(b) cannot speak to this point because they focus on the composition of employment.

However, panels (c)-(d) speak to this issue. Panel (c) shows the impact on the non-steel-intensive manufacturing employment share is somewhat weaker but otherwise similar to the impact on the manufacturing employment share.[23] Thus, it suggests the non-steel intensive manufacturing industries are not expanding to accommodate the reallocation away from steel-intensive manufacturing industries. However, panel (d) shows the post-2000 impact on the employment to working-age population ratio (which combines unemployed workers and those not in the labor force into a non-employed category) is economically negligible and never close to conventional levels of statistical significance. This is perhaps unsurprising given the modest effects in panel (a) on manufacturing employment, which is only about 10-20% of employment, and the economically large effects in panel (b) represent a subset of workers that make up less than 15% of manufacturing employment. That said, the effects in manufacturing are non-trivial and hence panel (d) provides evidence that the Bush steel tariff vulnerability shock does not fit the narrative that local labor markets struggled to reallocate workers and, in turn, saw higher unemployment rates and lower labor force participation.

Moving on from the adverse impacts on steel-consuming industries, we now look at the effect of local protection on the steel-production employment share. Panel (e) shows a similar downward trend in the pre-1997 and post-2001 periods, with a zero point estimate in the intervening years. However, we will shortly see that controlling for contemporaneous steel

[23]By definition, the steel-intensive and non-steel-intensive manufacturing employment shares sum to the manufacturing employment share.

AD duties simplifies interpreting the impact of local protection from the Bush steel tariffs on steel-production employment.

The primary identification threat we face is other confounding shocks in the early 2000s. The first natural candidate is the well-documented China shock that begins in the 1990s and accelerates in the 2001-2008 period following China's accession to the WTO. A second natural candidate is the raft of steel AD duties during the 1990s and 2000s.

Thus, we add time-varying controls for these shocks – IPW_{ct}, V_{ct}^{AD}, and P_{ct}^{AD} – to our set of controls $\boldsymbol{X}_{ct}$. Figure 5 shows the results. Three points stand out regarding the impact of local vulnerability to the Bush steel tariffs. First, panel (b) shows the impact on the steel-intensive manufacturing employment share is actually somewhat larger now. Second, panel (a) shows the impact on the manufacturing employment share is now notably more modest; the 2008 point estimate has fallen 40%. Third, panel (c) shows essentially no impact on the non-steel intensive manufacturing employment share and that any effect quickly dissipates upon removal of the tariffs.

For the impact of local protection from the Bush steel tariffs on the steel-production employment share, panel (e) shows a much smoother impact. As we will soon see, this is driven by controlling for local protection from steel AD duties. Moreover, panel (e) suggests that local protection from the Bush steel tariffs does not lead to any deviation from the pre-existing secular decline in the steel-production employment share. We see this more formally in two ways. First, we cannot reject the null that the panel (e) point estimate for 1994-2005, which stretches two full years beyond removal of the Bush steel tariffs, diverges from a linear trend extrapolated around any pre-2000 point estimate. Second, we estimate the impact of local protection after first-differencing equation (3) to remove a linear trend. Figure D.1 in the appendix shows negligible and statistically insignificant point estimates in every year 1994-2008. Thus, our results say the Bush steel tariffs did little to alter the secular movement away from steel-production employment during our sample.

As explained earlier, only having four steel industries underpin the variation in local protection across CZs, P_c, is undesirable from the Borusyak et al. (2022) identification perspective. However, one can alternatively interpret identification of local protection on the steel-production employment share through exogeneity of the 1998 CZ-industry employment shares (Goldsmith-Pinkham et al. (2020)). Chor and Li (2024) interpret this as (i) CZ-level trends in the steel-production employment share should be uncorrelated with 1998 CZ-industry employment shares and (ii) contemporaneous shocks cannot affect the steel-production employment share through the profile of 1998 CZ-industry employment shares. For the former, we have already argued that, conditional on a linear trend, the steel-production employment share is not differentially growing before (or after) 2000 across

CZs as a function of their 1998 shares of steel-production workers. For the latter, we argue that the two most natural confounding shocks to local protection from the Bush steel tariffs are the China shock and steel AD duties.

It may seem surprising that local protection from the Bush steel tariffs does not boost steel employment. However, this ignores the context of the steel industry's transformative restructuring and consolidation together with the Bush administration's hope that the tariffs would further facilitate this process. Accompanying the tariffs, the Bush administration required steel firms submit regular progress reports describing their work towards consolidation and improved financial performance (Devereaux et al., 2006). Moreover, USITC Chairman Stephen Koplan stated that such restructuring and consolidation "will mean further job losses in an already retrenched industry" in the USITC's safeguard tariff recommendations report (USITC, 2001, p.407). Consistent with his analysis, nine steel firms went bankrupt and many more smaller firms were acquired by the major steel firms International Steel Group and Nucor before removal of the Bush steel tariffs (Devereaux et al., 2006). Further reflecting these changes, data from the NBER-CES Manufacturing Industry Database reveals increased profitability and historic inventory rundowns in the 2001-2004 period.[24,25]

Figure 5 establishes clear baseline results on the impact of the Bush steel tariffs on local labor market outcomes. Most importantly, the Bush steel tariffs adversely affected employment in steel-intensive manufacturing industries and these effects persist for many years after the removal of the tariffs. As we discuss soon, the effects are economically large relative to the impact of the China shock. This is especially striking given one may expect larger adjustment in economic behavior by firms from permanent rather than temporary tariffs, and hence our results may understate the effects of permanent tariffs. Nevertheless, these adverse effects do not spillover to non-steel-intensive manufacturing nor do they spillover to increase the combined share of unemployed workers and those not in the labor force. Further, the Bush steel tariffs do not appear to arrest the secular decline in steel-production employment.

5.2 Robustness of baseline results

Before further discussing the Bush steel tariffs in the context of the China shock and contemporaneous steel AD duties, we discuss numerous exercises that emphasize the robustness of our baseline results in Figure 5.

[24]As a share of the value of shipments, (i) steel industry profits rose more than 50% from 20.8% in 2001 to 33.1% in 2004 and (ii) inventory run downs exceeded 2% for 2002-2003. Since the beginning of the database in 1958, 1985-1986 was the only other time the latter happened.

[25]Short-run capacity constrains are another reason that help explain the lack of steel industry employment response because US steelmakers were rationing steel to their customers in mid-2002 due to capacity constraints (Stundza (2022)).

Exposure-robust standard errors Our baseline results cluster standard errors at the state-level which allows for a flexible error correlation structure across CZs within a state but assumes independence across states. Although a standard approach, it ignores that CZs with similar industrial composition and hence potentially similar common shocks may lie in different states. This could undermine the statistical significance of our baseline results.

To address this issue, we calculate Borusyak et al. (2022) exposure-robust standard errors. As described in Section 4.2, we cluster at the NAICS sub-sector level because this is the industrial aggregation level where residual variation is largely clustered within rather than across clusters. Figure D.2 shows that, in our context, the conventional state-level clustered standards are more conservative than the NAICS sub-sector exposure-robust standard errors. This motivates our choice to use them in our baseline results.

Alternative trade shock controls Moving from Figure 4 to Figure 5 introduced controls for three trade shocks: the China shock, vulnerability to steel AD duties, and protection from steel AD duties. Given one may wonder the separate roles played by these additional controls, Figures D.3-D.5 control for each shock on its own. Figure D.3 shows the China shock drives the moderated impact of local vulnerability to the Bush steel tariffs on the manufacturing and non-steel-intensive manufacturing employment shares in Figure 5. Figure D.4 shows controlling for local vulnerability to steel AD duties drives the stronger impact of local vulnerability to the Bush steel tariffs on the steel-intensive manufacturing employment share in Figure 5. Figure D.5 shows local protection of steel AD duties drives the smooth impact of local protection from the Bush steel tariffs on the steel-production employment share in Figure 5.

The China shock literature emphasizes the possible endogeneity of Chinese import competition. Figure D.6 shows the results when we simply use this instrument IPW_{ct}^{IV} as a control variable instead of our baseline measure IPW_{ct}. Figure D.7 shows the results when we instrument for the baseline measure IPW_{ct} using the instrument IPW_{ct}^{IV}. Neither approach materially alters our baseline results.

Alternative exposure measures Our baseline analysis uses 1998 CZ-industry employment weights to aggregate industry-level shocks to the CZ level, and we also use 1998 CZ working-age population as regression weights. However, one may wonder why we do not use weights from the first year in our sample period.

The primary reason is the structure of our pre-1998 employment data from Eckert et al. (2021). Their data have the strong advantage of being a time-consistent panel of county-by-NAICS employment at the 6-digit NAICS level, which is especially important because of the

1998 switch in industry classification systems from SIC to NAICS. Nevertheless, Eckert et al. (2021) cannot concord a non-trivial number of SIC industries to 6-digit NAICS industries. Hence, a non-trivial share of pre-1998 employment is not reflected in any 6-digit NAICS industry.[26] This motivates our choice of 1998 weights. Further, the identification framework of Borusyak et al. (2022) only requires exogeneity of shocks and not weights.

However, we also construct measures of all local shocks – those relating to the Bush steel tariffs, steel AD duties, and the China shock – using 1993 weights and use the 1993 CZ working-age population as regression weights. Figure D.8 presents the results and shows little qualitative differences from Figure 5. The most notable differences are the larger 2008 standard errors in panels (a)-(c), as well as the statistically insignificant 2008 point estimate for the impact of local vulnerability on the manufacturing employment share.

Our baseline local vulnerability measure V_c includes the Bush steel tariff industries as industries that use steel as an input. This choice is motivated by a quirk implied by the Borusyak et al. (2022) equivalence result. Specifically, omitting the Bush steel tariff industries as using steel when calculating local vulnerability implies that the instrument for vulnerability of a Bush steel tariff industry i in the equivalent industry-level regression takes on a value of zero instead of its actual industry-level vulnerability value V_i. Nevertheless, we also construct vulnerability measures that exclude the Bush steel tariff industries (and steel AD industries) as industries that use steel when calculating local vulnerability V_c (and V_c^{AD}). Figure D.9 shows the results are virtually unchanged.

Alternative measurement of steel-consuming and steel-producing employment Our baseline results define steel-intensive manufacturing industries as those directly using more than \$7.50 per \$100 of output of any steel hit by Bush steel tariffs. This defines a set of 35 industries that essentially cover the top 10% of manufacturing industries in terms of steel intensity and 13% of US manufacturing employment. We now relax this threshold to \$5 per \$100 of output. This now defines a set of 62 industries that essentially cover the top 18% of manufacturing industries in terms of steel intensity and 20% of US manufacturing employment. Comparing panel (a) of Figure D.10 and panel (b) of Figure 5 shows this has virtually no effect on the impact of Bush steel tariff vulnerability.

As discussed above, a non-trivial share of employment in the SIC years 1993-1997 do not concord to any 6-digit NAICS industry. Thus, our baseline steel-intensive manufacturing employment and steel-producing employment measures allocate residual employment in the 1993-1997 years to 6-digit NAICS industries using the 1998 distribution of employment.

[26] Across county-year observations between 1993 and 1998, the mean share of employment concorded to 6-digit NAICS industries is only 46% with this share only reaching 74% at the 99^{th} percentile of the distribution.

Alternatively, we also construct steel-intensive manufacturing and steel-producing employment without allocating this residual employment. Panels (b) and (c) of Figure D.10 show the 1998-2008 results are virtually unchanged. However, reflecting our concern over not allocating residual employment in our baseline analysis, panel (b) shows the pre-1998 point estimates are notably shifted down relative to our baseline results in panel (b) of Figure 5.

Removing outliers To assess robustness to outliers, we remove observations where either the dependent variable or the key independent variable of interest (local protection for the steel-production employment share and local vulnerability otherwise) lie in the top or bottom 1% of their respective distributions. Figure D.11 shows the results are virtually unchanged relative to the baseline results.

5.3 Three trade shocks

We showed our baseline results in Figure 5 that control for the China shock and AD policy are robust. We now further investigate the relationship between the Bush steel tariffs and the contemporaneous shocks of rising Chinese import competition and steel AD duties.

5.3.1 Bush steel tariffs versus steel AD duties

Given the US steel industry has historically been the primary recipient of AD duties, it may seem surprising that our results are relatively unaffected by controlling for steel AD duties. Indeed, between 1996 and 2002, panels A-B of Table 3 show over 60% of product-by-AD case pairs and about 50% of 8-digit HS products subject to AD investigations were steel products (HS chapters 72 and 73) and about 60-70% of these steel products were hit with Bush steel tariffs. Thus, there is substantial concurrent overlap between the products targeted by the Bush steel tariffs and AD duties.

However, the very different timing of these AD duties and the Bush steel tariffs help explain why steel AD duties have little effect on our results. Of the steel products hit with Bush steel tariffs and AD duties in the 1996-2002 period, 80% were across six AD cases (see panel C of Table 3). For two cases, AD duties only lasted a few months because preliminary duties expired after the USITC reached a final injury determination of "no injury". For the other four cases, AD duties were in place until at least 2003 and were still overwhelmingly in place by 2015. Moreover, these AD duties go back to an earlier wave of steel AD cases in the early 1990s. Ultimately, for most of the Bush steel tariff products, steel AD duties had been in effect long before and stayed in effect long after the Bush steel tariffs.

5.3.2 Bush steel tariffs versus the China shock

Our baseline analysis showed that controlling for the China shock moderated the impact of local vulnerability to the Bush steel tariffs on the manufacturing employment share but did not affect the impact on the steel-intensive manufacturing employment share. Fundamentally, these results reflect the surprisingly weak industry-level correlation between Chinese import competition and vulnerability to the Bush steel tariffs. The correlation between V_j and $IPW_{j,2000}$ is only -0.035 and the correlation between V_j and the growth of IPW_j between 2000 and 2007 is only -0.009.[27]

Table 4 helps explain this weak industry correlation. Of the 50 industries most vulnerable to the Bush steel tariffs, panel A shows 64% lie in the sub-sectors for the manufacturing of fabricated metals or heavy machinery. Another 22%, lie in the manufacturing of primary metals or transportation equipment. This contrasts starkly with the emphasis and broad-based nature of rising Chinese import competition. Of the 50 industries with the strongest 2000-2007 growth in Chinese imports per worker, Panel B shows the heaviest concentration lies in the four sub-sectors for the manufacturing of office machinery; computer and electronic products; electrical equipment, appliances, and components; and miscellaneous products (including toys, jewelry, and sporting goods). Moreover, these sub-sectors only account for half of the top-50 industries, with other industries including furniture, fishing, leather products, and footwear among those with the strongest growth in import competition.

Moving beyond a comparison of the top 50 industries, Figure 6 illustrates the general lack of industry-level correlation between the two shocks. The y axis ranks the 355 tradable industries according to their growth in IPW_{jt} between 2000 and 2007 (lower ranks indicate higher growth). The x axis ranks these industries according to their vulnerability to the Bush steel tariff V_j (lower ranks indicate greater vulnerability). The fact that industries are fairly uniformly scattered across the 355×355 matrix indicates that, essentially, the distribution of Chinese import growth is independent of Bush steel tariff vulnerability and vice-versa.[28]

Despite the remarkable lack of industry-level correlation between the Bush steel tariff shock and the China shock, there is non-trivial correlation at the CZ-level albeit still relatively weak. Figure 7 illustrates the spatial distribution of Chinese IPW in 2000 and its 2000-2007 growth. The correlation between these two is 0.84 and their respective correlations with CZ-level Bush steel tariff vulnerability are 0.25 and 0.33. The concentration of the Bush steel tariff and China shocks within manufacturing creates greater correlation at the

[27] Industries with high Chinese imports per worker in 2002 tend to have the strongest growth in Chinese imports per worker over the 2000-2007 period. The correlation is 0.84.

[28] Figure A.3 displays the message from Figure 6 in an industry-level scatter plot of vulnerability V_j versus the Chinese IPW in either its 2000 level or 2000-2007.

CZ-level than the industry level, but the lack of industry-level still underlies the relatively weak CZ-level correlation. The more industrially concentrated nature of the Bush steel tariff shock in industries heavily relying on steel produces a geographical concentration in CZ-level vulnerability stretching from Michigan down to Louisiana. But the more industrially dispersed nature of the China shock, especially away from heavy manufacturing, produces a distinct pattern of CZ-level exposure that hits the north-east, south-east, and parts of the west coast more so than the corridor from Michigan to Louisiana.

With an understanding of the different nature of the Bush tariff shock and the China shock, we now explore the magnitude of the China shock. This verifies our analysis captures the well-known large adverse effect of the China shock. In turn, it helps benchmark the economic magnitude of our Bush steel tariff results.

Table 5 presents standardized point estimates for the China shock across various specifications. The dependent variable is the manufacturing employment share in columns (1)-(4) and the steel-intensive manufacturing employment share in columns (5)-(8). Columns (1) and (5) focus on our baseline specification at the annual frequency, but we instrument Chinese import competition. A CZ with \$1000 higher IPW_{ct} has a 1.009 percentage point larger decline (or smaller increase) in their manufacturing employment share. Although somewhat different from the canonical Autor et al. (2013) specification, a point we turn to next, the point estimate is quite similar to their baseline effect on manufacturing employment. Thus, our specification appears to capture the well-known large adverse effect of the China shock on CZ-level manufacturing employment.

The standardized coefficients in columns (1) and (5) also allow us to gauge the economic magnitude of our Bush steel tariff effects. The 2008 standardized coefficient in Figure 5 for the impact of vulnerability to the Bush steel tariff on the manufacturing share of employment is 0.051. This is roughly one-third of the -0.175 standardized coefficient for the impact of the China shock in column (1) of Table 5. Thus, the impact of Bush tariff vulnerability on the manufacturing employment share is economically large given the well-known large impacts of the China shock on manufacturing employment.

Perhaps surprisingly, the standardized coefficient for the impact of the China shock on steel-intensive manufacturing employment share in column (5) of Table 5 is only 0.004. This is 30-40 times smaller than the 2007-2008 impact of vulnerability to the Bush steel tariffs on the steel-intensive manufacturing employment share in Figure 5. It is also an order of magnitude lower than the impact of either the China shock or vulnerability to the Bush steel tariffs on the manufacturing employment share. This not only emphasizes the economically large impact of vulnerability to the Bush steel tariffs. It also again emphasizes the very different exposure of US industries to the two shocks and, in particular, that the China shock did not hit steel-intensive manufacturing industries very hard.

A caveat to our discussion is that the canonical analysis of the China shock by Autor et al. (2013) uses growth in Chinese imports rather than annual variation in Chinese imports. Thus, columns (2)-(4) and (6)-(8) use the canonical long-difference specification spanning the 2000-2007 period. This represents both our period of focus for the impact of the Bush steel tariffs and the post-2000 period of analysis by Autor et al. (2013). Columns (2)-(4) analyze the impact on the manufacturing employment share, first showing the impact of Bush steel tariff vulnerability in column (2) and the China shock in column (3) without controlling for the other. Column (4) includes both shocks. Columns (6)-(8) repeat these specifications for the impact on the steel-intensive manufacturing employment share.

The long-difference results emphasize the two points discussed above. First, both shocks are economically meaningful for the manufacturing employment share. Similar to Autor et al. (2013), column (3) says $1000 larger growth of Chinese IPW decreases the manufacturing employment share by 0.961. Column (4) shows that vulnerability to the Bush steel tariffs only slightly confounds the China shock and leaves a point estimate of 0.906 percentage points. In contrast, the China shock meaningfully confounds the standardized coefficient for Bush steel tariff vulnerability which falls about one-third between columns (2) and (4) when controlling for the China shock. Nevertheless, the column (4) standardized coefficient for Bush steel tariff vulnerability is still over 40% of that for the China shock and, hence, a large shock itself. Following the back of the envelope calculations in Autor et al. (2013), the mean CZ-level growth in Chinese imports per worker and the mean CZ-level vulnerability to the Bush steel tariff respectively explain 39.7% and 24.3% of the 2000-2007 decline in the US manufacturing employment share.[29]

Second, the steel-intensive manufacturing employment share is hit hard by Bush steel tariff vulnerability but not by the China shock. Columns (6) and (8) show a standardized coefficient for Bush steel tariff vulnerability that is virtually unchanged at around 0.364 and therefore unconfounded by the China shock. The impact is also economically large; it is actually slightly larger than the standardized coefficient of 0.360 for the impact of the China shock on the manufacturing employment share in column (4).[30] Moreover, the standardized coefficient for the impact of the China shock on the steel-intensive manufacturing

[29]Mean CZ-level 2000-2007 growth in Chinese IPW and vulnerability to the Bush steel tariff are, respectively, $1504 per worker and $32 per worker. The US manufacturing employment share fell from 14.75% to 11.32% from 2000 to 2007. Thus, $\frac{0.906\times1.504}{3.45} = 0.397$ and $\frac{26.041\times0.032}{3.45} = 0.243$.

[30]By definition, the unreported point estimate for the effect of vulnerability to the Bush steel tariffs on the non-steel-intensive manufacturing employment share from the long-difference specification in Table 5 must equal the difference in the point estimates reported in columns (4) and (8) of Table 5. Thus, the long-difference specification also produces the result that vulnerability to the Bush steel tariffs has essentially no impact on the non-steel-intensive manufacturing employment share.

employment share is only 0.018 in column (8) and statistically insignificant. Not only is this relatively small, it is 73% smaller than column (7) when not controlling for Bush steel tariff vulnerability. That is, the Bush steel tariff shock substantially confounds the China shock when looking at employment in steel-intensive manufacturing industries.

5.4 Heterogeneity of Bush steel tariff impacts

Charles et al. (2019, 2016) emphasize how the negative effects of local labor market shocks depend on the local dynamics of other key sectors. The negative effects are muted when another important local sector is expanding and can easily accommodate displaced resources. But the negative effects are exacerbated when another important local sector is contracting and limiting local reallocation of displaced resources. We use this insight to frame our investigation of the heterogeneous impact of vulnerability to the Bush steel tariffs. In particular, we show how three broad macroeconomic shocks during the 2000s shaped the response of local labor markets in the face of their vulnerability to the Bush steel tariffs.

First, Charles et al. (2019, 2016) emphasize the US house price bubble during the early-mid 2000s drove a construction boom until both burst in 2008. Using county-level house price data from the Federal Housing Finance Agency, this is true in our data too. CZ-level house prices grew on average 37% between 2000 and 2007. And, at the CZ-level, regressing the 2000-2007 growth in the construction employment share on the 2000-2007 growth in housing prices reveals a standardized coefficient of 0.128 ($p = .018$).[31]

Figure 8 splits the sample into CZs above and below the median along various dimensions and compares the impact of local vulnerability to the Bush steel tariffs on the steel-intensive manufacturing employment share for CZs above and below the median. Panels (a)-(b) split the sample according to 2000-2007 house price growth. For the 2001-2007 bubble period, they show the negative point estimate for CZs with above-median house price growth is about half that of below-median CZs. Moreover, the gap shrinks substantially once house prices and the construction sector collapse in 2008. This evidence is consistent with the narrative that the construction boom driven by the housing bubble insulated CZs from the adverse effects of local vulnerability to the Bush steel tariffs.

A second important US macroeconomic shock during the 2000s was the expansion in military expenditure. US military spending soared over 40% from a historic low of 3.1% of US GDP in 2000 to 4.4% of US GDP in 2008 after the September 11 2001 terrorist attacks

[31] Consistent with our other regressions, this regression controls for initial CZ characteristics, includes state fixed effects, clusters the standard errors by state, and weights CZs by their 1998 working age population. If we do not include controls, fixed effects, or regression weights, then the standardized coefficient is notably stronger at 0.278 ($p < .01$). The construction sector consists of industries within the 2-digit NAICS code 23.

and the onset of the second Iraq war.[32] We define military NAICS industries following the classification of Peacock (2014).[33] Panels (c)-(d) of Figure 8 split the sample according to the military share of employment in 2000. For the 2001-2008 period, they show the negative point estimate for CZs with above-median military employment share is less than half that of, and often much less than half, CZs below the median. Thus, like the house price appreciation-led expansion of the construction sector, expansion of military expenditure appears to have insulated CZs from the adverse effects of local vulnerability to the Bush steel tariffs.

In contrast to the expansionary nature of the previous two macroeconomic shocks, the US auto industry starkly declined in the 2000s from 1.1% of US employment in 2000 to only 0.76% in 2008.[34] The myriad of reasons include the recession and stock market crash of the early 2000s as well as record high gas prices during the mid-2000s which shifted demand away from US produced cars with low gas mileage. Panels (e)-(f) of Figure 8 split the sample according to the auto share of employment in 2000. For the 2001-2008 period, they show the negative point estimate for CZs with below-median auto employment share is around half that of CZs above the median. Thus, the collapse of the US auto sector appears to have exaggerated the adverse effects on CZs from local vulnerability to the Bush steel tariffs.

Intuitively, the above dimensions of heterogeneity illustrate the idea that the ability of local labor markets to deal with negative shocks depends on the ability of local labor markets to reallocate workers to other parts of the local economy. The housing bubble-driven construction boom, the economic expansion associated with soaring military expenditure, and the dramatic decline of the US auto sectors are specific examples. As a final dimension of heterogeneity, we explore this idea more generally, albeit perhaps more indirectly, by splitting the sample according to the number of job openings as a share of employment in 2000.[35] Similar to the above dimensions of heterogeneity, panels (g)-(h) of Figure 8 show the negative point estimates for CZs with above-median job opening rates in 2000 are about half that of CZs below the median during the early-mid 2000s.

[32] See the World Bank data for military expenditure as a share of GDP.

[33] Her military industries are Guns & Ammunition (33299A); Tanks & Armored Vehicles (336992); Shipbuilding (336611, 336612); Aircraft, Engine & Parts (336411, 336412, 336413); and Space Vehicle & Missile Manufacturing (336414, 33641A).

[34] We define the auto sector as the 4-digit NAICS industry groups of Motor Vehicle Manufacturing (3361) and Motor Vehicle Body, Trailer, and Parts Manufacturing (336A) and the 6-digit NAICS industry Motorcycle, Bicycle, and Parts Manufacturing (336991).

[35] Unfortunately, job opening data is only available at the state level in the Job Openings and Labor Turnover Survey from the US Bureau of Labor Statistics. Thus, the job opening rate is defined at the state-level and is invariant across CZs within a state.

5.5 A potential mechanism

Although our heterogeneity analysis speaks to the forces that shape the ability of local labor markets to deal with negative local labor market shocks, it does not provide a mechanism that rationalizes persistence of the negative effects. Indeed, Figure 8 shows the stark persistence of negative effects through 2008 even in CZs with muted effects.

One possible mechanism relates to the fixed costs that plants face when entering the market. The revenue stream an existing plant earns may cover its stream of costs, but may not also cover fixed entry costs if the plant had not yet entered the market. In this case, a *temporary* negative shock that leads plants to exit can result in *persistently* fewer plants.

To assess whether this mechanism could help explain the persistent impact of local Bush steel tariff vulnerability on the steel-intensive manufacturing employment share, we look at the impact on the steel-intensive manufacturing share of manufacturing establishments and all establishments. The potential mechanism says we should see a persistent negative effect on these establishment shares instead of a temporary effect or no effect.

Figure 9 shows the results. Due to the change in industrial classification from SIC to NAICS in 1998, the establishment shares change discontinuously in 1998.[36] Thus, we adjust our equation (3) specification to include CZ-by-pre 1998 and CZ-by-post 1997 fixed effects instead of simply CZ fixed effects.[37] Panel (a) uses our baseline steel-intensive threshold of at least $7.50 direct use of steel per $100 of output. There is little evidence of any notable pre-trend in either the pre-1998 SIC years or the pre-2000 NAICS years. However the point estimates become negative, with standardized coefficients around 0.025-0.05, from 2002 onward. While generally not statistically significant at the $p < .05$ level, Figure D.13 in the appendix shows p-values clearly in the 0.05-0.10 range or marginally above 0.10. Panel (b) of Figure 9 shows more precise and somewhat larger point estimates when we relax the steel-intensive threshold to a direct steel requirement of $5 per $100 of output. The dependent variable in panels (c)-(d) is the steel-intensive manufacturing share of all establishments. While there is a more notable pre-trend, it pushes in the opposite direction to the post-2000 point estimates which follow a very similar pattern to panels (a)-(b).

Overall, Figure 9 provides some support that persistent effects of local vulnerability to the Bush steel tariffs are related to persistent negative effects on the number of steel-intensive

[36]The CZ-level mean share of all establishments that are steel-intensive manufacturing establishments is 0.627%-0.656% in the 1993-1997 period but 0.489%-0.525% in the 1998-2008 period and shrinks around one-quarter from 0.656% to 0.507% from 1997 to 1998. As a share of manufacturing establishments, the range is 11.59%-12.09% in the 1993-1997 period and 10.19%-12.09% in the 1998-2008 period with a fall of around one-seventh from 12.10% to 10.41% from 1997 to 1998.

[37]Figure D.12 shows the results with CZ fixed effects. The results for the post-1997 NAICS years change little relative to Figure 9. The point estimates for the pre-1998 SICs are shifted downward relative to Figure 9 but show the same year-to-year shape.

establishments in the CZ. This makes sense to the extent that fixed entry costs represent an important barrier to entry and hence imply new firms may not replace exiting firms following a temporary negative shock.

6 Conclusion

The breadth and scale of current US tariffs has renewed interest – among academics, policy makers, and the general public alike – in the negative effects of tariffs on domestic firms who rely on importable goods as intermediate inputs. Surprisingly, this paper is the first academic analysis that investigates the employment effects of the Bush steel tariffs from the early 2000s.

Our main result is that the Bush steel tariffs have statistically and economically significant effects on employment in industries relying on inputs hit with the Bush steel tariffs. Moreover, these effects did not reverse themselves once the Bush steel tariffs were removed at the end of 2003. Instead, they persist until at least 2008. And, the effects are economically large. Our main analysis says the impact of vulnerability to the Bush steel tariffs on the manufacturing share of US employment is about 30-40% as large as the impact of the China shock. Thus, the Bush steel tariffs had important and persistent effects on employment in the overall manufacturing sector and especially in industries that used steel intensively.

Against the backdrop of these employment effects, other important macroeconomic shocks of the 2000s shaped the response of local labor markets. The negative effects were muted in locations prime for expansion of the construction sector due to the 2000s house price bubble or expansion of industries related to the concurrent historic expansion of US military expenditure. But, the negative effects were exacerbated in locations prone to large contractions in auto employment due to the dramatic decline of the US auto sector during the 2000s.

Intuitively, the presence of plant-level fixed entry costs could lead to persistently fewer establishments if tariffs lead plants to shut down. Indeed, we present evidence that vulnerability to the Bush steel tariffs led to a persistently fewer establishments which suggests a potentially important role for plant-level fixed costs translating temporary tariffs into persistent effects.

In contrast to the effects on downstream employment, we find no evidence of increased employment in the steel-producing industries protected by the Bush steel tariffs. Ultimately, our analysis emphasizes the costs of the Bush steel tariffs on intermediate inputs and downplays the benefits of the Bush steel tariffs for protected industries.

References

Acemoglu, D., Autor, D., Dorn, D., Hanson, G.H., Price, B., 2016. Import competition and the great US employment sag of the 2000s. Journal of Labor Economics 34, S141–S198.

Amiti, M., Redding, S.J., Weinstein, D.E., 2019. The impact of the 2018 tariffs on prices and welfare. Journal of Economic Perspectives 33, 187–210.

Autor, D., Dorn, D., Hanson, G.H., 2021. On the persistence of the China shock. NBER Working Paper No.29401 .

Autor, D.H., Dorn, D., Hanson, G.H., 2013. The China syndrome: Local labor market effects of import competition in the United States. The American Economic Review 103, 2121–2168.

Barattieri, A., Cacciatore, M., 2023. Self-harming trade policy? Protectionism and production networks. American Economic Journal: Macroeconomics 15, 97–128.

Becker, R.A., Gray, W.B., Marvakov, J., 2013. NBER-CES manufacturing industry database: June 2013 revision. National Bureau of Economic Research .

Blanchard, E.J., Bown, C.P., Chor, D., 2024. Did Trump's trade war impact the 2018 election? Journal of International Economics 148, 103891.

Bloom, N., Handley, K., Kurmann, A., Luck, P., 2019. The impact of Chinese trade on US employment: The good, the bad, and the apocryphal. Mimeo .

Borusyak, K., Hull, P., Jaravel, X., 2022. Quasi-experimental shift-share research designs. The Review of Economic Studies 89, 181–213.

Bown, C., 2019. Trump's fall 2019 China tariff plan: Five things you need to know. Peterson Institute for International Economics URL: https://rb.gy/7t6rkq.

Bown, C.P., Conconi, P., Erbahar, A., Trimarchi, L., 2021. Trade protection along supply chains. CEPR Discussion Paper No. DP15648 .

Cavallo, A., Gopinath, G., Neiman, B., Tang, J., 2021. Tariff pass-through at the border and at the store: Evidence from US trade policy. American Economic Review: Insights 3, 19–34.

Charles, K.K., Hurst, E., Notowidigdo, M.J., 2016. The masking of the decline in manufacturing employment by the housing bubble. Journal of Economic Perspectives 30, 179–200.

Charles, K.K., Hurst, E., Notowidigdo, M.J., 2019. Housing booms, declining manufacturing, and rising non-employment since 2000. Economic Journal 129, 209–248.

Choi, J., Levchenko, A.A., 2024. The long-term effects of industrial policy. Working Paper .

Chor, D., Li, B., 2024. Illuminating the effects of the US-China tariff war on China's economy. Journal of International Economics 150, 103926.

Cox, L., 2022. The long-term impact of steel tariffs on U.S. manufacturing. Mimeo .

Cox, L., Russ, K., 2018. Steel tariffs and U.S. jobs revisited. Econofact.org URL: https://econofact.org/steel-tariffs-and-u-s-jobs-revisited.

Devereaux, C., Lawrence, R., Watkins, M., 2006. Standing up for steel, in: Case Studies in US Trade Negotiation: Resolving Disputes. Institute for International Economics, Washington D.C.. volume 2.

Dix-Carneiro, R., Kovak, B.K., 2017. Trade liberalization and regional dynamics. American Economic Review 107, 2908–46.

Eckert, F., Fort, T.C., Schott, P.K., Yang, N.J., 2021. Imputing missing values in the US Census Bureau's County Business Patterns. NBER Working Paper No.26632 .

Fajgelbaum, P.D., Goldberg, P.K., Kennedy, P.J., Khandelwal, A.K., 2020. The return to protectionism. The Quarterly Journal of Economics 135, 1–55.

Flaaen, A., Pierce, J.R., 2024. Disentangling the effects of the 2018-2019 tariffs on a globally connected US manufacturing sector. Review of Economics and Statistics (forthcoming) .

Francois, J., Baughman, L.M., 2003. The unintended consequences of us steel import tariffs: A quantification of the impact during 2002. Study prepared for the CITAC Foundation, Trade Partnership Worldwide, Washington, DC .

Goldsmith-Pinkham, P., Sorkin, I., Swift, H., 2020. Bartik instruments: What, when, why, and how. American Economic Review 110, 2586–2624.

Handley, K., Kamal, F., Monarch, R., 2024. Rising import tariffs, falling export growth: When modern supply chains meet old-style protectionism. American Economic Journal: Applied Economics (forthcoming) .

Juhász, R., 2018. Temporary protection and technology adoption: Evidence from the Napoleonic blockade. American Economic Review 108, 3339–3376.

Lake, J., Nie, J., 2023. The 2020 US Presidential election and Trump's wars on trade and health insurance. European Journal of Political Economy 78, 102338.

Peacock, T.A., 2014. The profitability of US defense contracts: A study of implicit return on military sales. Ph.D. thesis. University of Hawai'i at Manoa.

Pierce, J.R., Schott, P.K., 2012. A concordance between ten-digit US harmonized system codes and SIC/NAICS product classes and industries. Journal of Economic and Social Measurement 37, 61–96.

Read, R., 2005. The EU-US WTO steel dispute: The political economy of protection and the efficiacy of the WTO dispute settlement understanding, in: Perdikis, N., Read, R. (Eds.), The WTO and the Regulation of International Trade. Edward Elgar.

Stundza, T., 2022. Steel flash report: Short-term spot prices will continue to escalate. Purchasing, April 30.

USITC, 2001. Investigation No. TA-201-73. Volume I: Determinations and views of commissioners. URL: https://www.usitc.gov/publications/safeguards/PUB3479.pdf.

Xu, C., 2022. Reshaping global trade: The immediate and long-run effects of bank failures. The Quarterly Journal of Economics 137, 2107–2161.

A Tables & figures

Table 1. Steel usage as an intermediate input

Panel A. Most heavily used intermediate inputs in economy (total requirement)

NAICS		Economy rank	Manuf. rank	Mean usage per $100
420000	Wholesale trade	1		$8.41
550000	Management of companies & enterprises	2		$5.68
531000	Real estate	3		$3.45
484000	Truck transportation	4		$3.07
331111	Iron & steel mills	5	1	$2.65
211000	Oil & gas extraction	6		$2.63
221100	Power generation & supply	7		
324110	Petroleum refineries	8	2	$2.08
325190	Other basic organic chemical manuf.	9	3	$1.87
3221A0	Paper & paperboard mills	10	4	$1.82
334413	Semiconductors & related device manuf.	13	5	$1.45
332910	Metal valve manuf.	80	30	$0.37
331222	Steel wire drawing	148	75	$0.17
335120	Lighting fixture manuf.	272	171	$0.05

Panel B. Industries most heavily using steel as an intermediate input

	Share of 6-digit codes		Total req.		Direct req.	
NAICS	Top 100 using ind	All ind	Rank	Usage per $100	Rank	Usage per $100
331 Primary metal manuf.	4%	4.50%				
331221 Rolled steel shape manuf.			1	$40.51	1	$39.36
331210 Iron, steel pipe & tube from purchased steel			2	$38.24	2	$38.47
331222 Steel wire drawing			3	$36.34	3	$37.36
332 Fabricated metal manuf.	25%	7.07%				
332114 Custom roll forming			4	$32.28	4	$31.23
332311 Prefabricated metal buildings & components			5	$29.05	5	$26.92
332600 Spring & wire product manuf.			6	$23.15	6	$24.54
333 Machinery manuf.	39%	9.64%				
333921 Elevator & moving stairway manuf.			10	$18.40	12	$16.26
333924 Industrial truck, trailer, & stacker manuf.			12	$17.48	15	$14.10
333111 Farm machinery & equipment manuf.			21	$13.69	22	$11.24
336 Transportation equipment manuf.	13%	3.85%				
336991 Motorcycle, bicycle, & parts manuf.			18	$14.74	20	$11.38
336500 Railroad rolling stock manuf.			20	$14.29	27	$9.77
336211 Motor vehicle body manuf.			31	$11.53	46	$7.47

Notes: In Panel A, mean usage per $100 for an input listed in the table defined as 100 multipled by mean industry-level total requirement of this input across all using industries. In Panel B, usage per $100 by the industry listed in the table defined as 100 multiplied by the sum of requirements across the four Bush steel tariff industries. In panel B, top 100 using industries defined in terms of total requirement across the the four Bush steel tariff industries.

Table 2. Balance tests of vulnerability shock

Panel A. Manufacturing industry characteristics (1998)

	Corr.	Std. Err.	Observations
Capital share of investment	-0.038	(0.088)	342
High-tech equipment share of investment	-0.064	(0.080)	342
Skill intensity	-0.048	(0.084)	344
Capital to labor ratio	0.023	(0.038)	344
Labor share of output	-0.079	(0.091)	344
Labor share of value added	0.046	(0.044)	344
Capital share of output	-0.037	(0.030)	344
Capital share of values added	0.054	(0.043)	344
Log TFP	-0.022	(0.018)	344
Log TFP growth	-0.004	(0.034)	142

Panel B. CZ characteristics (1990)

	Corr.	Std. Err. (CZ-shocks)	Std. Err. (Industry-shocks)
College educated population share	-0.231	(0.068)	(0.055)
Foreign born population share	-0.228	(0.047)	(0.031)
Female employment share	0.078	(0.048)	(0.074)
Routine occupation empoyment share	0.330	(0.079)	(0.080)
Occupation offshorability index	0.077	(0.044)	(0.080)
Observations		722	467

Notes: Vulnerability shock defined at industry-level in panel A using equation (6) and at CZ-level in panel B using equation (7). 1998 industry characteristics in panel A from the NBER-CES Manufacturing Database except capital and high-tech equipment share of investment from Acemoglu et. al. (2016). Some industry characteristics not observed for all 344 6-digit NAICS manufacturing industries. 1990 CZ characteristics in panel B from Autor et. al. (2013). Vulnerability and characterisics normalized to zero mean and unit variance so that regression coefficient from vulnerability on a characteristic is the raw correlation. Standard errors clustered by NAICS sub-sector in panel A, and by CZ (for CZ-level unit of analysis) or NAICS sub-sector (after transforming CZ-level data to industry-level data following Borusyak et. al. (2022)) in panel B. In this latter case, the SSIV weak-instrument F-statistic is 1870.85.

Table 3. Overlap of AD duties with Bush steel tariff products

Panel A. Frequency of AD duties at product-case level

	1996-2002			1989-2008		
	Steel	Non-steel	Total	Steel	Non-steel	Total
Bush products	219 (44%)		219 (44%)	292 (23%)		347 (27%)
Non-Bush products	97 (19%)	182 (37%)	279 (56%)	353 (27%)	597 (46%)	950 (73%)
	316 (63%)	182 (37%)	498	645 (50%)	597 (46%)	1297

Panel B. Frequency of AD duties at product level

	1996-2002				1989-2008			
	Steel		Non-steel		Steel		Non-steel	
	AD	Non-AD	AD	Total	AD	Non-AD	AD	Total
Bush products	98 (24%)	73 (18%)		171 (43%)	116 (23%)	55 (4%)		171 (27%)
Non-Bush products	71 (18%)		159 (40%)	230 (57%)	215 (27%)		497 (46%)	712 (73%)
	169 (42%)	73 (18%)	159 (40%)	401	331 (50%)	55 (4%)	497 (46%)	883

Panel C. Overlap and duration of large AD cases

Year	AD Case-ID	Steel type	Duration
1992	AD-573	Cut to length steel	Revoked on 1 country in 2000 and other 10 countries in 2005.
1992	AD-588	Hot rolled steel	Preliminary duties lifted after 4-6 months because final injury determination of "no injury".
1992	AD-597	Cold rolled steel	Revoked on all 3 countries in 2000.
1996	AD-753	Cut to length steel	By 2015, still in force on 3 of 4 countries. Revoked on other country in 2003.
1998	AD-806	Hot rolled steel	By 2015, still in force on 1 country. Revoked on other two countries in 2011.
1999	AD-815	Cut to length steel	By 2015, still in force on 3 countries. Revoked on two countries in 2012 and one country in 2005.
1999	AD-829	Cold rolled steel	Preliminary duties lifted after 4-6 months because final injury determination of "no injury".
2000	AD-898	Hot rolled steel	By 2015, still in force on 7 countries. Revoked on other 5 countries in 2006.
2001	AD-964	Cold rolled steel	Preliminary duties lifted after 4-6 months because final injury determination of "no injury".

Notes: Panel A shows count of product-by-AD cases in respective time periods of 1992-2002 and 1989-2008, split into the dimensions of steel versus non-steel products and Bush steel tariff versus non-Bush steel tariff products. Percentages are share of, respectively the 498 and 1297 product-cases in the 1992-2002 and 1989-2008 periods. Panel B shows count of products in the periods 1996-2002 and 1989-2008 with Bush steel tariff products split between those hit with AD duties versus not hit with AD duties and AD products split between steel and non-steel products. Percentages are share of, respectively, the 401 and 883 products covered by the Bush steel tariffs and AD duties in the 1996-2002 and 1989-2008 periods. In panel C, 1996-2002 cases listed account for 80% of the 219 product-by-AD cases in panel A covered by Bush steel tariffs and AD duties; 1992 cases represent earlier cases on these types of steel.

Table 4. Industry exposure to Bush steel tariff vulnerability and Chinese imports per worker

Panel A. Bush steel tariff vulnerability ($000s per worker)

NAICS	Share of 6-digit NAICS codes: Top 50	Share of 6-digit NAICS codes: All ind	Rank	Vulnerability
331 Primary metal manufacturing	8.00%	4.50%		
331221 Rolled steel shape manuf.			1	$3.31
331210 Iron, steel pipe & tube from purchased steel			2	$1.98
332 Fabricated metal manufacturing	32.00%	7.07%		
332114 Custom roll forming			4	$1.22
332430 Metal can, box, & other container manuf.				$1.01
333 Machinery manufacturing	32.00%	9.64%		
333298 All other industrial machinery manuf.			8	$0.68
333921 Elevator & moving stairway manuf.			11	$0.54
336 Transportation equipment manufacturing	14.00%	3.85%		
336110 Automobile & light truck manuf.			5	$1.08
336991 Motorcycle, bicycle, & parts manuf.			13	$0.52

Panel B. Chinese imports ($000s per worker)

NAICS	Share of 6-digit NAICS codes: Top 50	Share of 6-digit NAICS codes: All ind	Change IPW (2000-2007): Rank	Change IPW (2000-2007): $	IPW (2000): Rank	IPW (2000): $
333 Machinery manufacturing	12.00%	9.64%				
333313 Office machinery manuf.			10	$88.00	16	$40.34
333991 Power-driven handtool manuf.			15	$45.02	10	$51.82
334 Computer & electronic product manufacturing	12.00%	4.93%				
334300 Audio & video equipment manuf.			1	$289.18	2	$248.36
334119 Other computer peripheral equipment manuf.			4	$178.42	6	$132.40
334111 Electronic computer manuf.			5	$158.03	45	$12.01
334220 Broadcast & wireless comm. equip.			8	$117.61	38	$14.34
335 Electrical equip., appliance, & component manufacturing	12.00%	4.07%				
335211 Electric housewares & household fan manuf.			6	$144.81	5	$187.86
335221 Household cooking appliance manuf.			11	$73.82	17	$38.10
339 Miscellaneous manufacturing	14.00%	3.43%				
339930 Doll, toy, & game manuf.			2	$225.47	1	$316.92
339910 Jewelry & silverware manuf.			23	$30.52	24	$25.02
Other						
337127 Institutional furniture manuf.			3	$187.64	4	$193.03
114100 Fishing			7	$124.85	7	$100.29
316900 Other leather product manuf.			9	$92.01	8	$97.99

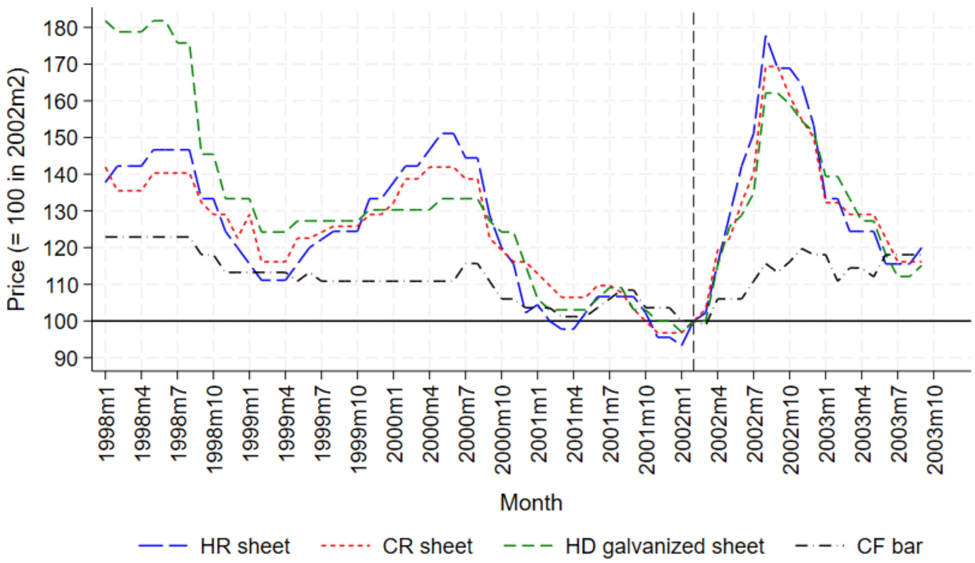
Notes: Panel A shows the four 3-digit NAICS sectors, and top two constituent 6-digit NAICS industries, that cover 43 of the top 50 6-digit NAICS industries in terms of industry-level vulnerability to the Bush steel tariffs. Panel B shows the four 3-digit NAICS sectors, and top constituent 6-digit NAICS industries, that cover 25 of the top 50 6-digit NAICS industries in terms of industry-level Chinese imports per worker (IPW).

Table 5. Impact of China shock

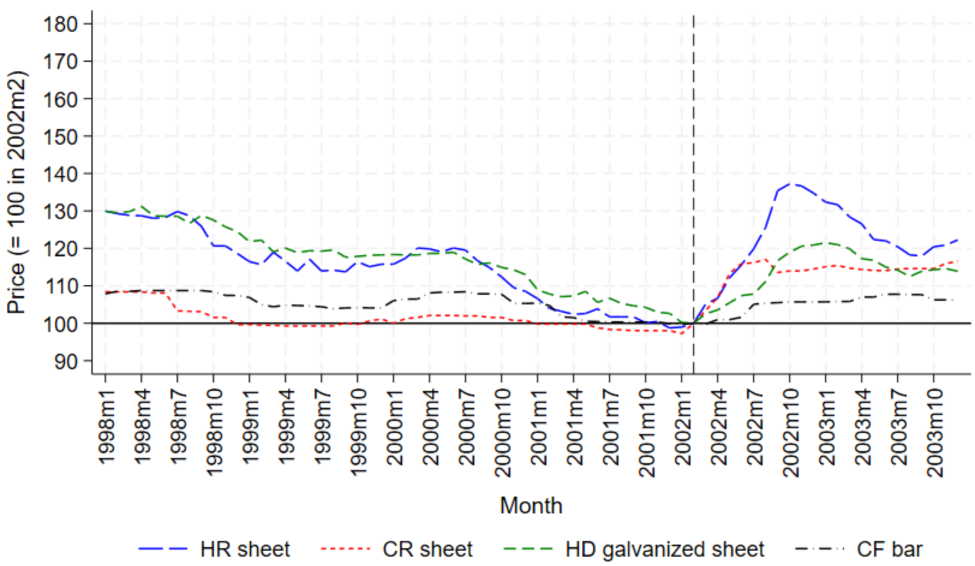
	Manufacturing Emp. Share				Steel-intensive Manuf. Emp. Share			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Local vulnerability		-38.667***		-26.041***		-26.041***		-25.783***
		(7.343)		(5.28)		(5.283)		(5.253)
Local IPW growth (2000-2007)	-1.038***		-0.961***	-0.906***	0.006		-0.067	-0.018
	(0.183)		(0.142)	(0.155)	(0.033)		(0.044)	(0.049)
N	11,504	719	719	719	11,504	719	719	719
Bush standardized coeff		-0.219		-0.146		-0.368		-0.364
China standardized coeff	-0.175		-0.382	-0.360	0.004		-0.067	-0.018
KP weak IV F-stat	797.68		1172.94	1260.76	797.68		1172.94	1260.76
IPW measure	Annual	Difference (2000-2007)			Annual	Difference (2000-2007)		
Specification	Annual	Long difference			Annual	Long difference		

Notes: Dependent variable is, in percentage points, manufacturing employment share in columns (1)-(4) and steel-intensive manufacturing employment share in columns (5)-(8). In columns (1) and (5), point estimates from equation (3) with controls consisting of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, local Chinese imports per worker instrumented with local Chinese importer per worker to other rich countries, and local protection from and local vulnerability to steel AD duties. In columns (2)-(4) and (6)-(8), point estimates from 2000-2007 long differenced specification that regresses change in employment share on local vulnerability to the Bush steel tariffs, the change in Chinese imports per worker (instrumented with the change in Chinese imports per worker to other rich countries), the change in local protection from and local vulnerability to steel AD duties, 1990 CZ characteristics, and state fixed effects. Standard errors clustered by state. Regressions weighted by 1998 CZ working-age population.

*, **, and *** indicate p-values below 0.10, 0.05 and 0.01 respectively.



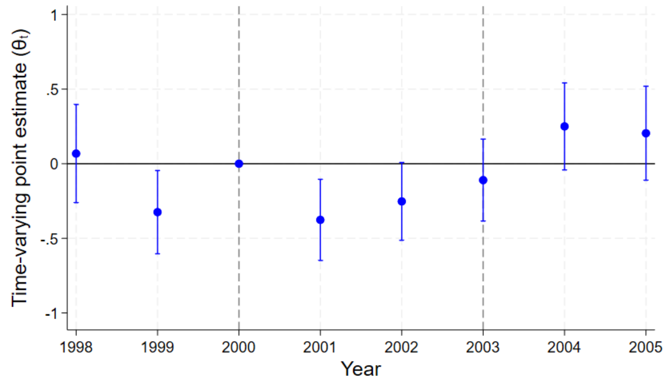
(a) Prices paid by US steel buyers



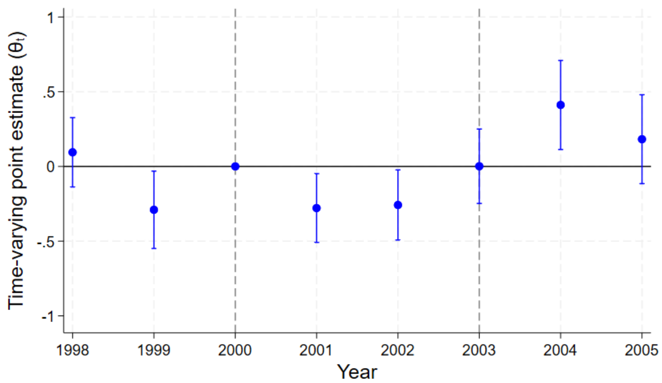
(b) Prices received by US steel producers

Notes: Panel (a) data for January 1998 through September 2003 report transaction prices paid by US steel buyers, hand-collected from the industry magazine *Purchasing*. Panel (b) data from January 1998 through December 2003 report producer price indices from the US Bureau of Labor Statistics. The indices are HR steel sheet (PDU3312-311), CR steel sheet (PDU3312-8), HD galvanized steel sheet (PDU3312-313) and CF bar (PDU3316-71). Prices normalized to 100 in February 2002, the last month before implementation of the Bush steel tariffs. Vertical line indicates February 2002.

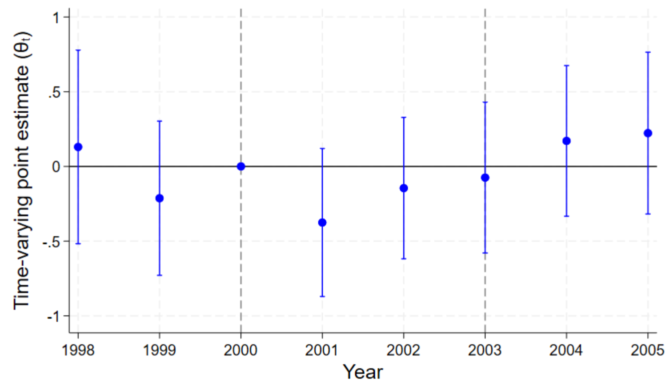
Figure 1: Monthly evolution of US steel prices: 1998-2003



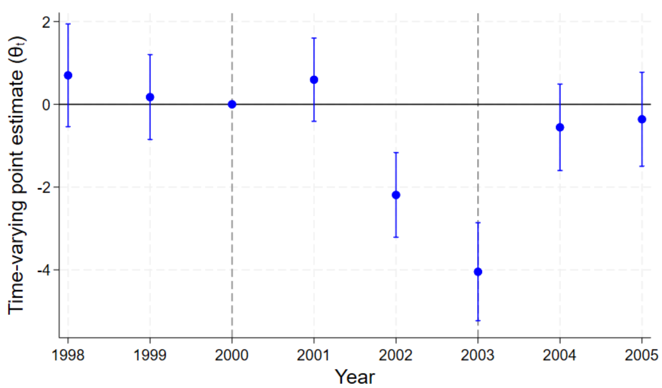
(a) Exporter prices



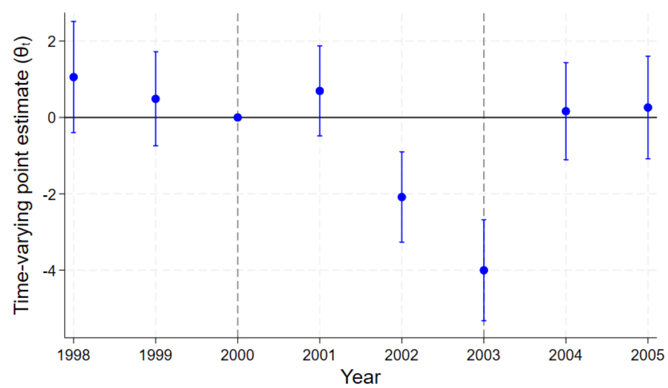
(b) Exporter prices: above median 1998 import share



(c) Exporter prices: below median 1998 import share



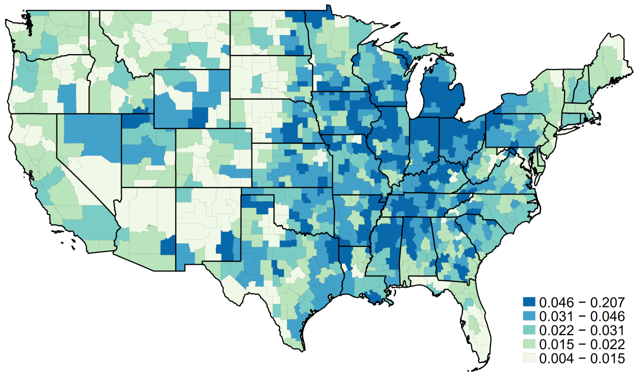
(d) Value of US imports



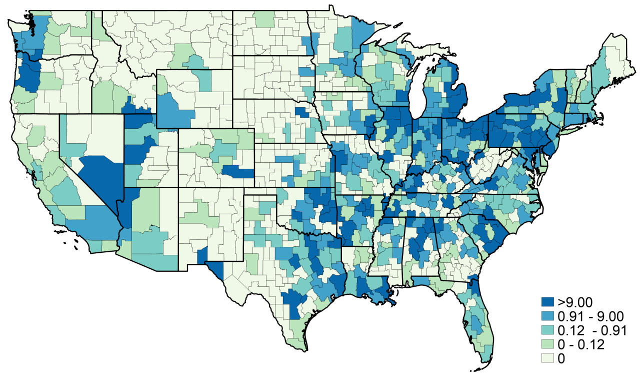
(e) Quantity of US imports

Notes: Panels report time-varying point estimates θ_t from eq. (1) in panels (a)-(c) and eq. (2) in panels (d)-(e). Dependent variable is tariff exclusive foreign exporter price (i.e. unit value) in panels (a)-(c), import value in panel (d) and import quantity in panel (e). Panels (b)-(c) split the sample depending on median 1998 import share at exporter-product level. 95% confidence intervals, standard errors clustered by product and year. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

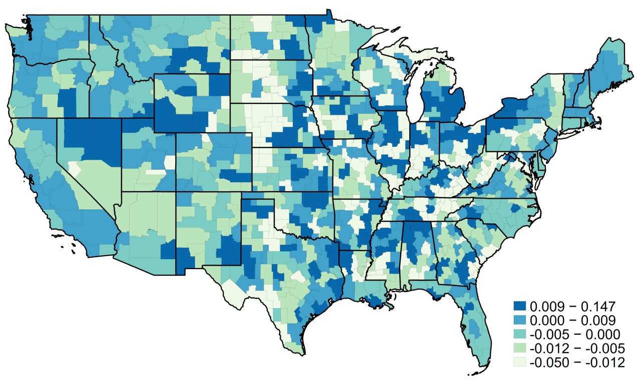
Figure 2: Impact of Bush steel tariffs on exporter steel prices and US steel imports



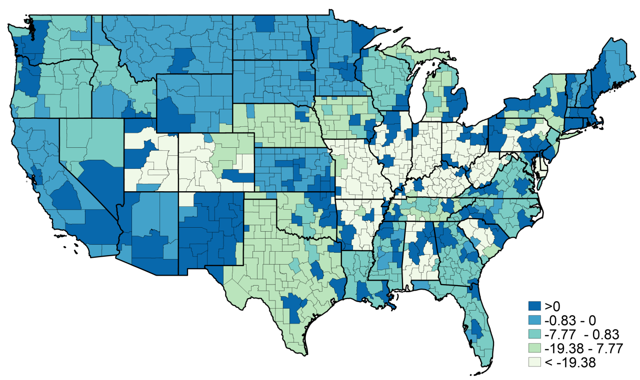
(a) Vulnerability (V_c)



(b) Protection (P_c)



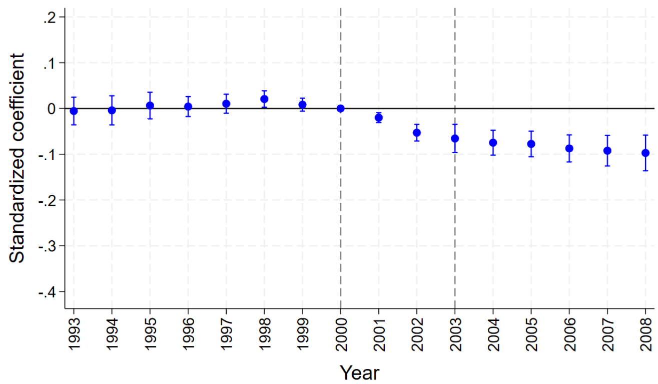
(c) Vulnerability (V_c): Fixed effects removed



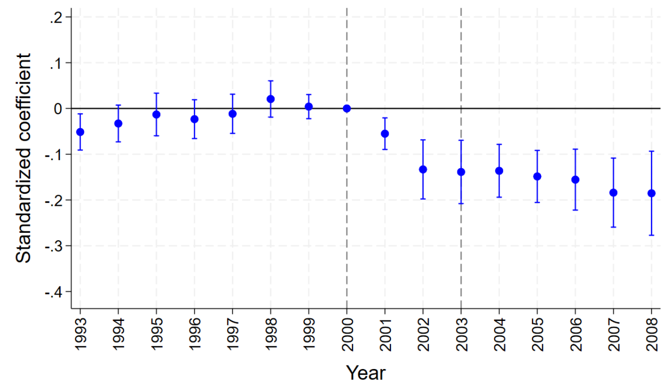
(d) Protection (P_c): Fixed effects removed

Notes: Vulnerability V_c defined in equation (7) and protection P_c defined in equation (8). Panels (c)-(d) demean vulnerability and protection at the state-level.

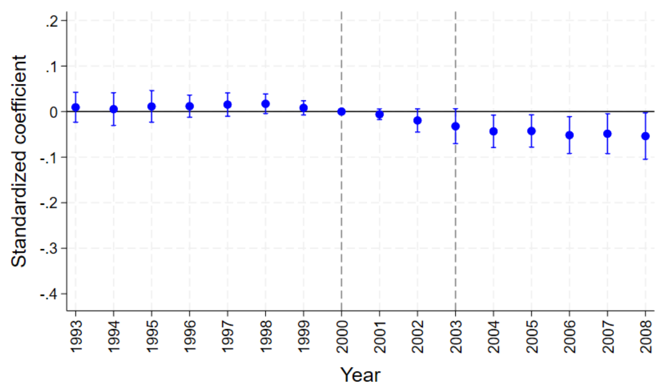
Figure 3: CZ-level vulnerability to and protection from the Bush steel tariffs



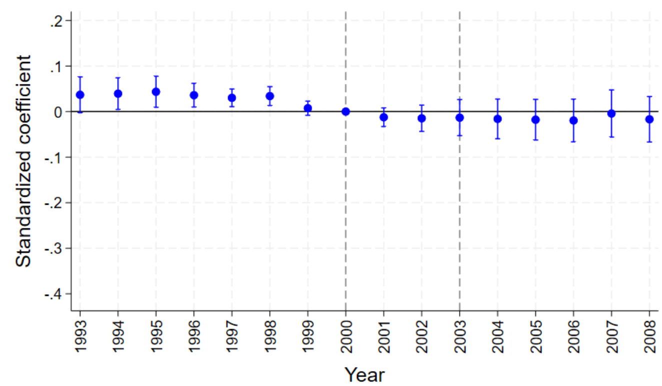
(a) Vulnerability (V_c) & manuf. emp. share



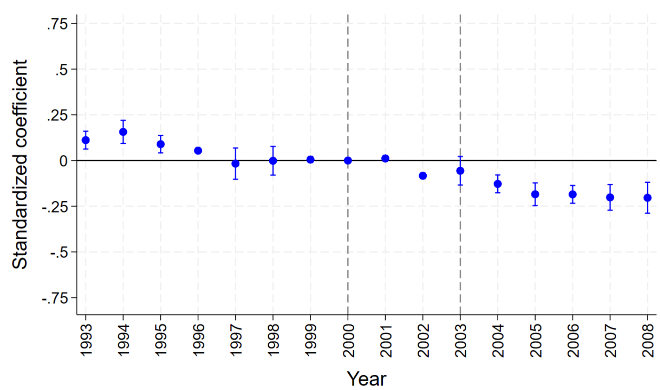
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



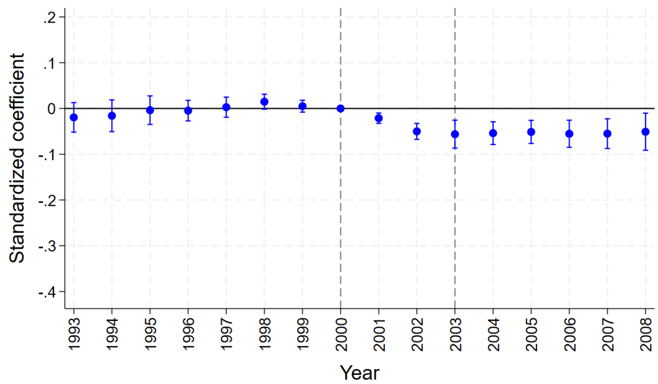
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



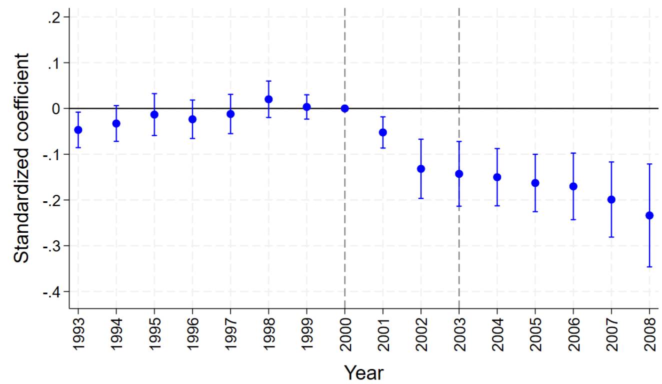
(e) Protection (P_c) & steel-producing emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies. 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

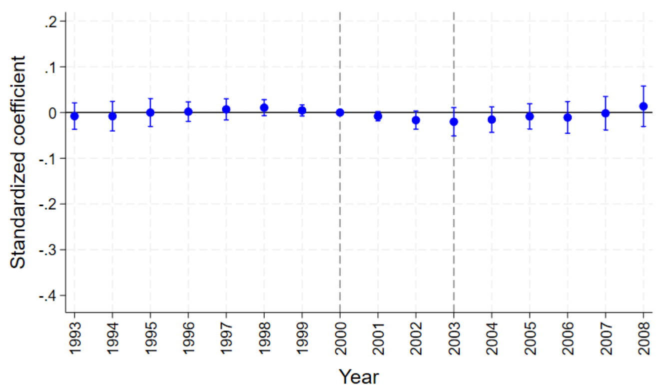
Figure 4: Effects of vulnerability & protection on CZ employment shares (without non-Bush trade shock controls)



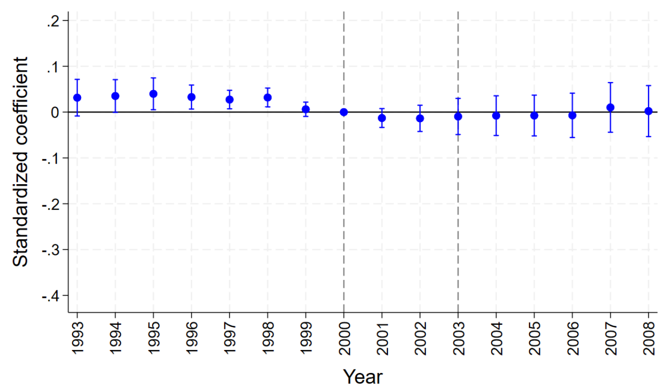
(a) Vulnerability (V_c) & manuf. emp. share



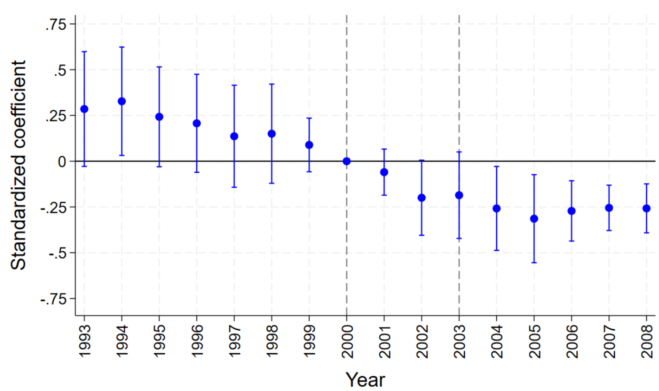
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



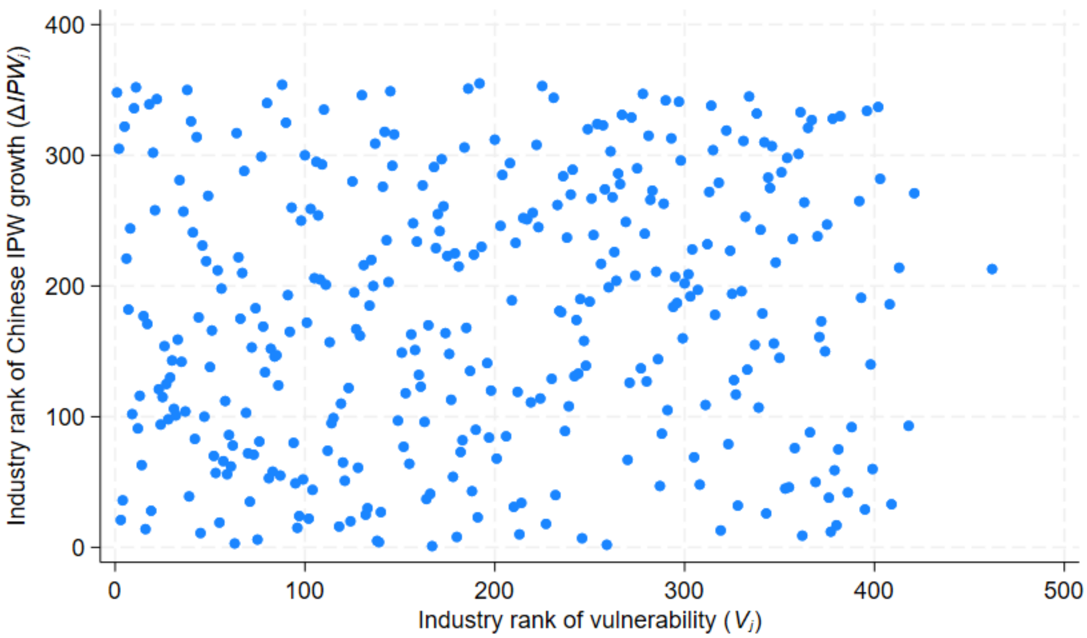
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



(e) Protection (P_c) & steel-production emp. share

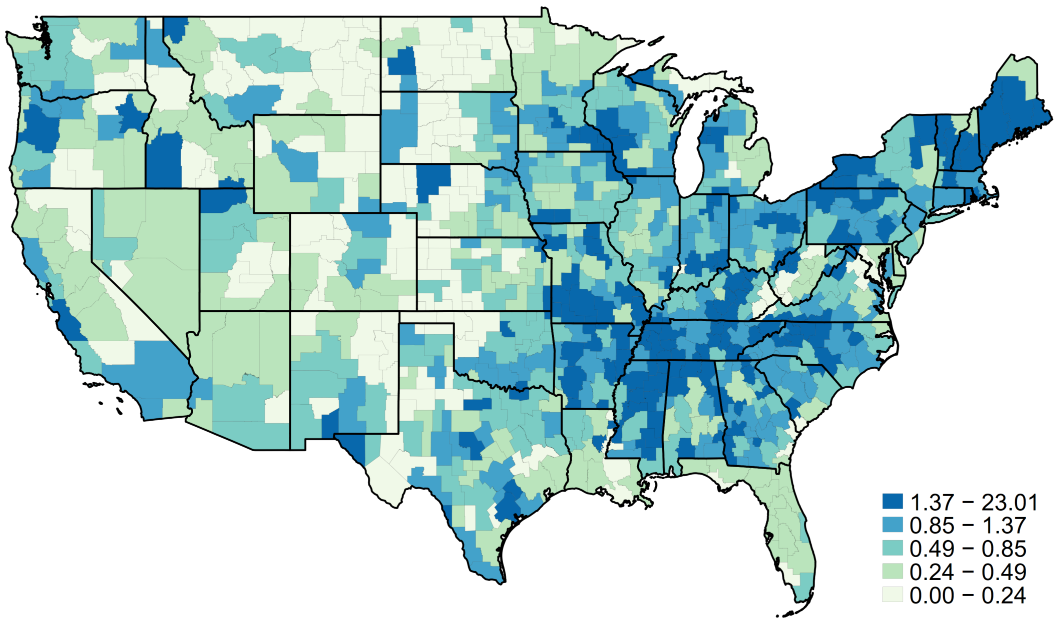
Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

Figure 5: Effects of vulnerability & protection on CZ employment shares (with non-Bush trade shock controls)

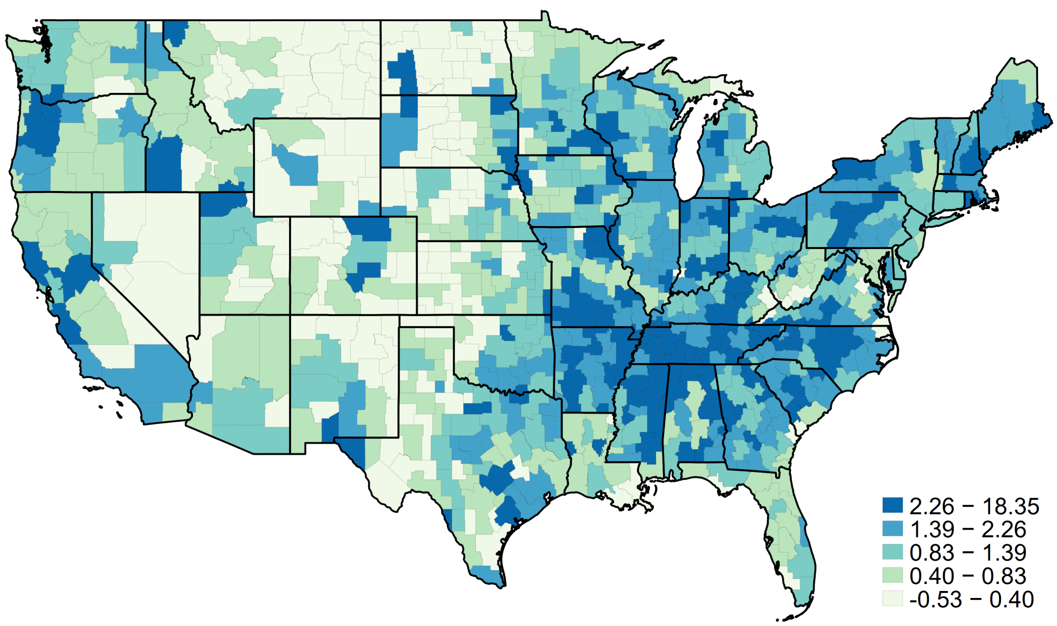


Notes: y-axis ranks tradable 6-digit NAICS industries according to the growth in Chinese imports per worker IPW_{jt} between 2000 and 2007 defined in equation (9). x-axis ranks these industries according to vulnerability V_j defined in equation (6). Rank of 1 on y- and x-axis indicates, respectively, largest growth and largest vulnerability.

Figure 6: Industry ranks of vulnerability to Bush steel tariffs versus 2000-2007 growth in Chinese imports per worker



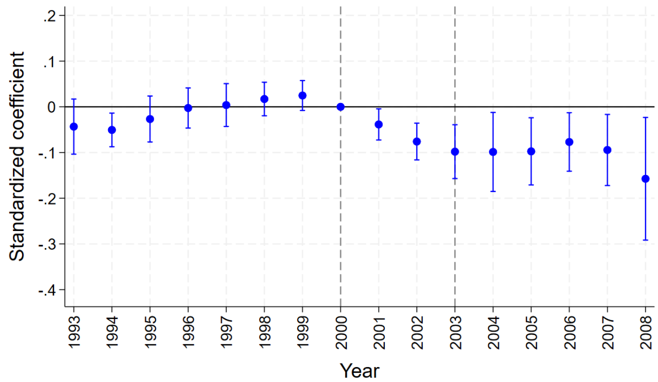
(a) Chinese imports per worker 2000 ($IPW_{c,2000}$)



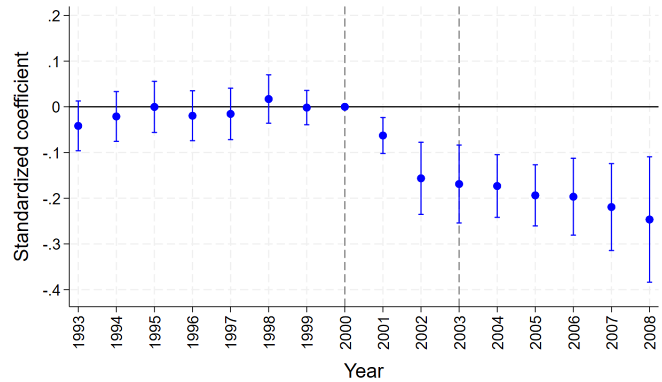
(b) 2000-2007 growth in Chinese imports per worker

Notes: Chinese imports per worker IPW_{ct} defined in equation (9).

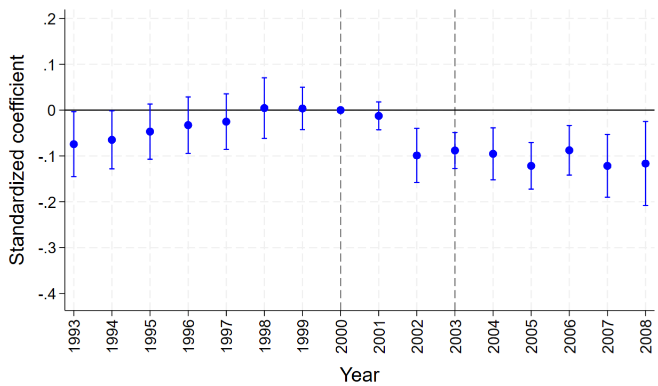
Figure 7: CZ-level Chinese import competition



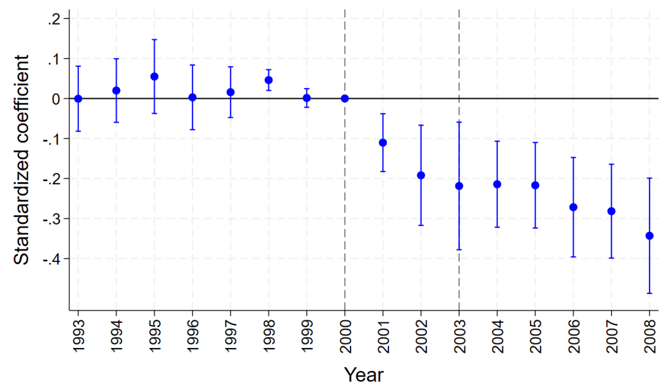
(a) CZs above median 2000-2007 house price growth



(b) CZs below median 2000-2007 house price growth

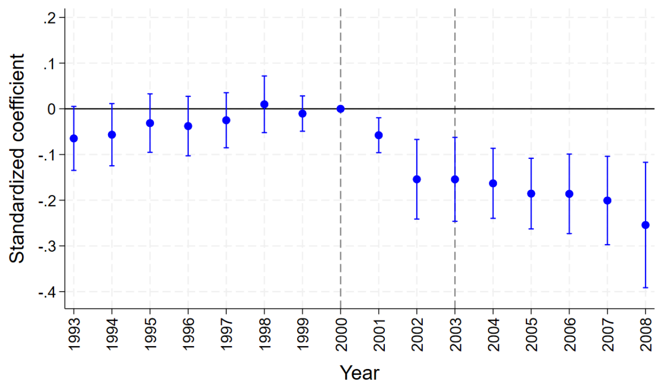


(c) CZs above median 2000 military emp. share

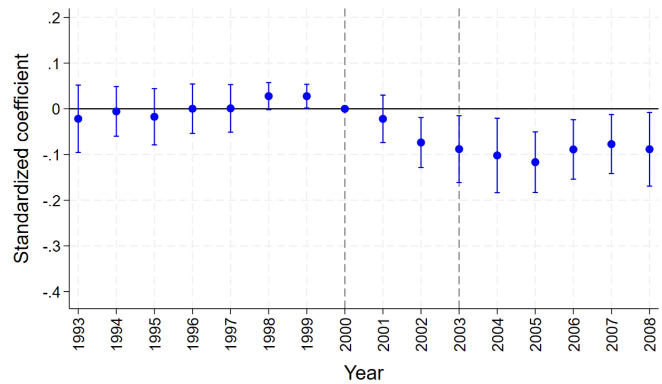


(d) CZs below median 2000 military emp. share

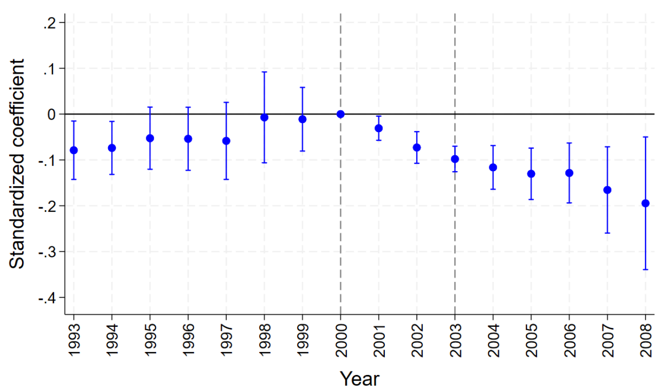
Figure 8: Heterogeneous impact of vulnerability to Bush steel tariffs on steel-intensive manufacturing employment share



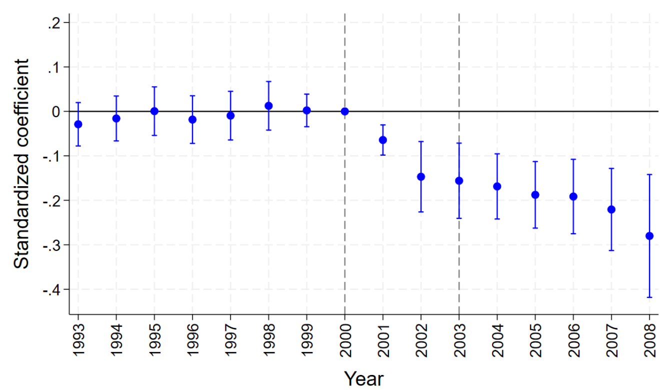
(e) CZs above median 2000 autos emp. share



(f) CZs below median 2000 autos emp. share



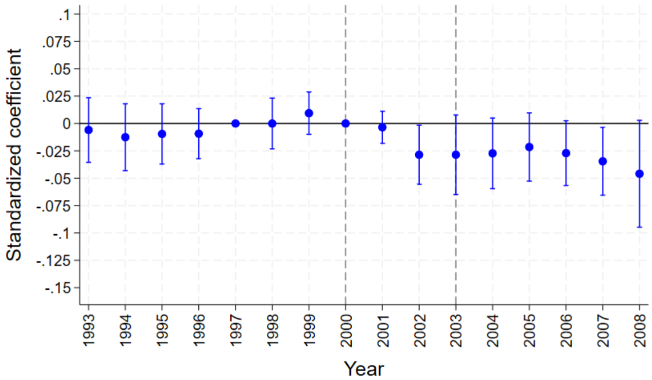
(g) CZs above median 2000 job opening rates



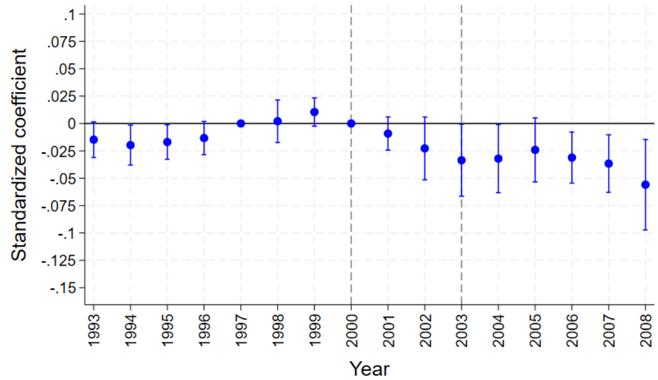
(h) CZs below median 2000 job opening rates

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3) of Bush steel tariff vulnerability (V_c) on steel-intensive manufacturing employment share. In panels (a)-(b), only 658 CZs have data for 2000-2007 house price growth. Military industries in panels (c)-(d) use definition of Peacock (2014) (see footnote (33)). Auto industries in panels (e)-(f) defined in footnote (34). 2000 job opening rate in panels (g)-(h) defined as number of state-level job openings as a share of state-level employment in 2000. Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

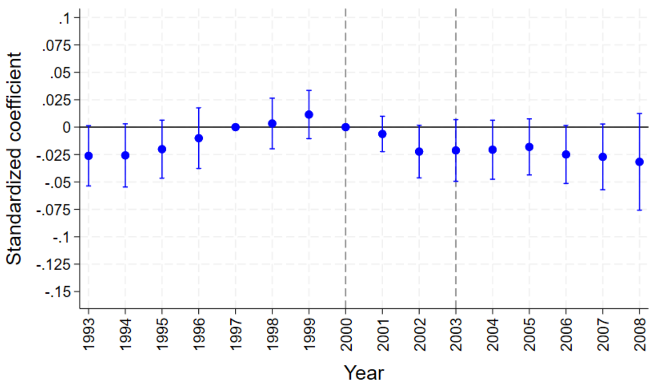
Figure 8: (cont.) Heterogeneous impact of vulnerability to Bush steel tariffs on steel-intensive manufacturing employment share



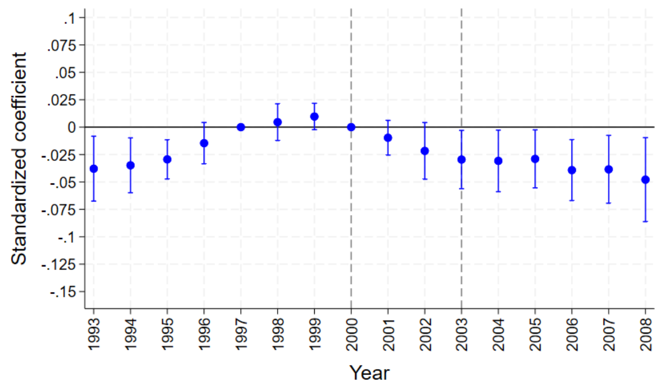
(a) Steel-int. share of manuf. estab. (7.5% direct usage)



(b) Steel-int. share of manuf estab. (5% direct usage)



(c) Steel-int. share of estab. (7.5% direct usage)



(d) Steel-int. share of estab. (5% direct usage)

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3) of Bush steel tariff vulnerability (V_c); fixed effects are state-year, CZ×pre1998, and CZ×post1997. Dependent variable is steel-intensive manufacturing establishments as share of manufacturing establishments in panels (a)-(b) and as share of all establishments in panels (c)-(d). Per \$100 output, direct usage threshold for steel-intensive defined as \$7.50 in panels (a) and (c) and \$5 in panels (b) and (d). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

Figure 9: Impact of local vulnerability to Bush steel tariffs on CZ steel-intensive establishments

B Structure of vulnerability shock

Table A1 explores the properties of the Bush steel tariff vulnerability shock from the perspective of the Borusyak et al. (2022) identification framework. Panel A presents summary statistics for industry-level vulnerability V_j and shows both substantial variation of V_j across industries and a dispersed distribution of employment across industries that can generate meaningful identification variation from industry-level variation in V_j when aggregating to the CZ level. The median and mean Bush steel tariff duties on steel inputs are, respectively, \$39 and \$115 per worker across all 467 industries with a standard deviation of \$250 per worker that is more than double the mean and an interquartile range of \$104 per worker that is approximately the mean.

Intuitively, the 467 industry-level observations of V_j cannot provide meaningful identifying variation when aggregating to the CZ level if almost all employment is concentrated in only a few industries. Thus, Borusyak et al. (2022) recommend defining the effective sample size as an inverse measure of employment concentration: the inverse Herfindahl-Hirschman Index (HHI) of employment across industries $\left(\sum_j \left(\frac{L_j}{\sum_j L_j}\right)^2\right)^{-1}$. Panel A of Table A1 shows the largest industry, which is Retail Trade, accounts for 13.3% of national employment and that the 467 industry-level observations reduce to an effective industry-level sample size of 28.87. Moreover, the distribution of employment within manufacturing – which houses the most vulnerable industries to the Bush steel tariffs (Retail Trade ranks in the bottom 5% of industry-level vulnerability) – is much less concentrated than employment across the economy as a whole. This can be seen by looking within manufacturing, where the 344 6-digit NAICS industries reduce to an effective sample size of 106.99.

To assess the appropriate clustering for standard errors, we aggregate the 467 6-digit NAICS industries into industry groups, sub-sectors, and sectors. Industry-groups are the 183 4-digit NAICS codes. Our sub-sectors are 3-digit NAICS codes with the exception that we combine 3-digit NAICS codes within the 2-digit NAICS code 33 into a single cluster because, as illustrated by Table 1, this 2-digit sector has the largest concentration of highly vulnerable industries to the Bush steel tariffs. In turn, we have 61 sub-sectors. Finally, our 12 NAICS sectors are Agriculture; Mining; Utilities; Construction; Manufacturing; Wholesale Trade; Retail Trade; Transportation and Warehousing; Professional Services; Arts, Entertainment and Recreation; and Accommodation and Food Services.

Panel B of Table A1 provides a hierarchical variance decomposition of vulnerability V_j between industries, industry-groups, sub-sectors, and sectors. It does so by reporting intra-class correlation coefficients (ICCs) from regressing V_j on random effects for industries, industry-groups, sub-sectors, and sectors. With an ICC over 0.5, panel B shows substantial correlation across industry-groups and hence strong evidence for clustering at a more aggregate level than 4-digit NAICS industry groups. However, the ICC of .062 (standard error of .077) for sub-sectors supports the assumption of minimal correlation of shocks across sub-sectors and suggests clustering standard errors by sub-sectors in our industry-level regressions. Panel A of Table A1 still shows an effective sample size of 18.617 sub-sectors.

Table A1. Properties of vulnerability shock

Panel A. Industry-level summary statistics

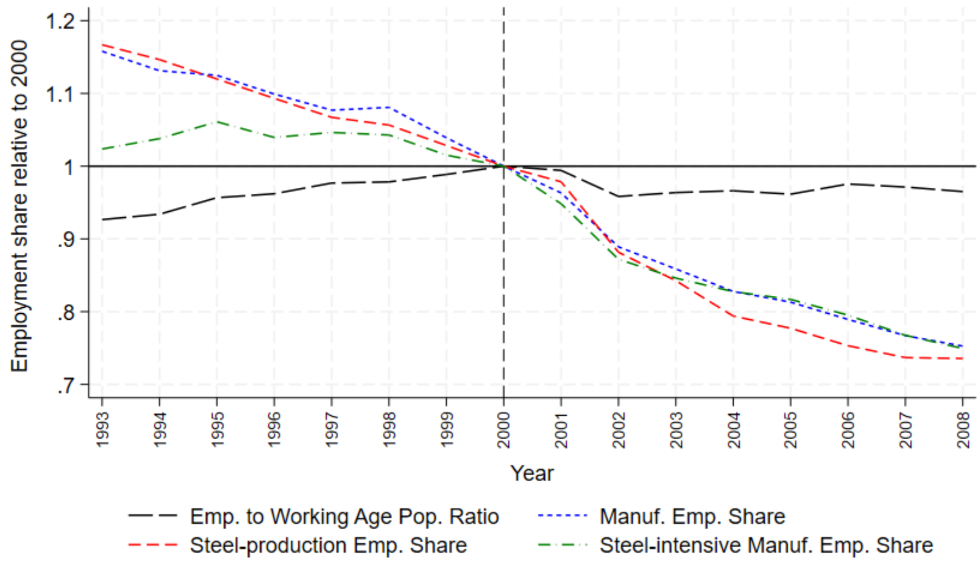
	Mean	Std. Dev.	Inter-quartile range	Observations	Effective sample size	Largest employment share
Industries	0.115	0.250	0.104	467	28.870	0.133
Sub-sectors				61	18.617	0.133

Panel B. Intra-cluster correlation

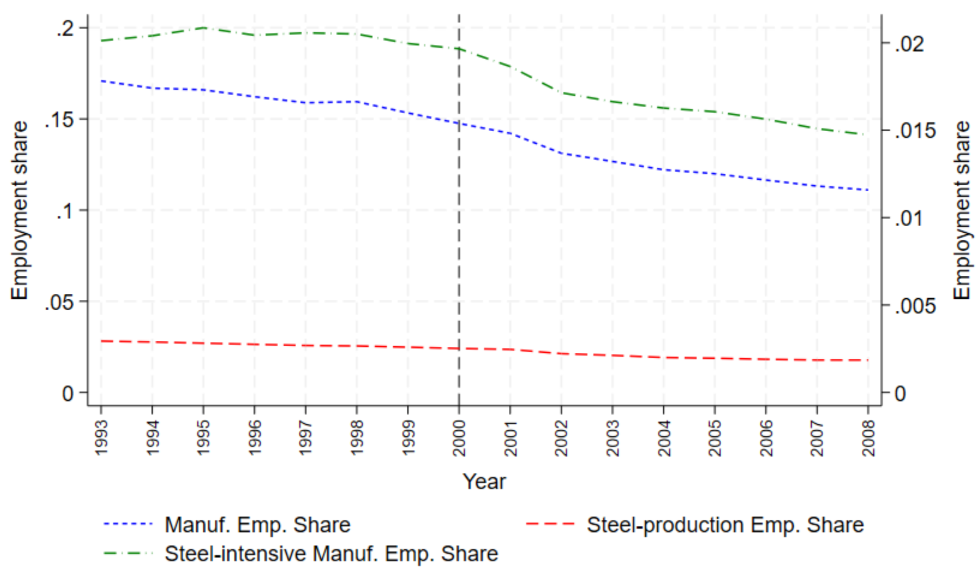
	Est.	Std. Err.	Observations
Sector	0.003	(0.012)	12
Sub-sector	0.062	(0.077)	61
Industry group	0.519	(0.290)	183
Industry	0.340	(0.081)	467

Notes: Industry-level vulnerability shock defined in equation (6). In panel A, effective sample size is the inverse Herfindahl index of the 1998 industry employment shares. Panel B reports intra-cluster correlation coefficients with robust standard errors given exchangable covariance structure and industrial aggregation heirachy defined by NAICS sector, sub-sector, industry group and industry. See Appendix B for more details.

C Appendix tables & figures



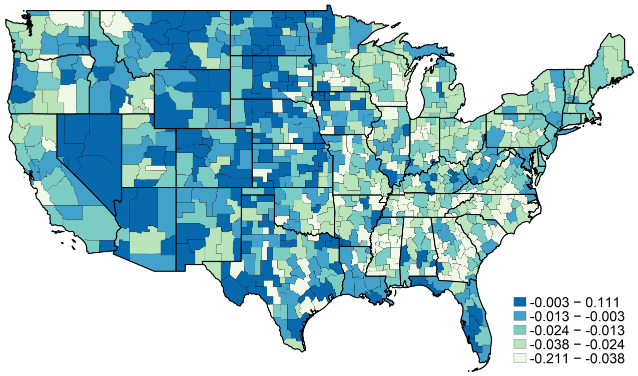
(a) Changes in employment shares relative to 2000



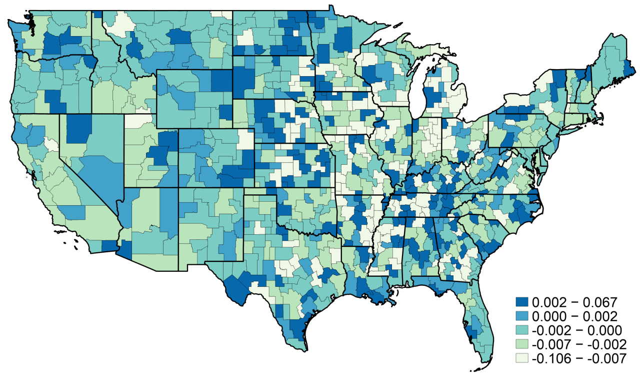
(b) Changes in employment shares

Notes: In panel (a), employment shares normalized to value of 1 in 2000. In panel (b), manufacturing employment share measured on left y-axis while steel-intensive manufacturing and steel-production employment shares measured on right y-axis.

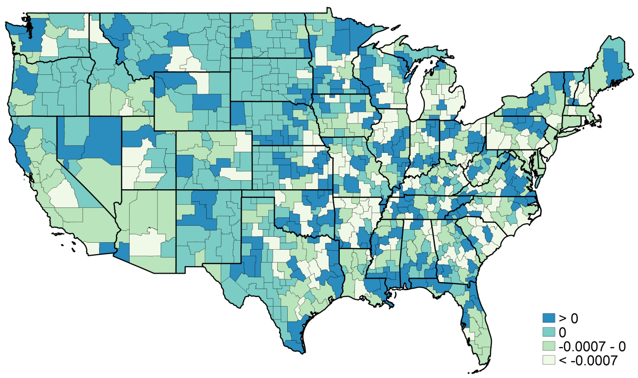
Figure A.1: US national employment changes 1993-2008



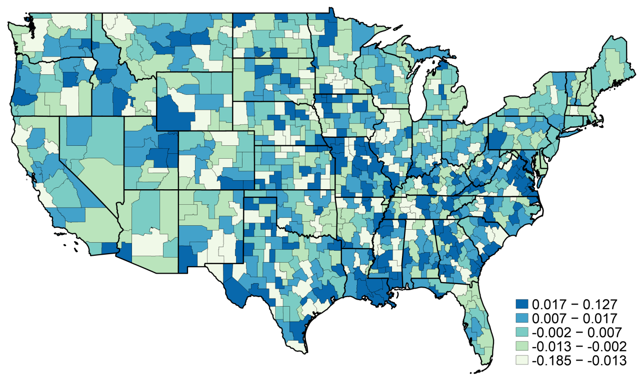
(a) Manufacturing employment share



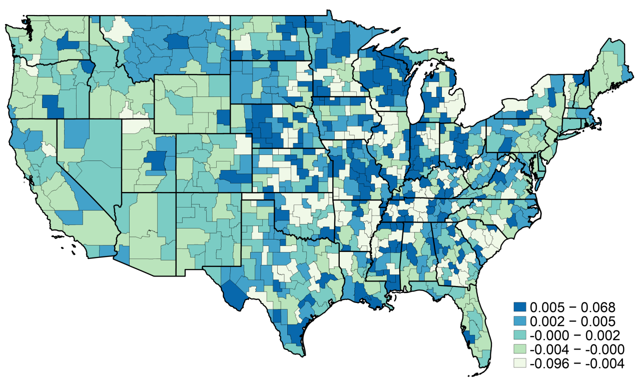
(b) Steel-intensive manufacturing employment share



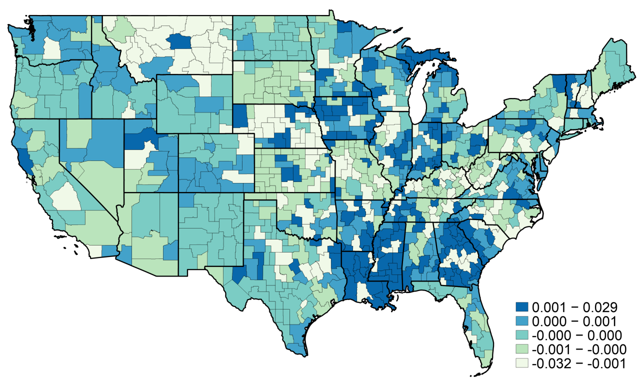
(c) Steel-production employment share



(d) Manuf. emp. share: Fixed effects removed



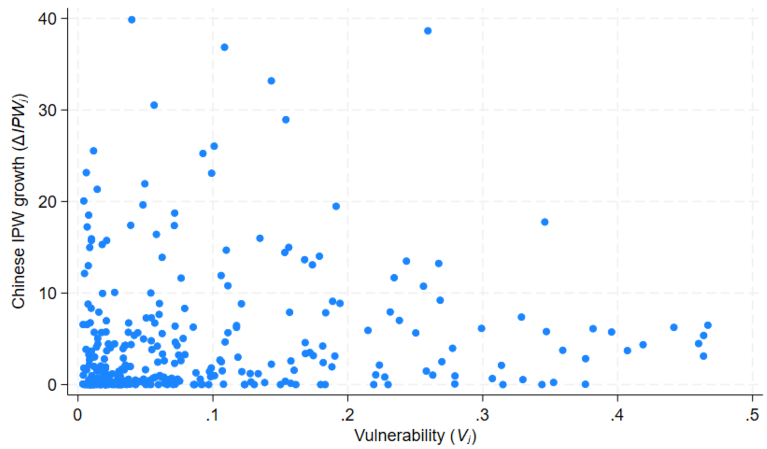
(e) Steel-int. manuf. emp. share: Fixed effects removed



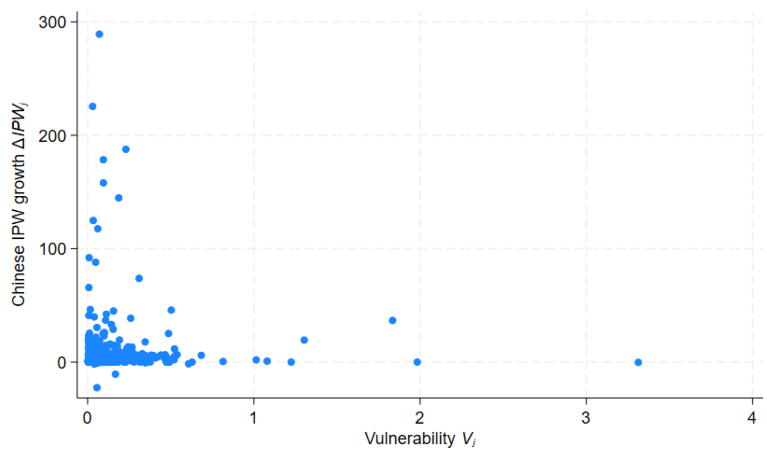
(f) Steel-prod. emp. share: Fixed effects removed

Notes: Steel-intensive manufacturing industries have direct requirement for at least one Bush steel tariff industry of at least $7.50 per $100 of output. Steel-production industries are those hit with Bush steel tariffs. Panels (b), (d), and (f) demean employment shares at CZ and state-year level.

Figure A.2: Changes in CZ-level employment shares 2000-2003



(a) Remove observations below 5^{th} or above 95^{th} percentiles



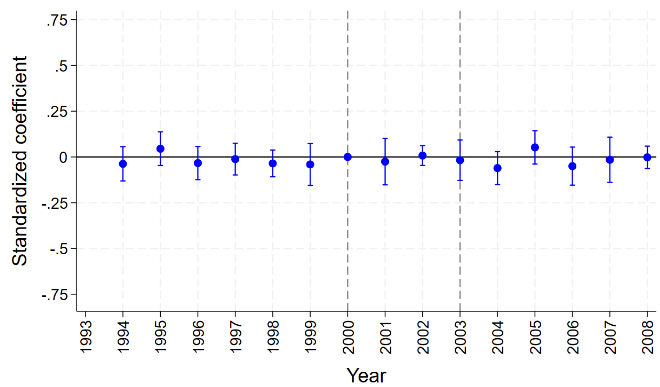
(b) All observations

Notes: Both panels display scatterplots of 2000-2007 industry-level growth in Chinese imports per worker IPW_{ct} defined in equation (9) on y-axis against industry-level vulnerability to the Bush steel tariffs defined in equation (6)) on the x-axis. Panel (a) removes observations below 5^{th} or above 95^{th} percentile of either variable.

Figure A.3: Industry level vulnerability to Bush steel tariffs & 2000-2007 growth in Chinese imports per worker

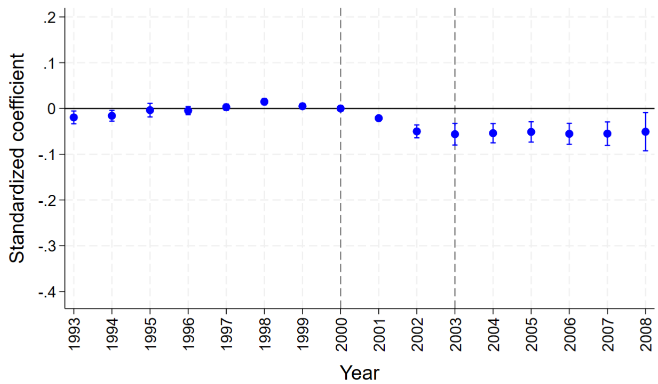
D Online Appendix

D.1 Appendix tables & figures

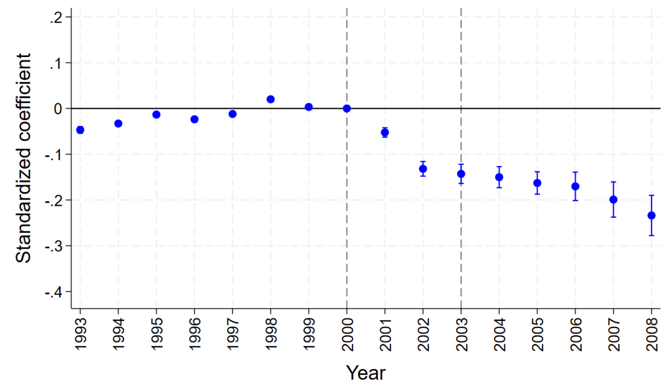


Notes: Figure reports standardized coefficients for time-varying point estimates of local protection (P_c) on the steel-intensive manufacturing employment share from first-differenced version of equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, first-differenced Chinese import competition (IPW_{ct}), and first-differenced protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). Fixed effects are state-year fixed effects. 95% confidence intervals with standard errors clustered by state. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

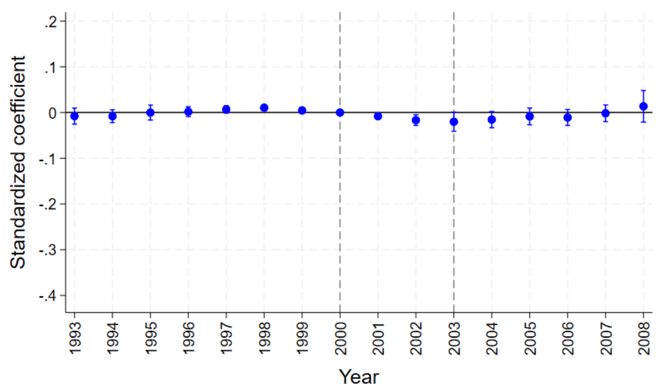
Figure D.1: Effects of protection on CZ steel-production employment share – Removing linear trend



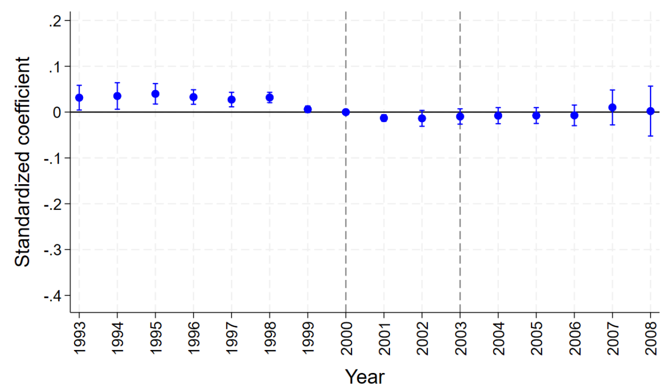
(a) Vulnerability (V_c) & manuf. emp. share



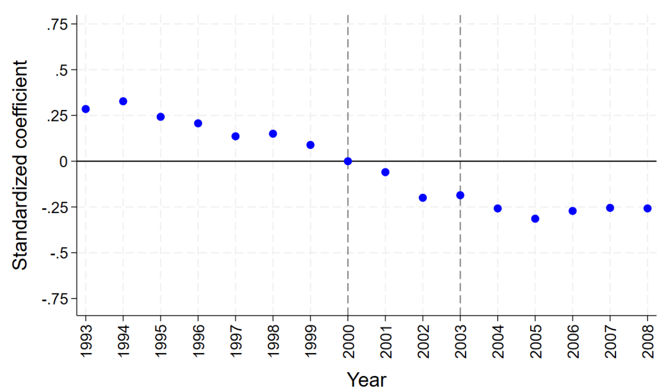
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



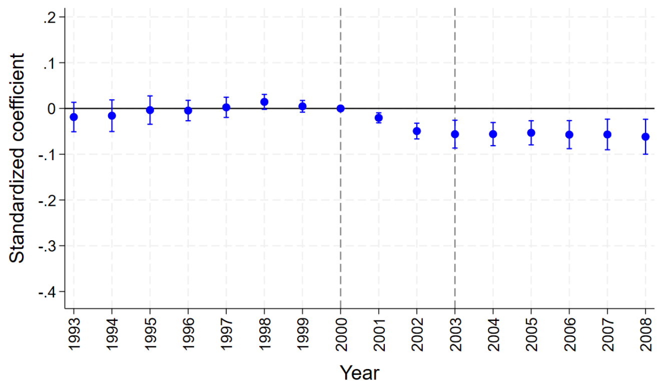
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



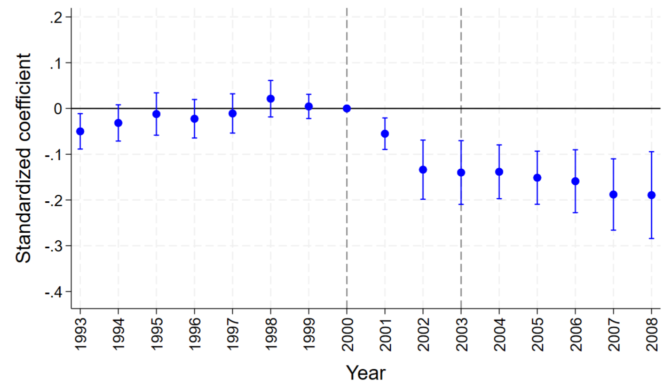
(e) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). 95% confidence intervals with Borusyak et al. (2022) exposure-robust standard errors clustered by NAICS sub-sector. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

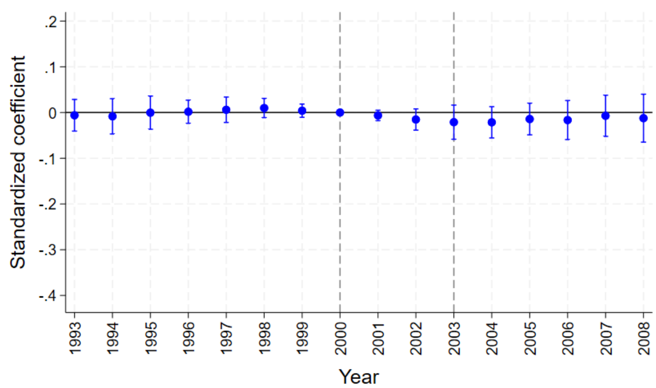
Figure D.2: Effects of vulnerability & protection on CZ employment shares – Exposure-robust standard errors



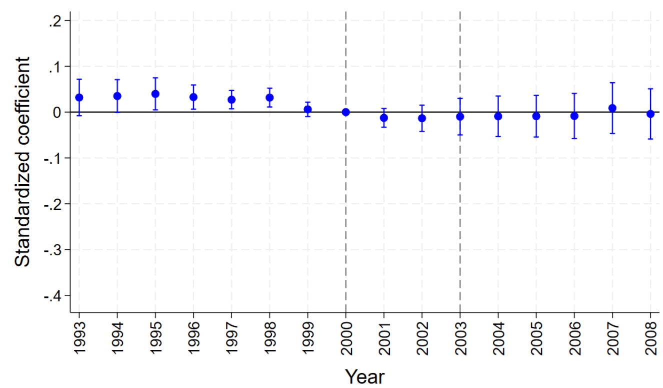
(a) Vulnerability (V_c) & manuf. emp. share



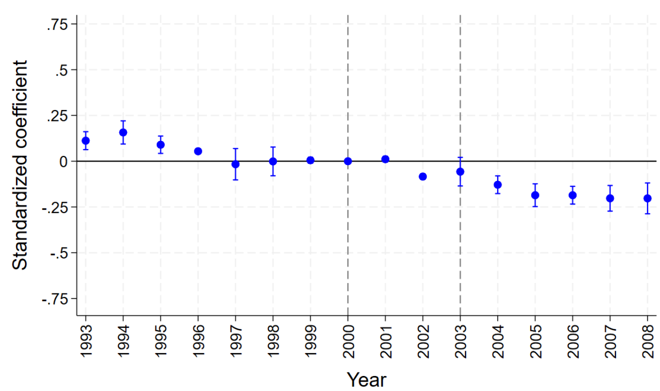
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



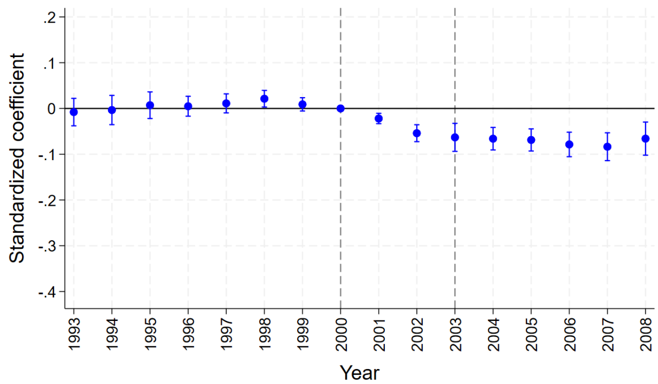
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



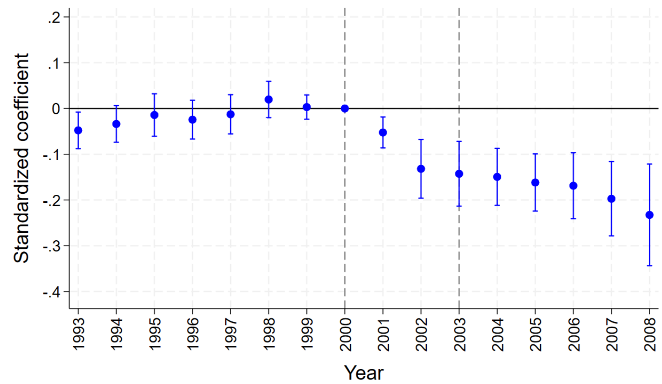
(e) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies and Chinese import competition (IPW_{ct}). 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

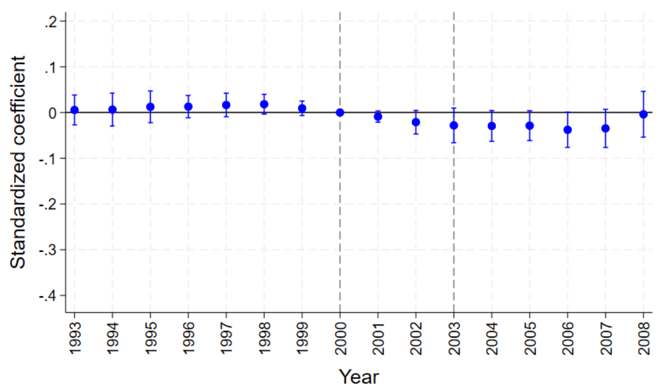
Figure D.3: Effects of vulnerability & protection on CZ employment shares – Local China shock as only non-Bush trade shock control



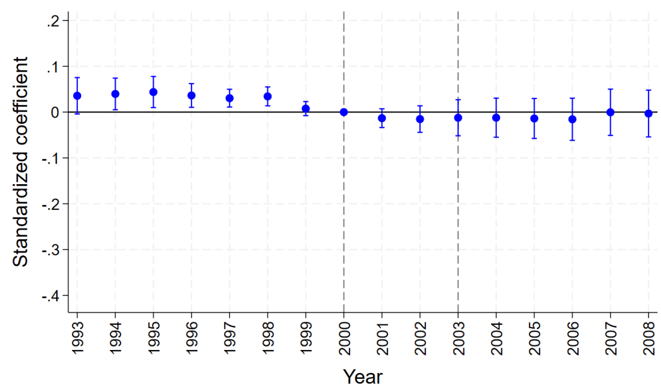
(a) Vulnerability (V_c) & manuf. emp. share



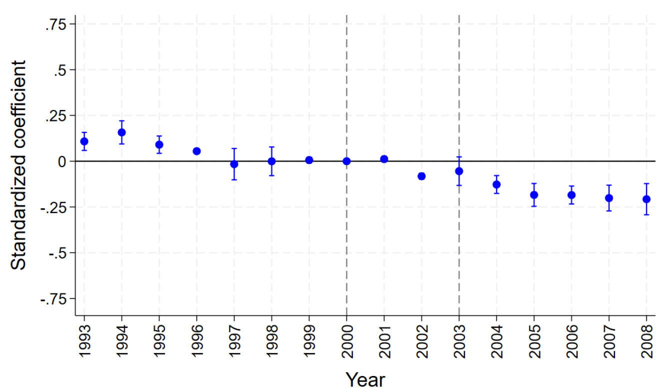
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



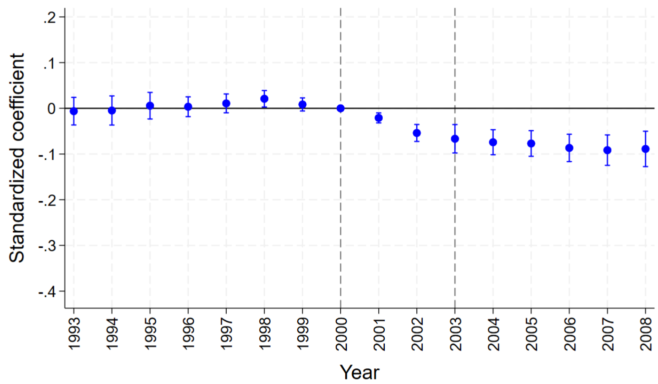
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



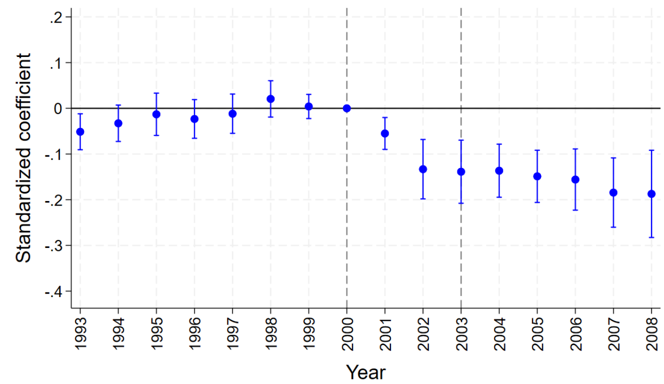
(e) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies and vulnerability to steel AD duties (V_{ct}^{AD}). 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

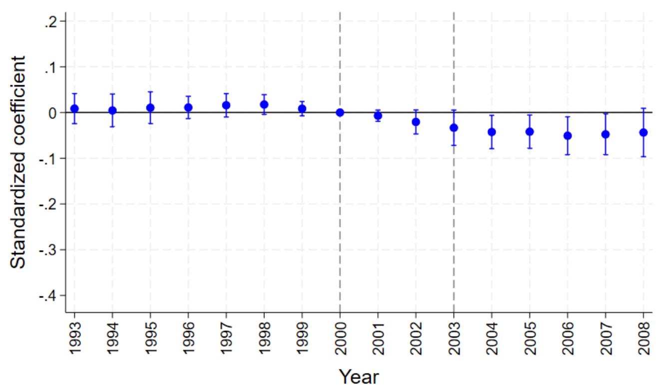
Figure D.4: Effects of vulnerability & protection on CZ employment shares – Local AD vulnerability as only non-Bush trade shock control



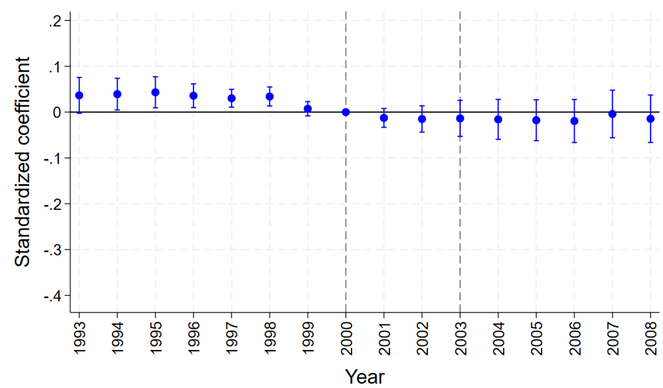
(a) Vulnerability (V_c) & manuf. emp. share



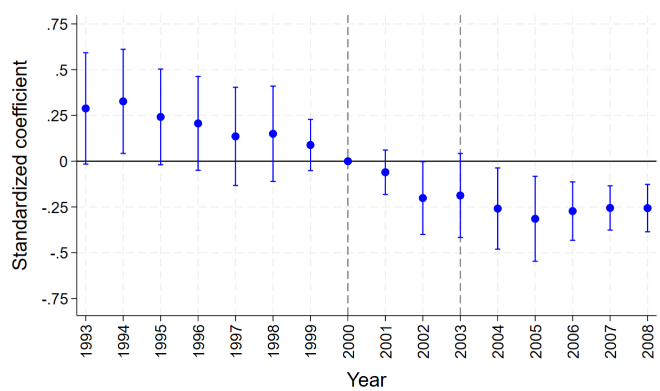
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



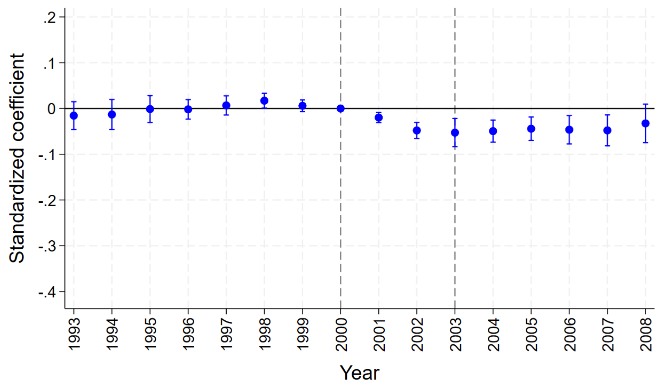
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



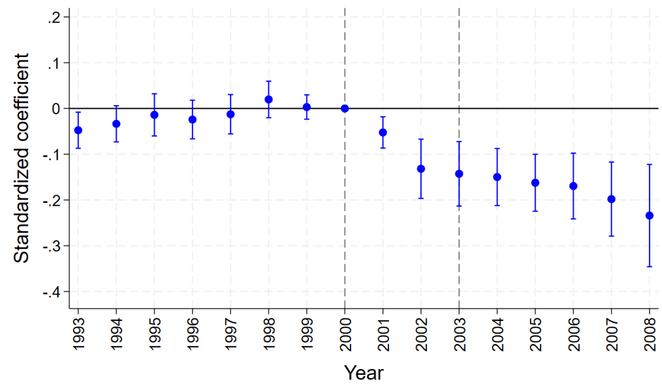
(e) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies and protection from steel AD duties (P_{ct}^{AD}). 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

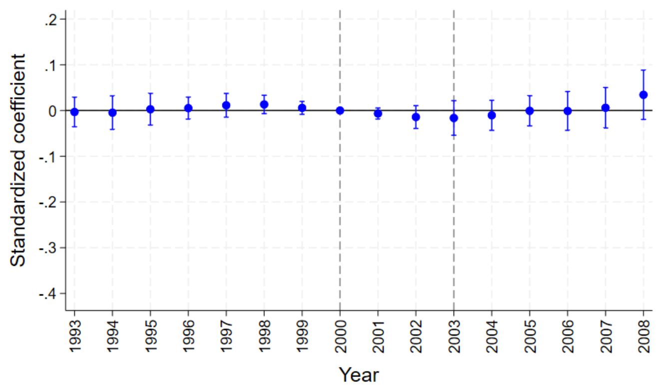
Figure D.5: Effects of vulnerability & protection on CZ employment shares – Local AD protection as only non-Bush trade shock control



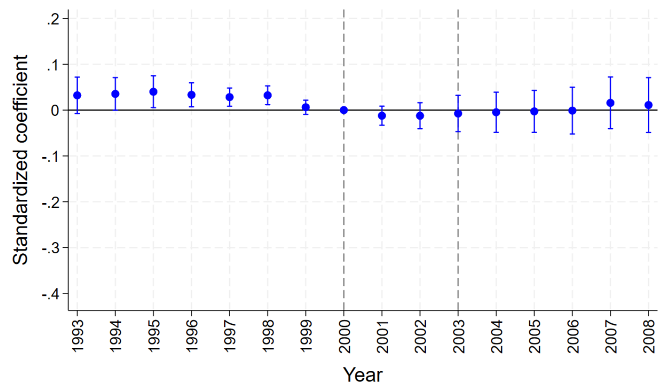
(a) Vulnerability (V_c) & manuf. emp. share



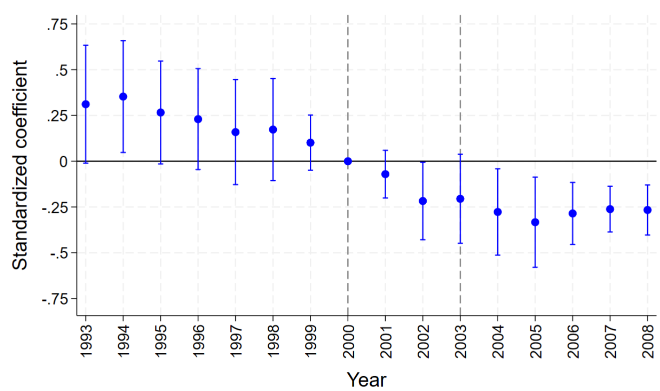
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



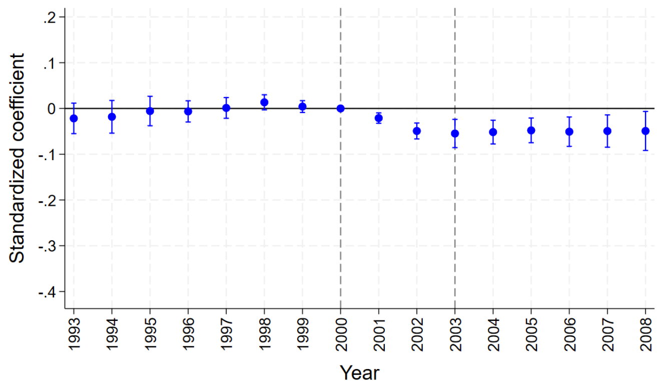
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



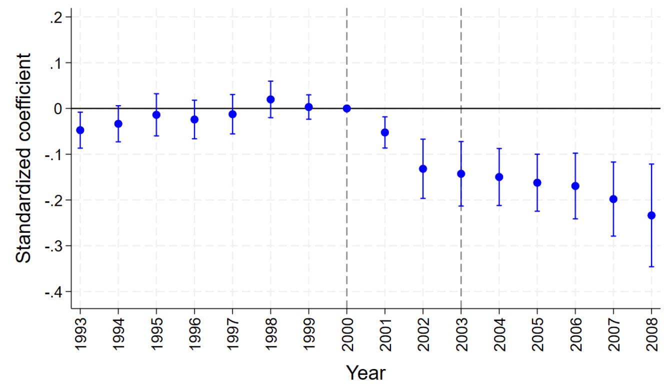
(e) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition IV (IPW_{ct}^{IV}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

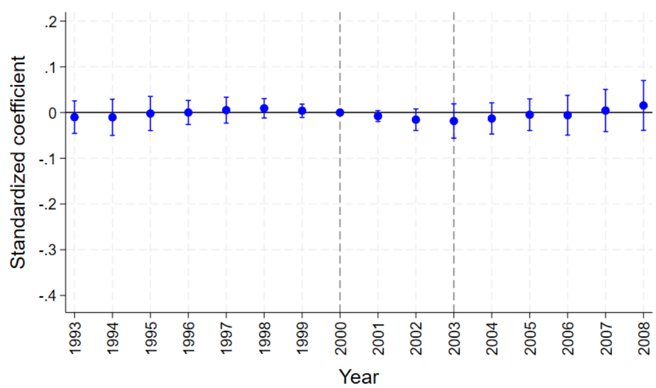
Figure D.6: Effects of vulnerability & protection on CZ employment shares – Local China shock instrument as a control



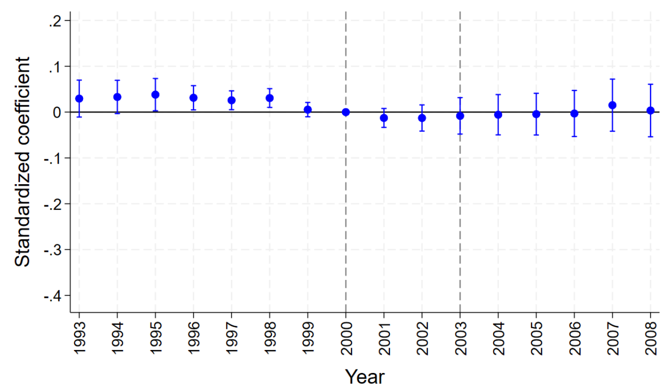
(a) Vulnerability (V_c) & manuf. emp. share



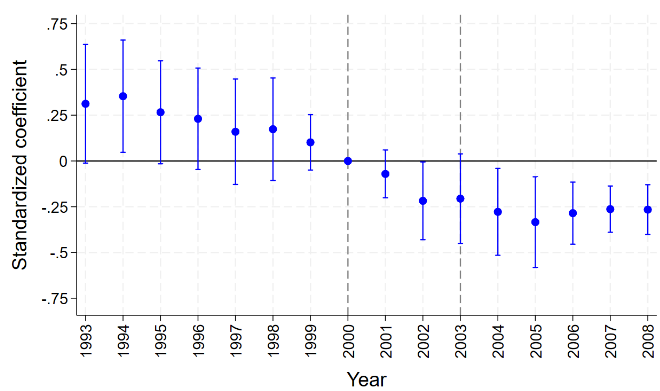
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



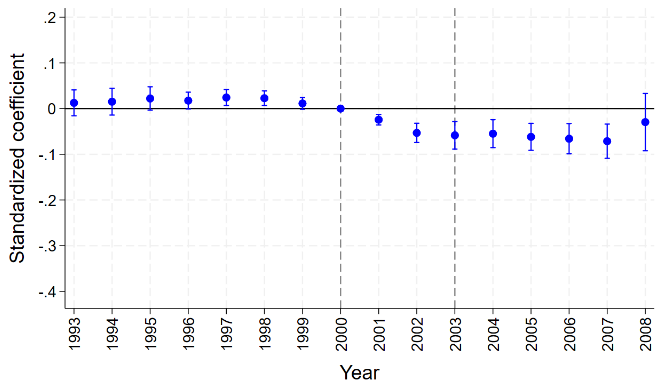
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



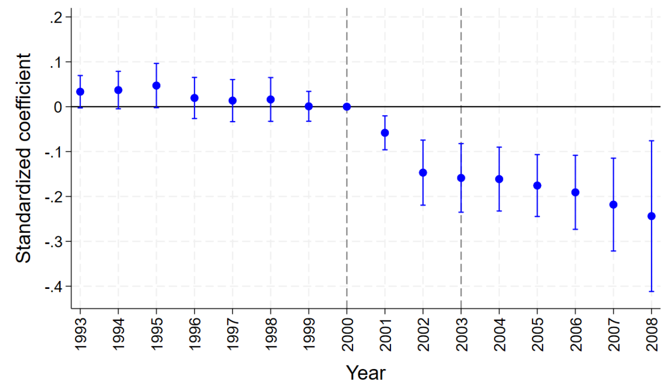
(e) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}) instrumented with IPW_{ct}^{IV}, and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). Chinese import competition 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

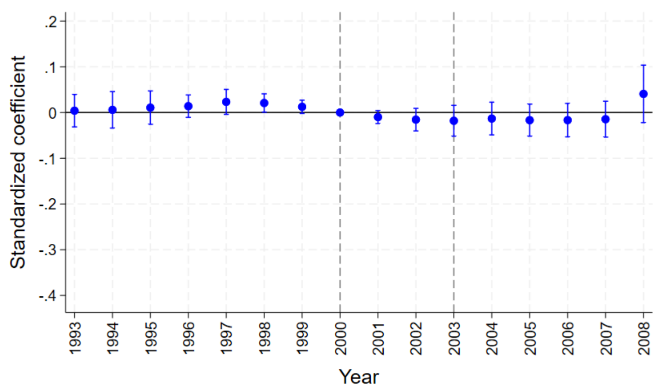
Figure D.7: Effects of vulnerability & protection on CZ employment shares – Instrumenting for local China shock



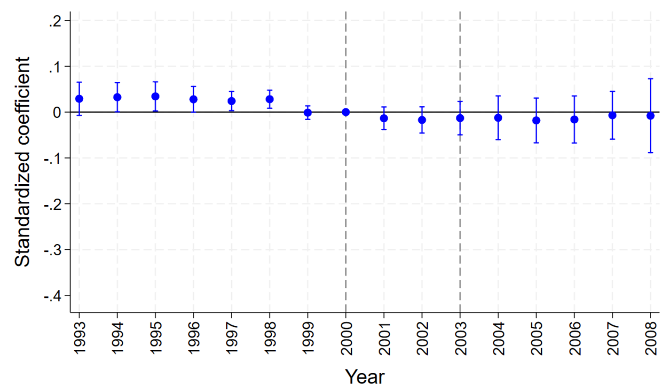
(a) Vulnerability (V_c) & manuf. emp. share



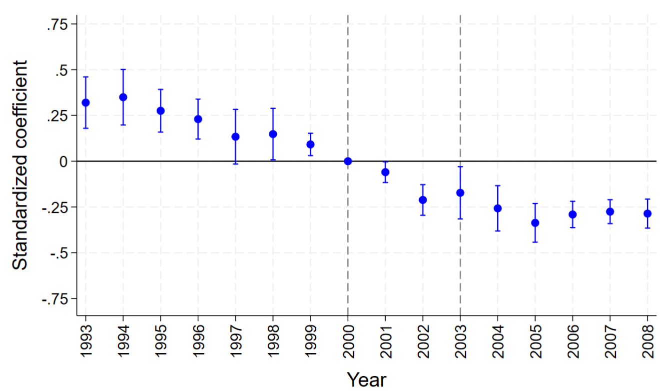
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



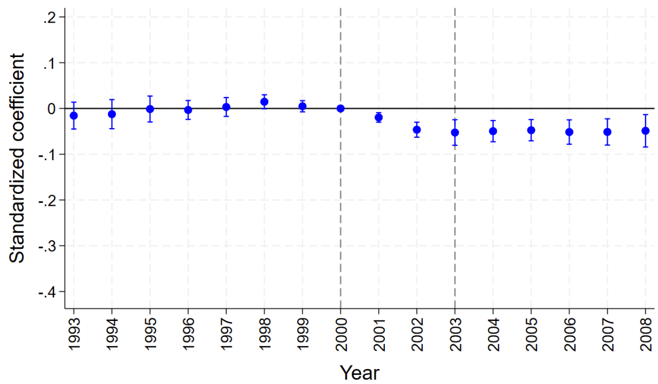
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



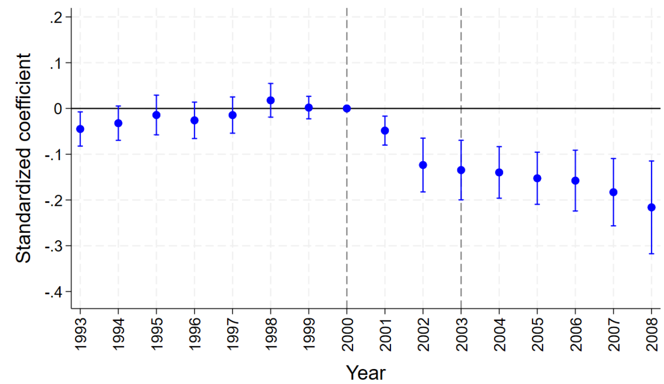
(e) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). 1993 CZ-employment weights in equations (7)-(8) and (9)-(10) for $V_c, P_c, V_{ct}^{AD}, P_{ct}^{AD}, IPW_{ct}$ and IPW_{ct}^{IV}. 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1993 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

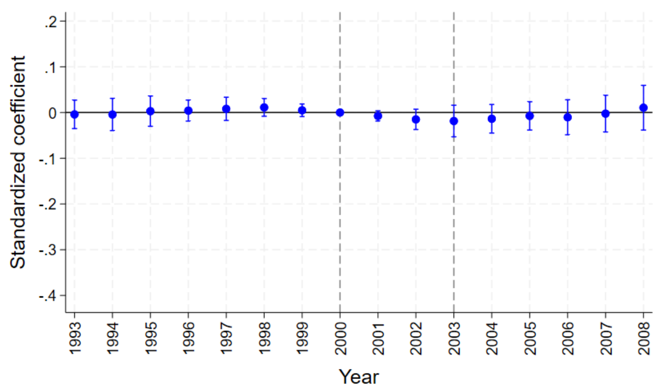
Figure D.8: Effects of vulnerability & protection on CZ employment shares – 1993 CZ-industry employment weights & CZ working-age population regression weights



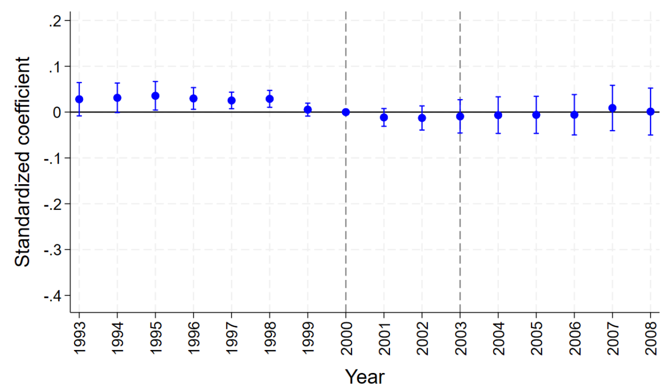
(a) Vulnerability (V_c) & manuf. emp. share



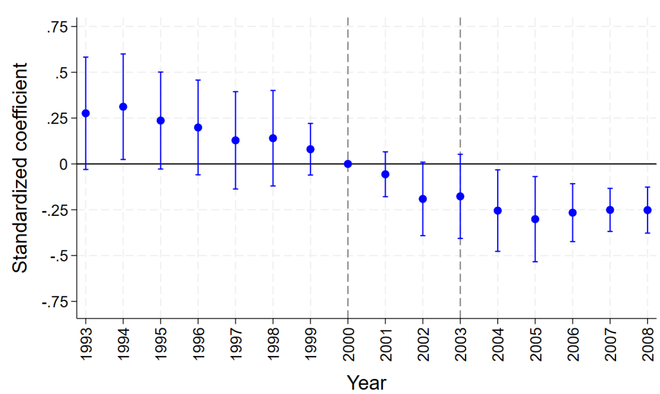
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



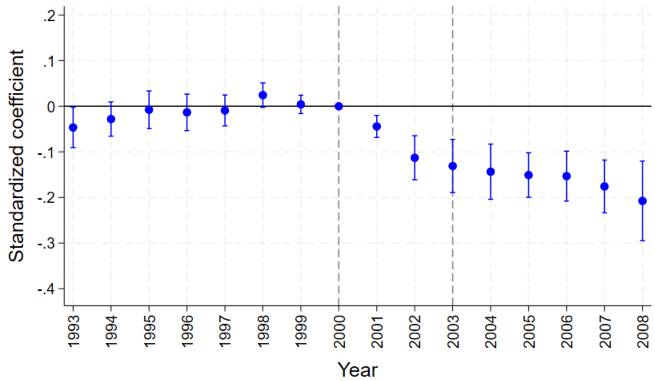
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



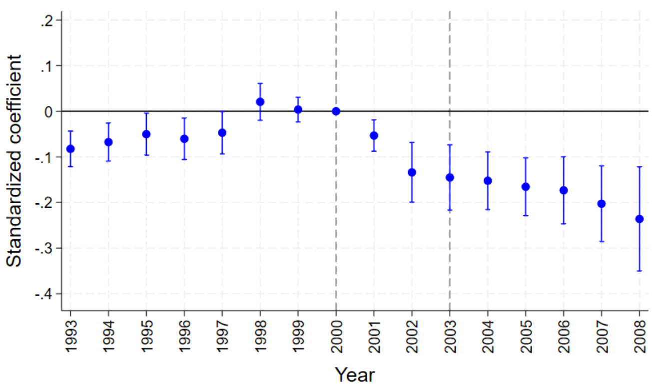
(e) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Bush steel tariff industries (steel HS chapters 72 and 73) excluded as steel-using industries j in equation (7) for V_c (V_{ct}^{AD}). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). Chinese import competition 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

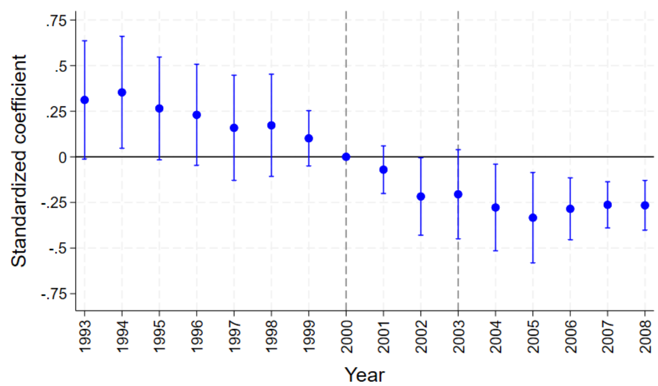
Figure D.9: Effects of vulnerability & protection on CZ employment shares – Excluding steel as a steel-consuming industry



(a) Vulnerability (V_c) & steel-int. manuf. emp. share



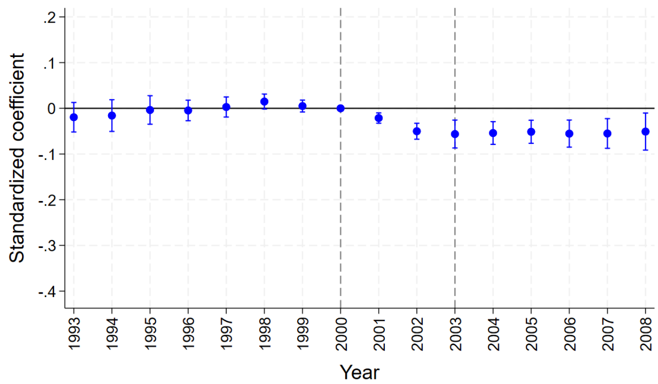
(b) Vulnerability (V_c) & steel-int. manuf. emp. share



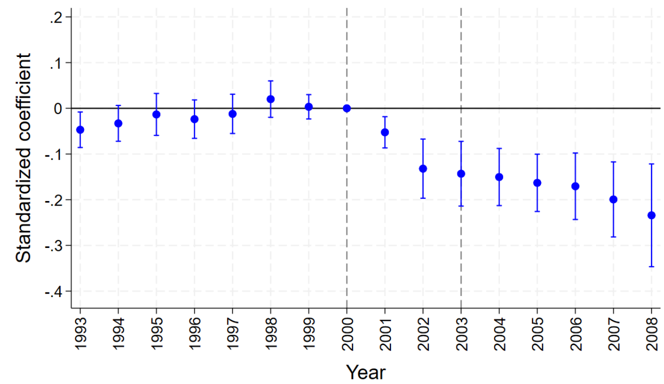
(c) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). In panel (a), steel-intensive manufacturing employment share defined using direct requirement of \$5 per \$100 of output. In panels (b) and (c), pre-1998 non-concorded employment left unallocated to 6-digit NAICS industries. Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). Chinese import competition 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

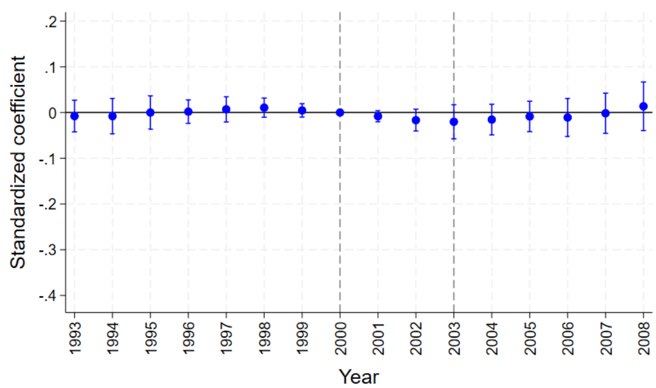
Figure D.10: Effects of vulnerability & protection on CZ employment shares – Alternative dependent variables



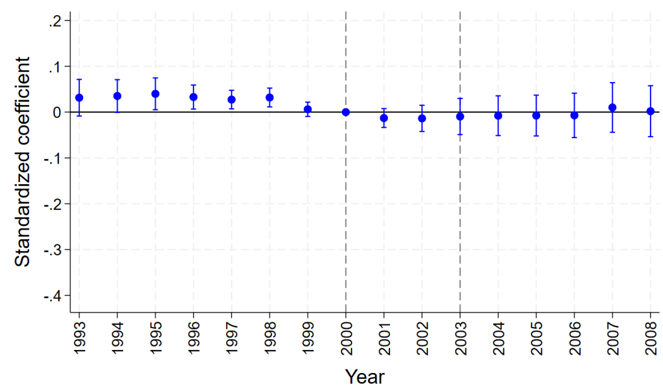
(a) Vulnerability (V_c) & manuf. emp. share



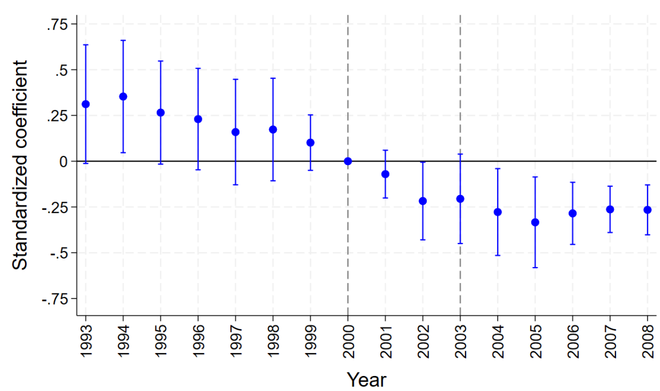
(b) Vulnerability (V_c) & steel-intensive manuf. emp. share



(c) Vulnerability (V_c) & non-steel-int. manuf. emp. share



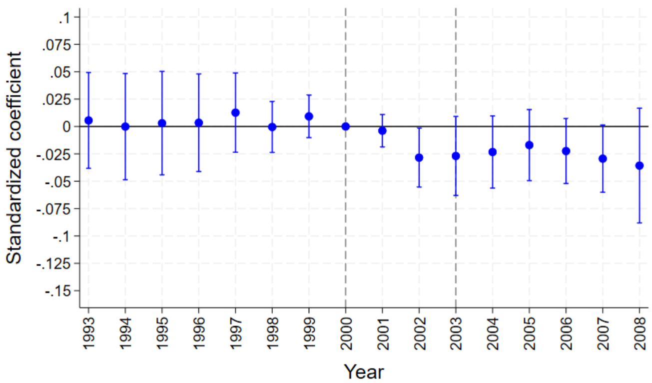
(d) Vulnerability (V_c) & emp.-to-working-age-pop. ratio



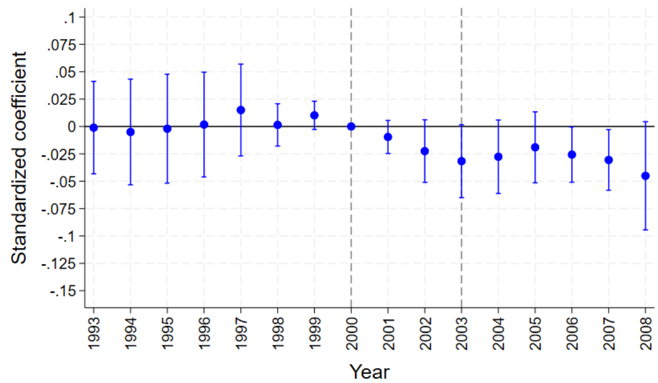
(e) Protection (P_c) & steel-production emp. share

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3). Observation dropped if in top or bottom 1% of distribution for dependent variable, V_c (in panels (a)-(d)), or P_c (in panel (e)). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). Chinese import competition 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

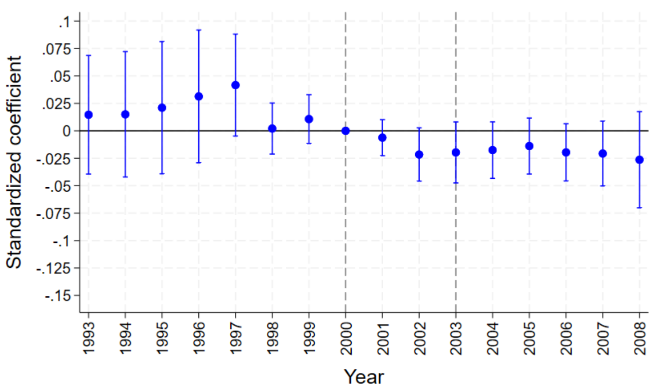
Figure D.11: Effects of vulnerability & protection on CZ employment shares – Excluding outliers



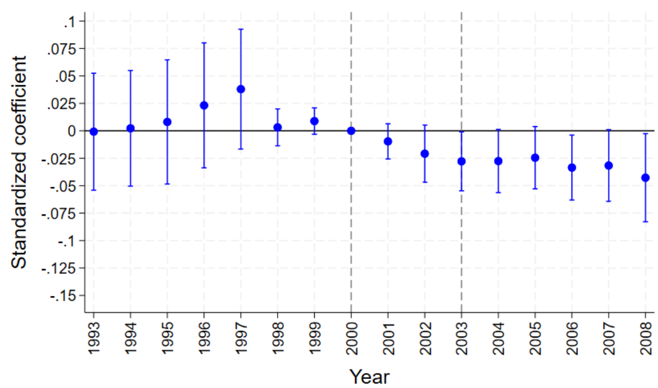
(a) Steel-int. share of manuf. estab. (7.5% direct usage)



(b) Steel-int. share of manuf estab. (5% direct usage)



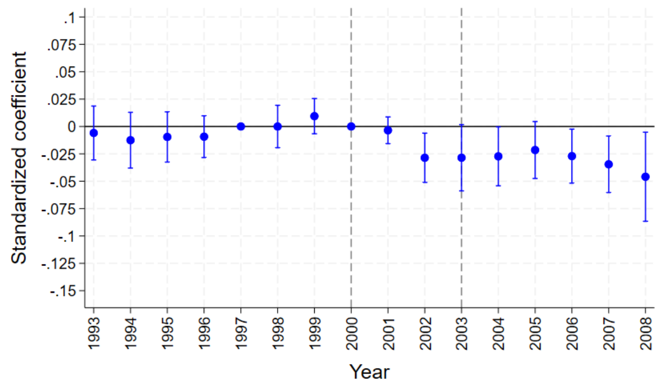
(c) Steel-int. share of estab. (7.5% direct usage)



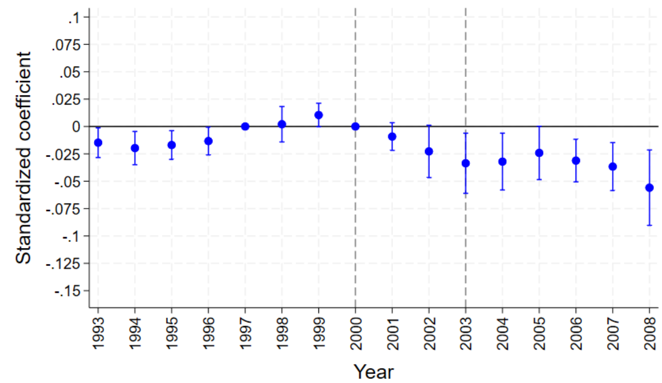
(d) Steel-int. share of estab. (5% direct usage)

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3) of Bush steel tariff vulnerability (V_c) with state-year and CZ fixed effects. Dependent variable is steel-intensive manufacturing establishments as share of manufacturing establishments in panels (a)-(b) and as share of all establishments in panels (c)-(d). Per \$100 output, direct usage threshold for steel-intensive defined as \$7.50 in panels (a) and (c) and \$5 in panels (b) and (d). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). 95% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

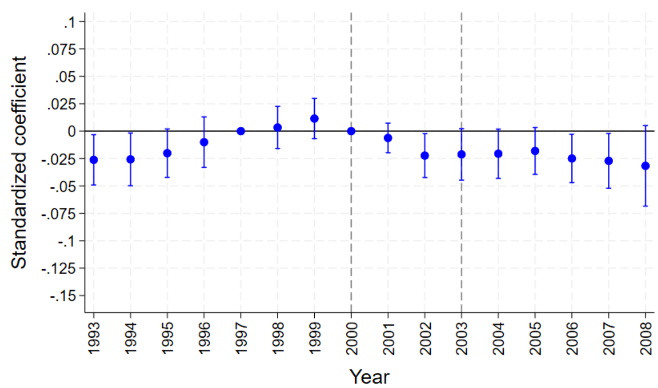
Figure D.12: Impact of local vulnerability to Bush steel tariffs on CZ steel-intensive establishments (CZ fixed effects)



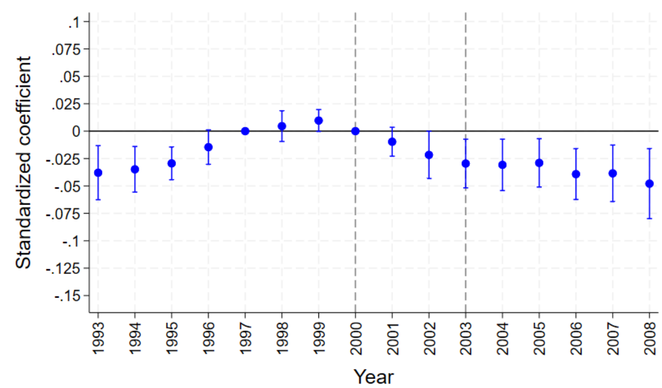
(a) Steel-int. share of manuf. estab. (7.5% direct usage)



(b) Steel-int. share of manuf estab. (5% direct usage)



(c) Steel-int. share of estab. (7.5% direct usage)



(d) Steel-int. share of estab. (5% direct usage)

Notes: Panels report standardized coefficients for time-varying point estimates $\boldsymbol{\beta}$ from equation (3) of Bush steel tariff vulnerability (V_c); fixed effects are state-year, CZ×pre1998, and CZ×post1997. Dependent variable is steel-intensive manufacturing establishments as share of manufacturing establishments in panels (a)-(b) and as share of all establishments in panels (c)-(d). Per \$100 output, direct usage threshold for steel-intensive defined as \$7.50 in panels (a) and (c) and \$5 in panels (b) and (d). Controls $\boldsymbol{X}_{ct}$ consist of 1990 CZ characteristics in panel B of Table 2 interacted with year dummies, Chinese import competition (IPW_{ct}), and protection from and vulnerability to steel AD duties (P_{ct}^{AD}, V_{ct}^{AD}). 90% confidence intervals with standard errors clustered by state. Regressions weighted by 1998 CZ working-age population. Vertical lines at 2000 and 2003 indicate, respectively, last year before Bush steel tariff process starts (omitted base year) and year Bush steel tariffs removed (removed in December 2003).

Figure D.13: Impact of local vulnerability to Bush steel tariffs on CZ steel-intensive establishments – 90% confidence intervals

D.2 Data appendix

D.2.1 Input output data

We obtain 1997 input-output (IO) tables from the US Bureau of Economic Analysis (BEA). Specifically, we obtain direct requirement and total requirement tables. One version of the direct requirement table specifies the amount of row input i used directly by column industry j and another version specifies this usage per dollar of column industry j output. The latter version also gives column industry j output as the sum of intermediate inputs used plus value added. A cell in the total requirement table specifies the total amount of row input i used by column industry j per dollar of row industry j output. Total usage not only takes into account the industry's direct use of input i, but also its indirect usage in that other inputs k use input i and the inputs used by input k also use input i and so on. By construction, the diagonal elements of the total requirement table weakly exceed 1 and one needs to subtract 1 from these elements to see usage of row industry $i = j$ as an input by column industry j.

D.2.2 Employment dependent variables

We obtain annual county-NAICS employment data at the 6-digit NAICS level from Eckert et al. (2021). The source of their data is the County Business Patterns (CBP), but they have concorded the data so the industry classification is NAICS 2012 in each year. This overcomes the typical challenge of periodic NAICS revisions and, crucially in our context, the switch from SIC to NAICS in 1998.

However, their data has an important limitation in the pre-1998 SIC years that poses problems for measuring employment in steel-intensive manufacturing industries before 1998 (but not for measuring employment in any year from 1998 onward or for measuring employment in manufacturing or steel-producing industries before 1998). The limitation is that they cannot concord some SIC industries to 6-digit NAICS industries. In these cases, the sum of concorded employment across 6-digit NAICS industries for a county-year is less than total employment for the county-year. And the magnitude is non-trivial: on average across the years 1993-1998, the county-level share of employment concorded to 6-digit NAICS industries is only 46% with this share only reaching 74% at the 99^{th} percentile of the distribution.

Nevertheless, Eckert et al. (2021) also report employment at more aggregate NAICS levels. Thus, the sum of concorded employment across 6-digit NAICS industries for a county-year is less than employment at the 2-digit or 4-digit NAICS code for the county-year in situations where a SIC industry could not be concorded to 6-digit NAICS industries. This is helpful because it allows measuring the amount of non-concorded employment within 4-digit and 2-digit NAICS codes for a county-year; indeed, all non-concorded manufacturing employment lies within 4-digit NAICS codes. Since these problems cease upon the switch from SIC to NAICS in 1998, we use a county's 1998 distribution of employment to allocate non-concorded employment for 4-digit NAICS codes across their constituent 6-digit codes when calculating pre-1998 steel-intensive manufacturing employment.

Given our reliance on the 1997 IO tables to define pre-Bush tariff measures of steel input usage across industries, we concord the Eckert et al. (2021) data to the 1997 NAICS used by the BEA in their IO tables. First, we use the US Census Bureau concordances to sequentially concord from NAICS 2012 to NAICS 2007 to NAICS 2002 to NAICS 1997. Although relatively rare, an industry in, say, NAICS 2007 can split among $N > 1$ NAICS 2002 industries. In these cases, we equally split the industry's NAICS 2007 employment among its N constituent NAICS 2002 industries. Second, we use the concordance provided by the BEA with their IO tables to concord from the official NAICS 1997 to the NAICS 1997 used by the BEA. These systems are quite similar, although the BEAs 1997 NAICS is more aggregate than the official 1997 NAICS. Construction is an exception where the 3-digit NAICS sub-sector 235 maps to all 6-digit construction codes in the BEA NAICS. In this case, we use 1997 output weights from the IO table to split 3-digit NAICS sub-sector 235 across the 6-digit BEA NAICS construction industries.

Ultimately, our annual county-industry employment data allows us to construct the dependent variables in our analysis: manufacturing employment share, steel-intensive manufacturing employment share, non-steel-intensive manufacturing employment share, steel-production employment share, and employment-to-working-age population ratio. Manufacturing industries are defined as 6-digit NAICS industries within 2-digit NAICS codes 31, 32, and 33. Our baseline definition of 6-digit steel-intensive manufacturing industries is 6-digit NAICS manufacturing industries with a direct requirement for at least one Bush steel tariff industry of at least \$7.50 per \$100 of output. Our alternative definition relaxes this direct requirement threshold to \$5 per \$100 of output. Non-steel-intensive manufacturing employment is defined as the difference between manufacturing and steel-intensive manufacturing employment. For the employment-to-working-age population ratio, we use annual county-level population from SEER. Specifically, we use the 19 age groups (adjusted) data and define the working-age population as 15-64 years of age. County-level employment and population data is concorded to 1990 CZs using the concordance on David Dorn's website.

D.2.3 Trade shocks

Bush steel tariffs and exemptions We obtain the list of 8-digit HS products h subject to the Bush steel tariffs and the applicable tariff τ_h from Note 11(d)(iii) in the Annex to Presidential Proclamation 7529. The tariffs went into effect on March 20 2002. Although they were scheduled to last three years with removal on March 21 2005 and annual decreases in the tariff on March 21 2003 and March 21 2004, they were ultimately removed in December 2003.

We define τ_h as the tariff upon implementation. We concord the tariffs from 8-digit HS codes h to the 6-digit NAICS 1997 codes i used by the BEA in their IO tables using the concordance from Pierce and Schott (2012) to move from 8-digit HS codes to NAICS 1997 codes and then from NAICS 1997 codes to those used by the BEA as described above in Appendix D.2.2. Ultimately, the four 6-digit NAICS 1997 industries hit with Bush steel tariffs are $i = 331111, 331222, 332910, 335120$ which correspond to Iron and Steel Mills, Steel Wire, Metal Valve Manufacturing, and Lighting Fixture Manufacturing.

Proclamation 7529 defines exporter-product exemptions to the tariffs. Item (2) on p.19 of the proclamation defines the US Free Trade Agreement partners – Israel, Canada, Mexico, and Jordan – as exempt. Item (3) on p.19 proclaims a set of developing countries exempt, as defined by Note 11(d)(i) in the Annex to the proclamation on p.44. Item (4) on p.19 proclaims exceptions to these developing country exemptions, as defined by Note 11(d)(ii) in the Annex to the proclamation on p.44. The exceptions define product-specific exceptions that apply to Brazil, Moldova, Turkey, Venezuela, Thailand, India, and Romania.

Our US import data comes from the USITC DataWeb. We use 1998 imports for consumption at the 8-digit HS level in equation (4) to calculate the Bush steel tariff duties d_i in NAICS industry i that would be collected on the pre-Bush tariff level of imports. The employment data described in Appendix D.2.2 and the IO data described in Appendix D.2.1 provide 1998 US industry-level employment L_i and steel usage s_{ij} needed to compute industry-level protection from the Bush steel tariffs P_i in equation (5) and industry-level vulnerability to the Bush steel tariffs V_j in equation (6). The employment data described in Appendix D.2.2 provide the 1998 CZ-industry level employment data L_{jc} and L_c needed to compute CZ-level vulnerability to and protection from the Bush steel tariffs in equations (7)-(8).

Anti-dumping tariffs We obtain data on anti-dumping (AD) tariffs from the Global Antidumping Database - 1980's-2015 hosted by The World Bank and originally developed by Chad Bown. These data record AD tariffs τ_{kht}^{AD} faced by exporting country k for 8-digit HS product h in year t. We define steel products as HS Chapters 72 (Iron and Steel) and 73 (Article of Iron and Steel) and, with two exceptions, follow equations (4)-(8) to calculate local protection from steel AD tariffs P_{ct}^{AD} and local vulnerability to steel AD tariffs V_{ct}^{AD}.

The first exception is that we calculate local protection from and local vulnerability to the steel AD tariffs, P_{ct}^{AD} and V_{ct}^{AD}, at the annual frequency given the time-varying nature of AD tariffs which are, fundamentally, temporary trade barriers. The second exception is that, given the exporter-product nature of AD tariffs, we use 1998 exporter-product imports IM_{kh} instead of 1998 product imports IM_h to define steel AD duties d_i used in equation (4). Specifically, we use the following definition when computing time-varying industry-level and CZ-level protection from and vulnerability to steel AD tariffs:

$$d_{it}^{AD} = \sum_{h \in H(i)} \sum_{k} d_{kht}^{AD} = \sum_{h \in H(i)} \sum_{k} \tau_{kht}^{AD} IM_{kh}. \tag{D.1}$$

China shock As described above, our US import data come from the USITC DataWeb. Additionally, we obtain annual imports at the 6-digit HS level from China into the high-income countries used for the China shock instrument (Australia, Denmark, Finland, Germany, Japan, New Zealand, Sweden, and Spain) from COMTRADE via the World Bank's WITS database. We normalize all imports to thousands of 1998 dollars using the GDP implicit price deflator (series A191RD3A086NBEA from the St.Louis Fed's FRED database) and concord to NAICS 1997 as described in Appendix D.2.3. The employment data described in Appendix D.2.2 then allows us to compute Chinese imports per worker IPW_{ct} and its instrument IPW_{ct}^{IV} as in equations (9)-(10).

D.2.4 Other data

Steel prices Section 3 uses three data sources for steel prices. First, we hand-collected data from the industry magazine *Purchasing* for monthly steel prices covering the period January 1998 through September 2003 when they stopped publishing these data. These prices represent transaction prices paid by US firms consuming steel as they come from a survey of a large number of firms purchasing steel. The magazine was published monthly and published prices in dollars per ton for hot-rolled (HR) steel sheet, cold-rolled (CR) steel sheet, hot-dipped (HD) galvanized steel sheet, and cold-formed (CF) steel bar. The published data contain the "latest price" and the price from the "previous month". Where possible, we obtain the month t price as the "previous month" price published in month $t+1$ because it reflects any updates to the initially published "latest price". Occasionally, prices are not published in a given month. In this case, we obtain the month t price using the "latest price" published in month t. Our approach ensures complete monthly coverage for January 1998 through September 2003.

As a measure of steel prices received by US steel producers, we collect monthly producer price indices from the US Bureau of Labor Statistics (BLS) for the period January 1998 through December 2003. The series are HR steel sheet (PDU3312-311), CR steel sheet

(PDU3312-8), HD galvanized sheet (PDU3312-313) and CF bar (PDU3316-71).

Figure 2 uses unit values as a measure of the tariff-exclusive price received by foreign exporters. As throughout the paper, US import data comes from the USITC DataWeb. Using these data, unit values are simply import value divided by import quantity.

Industry and CZ characteristics The balance tests in panel A of Table 2 use 1998 industry characteristics. Except for the capital and high-tech share of investment from Acemoglu et al. (2016), we take all industry characteristics from the NBER-CES Manufacturing Database (Becker et al. (2013)). The 1990 CZ characteristics in the balance tests in panel B of Table 2 come from Autor et al. (2013).

Data used in heterogeneity analysis We obtain annual county-level house price index data from the Federal Housing Finance Agency. This data is only available for 2739 counties, it is not available for 402 counties. We concord the county-level house price index data to the CZ level using the concordance described in Appendix D.2.2 and aggregating house price indices across counties within a CZ using the 1998 county-level working-age population as weights that were described in Appendix D.2.2. 658 out of 722 US mainland CZs have at least one county with house price index data in 2000 and 2007 so that we can compute 2000-2007 house price growth. Construction employment is defined as the 2-digit NAICS sector 23.

We define military NAICS industries following the classification developed by Peacock (2014). She defines five military industries. First, Guns & Ammunition consists of the official NAICS industries 332992, 332993 and 332994 which concord to the single BEA NAICS 1997 industry 33299A. Second, Tanks & Armored Vehicles consists of the official NAICS industry 336992 which is also a BEA NAICS 1997 industry. Third, Shipbuilding consists of the official NAICS industries 336611 and 336612 which are also BEA NAICS 1997 industries. Fourth, Aircraft, Engine & Parts consists of the official NAICS industries 336411, 336412 and 336413 which are also BEA NAICS 1997 industries. Fifth, Space Vehicle & Missile Manufacturing consists of the official NAICS industries 336414, 336415 and 336419 which concord to the BEA NAICS 1997 industries 336414 and 33641A.

We define the auto sector as two 4-digit NAICS industry groups and one 6-digit NAICS industry: Motor Vehicle Manufacturing (3361); Motor Vehicle Body, Trailer, and Parts Manufacturing (336A); and Motorcycle, Bicycle, and Parts Manufacturing (336991). The remainder of the 3-digit NAICS sub-sector 336 (Transportation Equipment Manufacturing) consists either of the military industries defined above or the two non-auto 6-digit NAICS industries of that are not 336500 Railroad Rolling Stock Manufacturing and 336999 All Other

Transportation Equipment Manufacturing.

We obtain job turnover data from the Job Openings and Labor Turnover Survey from the BLS. Unfortunately, these data only vary across states and not within states. Thus, our job opening rate is state-level job openings as a share of state-level employment.

Establishment data We obtain establishment count data from the County Business Patterns (CBP). The CBP report annual establishment counts at the county level and at the county-industry level (4-digit SIC in the pre-1998 years and 6-digit NAICS in the post-1997 years). We define all establishments for a county using the county-level establishment counts. We define manufacturing and steel-intensive manufacturing establishment counts for a county using the county-industry establishment counts.

To do so, we concord these establishment counts to the 1997 NAICS system used by the BEA in the 1997 IO tables. First, we concord the post-1997 NAICS years from their native NAICS to 1997 NAICS as described in Appendix D.2.2. Second, we concord the pre-1998 SIC years to NAICS 1997 using Pierce and Schott (2012). Finally, we concord from NAICS 1997 to the NAICS 1997 system used by the BEA as described in Appendix D.2.2.