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. We find 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. These large and persistent negative effects were concentrated in local labor markets that had low human capital or were strongly specialized in steel-consuming industries.

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1 Introduction

Economists, policy makers and the general 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 importable goods they use as intermediate inputs. The unprecedented breadth and scale of the Trump administration's tariff war brought this negative effect of tariffs to the front of the public discussion. Indeed, Trump's first attack in the tariff war was the Section 232 "national security" tariffs on steel and aluminum that are key inputs for the US manufacturing sector. And, his subsequent attacks on China prioritized tariffs on intermediate goods and capital goods that firms use as inputs rather than prioritizing tariffs on goods bought by the general public (Bown (2019)). 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.

While the recent tariff war renewed public interest and policy-making focus on the adverse effects on firms who rely on importable goods as intermediate inputs, 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 President Bush 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.

In this paper, we analyze the impact of the Bush steel tariffs on employment in steel-consuming (i.e. downstream) industries and the steel-producing industry. Our analysis uses a generalized difference-in-difference methodology in a local labor markets setting. In June 2001, President Bush 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 10-30% 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 on their use of steel as an input. After controlling for various factors (including time-varying state-level trends, time-varying national shocks, time-invariant CZ-level attributes, and time-varying Chinese import competition), 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 three main results. First, the Bush steel tariffs had large negative short-run effects on local steel-consuming employment but no notable positive effects on local employment in the steel industry. We alternatively think of the steel-consuming industry as the entire manufacturing sector or the most steel-intensive subset of industries within manufacturing. Conditional on the controls, there is no pre-trend in local steel-consuming employment (as a share of the CZ-level 2000 working-age population) during the pre-Bush steel tariff period of 1998-2000. We find statistically and economically significant effects once the Bush steel tariff process starts in 2001, especially in the highly steel-intensive industries, and these effects continue growing through 2002 and 2003. A change in CZ-level vulnerability to the Bush steel tariffs between the 25th and 75th percentile explains about 40% of the change in the manufacturing employment share between 2000 and 2003. This number rises to around 100% of the change in the employment share for the most steel-intensive industries. Thus, our results emphasize the negative downstream employment effects of tariffs levied on key inputs and downplay any potential positive effects for the protected industry.

Our second main result is that 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. This striking result is true for both employment in the overall manufacturing industry and in the most steel-intensive manufacturing industries.

Our third main result explores the mechanism behind these negative and, especially, persistent effects of the Bush steel tariffs on steel-consuming employment. We focus on two mechanisms emphasized in the recent literature on trade shocks and local labor market outcomes: an inability of CZs to deal with negative trade shocks due to the low human capital of their workforce (Bloom et al. (2019)) and reverse agglomeration (Dix-Carneiro and Kovak (2017)). We find an important role for human capital. CZs above and below the median of the college-educated population share both experience similar negative impacts on steel-consuming employment during the Bush tariff years of 2001-2003. But, CZs above the median see these negative effects dissipate quickly while CZs below the median see these persist for at least five years after the Bush steel tariffs end. We find an even stronger role for reverse agglomeration. CZs weakly specialized in steel-consuming industries, based on employment shares at the beginning of our sample in 1998, do not see any negative effects of the Bush steel tariffs on steel-consuming employment. Rather, CZs strongly specialized in steel-consuming industries drive all of the large negative and persistent effects in our baseline analysis. Ultimately, consistent with recent literature, we find that human capital and reverse agglomeration are important channels that mediate the impact of local labor market shocks.

As pointed out by Cox and Russ (2018), "Estimates of job losses in steel-using industries as a consequence of the [Bush] safeguard tariffs imposed in the early 2000s are few but range from 26,000 to 200,000 jobs." Moreover, the two studies referenced here are both policy-focused analyses rather than academic-focused analyses. At the high end, and still very often-cited by the media, is the analysis of Francois and Baughman (2003) carried out by their international trade consultancy firm Trade Partnership for the lobby group Consuming Industries Trade Action Coalition (CITAC).[1] They obtain their 200,000 job loss result using 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.[2] At the low end with their 26,000 job loss result is Hufbauer and Goodrich (2003) in a policy analysis for the non-partisan Peterson Institute for International Economics. To the best of our knowledge, ours is the first academic analysis on the employment effects of the Bush steel tariffs.

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 to ours is a subsequent paper by Cox (2022). Despite the methodological differences between Cox's 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. Interestingly, these effects appear part of a persistent

[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] Obtaining a job loss number due to the Bush steel tariffs is difficult in a difference-in-difference setting because the treatment effect measures the relative effect of the treatment between the treated and untreated groups. However, we get a job loss number in 2003 of around 110,000 jobs if we (1) take our 2003 point estimates for the effect of the Bush steel tariffs on manufacturing employment, and (2) multiply by each CZ's vulnerability to the Bush steel tariffs, and (3) multiply by each CZ's working-age population to convert into an absolute jobs number, and (4) and aggregate across all CZs.

restructuring by foreign buyers away from US exporters to other top exporting countries. Moreover, Cox (2022) also confirms that downstream steel-intensive industries experienced persistent employment declines following the Bush steel tariffs.

Most closely related to our paper in the strand of the literature on Trump's trade war tariffs is Flaaen and Pierce (2020).[3] 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 (2020), 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 (2020) 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, 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 (2020) 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.[4] Like us, Barattieri and Cacciatore (2020) 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

[3]Various recent papers have focused on the negative effects of the Trump administration's trade war. Multiple papers have focused on the fact that the tariff increases were indeed passed on to US importers rather than foreign exporters (e.g. Amiti et al. (2019); Fajgelbaum et al. (2020); Cavallo et al. (2021)). Handley et al. (2020) 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.

[4]In an extension, Barattieri and Cacciatore (2020) show their results are robust to including safeguard tariffs.

understanding of real world implications of trade policy.

The second closely related strand of the literature establishes that trade shocks can have persistent effects on employment. Dix-Carneiro and Kovak (2017) show that Brazilian regions exposed to greater unilateral liberalization in the early 1990s had worse earnings and employment outcomes and that these effects continued growing for at least 10 years after the liberalization. Autor et al. (2021) show that CZs more exposed to Chinese import competition in the 2000-2007 period had worse labor market outcomes even in 2019. While these studies emphasize the persistent effects of *permanent* trade shocks, our results emphasize the persistent effects of *temporary* trade shocks.

Finally, the third closely related strand of the literature investigates mechanisms behind the persistence of trade shocks. The literature has emphasized how the ability of firms to change the types of things they produce (Bloom et al. (2019)) and the ability of local economies to reallocate workers between industries (Autor et al. (2021)) depends on the education level of their workforce.[5] Dix-Carneiro and Kovak (2017) 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 local labor demand shocks over time. Cox (2022) builds a model showing how temporary tariffs can disrupt buyer-seller relationships and how such disruptions can persist due to relationship-specific fixed costs and presents supporting calibration evidence in the context of the Bush steel tariffs. Our analysis complements the literature emphasizing the human capital and reverse agglomeration mechanisms by showing that whether the negative effects from a temporary tariff shock become persistent can depend on the CZ's level of human capital and its initial level of specialization in the industries directly and adversely affected by the shock.[6]

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. Section 4 presents our local labor markets analysis. Section 5 concludes.

[5] This strand of the literature builds on earlier work emphasizing the more general idea that a location's ability to deal with negative economic shocks depends on the education level of its workforce (e.g. Glaeser and Scheinkman (1995) and Diamond (2016)). As proxied by the CZ's college-educated population share, and in response to strong import competition from China, Bloom et al. (2019) show how firms in high human capital CZs switched production from manufacturing to services but firms in low human capital CZs simply shut down. Autor et al. (2021) show how workers in high human capital CZs, but not low human capital CZs, transitioned from manufacturing to non-manufacturing industries within their CZ in response to strong import competition from China.

[6] While Cox (2022) focuses on the negative effects for exporters in the US steel-consuming industry and hence US exporter relationships with foreign buyers, the same mechanism should also operate when domestic US firms and consumers buy products from the US steel-consuming industry. Thus, relationship-specific fixed costs could also be important for understanding our persistence results.

2 Institutional background

A key issue for our analysis is whether the timing of the Bush steel tariffs are 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 that the institutional and historical background of the steel industry and their demand for protection imply the timing of the Bush steel tariffs is plausibly exogenous. Intuitively, the idea is twofold. First, the steel industry was undergoing a large-scale and long-term restructuring process during the 1980-2010 period and was continually 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. The remainder of this section expands on the institutional background behind the Bush steel tariffs.

2.1 Temporary trade barriers

The WTO explicitly allows three types of temporary trade barriers. The two most common types are CV duties and, especially, AD duties. These tariffs are applied against specified offending countries and US industries can petition the US government for these under the Tariff Act of 1930. In either case, US industries must suffer material injury – as adjudicated by the USITC – and foreign firms must be "dumping" their product in the US at below fair market value or exporting it to the US with the benefit of foreign government subsidies – as adjudicated by the Department of Commerce. If both criteria are satisfied, the Department of Commerce imposes the associated duties.

The third type of temporary tariff barrier is a safeguard tariff which is applied against all imports of a product. Emphasizing their rarity, safeguard tariffs were not used between Bush's steel safeguard tariffs and President Trump's 2018 safeguard tariffs on solar panels and washing machines. Section 201 of the 1974 Trade Act allows the USITC to investigate whether import surges are a *substantial* cause of *serious* injury to a domestic industry and write a report with policy recommendations. The USITC can self-initiate a Section 201 investigation or it can be triggered by a trade association, firm, union, or group of workers. After considering the USITC's report and recommendations, the President decides on what policies, if any, will be implemented. The notably higher bar for imposing safeguard tariffs than AD and CV duties coupled with the subsequent Presidential discretion over the final decision helps explain their rarity.

2.2 The US steel industry

The US steel industry underwent a long period of transformative restructuring during the 1980s, 1990s and 2000s. Historically, the US steel industry consisted of integrated mills that, as part of a vertically integrated process, converted raw steel inputs into finished steel products. These mills produced basic bulk steel products at large-scale using very capital-intensive but outdated technologies (Read (2005)). However, the 1980s and 1990s saw the emergence of mini-mills that converted scrap metal into finished steel. These mills produced small-batch niche steel products at smaller scale using less capital intensive but more advanced technologies (Read (2005)). A lot of restructuring had already happened by the late 1990s: mini-mills had as much as 40% market share in certain steel products, dozens of inefficient integrated mills had closed, and the steel industry labor force had fell more than 50% (Devereaux et al. (2006)).

Nevertheless, problems persisted. Although operating at large-scale, US integrated mills operated at smaller scale than many of their foreign counterparts. The top 6 EU steel firms accounted for two-thirds of EU steel output in the early 2000s at an annual average of 27 million tonnes each. In contrast, it took the top 12 US firms to produce two-thirds of US steel output with each producing an annual average of only 8.5 million tonnes (Read (2005)). Consolidation in the industry was also hampered by soaring "legacy" costs of integrated mills in the form of generous wages and as well as health, pension, and severance benefits (Devereaux et al. (2006)). Global factors including low-price foreign competition and global excess steel capacity also presented ongoing challenges (Devereaux et al. (2006)).

2.3 Demand for steel protection and steel safeguard tariffs

The ongoing challenges faced by the US steel industry despite the transformative restructuring process led to continued demand for protection during the 1980s, 1990s and 2000s. Before President Clinton took office in January 1993, US presidents imposed quota-like restrictions on the volume of steel imports nearly continuously since President Nixon began doing so in 1969. In the 1980s and early 1990s, President Carter did so through allowing limited imports when sold above a certain price while Presidents Reagan and George H. Bush did so through voluntary export restraints negotiated with US trading partners (Devereaux et al. (2006)). After the voluntary export restraints expired under President George H. Bush, AD duties became the standard form of steel industry protection. In the 1992-2002 period, nearly 500 8-digit HS products received AD duties and more than 60% of them were steel products (see Section 4.3.3). Given AD duties only impose tariffs on steel imports from specified countries, the steel industry began pushing for safeguard tariffs during President Clinton's terms because they hit all steel imports.

The Clinton administration seriously considered imposing steel safeguard tariffs (Devereaux et al. (2006)). Members of Congress such as Democratic Senator John Rockefeller from West Virginia, who was a close friend of President Clinton, and administration officials in the Commerce Department and the USITC supported steel safeguard tariffs. But Treasury Secretary Robert Rubin and his successor Lawrence Summers were very influential voices against the safeguard tariffs because, in various ways, they would damage the regular and predictable access to foreign markets that underpinned the economic success of the Clinton years. Ultimately, although sympathetic to the plight of US steel workers, President Clinton was proud of his free trade accomplishments, which included the controversial passage of NAFTA, and he saw safeguard tariffs as a blemish on his record.

After years of unsuccessfully pressuring the Clinton administration to initiate a Section 201 safeguard investigation, the steel industry's chances of successfully pressuring the Bush administration initially seemed low. Neither the steel unions nor key politicians in the Congressional Steel Caucus had strong relationships with President Bush or key members of his administration. Moreover, important pillars of President Bush's 2000 electoral campaign against Al Gore were free trade and free markets (Devereaux et al. (2006)). However, things changed quickly and unexpectedly (Devereaux et al. (2006)). By May 2001, less than 4 months after taking office, the Bush administration was seriously considering safeguard tariffs. On June 5 2001, President Bush surprised steel firms, the steel union, and Congress by announcing it would ask the USITC to investigate steel safeguard tariffs. By October 2001, the USITC concluded its investigation and found that an import surge of steel was a substantial cause of serious injury being suffered by the steel industry and recommended tariffs on a wide range of steel products (USITC (2001)).

Given the Bush administration self-initiated the steel safeguard investigation, it was fully expected that President Bush would impose safeguard tariffs. He did so in March 2002 and largely followed the USITC report's recommendations by imposing steel tariffs of 13%-30% on over 170 8-digit HS steel products.[7] These tariffs were set to phase out by March 2005. However, the WTO agreed with the EU and other countries that the safeguard tariffs did not meet the required WTO criteria. While the EU consistently threatened retaliatory tariffs, eventually on a list of US exports worth over $2bn, it agreed to postpone implementing the tariffs until December 2003 following the US appeal at the WTO (Devereaux et al. (2006)). After the US lost their appeal in November 2003, President Bush complied with the WTO ruling and removed the tariffs in December 2003.[8]

[7] See Presidential Proclamation 7529 of March 5, 2002.

[8] Further information on this WTO dispute can be found on the WTO website.

3 Impact of Bush tariffs on steel prices and imports

Our research question revolves around the employment effects of the Bush steel tariffs. However, any such effects should stem 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 the level of US steel imports. Thus, this section investigates the impacts of the Bush steel tariffs on the price of steel in the US and the level of US steel imports.

Two important institutional features of the Bush steel tariffs guide our estimation strategy. First, President Bush granted various countries exemptions to the steel tariffs in his Presidential Proclamation 7529 that specified the safeguard tariffs. In particular, Bush largely exempted US Free Trade Agreement partners (Canada, Mexico, and Israel) and beneficiaries of the US Generalized System of Preferences program (developing countries) since these countries were already getting tariff free access to the US.[9,10] Second, the USITC investigation into steel safeguard tariffs covered a large set of products but it recommended tariffs on only about 60% of investigated products. That is, the USITC recommended "exempting" certain steel products from the safeguard tariffs. Indeed, President Bush largely followed this recommendation. Thus, ultimately, there were not only some exempt and non-exempt exporting countries but also some exempt and non-exempt steel products.

An obvious strategy to estimate the impact of the Bush steel tariffs on US prices and US imports would be a difference-in-difference type estimator revolving around the first institutional feature: some countries were exempt from the steel tariffs. Looking at products hit with the Bush steel tariffs, one could then see how US prices and imports changed around the time of the Bush steel tariffs and whether they changed differentially between non-exempt versus exempt countries. Any differential effects would appear to reflect impacts of the Bush steel tariffs. However, a problem with this approach is that such differential effects could instead represent that non-exempt and exempt countries were experiencing different kinds of steel industry shocks (e.g. non-exempt countries might have been experiencing productivity shocks in the broader steel industry that exempt countries were not).

The second institutional feature of the Bush steel tariffs helps solve this problem: some steel products were exempt from the steel tariffs. Specifically, one could conduct the same difference-in-difference analysis described above but for exempt products. Subtracting this second difference-in-difference estimate for exempt steel products from the first difference-

[9] As described by Besedeš et al. (2020), there were still some phase-out of US MFN tariffs on Canada and Mexico left in 2001. As laid out in the annual US Harmonized Tariff Schedule that specifies the product-by-product tariffs applied by the US on each of its trading partners, some products are excluded from the GSP program and some exporters are excluded from the program on a product-by-product basis.

[10] See Presidential Proclamation 7529 for further details.

in-difference estimate for non-exempt steel products would then purge the first estimate of any steel industry shocks differentially affecting the exempt versus non-exempt countries.

We implement this idea using a generalized triple difference specification. The variable nonExempt_j indicates whether exporting country j is exempt from the Bush steel tariffs per Presidential Proclamation 7529. τ_h is the Bush steel safeguard tariff for HS8 product h in 2002. Product h is exempt from the Bush steel tariffs with $\tau_h = 0$ if the USITC recommends it not receive a tariff in USITC (2001) and President Bush does not impose a tariff in Presidential Proclamation 7529. The dependent variable could be either imports of product h from exporter j in year t for the period 1998-2003 – which come from Besedeš et al. (2020) as either imports in value m_{jht} or quantity q_{jht} – or the price received by the exporter as proxied by its unit value $p_{jht} = \frac{m_{jht}}{q_{jht}}$.[11] Denoting fixed effects by γ, our triple difference specification is then

$$\ln y_{jht} = \boldsymbol{\theta} \ln\left(1+\tau_h\right) \times 1\left(\text{nonExempt}_j\right) \times \mathbf{Year}_t + \gamma_{ht} + \gamma_{jt} + \gamma_{jh} + \varepsilon_{jht}. \qquad (1)$$

where $\mathbf{Year}_t = (1998, 1999, 2001, 2002, 2003)$ is a vector of year dummies with the year 2000 as the omitted base year. ε_{jht} is the mean zero error term.

The coefficients of interest are the vector $\boldsymbol{\theta}$. This vector contains a separate coefficient for each year in the 1998-2003 period except the omitted base year 2000. Intuitively, the coefficient θ_t represents the change between 2000 and year t in the dependent variable y_{jht} for *non-exempt steel products* in exempt versus non-exempt countries (the first difference-in-difference) vis-a-vis the change between 2000 and year t in the dependent variable y_{jht} for *exempt steel products* in exempt versus non-exempt countries (the second difference-in-difference).

Figure 1 shows the results. We treat the year 2000 as the base year because this is the last year before the Bush steel tariff process started in early-mid 2001. There is no evidence of a pre-trend because all point estimates are statistically insignificant in 1998 and 1999.

Panel (a) illustrates the pass through elasticity from the Bush steel tariffs to the tariff-exclusive price received by the foreign exporter. As expected, the point estimates in the pre-Bush steel tariff period of 1998-1999 are not only statistically insignificant but also imprecisely estimated. The point estimates of around 0.3 indicate a 70% pass through to the tariff inclusive US importer price but the point estimate of around 0.9 at the edge of the 95% confidence interval in 1998 indicates only a 10% pass through to the tariff inclusive US importer price. However, the Bush steel tariff period of 2001-2003 allows a fairly precise estimate of the pass through elasticity. Even the largest point estimate of around 0.05 says

[11] The data in Besedeš et al. (2020) is from the USITC dataweb. See Besedeš et al. (2020) for more details.

that 95% of the tariff passes through to the tariff inclusive US importer price and the point estimate of around 0.5 at the edge of the 95% confidence interval still indicates 50% of the tariff passes through to the tariff inclusive US importer price. These very small pass through elasticities to the tariff exclusive foreign exporter price and, in turn, large pass through elasticities to the tariff inclusive US importer price is consistent with recent literature on the Trump trade war (e.g. Amiti et al. (2019); Fajgelbaum et al. (2020); Cavallo et al. (2021)) and NAFTA (Besedeš et al. (2020)).

Panels (b) and (c) illustrate the elasticity of US imports to the Bush steel tariffs. Especially in 2002 and 2003, the effect of the Bush steel tariffs is statistically significant and similar in magnitude to the broader trade literature. In terms of import values or import quantities, the point estimates in the $2.5 - 4.5$ range indicate that US imports fall about 2.5% in response to a 1% tariff increase. This fits in the Simonovska and Waugh (2014) range of $2.8 - 4.5$ and at the lower end the $4 - 8$ traditional range of trade elasticity estimates in the trade policy literature reported by Ruhl et al. (2008). However, Ruhl et al. (2008) discusses that elasticity estimates tend to be notably lower in the $0 - 3$ range when estimated using transitory shocks rather than permanent shocks. Given safeguard tariffs are legislated as temporary tariffs, our elasticity estimates fit squarely in the expected range based on prior literature.

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 tariffs as a trade policy shock.

4 Impact of Bush steel tariffs on local labor markets

4.1 Empirical methodology

Letting c index commuting zones (CZs) and t index periods, the simplest difference-in-difference (DD) specification would be

$$y_{ct} = \alpha_0 + \boldsymbol{\alpha}_1 \boldsymbol{B}_c + \alpha_2 Post_t + \boldsymbol{\beta} \boldsymbol{B}_c \times Post_t + \varepsilon_{ct}. \tag{2}$$

Here, y_{ct} is a labor market outcome at the CZ-year level. As a share of the 2000 CZ working-age population, our main labor market outcomes are the share of manufacturing employment, the share of employment in steel-consuming industries and the share of employment in steel-producing industries. $\boldsymbol{B}_c = [V_c \ P_c]$ is a vector of time-invariant measures of CZ exposure to the Bush steel tariffs: V_c is a measure of vulnerability to using steel as an intermediate input and P_c is a measure of protection afforded to steel production. $Post_t$ is an indicator variable for whether year t is 2001 and onwards 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.

Since the vector of coefficients of interest is $\boldsymbol{\beta}$, fixed effects can control for various confounding factors. Using CZ and time fixed effects yields the following specification:.

$$y_{ct} = \alpha_0 + \boldsymbol{\beta}\boldsymbol{B}_c \times Post_t + \gamma_c + \gamma_t + \varepsilon_{ct}. \tag{3}$$

This controls for time-invariant CZ variables such as a CZ's historical dependence on manufacturing, steel production, and steel consumption (e.g. initial employment shares in these sectors). The time fixed effects control for time-varying national shocks including business cycle fluctuations.

Our main specification goes further in three ways. First, we allow time-varying treatment effects $\boldsymbol{\beta} = (\boldsymbol{\beta}_{1998}, \boldsymbol{\beta}_{1999}, \boldsymbol{\beta}_{2001}, ..., \boldsymbol{\beta}_T)$ with 2000 being the omitted base period and T indexing the last year in our sample (we will alternatively use $T = 2003$ or $T = 2008$). Thus, our time-varying treatment effects are always measured relative to this base period. These time-varying treatment effects allow for differential pre-trends corresponding to a CZs level of exposure to the Bush steel tariffs. They also allow the effects of the steel tariffs to emerge immediately or slowly after their implementation and to persist throughout the sample period or reverse themselves after the steel tariffs are removed in late 2003. Second, we add state-year fixed effects to control for time-varying shocks at the state-level rather than at the national-level (e.g. state-level rather than national-level business cycle fluctuations). Third, given the large literature emphasizing the adverse impacts on US labor market outcomes of rising Chinese import penetration over our sample period, we control for CZ-by-year exposure to Chinese import competition (IP_{ct}). Ultimately, our main specification is

$$y_{ct} = \alpha_0 + \boldsymbol{\beta}\boldsymbol{B}_c \times \mathbf{Year}_t + \delta IP_{ct} + \gamma_c + \gamma_{st} + \varepsilon_{ct}. \tag{4}$$

where $\mathbf{Year}_t = [1998_t, 1999_t, 2001_t, ..., T_t]$ is a vector of year dummies such that, for example, $1998_t = 1$ if $t = 1998$.

A key consideration when addressing identification issues in a difference-in-difference framework is whether the parallel trends assumption holds. Our use of time-varying treatment effects directly illustrate the plausibility of this assumption. Specifically, pre-trends will show up as economically and statistically significant effects in the years of 1998 and 1999 before the year 2000 base period.

4.2 Data

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

We concord the 8-digit HS Bush steel tariff products to the 6-digit NAICS industries in the BEA I-O tables.[12] The 171 8-digit HS products hit with Bush steel tariffs map into four 6-digit NAICS products $i = 331111, 331222, 332910, 335120$. Respectively, these are Iron and Steel Mills, Steel Wire, Metal Valve Manufacturing, and Lighting Fixture Manufacturing.

Using the 1997 BEA input-output (I-O) tables, we collect measures of how much each 6-digit NAICS industry j relies on each 6-digit NAICS Bush steel tariff industry i as an input. Specifically, we collect the *direct requirement* that represents industry j's purchases of industry i as an input per \$100 of industry j output and *the total requirement* that measures this as well as the amount of industry i embedded in other inputs used by industry j per \$100 of industry j output. We denote these requirements by r_{ij} with the context making clear whether this is a direct requirement or a total requirement.

Table 1 summarizes the direct and total requirement data. Panel (a) lists the top intermediate inputs measured in terms of the average total requirement per \$100 of output across all industries in the economy. The top four intermediate inputs are outside manufacturing, but are also much more aggregate 2-digit or 3-digit NAICS industries: Wholesale Trade, Management, Real Estate, and Truck Transportation. 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 in the economy uses \$2.67 of this steel per \$100 of its output either directly or embedded in its other inputs. Rounding out the top five most important manufacturing inputs are Petroleum Refineries, Other Basic Organic Chemical Manufacturing, Paper and Paperboard Mills, and Semiconductors and Related Device Manufacturing with an average usage by other industries of \$1.46-\$2.09 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 the steel hit by the Bush steel tariffs.

Panel (b) of Table 1 shows the industries that most rely on the four steel industries hit by the Bush steel tariffs. Usage in panel (b) is defined as the sum of the total or direct requirement across the four industries hit with Bush steel tariffs. Panel (b) shows that the ranking of industries who most rely on steel is very similar regardless of whether input usage

[12] To do so, we first use the HS to NAICS 1997 concordance from Pierce and Schott (2012) and then use the BEA concordances provided with their I-O tables to go from NAICS 1997 to the BEA's NAICS I-O 1997 codes.

is defined as total or direct requirements. The industry that most relies on the Bush steel tariff industries is Rolled Steel Shape Manufacturing with a total requirement of the Bush steel tariff industries of \$40.51, and a direct requirement of \$39.36, per \$100 of output. The 20 industries that most rely on steel use a total requirement of at least \$14 per \$100 of output and these industries all have a direct requirement of steel of at least \$9.50 per \$100 of output. Ultimately, many manufacturing industries rely very heavily on the steel industries hit by the 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. V_c captures a CZ's vulnerability to the Bush steel tariffs through its reliance on local production that uses steel as an input. In contrast, P_c captures the protection received by a CZ through its local steel production.

We use three steps to construct the CZ-level measure of vulnerability to the Bush steel tariffs V_c. First, we use 1998 import weights from the USITC Dataweb to aggregate from 8-digit HS Bush steel tariffs to 6-digit NAICS tariffs used by the 1997 BEA I-O tables (see Section 4.2.1). Aggregating across 8-digit HS products h, the Bush tariff for 6-digit NAICS industry i is

$$\tau_i = \sum_{h \in H(i)} \tau_h \frac{IM_h}{IM_i} \tag{5}$$

where $H(i)$ is the set of 8-digit HS Bush steel tariff products that map to 6-digit NAICS industry i and IM denotes imports. As described above, the 171 8-digit HS products hit by the Bush steel tariffs map into four 6-digit NAICS products $i = 331111, 331222, 332910, 335120$.

Second, we construct a measure of how much CZ c relies on these four 6-digit NAICS steel industries. Specifically,

$$R_{ci} = \sum_j \frac{r_{ij} e_j}{L_j} \frac{L_{jc}}{L_c}. \tag{6}$$

Here, we start with the total requirement r_{ij} of NAICS steel industry i used by NAICS industry j (per \$100 of industry j output). We then multiply by industry j's output e_j to get the total requirement of steel i to produce the industry-level output e_j and divide by US industry j employment to get a per US industry-j worker measure of reliability on steel i. To convert into the CZ-level measure R_{ci}, we aggregate across all industries j using the employment shares $\frac{L_{jc}}{L_c}$ in CZ c noting that all of our employment data comes from the County Business Patterns (CBP). Ultimately, R_{ci} is a per-worker measure of how much CZ c relies on the 6-digit NAICS steel industry i as an intermediate input.

Third, after scaling by the Bush steel tariff on NAICS steel industry i, we aggregate across the NAICS steel industries to get an overall measure of CZ vulnerability to the Bush steel tariffs. Thus, our final measure of CZ-level vulnerability to the Bush steel tariffs is:

$$V_c = \sum_i \tau_i R_{ci}. \tag{7}$$

We use two steps to construct the CZ-level measure of protection P_c for local steel production by the Bush steel tariffs. To proxy for an industry's size, we start with a US-level output per worker measure for steel industry i: $\frac{e_i}{L_i}$. We then scale this by the Bush steel tariff for industry i and aggregate to the CZ-level using CZ-level employment shares:

$$P_c = \sum_i \tau_i \frac{e_i}{L_i} \frac{L_{ic}}{L_c}.$$

Figure 2 shows the spatial distribution of CZ-level vulnerability to the Bush steel tariffs V_c and CZ-level protection from the Bush steel tariffs P_c. Panel (a) illustrates vulnerability V_c. It shows the Rust Belt states of Michigan, Indiana and Ohio are particularly vulnerable to tariffs on steel through their reliance on steel as an input but that this vulnerability stretches down a corridor through Kentucky, Tennessee, Alabama and Mississippi. Other pockets of particular vulnerability include south-east Texas and around the Gulf Coast into Louisiana; western Texas and south-eastern New Mexico; north-eastern North Dakota and north-west Wisconsin; and the mountain states of Wyoming, Colorado, and Utah and into north-east Nevada. Given our estimation strategy uses state-year fixed effects, panel (b) illustrates vulnerability after removing state fixed effects.[13] As expected, this generates a lot more variation across the US and this variation underpins our later results.

Panel (c) illustrates protection P_c. About 46% of all CZs have no employment in the four Bush steel tariff industries and hence $P_c = 0$. The CZs receiving most protection are scattered across the US with the biggest cluster in the Rust Belt areas of eastern Michigan, eastern Ohio, and western Pennsylvania. While positively correlated, the correlation between vulnerability V_c and dependence P_c is not very strong with a correlation coefficient of 0.38. Panel (d) illustrates protection after removing state fixed effects and shows more variation across the US. In particular, panels (b) and (d) show the different geographic variation in vulnerability and protection underlying the separate estimates of their effects in our later results.

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

4.2.3 CZ-level exposure to Chinese import competition

Given the rapid rise in import competition from China during the early 2000s, we control for a time-varying measure of Chinese import competition. Specifically, we define import penetration from China for CZ c in year t as

$$IP_{ct} = \sum_j \frac{\sum_{h \in H(j)} IM_{ht}^{CHN}}{L_{j1998}} \frac{L_{jc1998}}{L_{c1998}}. \tag{8}$$

Chinese import data comes from the USITC dataweb and we aggregate Chinese imports from the HS8 level to the 6-digit NAICS level. After dividing by 1998 US employment in a 6-digit NAICS industry j to get a US per worker measure of Chinese import penetration, we aggregate to the CZ-level using the CZ's time-invariant 1998 employment composition across all 6-digit NAICS industries j.

Figure 3 shows the spatial distribution of Chinese import penetration for the year 2002. Comparing this with Figure 2 clearly shows that CZ-level exposure to Chinese import penetration is largely uncorrelated with CZ-level vulnerability to or protection from the Bush steel tariffs. More formally, at the CZ-level in 2002, the correlation between Chinese import penetration IP_{ct} and vulnerability V_c is only 0.062 and is only 0.002 between Chinese import penetration IP_{ct} and protection P_c. Thus, our variables capturing CZ-level exposure to Chinese import penetration and the Bush steel tariffs are really capturing very different trade shocks.

4.2.4 Employment outcomes

All of our employment data comes from the County Business Patterns (CBP) for the sample period 1998-2008. Our main analysis uses three CZ-level employment variables, each expressed as a share of the 2000 CZ working-age population.[14] First, manufacturing employment covers the 2-digit NAICS sectors 31-33. Second, we define the most steel-intensive subset of manufacturing industries as the "steel-consuming industry". These 6-digit NAICS industries have a direct requirement in at least one of the four 6-digit NAICS steel industries hit by the Bush steel tariffs above \$5 per \$100 of output. There are 61 of these industries (see Table 1 for a snapshot) and cover about 20% of US manufacturing employment. Third, the steel-producing industry covers the four 6-digits NAICS steel industries hit by the Bush steel tariffs. In extensions, we also consider two additional employment variables, again as a share of the 2000 CZ working-age population: non-manufacturing and overall employment.

[14] To get CZ working-age population, we use PUMA-level 2000 decennial data from IPUMS and concord to the county-level and then the CZ level using the concordances from Autor and Dorn (2013) (obtained from David Dorn's website).

Figure 4 shows how these five employment share variables change over our 1998-2008 sample for the US. Panel (a) plots each employment share relative to its own 2000 value while panels (b) and (c) show how these shares vary over time. For the three main employment share variables – manufacturing, steel-consuming industries, and steel-producing industries – panel (a) shows each is around 80% of its 2000 value by 2008. In levels, panel (b) shows the manufacturing employment share falls by 2.2% points from 9.8% in 1998 to 7.6% in 2008 (left-hand axis) and the steel-consuming industry employment share falls by 0.4% points from 1.9% to 1.5% over this same period (right-hand axis). The fall in steel-consuming industries is about 20% of the fall in the manufacturing sector and matches its employment share within manufacturing and makes it an important industry within the US economy. The steel-producing employment share falls by a small absolute amount of 0.05% points from 0.2% to 0.15%. Each of these employment share variables, especially the steel-consuming industry employment share, decline particularly quickly in the 2001-2003 window.

In contrast to the manufacturing employment share and employment shares within manufacturing, panel (a) shows the non-manufacturing employment share rises from around 95% of its 2000 level in 1998 to about 110% of its 2000 level in 2008. In turn, the overall employment to working-age population share rises from around 95% of its 2000 level in 1998 to about 105% of its 2000 level in 2008. In levels, panel (c) shows the non-manufacturing employment share rises 8.9% points from 51.8% in 1998 to 60.7% in 2008 and leads the overall employment to working-age population ratio to increase by 6.4% from 61.8% to 68.2%.

Figure 5 illustrates the CZ-level variation in employment outcomes over the 2000-2003 period. This period starts the year before the investigation process for Bush steel tariffs began and ends in the year where Bush removed the steel tariffs. Panels (a), (c) and (e) depict the employment share changes for manufacturing, steel-consuming industries and steel-producing industries respectively while panels (b), (d) and (f) remove CZ and state-year fixed effects. Panel (a) shows the decline in the manufacturing employment share over this period is heavily concentrated in the eastern half of the US. In fact, manufacturing employment shares actually increase in the top 20% of CZs and these are concentrated in the western half of the US. After removing the fixed effects, panel (b) shows much more geographic variation that underlies our later results. Comparing panels (a)-(b) with panels (a)-(b) of Figure 2 reveals a negative correlation, especially in the Rust Belt states of Michigan, Indiana and Ohio, and is suggestive of our later results. While still heavily concentrated in the eastern half of the US, panel (c) shows more geographic variation in terms of the contraction in steel-consuming industry employment. After removing the fixed effects, a comparison of panels (c)-(d) and panels (a)-(b) of Figure 2 again reveals a negative correlation especially in the same Rust Belt states. Overall, Figures 2 and 5 give a good idea of the variation underlying our main results later about the negative consequence of the Bush steel tariffs.

Panel (e) of Figure 5 shows the change in steel-producing industry employment. It shows a general decline in western Pennsylvania, eastern Michigan and north-eastern Ohio which corresponds to panel (c) of Figure 2 as the areas most dependent on employment in the Bush steel tariff industries. Nevertheless, the correlation between employment declines and protection P_c is not as visually obvious as the correlation between vulnerability and employment.

4.3 Results

4.3.1 Short run results

Standard international trade theory suggests that steel tariffs should boost production of steel but reduce production of firms that use steel as a key intermediate input. To the extent that industrial employment is positively correlated with industrial production, employment should rise in the steel-producing industry but fall in industries that rely on steel as an important intermediate input. In turn, the net effect on manufacturing output is ambiguous given the key nature of steel as an input throughout the manufacturing sector.

We begin by showing results that include both the 1998-2000 period before the Bush steel tariff process began and the 2001-2003 period that finishes with President Bush removing the steel safeguard tariffs in December 2003. Figure 6 shows these results. It shows the relevant point estimates and 95% confidence intervals for the time varying treatment effects $\boldsymbol{\beta}_t$ from equation (4). Panel (a) shows the effects of vulnerability V_c to the Bush steel tariffs on manufacturing employment as a share of the 2000 CZ-level working-age population. Importantly, panel (a) shows the absence of a pre-trend: our measure of vulnerability to the Bush steel tariffs does not impact the change in employment between either 1998 or 1999 and 2000. Moreover, these point estimates are very small. However, panel (a) shows statistically significant negative point estimates from 2001 onwards. That is, manufacturing employment fell more in CZs that were more vulnerable to the Bush steel tariffs. This effect increases by about 75% from 2001 to 2002 and then another 10% in 2003.

These effects from panel (a) are economically significant. To see this, we multiply the 2003 point estimate from equation (4) by the change between the 25th and 75th percentiles of vulnerability to Bush steel tariffs and express it as a share of the mean change in the CZ-level manufacturing employment between 2000 and 2003. Doing so reveals that the Bush steel tariffs account for nearly 36% of the change in manufacturing employment between 2000 and 2003. Thus, the Bush steel tariffs had quick and notable adverse impacts on manufacturing employment.

To further guard against any concerns regarding pre-trends, we follow Finkelstein (2007) and Flaaen and Pierce (2020) by comparing how the point estimates change in the pre-Bush steel tariff period versus the Bush steel tariff period. This entails looking at the statistic $W_t = (\beta_t - \beta_{2000}) - \kappa_t (\beta_{2000} - \beta_{1998})$ for $t = 2001, 2002, 2003$ where κ_t adjusts for the possible different lengths of the two periods.[15] Essentially, this is a thought experiment that, regardless of statistical significance of the point estimates in the pre-period, linearly extends any pre-trend from the pre-period into the post-period and checks whether the resulting extrapolated effect is statistically different than the point estimate in the post-period. Because the year 2000 is our omitted reference year, $\beta_{2000} \equiv 0$ and hence $W_t = \beta_t + \kappa_t \beta_{1998}$. Given the small magnitude of the 1998 point estimate, W_t differs little from the point estimate β_t in 2001, 2002 or 2003 and hence only marginally reduces the economic magnitude described above.[16] Moreover, the effects are still statistically significant at the $p = .001$ level in 2001, $p = .003$ level in 2002, and at the $p = .038$ level in 2003. This exercise further strengthens the credibility of the results in panel (a) that describe the short-run impact of the Bush steel tariffs.

Naturally, the manufacturing sector as a whole relies on steel as a key intermediate input. Nevertheless, some manufacturing industries rely on steel more than other manufacturing industries. Thus, we expect stronger effects in manufacturing industries that especially rely on steel as an intermediate input if the effects from panel (a) actually reflect effects of the Bush steel tariffs.

Panel (b) shows the results where the dependent variable is employment in steel-consuming industries rather than overall manufacturing employment. As discussed above, we define steel-consuming industries as the set of industries that have a direct requirement for any of the Bush steel tariff industries of at least \$5 per \$100 of output. Importantly, panel (b) illustrates the absence of a pre-trend; indeed, the point estimates flip sign between 1998 and 1999 so that, if anything, employment is fluctuating above and below its 2000 level across 1998 and 1999. Moreover, panel (b) also illustrates the same qualitative effects as for overall manufacturing but with a stronger economic magnitude. The statistically significant adverse effects of vulnerability to the Bush steel tariffs emerge in 2001, increase by about 65% in 2002 and then another 25% in 2003.

The economic magnitude of Bush steel vulnerability is notably larger in the steel-consuming industry than the manufacturing industry overall. Moving from the 25th to 75th percentile of vulnerability to the Bush steel tariffs accounts for about 110% of the change in steel-

[15] Specifically: $\kappa_t = 0.5$ in 2001, $\kappa_t = 1$ in 2002, and $\kappa_t = 1.5$ in 2003.

[16] The point estimates for β_t of -11.64, -20.24, and -22.08 shrink to point estimates for W_t of -11.00, -18.98, and -20.18 in $t = 2001, 2002, 2003$ respectively.

consuming industry employment between 2000 and 2003. The substantially stronger effect in the steel-consuming industry than the manufacturing industry overall is exactly what one would expect if the treatment effects are indeed reflecting effects of the steel tariffs.

Guarding further against concerns about pre-trends using the Finkelstein (2007) approach described above still leaves very large economic significance. Although statistically insignificant, the 1998 point estimate is larger in magnitude when looking at the effects on steel-consuming employment than manufacturing employment. As such, the statistic W_t is about 23% smaller than β_t in 2001, about 28% smaller in 2002 and about 33% smaller in 2003.[17] Nevertheless, even shaving one-quarter to one-third of the economic magnitude still leaves highly economically significant effects of the Bush steel tariffs on steel-consuming employment. And the effects are statistically significant too: at the $p = .007$ level in 2001, the $p = .021$ level in 2002, and the $p = .082$ level in 2003.

Panels (a)-(b) show the substantial negative effects of the Bush steel tariffs for CZs who are vulnerable due to their reliance on steel as an intermediate input. In contrast, panel (c) investigates the potentially positive impacts of the Bush steel tariffs on CZs receiving protection for their local steel industry. The point estimates are again small and statistically insignificant in the pre-Bush steel tariff period of 1998 and 1999 which indicates absence of any pre-trend. The point estimate is essentially zero and precisely estimated in 2001. And while the point estimate in 2003 is positive, it is economically small and very imprecise. Further, although larger but still relatively small, the point estimate is actually negative in 2002. Overall, we do not find any evidence of the Bush steel tariffs increasing local steel employment.

One natural interpretation is that the long-run and transformative restructuring of the steel industry during the 1980s, 1990s and 2000s dwarfed the importance of what were always temporary steel tariffs. Moreover, while our analysis downplays any effects on steel employment, two basic descriptive statistics suggest the tariffs did affect incentives of steel producers and benefit them. Accompanying our documented effects on the increased price of steel in the US in Section 3, data from the NBER-CES Manufacturing Industry Database (Becker et al. (2013)) reveals that steel industry profits as a share of the value of shipments rose by more than 50% from 20.8% in 2001 to 33.1% in 2004. This data also reveals that the steel industry ran down inventories at historically record pace. As a share of the value of shipments, inventory run downs exceeded 2% for 2002-2003 with 1985-1986 being the only other time this happened since the beginning of the database in 1958.

In summary, the key conclusion from Figure 6 is that the Bush steel tariffs had substantial

[17] The point estimates for β_t of -7.59, -12.49, and -15.55 shrink to point estimates for W_t of -5.86, -9.03, and -10.37 in $t = 2001, 2002, 2003$ respectively.

short run negative effects and no significant positive effects on local employment. CZs especially vulnerable to the Bush steel tariffs because they relied on steel as an intermediate faced notably worse outcomes in terms of overall manufacturing employment and even more so in terms of employment in the heavy steel-consuming industries within manufacturing. Moreover, CZs who could potentially benefit from the Bush steel tariffs due to protection for their local steel industry did not see any notable increases in steel employment. These results emphasize the importance of downstream industries when imposing tariffs on key intermediate inputs.

4.3.2 Persistence results

Given the substantial short-run adverse effects of vulnerability to the Bush steel tariffs on downstream employment, we now investigate whether these effects dissipated upon removal of the Bush steel tariffs in December 2003 or whether they persisted. Indeed, Figure 7 starkly shows that the adverse effects of the steel tariffs were persistent from 2003 until at least 2007. While the 2008 point estimates are very imprecise, the point estimates – for both manufacturing employment and steel-consuming employment – in the 2004-2007 period are very stable in terms of their magnitude as well as their statistical and economic significance. In part, the longer effects could be due to the steel tariffs initially being set to last until March 2005 even though a successful WTO challenge by other countries led President Bush to remove around 15 months earlier than planned. But the stability of the effects extending through at least 2007 suggests the adverse effects of the steel tariffs extended well beyond when the tariffs were expected to expire.[18]

Recent literature has proposed two mechanisms that could shed light on our vulnerability results and especially their persistence. The first potential mechanism is a dearth of human capital hypothesis. In the context of the well-known China shock, Bloom et al. (2019) show that the negative labor market effects are concentrated in low human capital CZs and Autor et al. (2021) show that the persistence of the China shock through 2019 is partly driven by these low human capital CZs. The second potential mechanism is a reverse agglomeration hypothesis. Dix-Carneiro and Kovak (2017) show that severity of the negative local labor market outcomes in Brazil following their unilateral liberalization in the early 1990s persisted for, and even became stronger, over the following 20 years. They present substantial evidence that this stemmed from the initial negative local labor demand shocks combined with slow regional capital adjustment and associated labor demand.

We begin by exploring the role played by the dearth of human capital hypothesis in our results. Following Bloom et al. (2019) and Autor et al. (2021), we split CZs into low and high

[18]Unfortunately, the Great Recession began in late 2008 and complicates a longer-run analysis.

human capital CZs according to whether their college educated population shares are below or above the median CZ. We then estimate equation (4) separately for each subsample.

Panels (a)-(b) of Figure 8 show the effects on manufacturing and steel-consuming employment. In both panels, there are no notable differences in the point estimates across low and high human capital CZs in 1998 and 1999. Two takeaways stand out. First, the negative effects in the 2001-2003 period are concentrated in low human capital CZs both in terms of statistical and economic significance. Second, the negative effects remain stable and statistically significant in low human capital CZs after the Bush tariffs end but are small and statistically insignificant in high human capital CZs by 2004 or 2005. Ultimately, our results are consistent with the notion that, in response to negative shocks, a higher skilled workforce make it easier for manufacturing firms to start producing different goods (either in the same or different industry) and for local labor markets to reallocate workers across firms and industries in the short to medium run.

We now explore the role played by reverse agglomeration in our results. If reverse agglomeration is playing a role, the effects on employment should be stronger in CZs that initially specialize more in steel-consuming industries. It is these CZs that would experience larger initial negative shocks and hence larger and more persistent negative effects. Thus, we split CZs into weak and strong specialization in steel-consuming industries according to whether their 1998 share of employment in steel-consuming industries is above or below the median CZ. We then estimate equation (4) separately for each subsample.

Panels (c)-(d) of Figure 8 show the results for both manufacturing employment and steel-consuming employment are even starker than when looking at low versus high human capital CZs. In both panels, there are no notable differences in the 1998 and 1999 point estimates across weakly and strongly specialized CZs. For CZs weakly specialized in steel-consuming industries, there are no statistically or economically significant effects at any point in time. All of the economically and statistically significant effects and all of the persistence in our baseline analysis is driven by CZs strongly specialized in steel-consuming industries. Ultimately, our results are consistent with the notion that reverse agglomeration processes can extend the time that local labor markets suffer the negative consequences of local shocks far beyond the contemporaneous time period of the shock.

4.3.3 Extensions and robustness

Alternative dependent variables One may wonder whether the negative effects on local employment from local vulnerability to the Bush steel tariffs spill over into the non-manufacturing sector or instead whether non-manufacturing expands to adsorb displaced manufacturing workers. Additionally, one may wonder whether we can detect these negative effects in overall employment. Thus, we first investigate the effect of vulnerability to the Bush steel tariffs on two additional employment outcomes: non-manufacturing employment and overall employment.

Panel (a) of Figure 9 shows the results for non-manufacturing employment in our full sample of CZs. The estimates are quite imprecise but are never statistically significant and often close to zero. Thus, there is no evidence of important spillover effects on non-manufacturing employment nor expansion of the non-manufacturing sector. Panel (b) shows the results for total employment. As expected, the point estimates are very close to the sum of the point estimates for manufacturing and non-manufacturing employment. Thus, the point estimates are negative. However, the noise in the non-manufacturing point estimates means the point estimates for overall employment are generally statistically insignificant.

Panels (c)-(d) of Figure 9 show the results for non-manufacturing employment according to the split of CZs into, respectively, low versus high human capital CZs and weakly versus strongly specialized CZs in steel-consuming industries. Similar results for our overall sample of CZs also hold for both low and high human capital CZs: there are no spillover effects on non-manufacturing employment nor expansion of the non-manufacturing sector. Panel (d) shows this is also the case for CZs initially strongly specialized in steel-consuming industries and, at least until around 2006, for CZs initially weakly specialized in steel-consuming industries.

Our analysis thus far has measured CZ employment outcomes as a share of a CZ's 2000 working-age population. Figure 10 instead measures these employment outcomes as a share of a CZ's time-varying aggregate employment. Overall, these results show our baseline results remain robust when switching to employment outcomes as a share of CZ time-varying aggregate employment.

Alternative measures of steel tariff exposure Our baseline measure of vulnerability to the Bush steel tariffs, V_c, aggregates across reliability R_{ci} on each Bush steel tariff industry i (see equation (7)). Further, CZ c's reliability on steel industry i, R_{ci}, aggregates across the usage of steel industry i by every other industry j in the economy using industry j's total requirements r_{ji} for steel input i and industry j's output. We now modify this measure in two alternative ways. First, panels (a)-(b) of Figure 11 show the results using industry-level direct requirements rather than total requirements for steel. Second, panels (c)-(d) of Figure 11 show the results when using industry-level value added rather than industry-level output. Both sets of results show our baseline results remain robust when using these alternative measures of vulnerability to the Bush steel tariffs.

Alternative specifications We now investigate two alternative specifications. Our baseline analysis does not weight our regressions. While one may be concerned that the results are overly influenced by smaller CZs, Solon et al. (2015) argue that such a concern is not a reason to use regression weights. Instead, they argue that such concerns should be dealt with by exploring heterogeneity of the causal effect according to CZ-size. Thus, we follow their advice and do not use regression weights in our main analysis. Nevertheless, they also argue that important differences between unweighted and weighted regression results can indicate model misspecification. Thus, panels (a)-(c) of Figure 12 use regression weights corresponding to the 2000 CZ-level working-age population and shows our baseline results are robust to using these regression weights.

Our baseline analysis defined the highly steel-intensive subset of industries within manufacturing as steel-consuming industries if their direct requirement for the Bush steel tariff products exceeded $5 per $100 of output. This defined a set of 61 industries comprising, in any year between 1998 and 2008, around 20% of US manufacturing employment. We now present results using a higher threshold of $7.50 per $100 of output. This defines a smaller set of 33 industries comprising, in any year between 1998 and 2008, around 13% of US manufacturing employment. Panel (d) of Figure 12 shows that our baseline results remain qualitatively unchanged. Moreover, the economic magnitudes also remain essentially unchanged because the one-third smaller point estimates offset the one-third smaller size of employment in the more narrowly defined steel consuming industry.

Anti-dumping duties One potential concern of analyzing the Bush steel tariffs is the concurrent presence of AD duties on steel. As is well known, the US steel industry has been one of the main historical recipients of AD duties. Panel (a) of Table 2 illustrates the industrial composition of AD duties over the 1996-2002 period and the overlap with products hit by Bush steel tariffs.[19] Over this period, 497 8-digit HS products were hit with AD duties, with some hit multiple times, and 315 (63%) of these were Iron and Steel (HS Chapter 72) and Articles of Iron and Steel (HS Chapter 73) products. Of these 315 steel products, 219 (70%) were hit with Bush steel tariffs. Thus, substantial and concurrent overlap exists between the products targeted by the Bush steel tariffs and AD duties.

Of the 219 products with overlap between AD duties in the 1996-2002 period and Bush steel tariffs, 175 (80%) were across six AD cases. As panel (b) of Table 2 shows, these 175 instances of AD duties fall within just six AD cases: two each for the steel product categories of cut-to-length steel, cold-rolled steel, and hot-rolled steel. For two cases, the AD duties

[19] Our AD data comes from the Global Antidumping Database - 1980's-2015 hosted by The World Bank and originally developed by Chad Bown.

only lasted a few months because the preliminary duties expired upon the USITC reaching a final injury determination of "no injury". For the other four cases, the AD duties were in place until at least 2003 and overwhelmingly still in place by 2015. Moreover, as panel (b) of Table 2 shows, AD duties in these steel product categories stretch 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. Thus, given the very different timing of these AD duties and the Bush steel tariffs, our results are unlikely to be driven by steel AD duties.

5 Conclusion

The breadth and scale of President Trump's tariff war have 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. Moving from the 25th to the 75th percentile of CZ-level vulnerability to the Bush steel tariffs explains about 36% of the change in CZ-level manufacturing employment between 2000 and 2003 when the Bush steel tariffs were developed and implemented. This figure rises to around 100% when looking at employment in CZ-level steel-consuming industries.

These substantial short-run negative effects on downstream industries did not reverse themselves once the Bush steel tariffs were removed at the end of 2003. Instead, they persist until at least 2008. 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.

These large and persistent negative effects were concentrated in local labor markets that had low human capital or were strongly specialized in steel-consuming industries. As such, our results emphasize two points made in the recent literature. First, manufacturing firms can more easily start producing different goods and local labor markets can more easily reallocate workers across firms and industries in the short to medium run following negative shocks when they have a higher skilled workforce. Second, reverse agglomeration processes can extend the time that local labor markets suffer the negative consequences of local shocks far beyond the contemporaneous time period of the shock.

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. Our results thus suggest significant and long-lasting damage from the Trump administration's national security tariffs on steel and aluminum.

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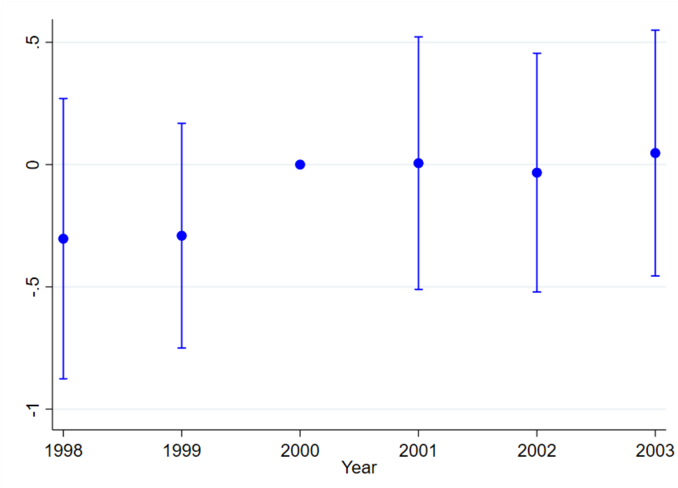
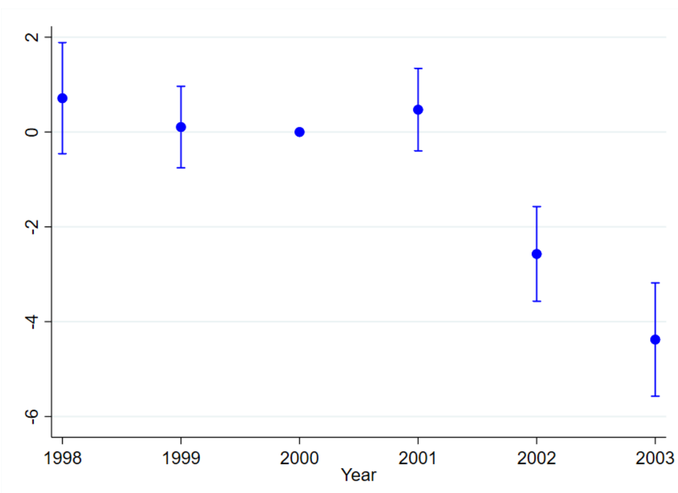
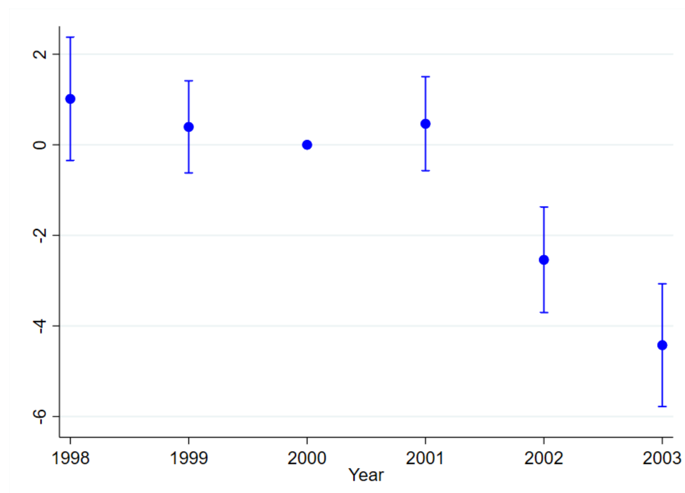
A Figures & tables



(a) Foreign exporter prices



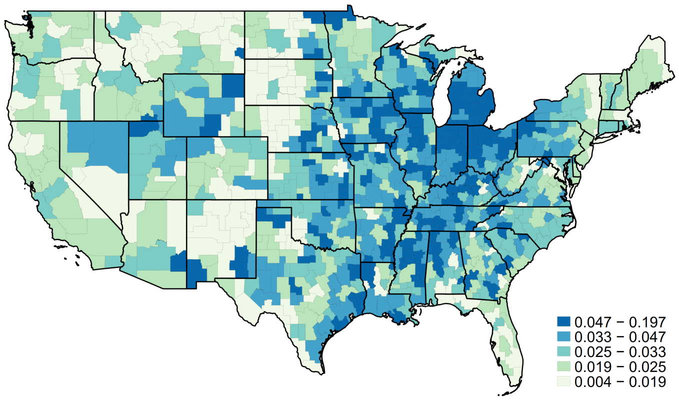
(b) Value of US imports



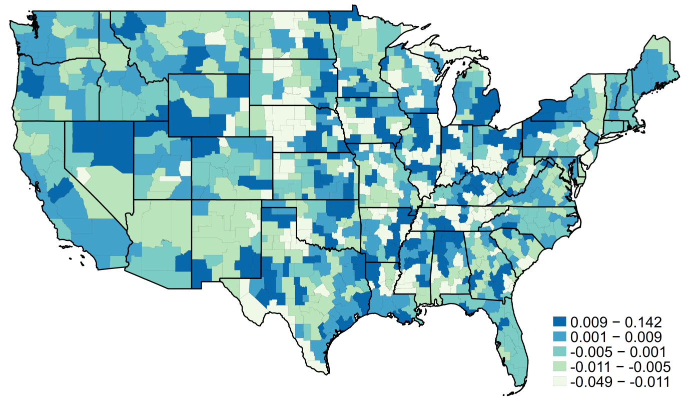
(c) Quantity of US imports

Figure 1: Impact of Bush steel tariffs on exporter steel prices and US steel imports

Notes: Point estimates from estimating equation (1). Dependent variables are unit value in panel (a), value of US imports in panel (b), and quantity of US imports in panel (c). Figure illustrates 95% confidence intervals. Two-way standard errors clustered at country-by-HS8 and year-by-HS8. See main text for more details.



(a) Vulnerability



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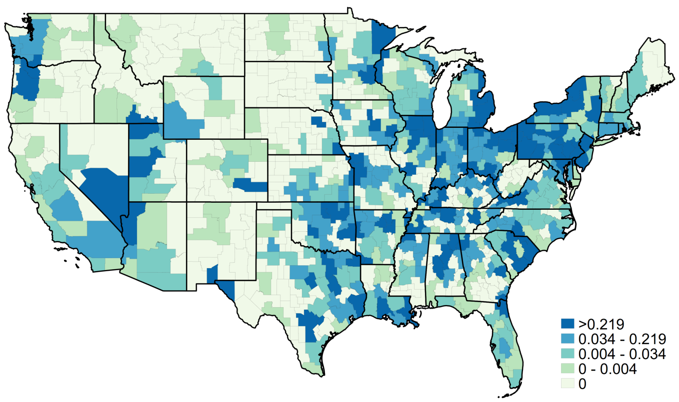
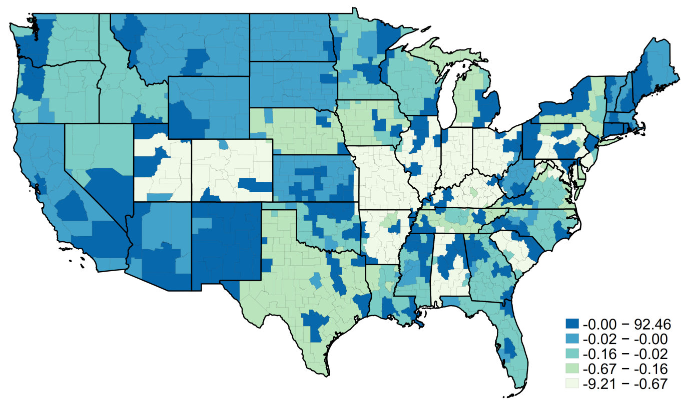


(c) Protection



(d) Protection (fixed effects removed)

Figure 2: CZ-level vulnerability on and protection from Bush steel tariffs

Notes: Definitions of CZ-level vulnerability and protection in main text. Panels (b) and (d) remove state fixed effects. See main text for further details.

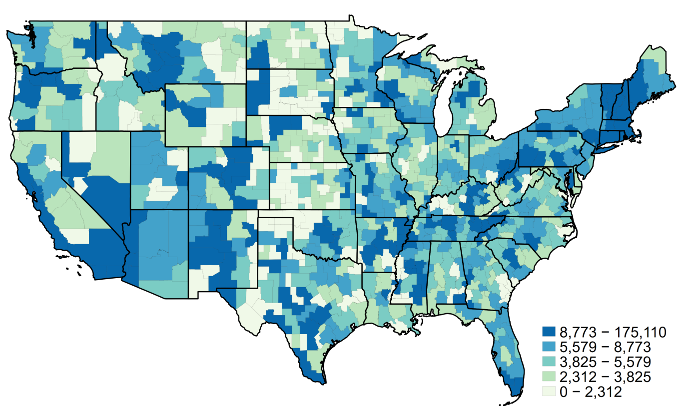
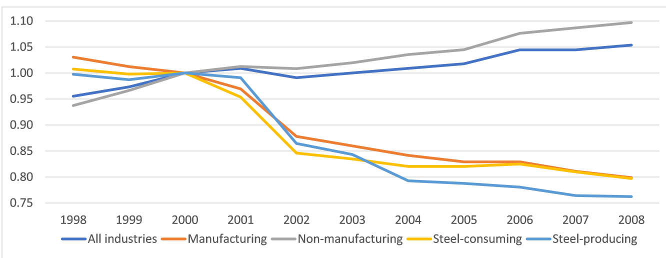
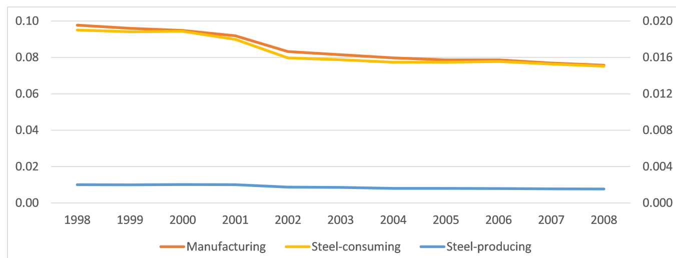


Figure 3: CZ-level exposure to Chinese import penetration in 2002

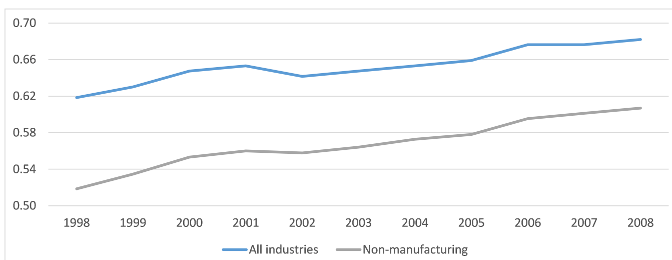
Notes: Definition of CZ-level exposure to Chinese import penetration in main text. See main text for further details.



(a) Changes in employment-to-working age population ratio relative to 2000



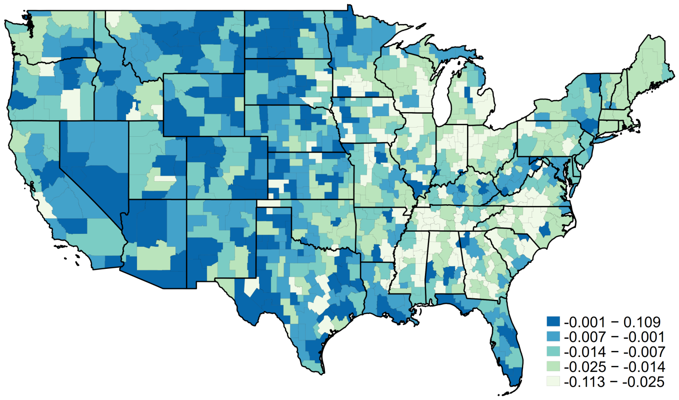
(b) Changes in employment-to-working age population ratio



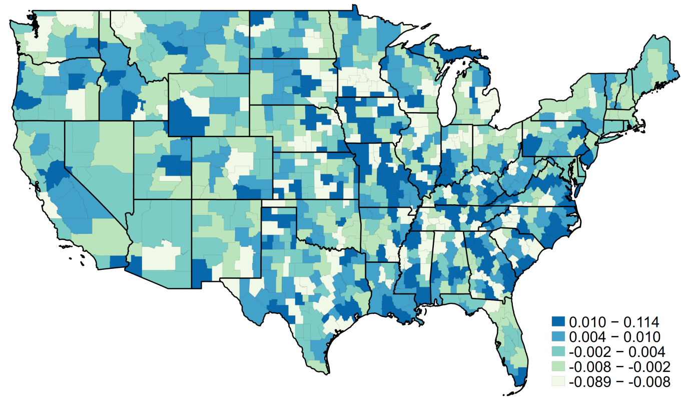
(c) Changes in employment-to-working age population ratio

Figure 4: US national employment changes 1998-2008

Notes: All employment shares are shares of 2000 US working-age population. In panel (b), left-hand scale for Manufacturing series and right-hand scale for Steel-consuming and Steel-producing series. See main text for further details.



(a) Manufacturing industry



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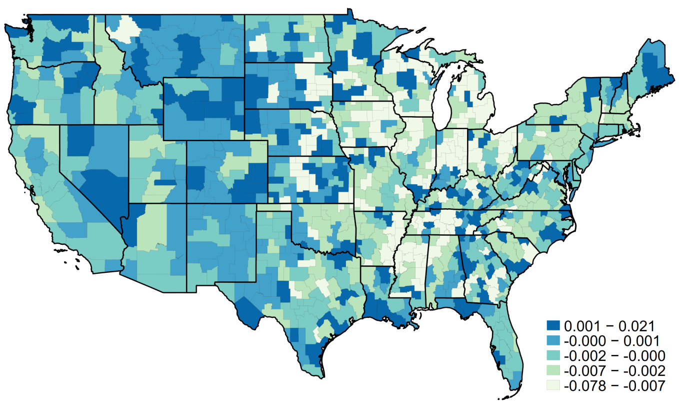
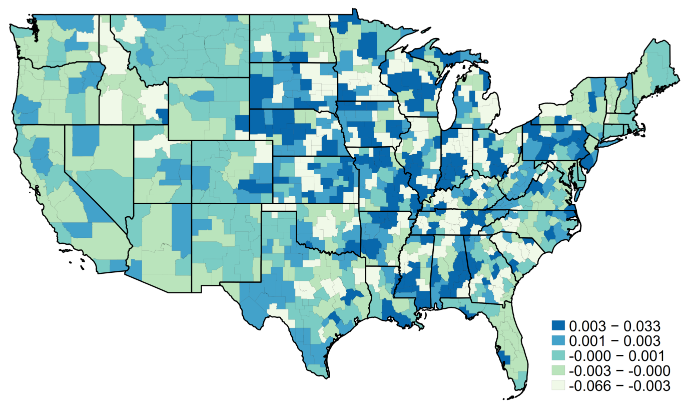
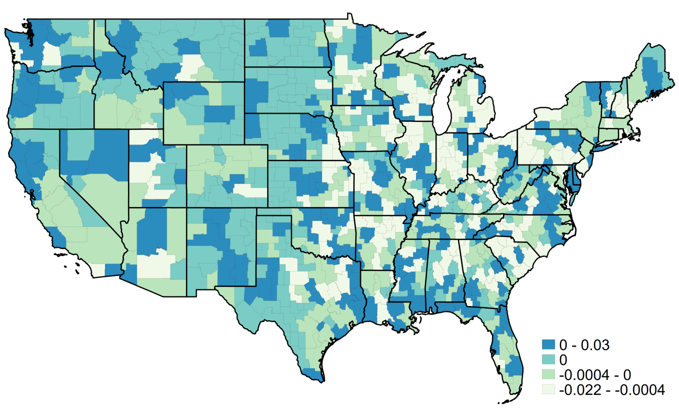


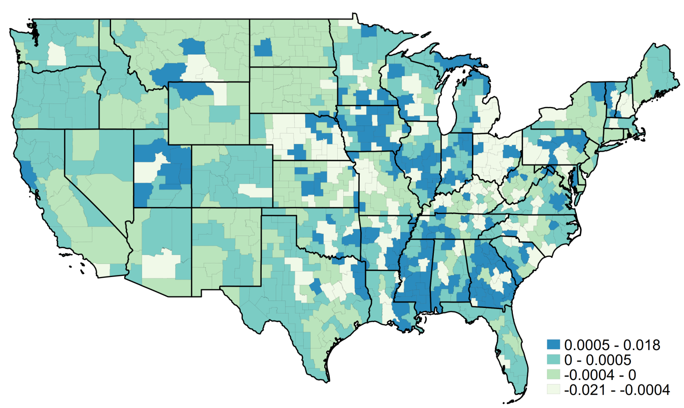
(c) Steel-consuming industry



(d) Steel-consuming industry (fixed effects removed)



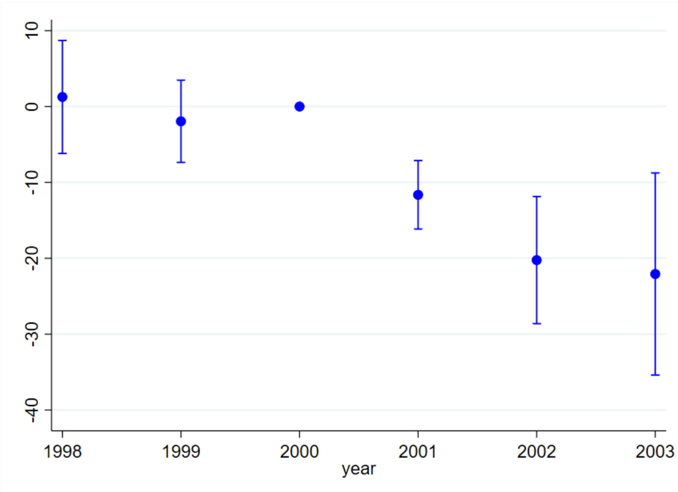
(e) Steel industry



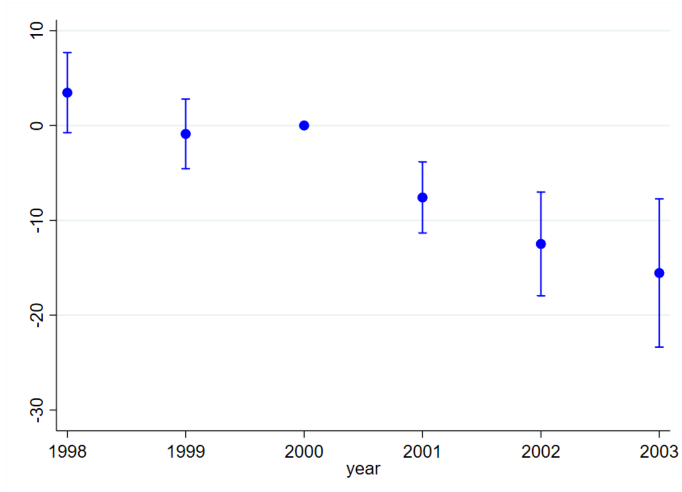
(f) Steel industry (fixed effects removed)

Figure 5: CZ-level change in employment shares 2000-2003

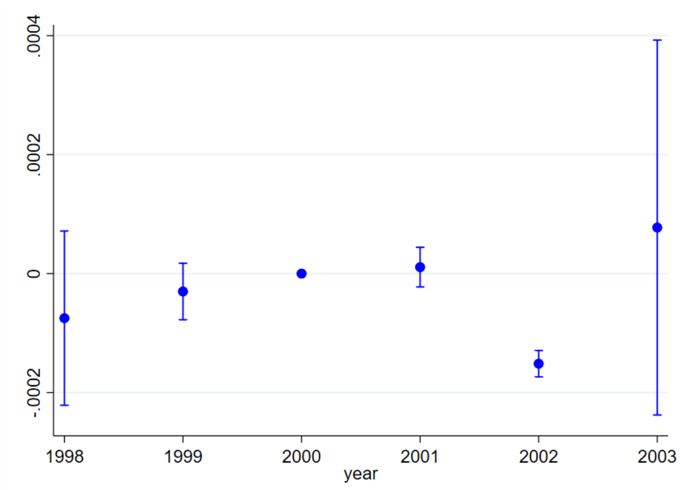
Notes: All employment shares are shares of 2000 CZ-level working-age population. Panels (b), (d) and (f) remove state-year and CZ fixed effects. See main text for further details.



(a) Vulnerability and manufacturing employment



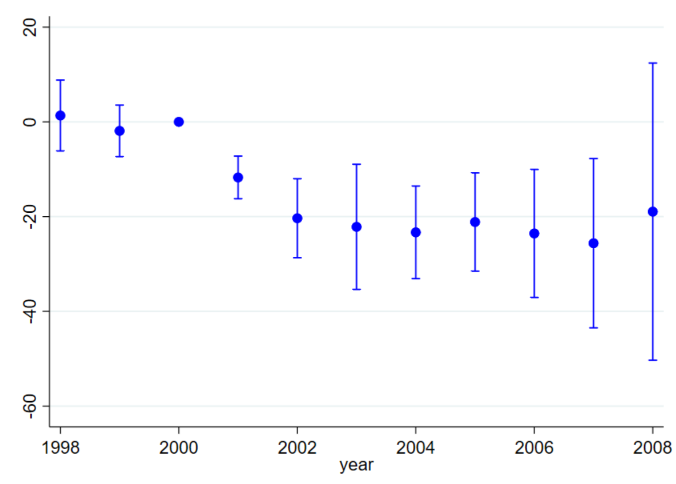
(b) Vulnerability and steel-consuming employment



(c) Protection and steel employment

Figure 6: Short-run effects of vulnerability and protection on CZ-level employment shares

Notes: All panels estimate equation (4). All dependent variables are employment shares of 2000 CZ-level working-age population. Standard errors clustered by state. See main text for further details.



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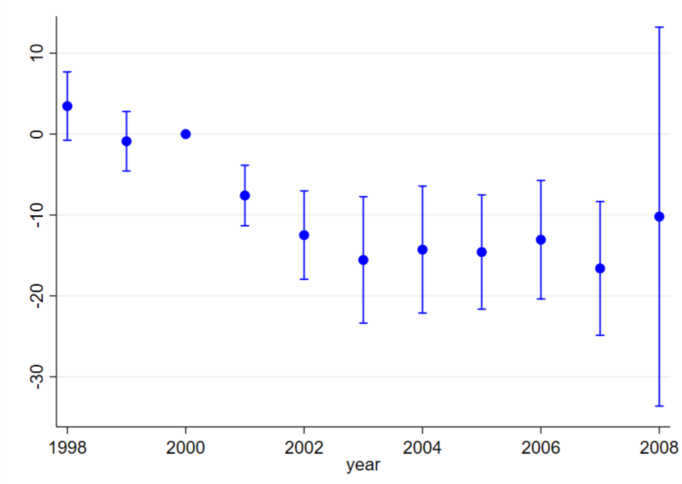
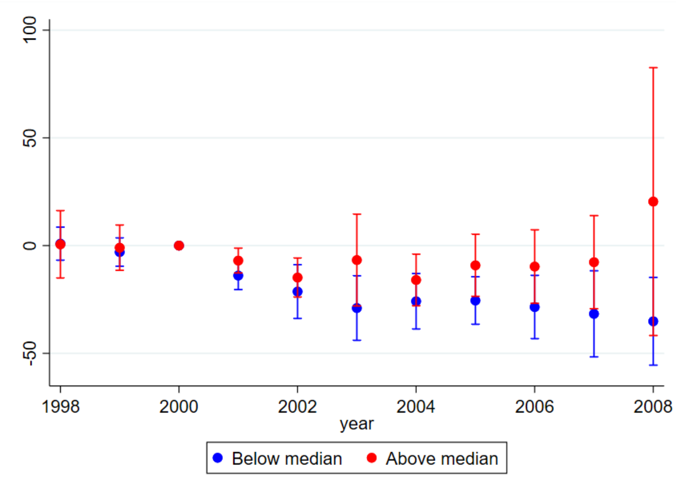


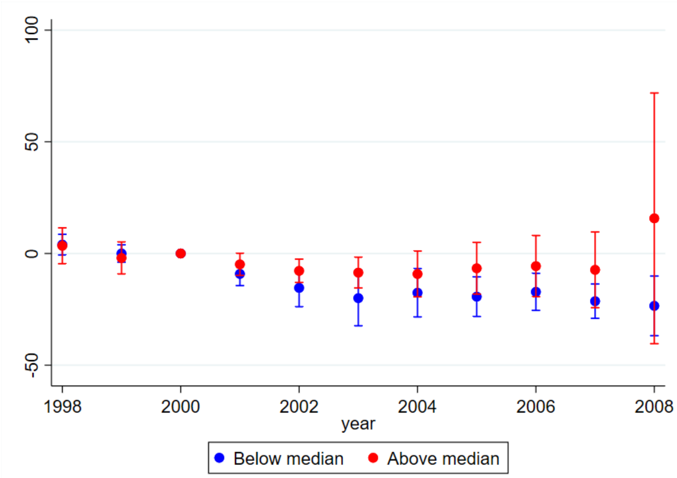
(b) Vulnerability and steel-consuming employment

Figure 7: Persistent effects of vulnerability on CZ-level employment shares

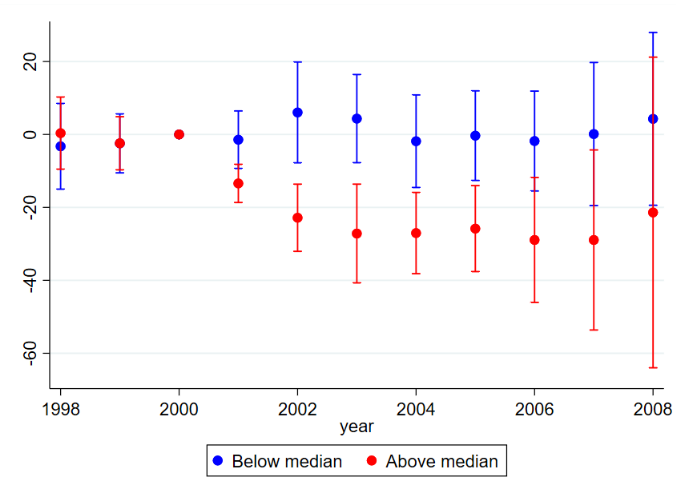
Notes: All panels estimate equation (4). All dependent variables are employment shares of 2000 CZ-level working-age population. Standard errors clustered by state. See main text for further details.



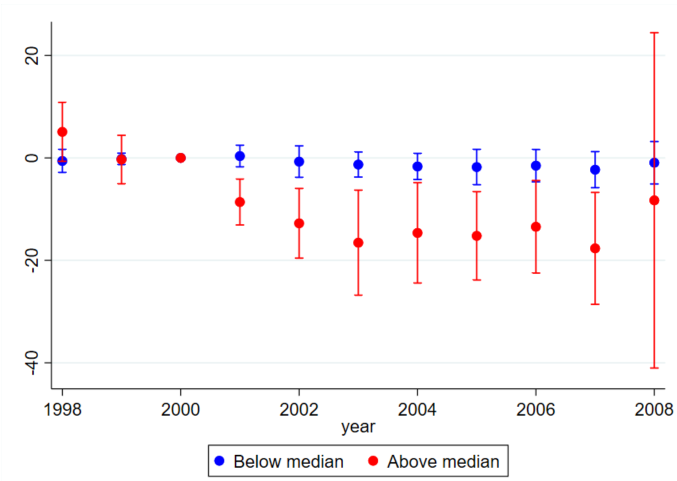
(a) Manufacturing employment & human capital



(b) Steel-consuming employment & human capital



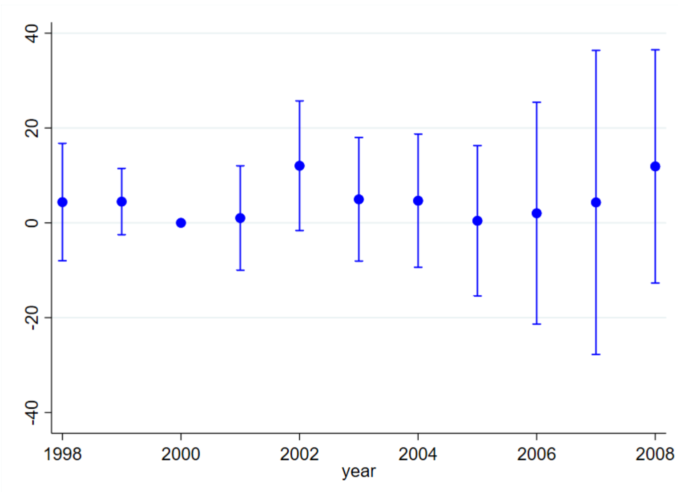
(c) Manufacturing employment & specialization



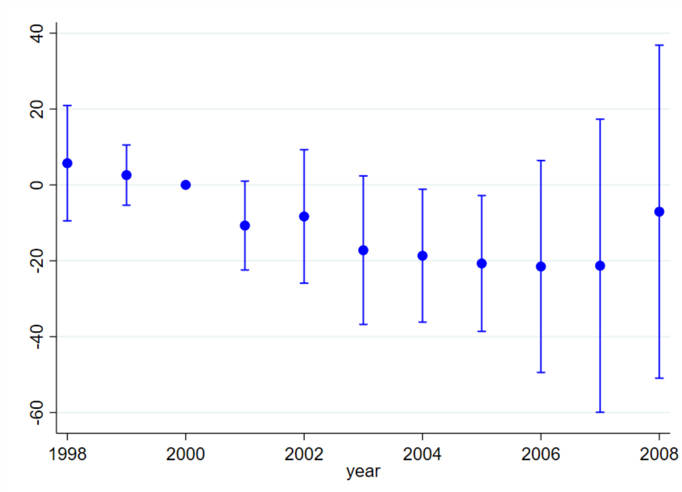
(d) Steel-consuming employment & specialization

Figure 8: Heterogeneity – low vs high human capital and weakly vs strongly specialized CZs

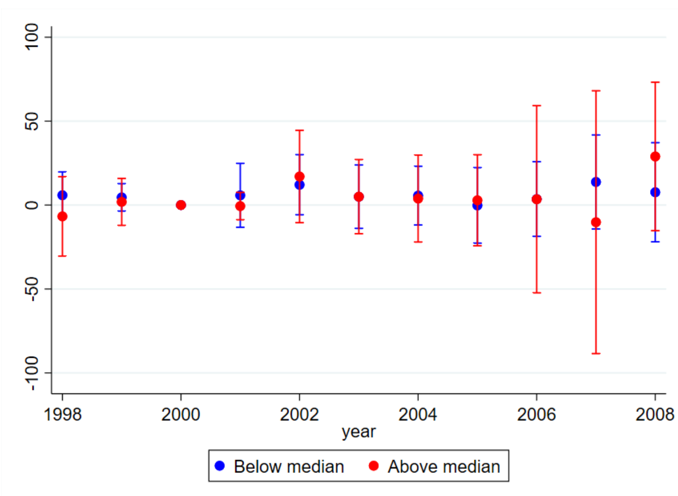
Notes: All panels estimate equation (4). Panels (a)-(b) do so separately for the subsamples of CZs with a college educated population share above and below the median CZ. Panels (c)-(d) do so separately for the subsamples of CZs with a 1998 share of steel-consuming employment above and below the median CZ. All dependent variables are employment shares of 2000 CZ-level working-age population. Standard errors clustered by state. See main text for further details.



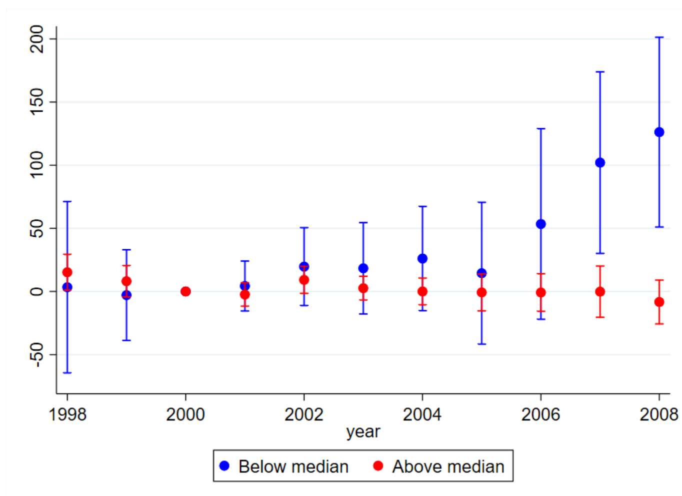
(a) Vulnerability and non-manufacturing employment



(b) Vulnerability and total employment



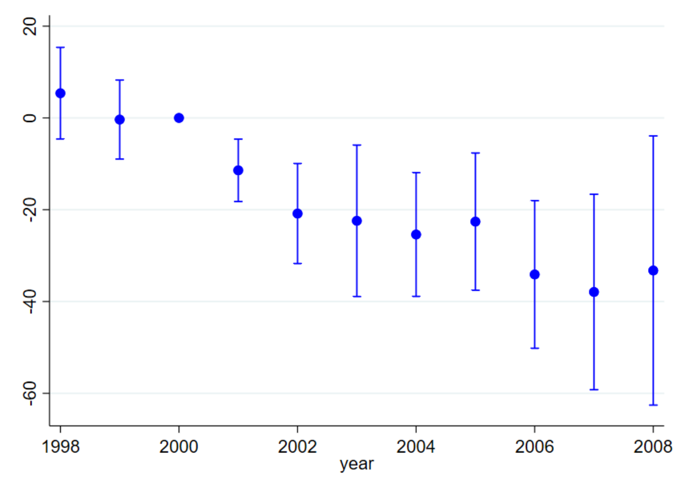
(c) Non-manufacturing employment & human capital



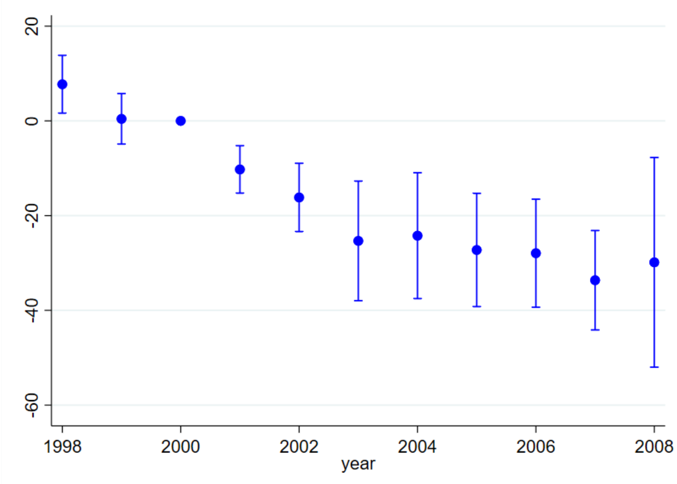
(d) Non-manufacturing employment & human capital

Figure 9: Alternative dependent variables: non-manufacturing and total employment

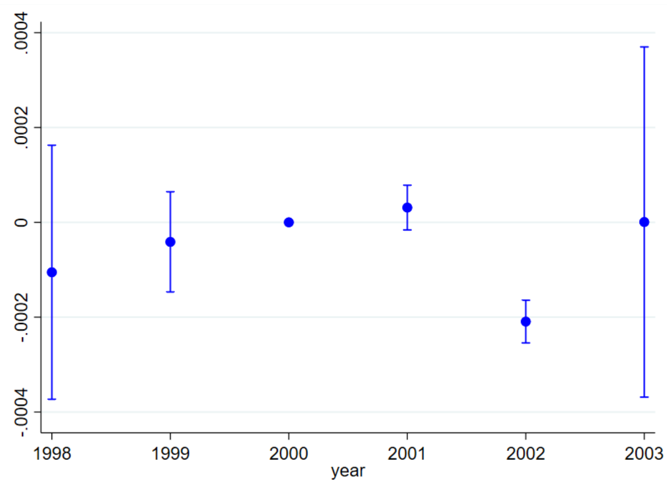
Notes: All panels estimate equation (4). All dependent variables are employment shares of 2000 CZ-level working-age population. Panels (a)-(b) use the full sample of CZs. Panels (c)-(d) respectively, estimate equation (4) separately for, respectively, CZs above and below the median CZ in terms of the college educated population share and the share of 1998 employment in steel-consuming industries. Standard errors clustered by state. See main text for further details.



(a) Vulnerability and manufacturing employment



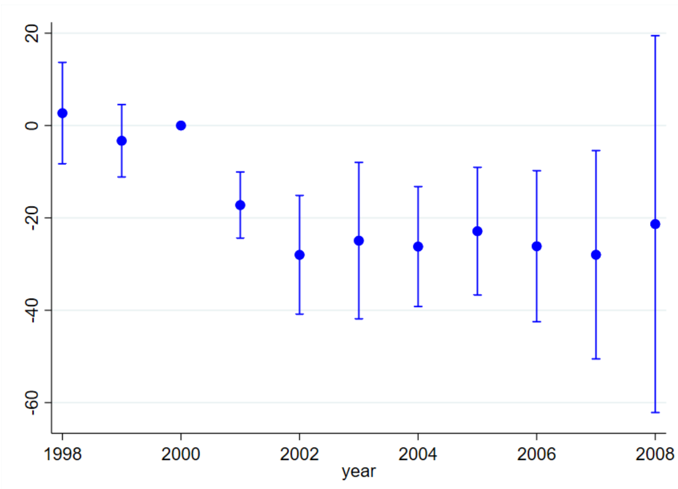
(b) Vulnerability and steel-consuming employment



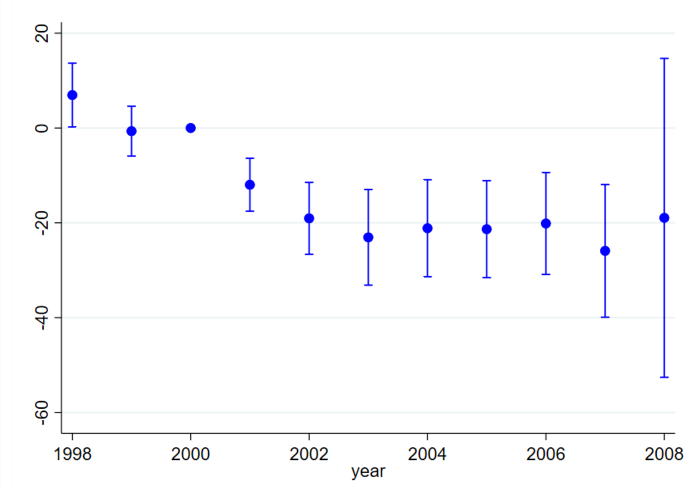
(c) Non-manufacturing employment & human capital

Figure 10: Alternative dependent variables: time varying share of employment

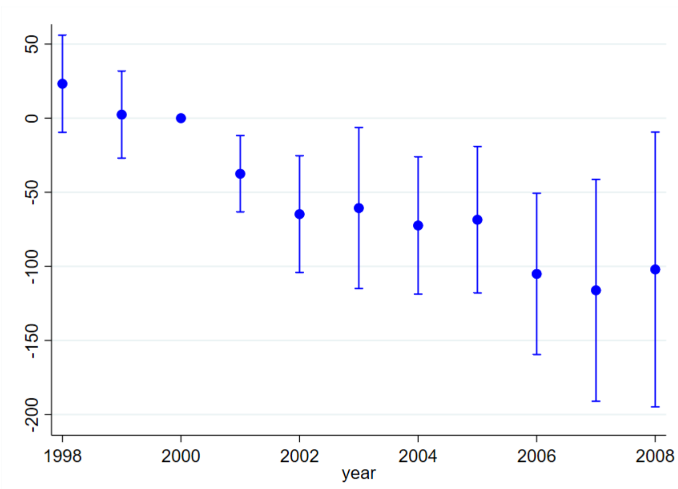
Notes: All panels estimate equation (4). Employment share dependent variables are shares of time-varying CZ-level total employment. Standard errors clustered by state. See main text for further details.



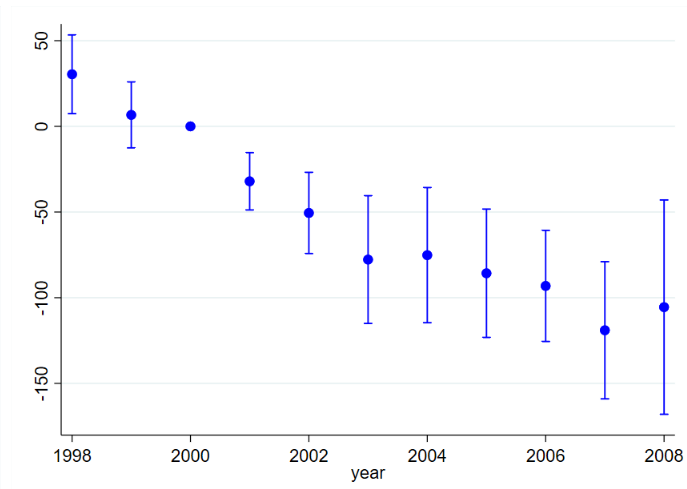
(a) Vulnerability and manufacturing employment



(b) Vulnerability and steel-consuming employment



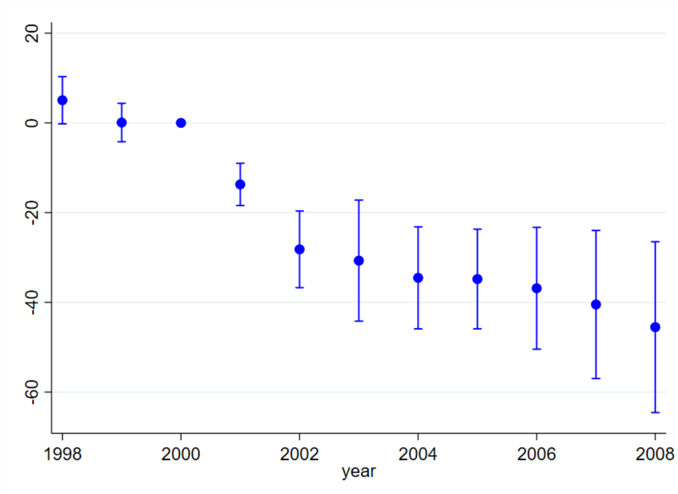
(c) Vulnerability and manufacturing employment



(d) Vulnerability and steel-consuming employment

Figure 11: Alternative measures of vulnerability to Bush steel tariffs

Notes: All panels estimate equation (4). All dependent variables are employment shares of 2000 CZ-level working-age population. When constructing CZ-level vulnerability, panels (a)-(b) use direct requirements (rather than indirect requirements) and panels (c)-(d) use industry-level value added (rather than industry-level output). Standard errors clustered by state. See main text for further details.



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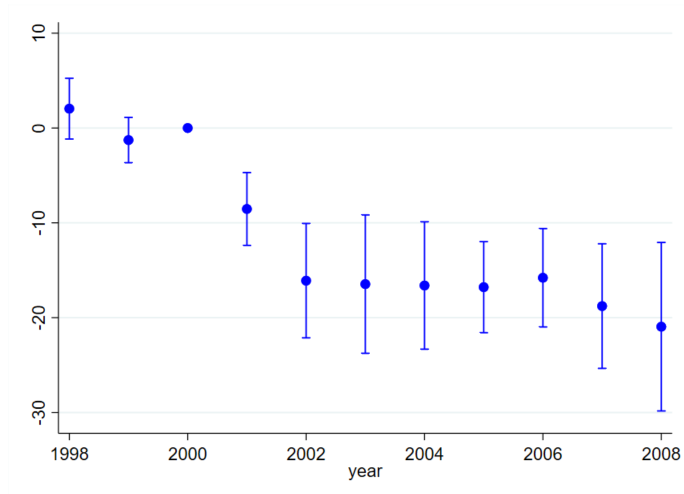
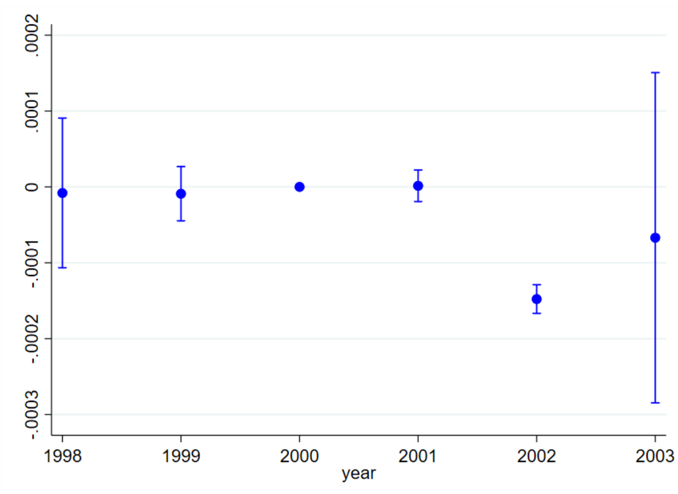
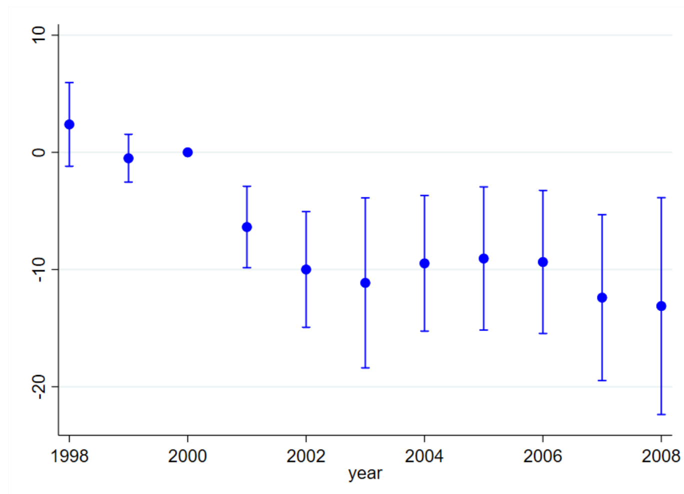


(b) Vulnerability and steel-consuming employment



(c) Protection and steel employment



(d) Vulnerability and steel-consuming employment

Figure 12: Alternative specifications

Notes: Panels (a)-(c) estimate equation (4) using regression weights corresponding to 2000 CZ working-age population. Panel (d) defines steel-consuming employment using a direct requirement threshold of $7.50 per $100 of output. All dependent variables are employment shares of 2000 CZ-level working-age population. Standard errors clustered by state. See main text for further details.

Table 1. Steel usage as an intermediate input

Panel A. Top intermediate inputs in economy (total requirement)

NAICS	Industry	Economy Rank	Manuf. Rank	Avg. Usage per $100
420000	Wholesale trade	1		$8.46
550000	Management of companies and enterprises	2		$5.71
531000	Real estate	3		$3.47
484000	Truck transportation	4		$3.09
331111	Iron and steel mills	5	1	$2.67
211000	Oil and gas extraction	6		$2.64
221100	Power generation and supply	7		$2.27
324110	Petroleum refineries	8	2	$2.09
325190	Other basic organic chemical manufacturing	9	3	$1.88
3221A0	Paper and paperboard mills	10	4	$1.83
334413	Semiconductors and related device manufacturing	13	5	$1.46
325211	Plastics material and resin manufacturing	15	6	$1.45
33441A	All other electronic component manufacturing	16	7	$1.29
321113	Sawmills	20	8	$1.06
336300	Motor vehicle parts manufacturing	24	9	$0.99
322210	Paperboard container manufacturing	25	10	$0.97
332910	Metal valve manufacturing	80	30	$0.37
331222	Steel wire drawing	148	75	$0.17
335120	Lighting fixture manufacturing	273	171	$0.05

Panel B. Top industries using steel as an intermediate input

		Total Requirement		Direct Requirement	
NAICS	Industry	Rank	Usage per $100	Rank	Usage per $100
331221	Rolled steel shape manufacturing	1	$40.51	1	$39.36
331210	Iron, steel pipe and tube from purchased steel	2	$38.24	2	$38.47
331222	Steel wire drawing	3	$36.34	3	$37.36
332114	Custom roll forming	4	$32.28	4	$31.23
332311	Prefabricated metal buildings and components	5	$29.05	5	$26.92
332600	Spring and wire product manufacturing	6	$23.15	6	$24.54
332996	Fabricated pipe and pipe fitting manufacturing	7	$22.79	7	$21.71
332111	Iron and steel forging	8	$20.15	8	$18.34
332420	Metal tank, heavy gauge, manufacturing	9	$18.47	10	$16.63
333921	Elevator and moving stairway manufacturing	10	$18.40	12	$16.26
332812	Metal coating and nonprecious engraving	11	$17.66	9	$17.25
333924	Industrial truck, trailer, and stacker manufacturing	12	$17.48	15	$14.10
332313	Plate work manufacturing	13	$17.42	11	$16.41
332323	Ornamental and architectural metal work manufacturing	14	$17.22	13	$15.87
332312	Fabricated structural metal manufacturing	15	$15.44	18	$12.76
332213	Saw blade and handsaw manufacturing	16	$15.38	14	$15.24
332430	Metal can, box, and other container manufacturing	17	$15.07	17	$13.12
336991	Motorcycle, bicycle, and parts manufacturing	18	$14.74	20	$11.38
33211A	All other forging and stamping	19	$14.64	16	$13.34
336500	Railroad rolling stock manufacturing	20	$14.29	27	$9.77

Notes: NAICS codes are 6-digit 1997 NAICS codes from BEA I-O classification system. In Panel B, the Usage per $100 is defined as the sum of relaibility r_ij across the four Bush steel tariff industries *i* for the industry *j* listed in the table. See main text for more details.

Table 2. Anti-Dumping Duties and Bush Steel Tariffs

Panel A. Overlap

	Steel			
	AD	Non-AD	AD non-steel	Total
Bush tariff products	219	73		292
Non-Bush tariff products	96		182	278
AD totals	315		182	497

Panel B. Overlap and duration of AD duties

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-894	Cold rolled steel	Preliminary duties lifted after 4-6 months because final injury determination of "no injury".

Notes: Source is Global Antidumping Database - 1980's-2015 which is hosted by The World Bank and originally developed by Chad Bown