Disentangling the Effects of the 2018-2019 Tariffs on a Globally Connected U.S. Manufacturing Sector *

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December 10, 2021

First Version: December 2019

Abstract

This paper estimates the relationship between the unprecedented U.S. tariff increases of 2018-2019 and outcomes in the domestic manufacturing sector. Despite being intended, in part, to boost manufacturing activity, we find that U.S. industries more exposed to tariff increases experience relative reductions in employment, as a small positive effect from import protection is offset by larger negative effects from rising input costs and retaliatory tariffs. Higher tariffs are also associated with relative increases in producer prices due to rising input costs. Lastly, the tariffs have broader impacts, as counties more exposed to rising tariffs exhibit relative increases in unemployment rates.

*We are grateful to Vivi Gregorich for superb research assistance. We thank Costas Arkolakis, Matilde Bombardini, Lorenzo Caliendo, Paola Conconi, Aksel Erbahar, Ryan Monarch, Peter Schott, Lorenzo Trimarchi and participants in various seminars and conferences for useful comments. Any opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the Board of Governors or its research staff.

1 Introduction

The unprecedented increase in tariffs imposed by the United States against its major trading partners since early 2018 has brought renewed attention to the economic effects of tariffs. While vast theoretical and empirical literatures document the effects of changes in trade policy, it is not clear how prior estimates apply when there are virtually no modern episodes of a large, advanced economy raising tariffs in a way comparable to the U.S. in 2018-2019. Further complicating estimation of the effects of tariffs is the rapid expansion of globally interconnected supply chains, in which tariffs can have impacts through channels beyond their traditional effect of limiting import competition.

Another important feature of these tariffs is that they were imposed, in part, to boost the U.S. manufacturing sector by protecting against what were deemed to be unfair practices of trading partners, principally China. Thus, understanding the impact of tariffs on manufacturing is important, as some may view the negative consequences of tariff increases documented in existing research—including higher prices, lower consumption, and reduced business investment—as an acceptable cost for boosting manufacturing activity in the United States.

This paper provides the first comprehensive estimates of the effect of recent tariffs on the U.S. manufacturing sector, while also considering spillovers to the broader labor market. A key feature of this analysis is accounting for the different channels through which tariffs could affect manufacturers in the presence of global trade and supply chain linkages. U.S. import tariffs may protect some U.S.-based manufacturers from import competition in the domestic market, allowing them to gain market share at the expense of foreign competitors. However, U.S. tariffs imposed on intermediate inputs could result in increased costs that may hurt U.S. firms' competitiveness in producing for both the export and domestic markets. Moreover, U.S. trade partners have imposed retaliatory tariffs on U.S. exports of certain goods, which could again put U.S. firms at a disadvantage in those markets, relative to their foreign competitors. Disentangling the effects of these three channels and determining which effect dominates is an empirical question of critical importance.

We begin by constructing industry-level measures that capture exposure to each of these three channels, which we refer to as exposure to "import protection," "rising input costs," and "export retaliation." We relate these measures to manufacturing employment, production, or prices using a generalized difference in differences approach. In particular, we regress industry-month-level outcomes on interactions of month dummies and each of the three channel measures, as well as industry controls. We use two approaches to difference out pre-existing industry-level trends and isolate the response of manufacturing outcomes to the imposition of tariffs, including the procedure developed in Finkelstein (2007), as well as detrending dependent variables.

We find that tariff increases enacted since early 2018 are associated with relative reductions in U.S. manufacturing employment and relative increases in producer prices. In terms of manufacturing employment, rising input costs and export retaliation account for the negative relationship, and the contribution from these channels more than offsets a small positive effect from import protection. Supporting analysis indicates that the employment response is driven primarily by lowered job creation, with a smaller contribution from elevated job destruction. For producer prices, the relative increases associated with tariffs are due primarily to the rising input cost channel. We find little evidence for a relationship between industrial production and any of the three tariff channels considered and provide evidence that this lack of a response is due to the historically high orders backlog that manufacturers built up in the two years prior to imposition of the tariffs.

In terms of economic significance, shifting an industry from the 25th percentile to the 75th percentile in terms of exposure to each of these channels of tariffs is associated with a relative reduction in manufacturing employment of 2.7 percent, with the positive contribution from the import protection effects of tariffs (0.4 percent) more than offset by the negative effects associated with rising input costs (-2.0 percent) and retaliatory tariffs (-1.1 percent). For producer prices, an interquartile shift in exposure to tariffs is associated with a 3.3 percent relative increase in factory-gate prices. We note that these estimates provide information about the responses of more-exposed relative to less-exposed industries, but do not reflect general equilibrium effects of the tariff increases.

To consider potential effects of the tariffs outside the manufacturing sector, we estimate the relationship between county-level unemployment rates and geographic measures of exposure to the three tariff channels. We find that counties with higher exposure to tariffs experience relative increases in unemployment rates. This finding suggests that workers who lose employment in the manufacturing sector due to tariffs are not readily absorbed into employment in other sectors.

Therefore, while a large literature has documented negative implications of import competition for some domestic manufacturing workers (Autor, Dorn and Hanson (2013), Pierce and Schott (2016)), our results suggest that simple tariff increases do not necessarily yield short-term benefits for these workers. Rather, we find that the impact of import tariffs is complicated by the presence of global trade and supply chain linkages, where the traditional import protection effect of tariffs can be offset by unintended impacts to input costs and retaliatory tariffs.

This paper contributes to the evolving literature examining the effects of recent global trade tensions on the U.S. economy. Early work includes Amiti, Redding and Weinstein (2019) and Fajgelbaum et al. (2020) who find near-complete pass-through of U.S. tariff increases to domestic prices, implying welfare losses, though of a relatively small magnitude. Cavallo et al. (2021) show that product composition appears to be a key determinant in the differences in tariff pass-through between U.S. imports and U.S. exports, while also showing that the majority of U.S. tariff increases are being absorbed by U.S. retailers. Flaaen, Hortaçsu and Tintelnot (2020) examine the case of U.S. tariffs imposed on washing machines, showing that tariffs on individual countries can lead to the relocation of production across borders, while tariffs on broader sets of countries lead to substantial price increases for both targeted products and complementary goods. Handley, Kamal and Monarch (2020) find that U.S. import tariffs on inputs lead to reduced exports for firms in affected industries, and Bown et al. (2020) find that tariffs imposed since the 1980s have lowered sales and employment while increasing prices in downstream industries. Results in each of those papers are consistent with our finding of the importance of the rising input cost channel of tariffs and highlight the importance of considering the implications of global value chains and networks when evaluating the effects of tariffs (Antràs, Fort and Tintelnot (2017), Antràs and Chor (2018), Alfaro et al. (2019), Bernard and Moxnes (2018)).

Focusing on geographic exposure to tariffs, Waugh (2019) finds that counties specializing in industries subject to Chinese retaliatory tariffs experience reductions in new auto sales, Goswami (2020) finds that commuting zones subject to higher retaliatory tariffs experience lower employment growth, with no effect from import protection, and Blanchard, Bown and Chor (2019) show that retaliatory tariffs can explain a shift in voting away from Republican House candidates in the 2018 election. In terms of financial impacts, Huang et al. (2019) and Amiti, Kong and Weinstein (2020) find that the effects of tariffs carry through to firms' financial performance, with firms more engaged in trade with China experiencing lower stock returns and, in turn, higher default risk and lower investment, respectively, after the announcement of new rounds of tariffs targeting China. Lastly, in research focusing on uncertainty regarding tariff rates, Caldara et al. (2019) find that increases in measured trade policy uncertainty reduce investment in firm-level and aggregate data.

Although we highlight the recent and rapidly expanding literature on the 2018-2019 tariffs, the ideas of accounting for retaliatory tariffs and supply chain effects of tariffs go back decades. Early examinations of optimal tariffs given the potential for retaliation can be found in Kaldor (1940) and Johnson (1953). The counteracting effect of tariffs on intermediate inputs used in further domestic production—the rising input cost channel described above—was highlighted in Balassa (1965) and Corden (1966), and is present in a wide range of more recent empirical research such as Amiti and Konings (2007) and Topalova and Khandelwal (2011), among others.[1] The scale of the 2018-2019 tariffs, the increased availability of data, and the immensely expanded network of global supply chains permits a quantitative examination of these channels that was not possible before.

Our paper makes several contributions to the existing literatures. First, we explicitly

[1]The effects of changes in tariffs on an industry's output—the import protection channel we examine—have been examined in an extensive empirical literature including, for example, Pavcnik (2002), Trefler (2004), Fernandes (2007), and Artuç, Chaudhuri and McLaren (2010).

measure and estimate the effects of several channels through which tariffs could affect manufacturing industries, which we find to be important given that tariffs can simultaneously protect an industry's output, while raising prices for its inputs, and subjecting it to retaliation in its export markets. Second, we focus specifically on the manufacturing sector, the sector whose output and employment were targeted to be boosted by tariffs, and find that the trade war has been a drag on employment and has failed to increase output, providing context for decision-makers evaluating the efficacy of the tariffs. Third, we provide the first simultaneous examination of the output, employment, and price effects of the 2018-2019 tariffs in a particular sector, and highlight that the tariffs have been associated with price increases, even as they have failed to boost activity in the sector. Finally, we consider the possibility of spillover effects from the manufacturing sector to the broader economy and find that manufacturing workers who lose employment due to tariffs have not been quickly absorbed into employment in other sectors, as indicated by increases in unemployment rates in more affected counties.

2 Background, Data, and Industry-Level Measurement

This section provides background information on manufacturing activity, tariff rounds, data sources, and calculation of key variables.

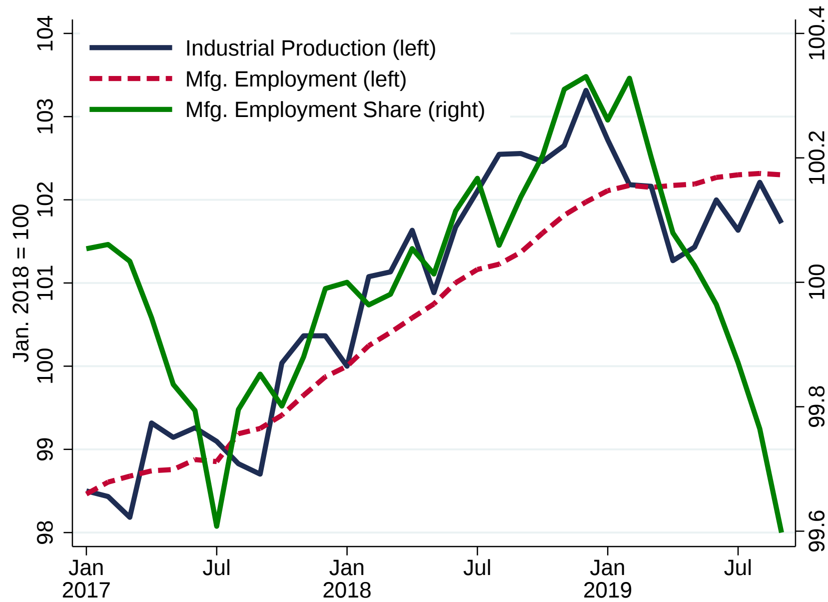
2.1 Recent Trends in U.S. Manufacturing

Figure 1 describes manufacturing activity in the period around the imposition of tariffs (January 2017 to September 2019). As indicated in the figure, manufacturing employment and output increased steadily in 2017 and, indeed, through much of 2018. Toward the end of 2018, however, manufacturing output declined noticeably and employment growth stalled. The decline in the manufacturing share of employment from late 2018 indicates that the weakness in manufacturing employment was specific to that sector, as nonmanufacturing employment continued to grow steadily. The inflection point in manufacturing activity occurring after the imposition of substantial tariffs by the U.S. and its trading partners provides motivating evidence for our detailed analysis of the role of these tariffs on the manufacturing slowdown.

2.2 Timing and Features of U.S. and Retaliatory Tariffs

Panel (a) of Figure 2 displays the magnitude and timing of the three main U.S. tariff actions—which were initiated by the U.S. government, as opposed to being requested by industries or firms—in 2018 and 2019. The first of these actions, shown in green, entailed "Section 201"

Figure 1: Measures of Manufacturing Activity: Jan. 2017 to Sep. 2019



Sources: Federal Reserve Board (FRB) for industrial production; U.S. Department of Labor, Bureau of Labor Statistics for employment.
Notes: Figure displays manufacturing industrial production, manufacturing employment, and the manufacturing share of private employment, each indexed to be 100 in January 2018.

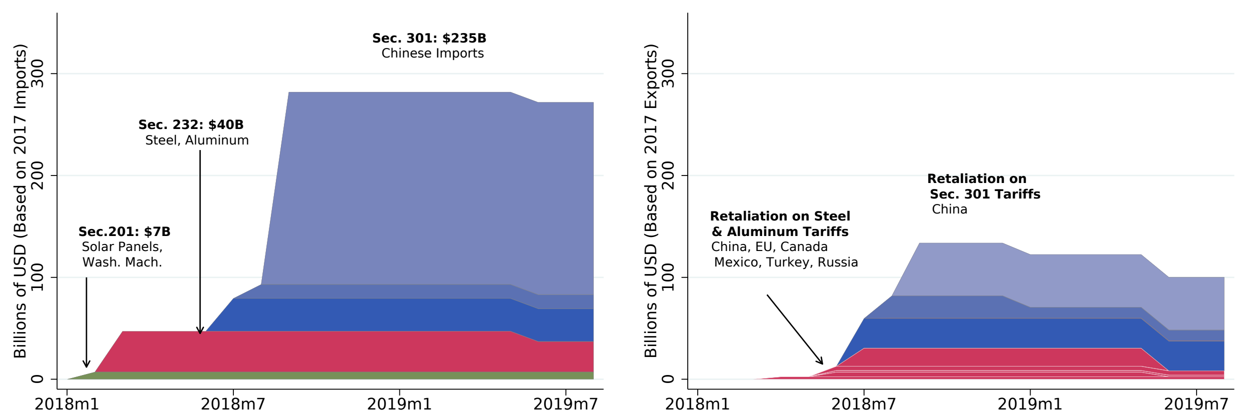
tariffs enacted in February 2018 against imports of washing machines and solar panels from all countries. The second major tariff action, shown in red, affected steel and aluminum imports beginning in March 2018. These rarely-used "Section 232" tariffs, which were justified on national security grounds, were applied at 25 percent on steel and 10 percent on aluminum, and covered nearly all countries, with limited exceptions. The third and most significant action—shown in shades of blue—followed a "Section 301" investigation that concluded that certain Chinese intellectual property and technology transfer policies were illegal under U.S. trade law. The original U.S. tariffs resulting from this investigation were imposed in July 2018 and covered $34 billion of imports from China at a 25 percent rate. However, in a series of back-and-forth retaliations between the U.S. and China, the U.S. expanded the list of covered imports by $16 billion in August and then by nearly $200 billion in September.

U.S. trading partners responded to these actions with retaliatory tariffs on U.S. exports, which are summarized in Panel (b) of Figure 2. As shown in red, in response to the Section 232 tariffs on steel and aluminum, China announced retaliatory tariffs on U.S. exports in April of 2018, while other countries imposed retaliatory tariffs in June and July. In response to the Section 301 tariffs, China imposed retaliatory tariffs in three phases shown in shades of blue. The equal scale of the axes in the two panels makes clear that the value of U.S. exports subject to retaliatory tariffs was substantially smaller than the value of U.S. imports subject to U.S. tariffs.

Lastly, we note that the effect of U.S. tariffs on the domestic manufacturing sector de-

Figure 2: Timeline of New Tariffs Imposed: 2018-2019

(a) New U.S. Import Tariffs **(b)** Retaliatory Tariffs on U.S. Exports



Sources: United States International Trade Commission (USITC) for 2017 import and export values.
Notes: See Tables B1 and B2 for details on the set of relevant products and trade values. In Panel (2a), the decline in mid-2019 reflects Canada and Mexico being removed from the steel and aluminum tariffs.

pends, at least in part, on the products that are affected and how they fit into global supply chains. U.S. manufacturers competing with Chinese imports in the U.S. market, for example, would likely fare differently than manufacturers that rely on Chinese inputs for their U.S. production. As a rough guide of how these tariffs are split along these dimensions, we apply the United Nations Broad Economic Categories (BEC) classification to these tariffs (see also Bown, Jung and Lu (2019*b*) for a similar breakdown) and find that the overwhelming majority of the value of U.S. imports subject to tariffs consists of intermediate and, to a lesser extent, capital goods, each of which are used by U.S. manufacturers as inputs to their production processes (See Appendix Figure B1). Recalling the prominence of imported inputs among the set of goods subject to tariffs will be helpful when considering the effects of the three channels of tariffs in Section 3.

2.3 Data and Measurement

This section describes data sources and calculation of the variables used in the empirical analysis. Our sample period extends from January 2017 to September 2019, which allows us to observe industry-level outcomes before and after the imposition of tariffs, though we note that this analysis is necessarily short-term in nature.[2] Industries, in our setting, are roughly equivalent to the four-digit NAICS, with minor differences in aggregation across dependent variables that are described in Section B.4 of the Appendix.

[2]While a fourth round of U.S. tariffs was imposed in September 2019, we are unable to examine that additional round given the short time between its imposition and the massive disruption of trade with China that began with the December 2019 outbreak of Covid-19 in China.

2.4 Dependent Variables

We draw monthly values of the dependent variables for our analysis—industry output, employment, and producer prices—from three sources. Monthly data on employment at the industry-level are from the the Bureau of Labor Statistics' Current Employment Statistics. Data on monthly industry output come from the Federal Reserve's G.17 Release on Industrial Production and Capacity Utilization. And finally, we use the producer price index, also from the Bureau of Labor Statistics, to measure monthly changes in prices across industries.

2.5 Industry-Level Measures of Trade Policy Impact

We construct industry-level measures capturing each of the three potential tariff channels described above: import protection, export retaliation, and rising input costs.[3] In our baseline analysis, we calculate exposure to the three tariff channels based on the cumulative set of products covered by all tariff actions described in Section 2.2. Appendix Section B.10 describes additional results in which we calculate separate measures of import protection for each individual wave of tariffs. As discussed below and shown in Appendix Figure B2, the measures we calculate vary substantially across industries.

Import Protection

One of the most salient ways that tariffs could affect an industry's economic activity is by restricting foreign competition. Let Ω^I be the list of U.S. imported product-country pairs (pc) subject to new tariffs.[4] The variables imp_i and exp_i identify total industry i imports and exports—drawn from data from the USITC—and Q_i equals domestic production, measured as the value of shipments in the NBER-CES Manufacturing Industry Database, all based on 2016 data. $\Delta\tau_{ipc}$ measures the change in the tariff rate (in percentage points), based on the tariff rates in effect at the end of our sample period. Using these definitions, our measure of "import protection" is given by:

$$\text{Import Protection}_i = \frac{\sum_{pc\in\Omega^I} imp_{ipc}\Delta\tau_{ipc}}{Q_i + imp_i - exp_i}. \tag{1}$$

As indicated in the equation, this measure is calculated for each industry, i, by summing the value of tariff-affected imports from country c of product p, multiplying the value of those

[3] A range of theoretical models with input-output linkages can motivate our channel measures. We describe one useful example from Adão, Arkolakis and Esposito (2020) in detail in Appendix A and discuss how their measures of the various responses to bilateral trade cost shocks compare with the measures we employ.

[4] We use lists of product-country pairs subject to new tariffs from publicly available sources including Bown and Kolb (2019) and concordances from Pierce and Schott (2012) to map products to industries, as described in detail in Appendix Section B.2.

imports by the applicable increase in tariff rates, and then dividing by the value of domestic absorption.

Export Retaliation

While U.S. tariffs may reduce competition for some industries in the domestic market, U.S. trading partners responded with retaliatory tariffs that may harm domestic manufacturers by decreasing their competitiveness in foreign markets. We measure this potential effect for each industry as the value of U.S. exports subject to new retaliatory tariffs, multiplied by the applicable increase in tariff rates, and divided by the value of U.S. output. In particular, defining Ω^E to be the list of U.S. exported product-country pairs (pc) subject to retaliatory tariffs, we define exposure to "export retaliation" as:

$$\text{Export Retaliation}_i = \frac{\sum_{pc \in \Omega^E} exp_{ipc} \Delta \tau_{ipc}}{Q_i}. \tag{2}$$

Rising Input Costs

The final channel captures the potential impact of U.S. tariffs on input costs via supply chain linkages with foreign countries. Data on an industry's inputs come from the "use" table of the Bureau of Economic Analysis's 2012 input-output tables, the most recent vintage available. This table consists of a matrix with elements use_{ij} that report the dollar value of commodity j used in industry i production. With information on industry i's use of total intermediate inputs M_i and compensation of employees $Comp_i$, it is straightforward to construct a matrix SC_{ij} with the share of input costs of commodity j in industry i:

$$SC_{ij} = \frac{use_{ij}}{M_i + Comp_i}, \tag{3}$$

Then, we define TIS_j as the tariff-affected import share of domestic absorption of commodity j to capture the relevance of tariffs to the domestic market for commodity j:

$$TIS_j = \frac{\sum_{pc \in \Omega^I} imp_{jpc} \Delta \tau_{jpc}}{Q_j + imp_j - exp_j}, \tag{4}$$

By multiplying the terms from equations (3) and (4) we arrive at the (implied) tariff-affected import share of costs in industry i from commodity j.[5] Finally, summing across commodities j yields our measure of exposure to "rising input costs" for industry i:

[5] Without additional detail on the sources of inputs across industries, we must use the "proportionality assumption," i.e. that the distribution of the uses of imported commodities in an industry is proportional to overall commodity usage.

$$\text{Rising Input Costs}_i = \sum_j \frac{use_{ij}}{M_i + Comp_i} \frac{\sum_{pc \in \Omega^I} imp_{jpc} \Delta\tau_{jpc}}{Q_j + imp_j - exp_j}. \tag{5}$$

2.6 Other Control Variables

Industries with varying exposure to international trade may respond differently to shocks even in the absence of changes in trade policy, and in this case, the tariff exposure measures described above may be spuriously correlated with industry outcomes. To isolate the effect of tariffs, we include additional industry-level controls that account for general levels of international exposure, irrespective of exposure to new tariffs. We measure export exposure as the export share of shipments, import exposure as the import share of domestic absorption, and import cost exposure as the fraction of an industry's input costs coming from imported goods. In addition, we include controls for industry-level capital intensity. Each of these measures is calculated using data from 2016 from the data sources described in Section 2.5 and then interacted with month dummies as described in Section 3.

3 Short-Run Impacts of Tariffs on Manufacturing

This section discusses the empirical strategy we use to estimate the relationship between recent tariffs and outcomes in the manufacturing sector and presents results.

3.1 Empirical Strategy

Some industries are highly protected with respect to their output, while also being highly subject to tariffs on their inputs or exports, underscoring the need for a systematic approach to estimate the impacts of tariffs on the manufacturing sector.[6] Any bivariate relationship between an outcome measure and one of the channels identified above could end up conflating multiple, potentially offsetting effects on an industry. Therefore, we control for all three channels in our baseline specification, allowing us to calculate estimates of the effect of each channel holding the others constant, and determining which effect dominates.[7]

We adopt a flexible setup that allows the effects of each of the channels to vary over time. In particular, we interact the industry-level measures for each of the tariff channels with a full set of month dummies. This approach allows us to observe the exact timing of

[6] The correlations between the three tariff measures are: rising input costs and import protection (0.38), rising input costs and export retaliation (0.08), and import protection and export retaliation (0.23). Appendix Tables B3, B4, and B5 list the top ten industries in terms of exposure to the three channels.

[7] Section B.9 of the Appendix provides equivalent results in which the dependent variables are regressed separately on each individual tariff channel measure.

any change in trend associated with the three tariff channels and subsequently control for any pre-trends in outcome variables across industries.

Our estimating equation is given by:

$$y_{it} = \alpha + \sum_t \gamma_t \mathbf{1}(M_t = t)(\text{Import Protection}_i) + \sum_t \theta_t \mathbf{1}(M_t = t)(\text{Input Cost}_i) \; ... \qquad (6)$$
$$+ \sum_t \lambda_t \mathbf{1}(M_t = t)(\text{Export Retaliation}_i) + \sum_t \Big(\mathbf{1}(M_t = t) \times \mathbf{X_i'} \boldsymbol{\beta_t}\Big) + \delta_i + \delta_t + \varepsilon_{it}$$

where y_{it}, is the log of either employment, output, or the producer price index of industry i in time t. The $\mathbf{1}(M_t = t)$ terms indicate a set of month dummies (spanning February 2017 to September 2019). Import Protection$_i$, Input Cost$_i$, and Export Retaliation$_i$ are the three tariff channel measures described above, and $\mathbf{X_i'}$ contains the general controls for international conditions as well as capital intensity. The δ_i and δ_t terms are industry and month fixed effects, respectively. Standard errors are clustered at the three-digit NAICS level, which yields conservative estimates of statistical significance.

One concern with this approach is the potential for tariffs to have been assigned to specific industries based on trends in the dependent variables we examine, i.e., employment, production, or prices. Several aspects of how the 2018-2019 tariffs were determined, however, make detailed targeting of industries based on these outcomes unlikely, and our treatment of tariffs in equation (6) is consistent with the existing literature (i.e. Fajgelbaum et al. (2020) and Cavallo et al. (2021)). First, the bulk of the 2018-2019 tariffs resulted from investigations initiated by the U.S. government for the purpose of addressing longstanding complaints against U.S. trading partners, especially treatment of intellectual property in China. This process stands in contrast to that associated with temporary tariffs like antidumping duties, where industries experiencing negative shocks apply for assistance from the government. Second, the tariffs imposed were largely uniform—91 percent of the value of targeted imports was subject to a 25 percent ad valorem duty rate—and covered broad groups of industries, with nearly all imports from China ultimately subject to tariffs. Third, tariff lists were assembled quickly, with the timing of tariffs imposed and magnitude of trade covered largely determined by the tit-for-tat responses of U.S. trading partners, particularly China. In sum, while products subject to tariffs were clearly not chosen randomly, there is substantial evidence that they were chosen primarily based on strategic considerations of the trade war, rather than on short-run industry-specific trends in employment, output, or prices.

Another feature of difference in differences analysis is the need to address differing trends across industries prior to the implementation of new tariffs, which we find to be important in our analysis. We utilize two approaches to explicitly account for pre-trends. First, we estimate equation (6) and then follow Finkelstein (2007) by differencing out the pre-trend path for each coefficient, thereby arriving at a point estimate that isolates the impact of each tariff channel, net of any pre-existing trends. Specifically, for a given set of coefficients (say, the γ_t coefficients above) we calculate the following:

$$\Delta y_{it}^{\gamma} = (\overline{\gamma}_{\text{Jul-Sep19}} - \overline{\gamma}_{\text{Dec17-Feb18}}) - \kappa(\overline{\gamma}_{\text{Dec17-Feb18}} - \overline{\gamma}_{\text{Feb17-Apr17}}). \tag{7}$$

This calculation compares changes in average coefficients over two periods: A post-tariff period spanning just before tariffs were put in place (December 2017 - February 2018) to the final three months of our sample (July-September 2019); and a pre-tariff period from the start of the sample (February - April 2017) to just before tariffs were put in place (December 2017 - February 2018).[8] As an alternative approach for netting out pre-trends, we replace the outcome variable y_{it} in equation 6 with the equivalent measure after removing an industry-specific linear trend for the period from January 2017 to January 2018, the last full year before the implementation of new tariffs. One attractive feature of this approach is that it allows us to observe the precise timing of any change in relationship between exposure to the tariff channels and manufacturing outcomes.

3.2 Results

Table 1 reports estimates from the Finkelstein (2007) approach (equation 7). Figure 3 provides a visual representation of the alternative results of estimating equation 6 for each of the three detrended outcomes of interest. Specifically, the three panels of the figure display coefficient estimates and 90 percent confidence intervals for the interactions of the tariff channel measures with month dummies for the dependent variables of employment (Panel (a)), industrial production (Panel (b)), and producer prices (Panel (c)).[9]

Estimates for employment are reported in column 1 of Table 1 and Panel (a) of Figure 3. As shown in the first column of the table, we find statistically significant relationships between manufacturing employment and all three tariff channels, with each relationship taking the expected sign. First, we find a negative and highly statistically significant relationship between manufacturing employment and exposure to the rising input cost channel capturing tariffs on imported inputs. The timing of this impact is shown in Figure 3 (left column of Panel (a)) as a downward shift of coefficient estimates following the imposition of tariffs. Table 1 also reveals a negative and statistically significant relationship between exposure to export retaliation and manufacturing employment, which appears as a downward turn of co-

[8]The κ term adjusts for the differing lengths of the post-tariff and pre-tariff periods.

[9]Appendix Section B.8 presents results for the non-detrended version of Equation 6. As shown in Figure B4, coefficient patterns sometimes indicate the presence of differing pre-existing trends for more- versus less-exposed industries, followed by breaks in trend that occur as tariffs are put into place. As discussed in Finkelstein (2007), these breaks in trend represent the impact on the dependent variables that can be attributed to tariffs, with our two approaches representing alternative ways to capture these impacts by netting out pre-existing trends.

efficient estimates in the right column of Panel (a) of Figure 3. Lastly, we find a positive and marginally statistically significant relationship between import protection and employment in Table 1, which manifests itself as a subtle and imprecisely estimated shift up in coefficient estimates once tariffs begin to be imposed in the middle column of Panel (a). The results in Panel (a) of Figure 3 also indicate intuitive differences in the timing of observed effects for each of the channels. Coefficient estimates for the retaliatory tariff channel begin to shift almost immediately after those tariffs are imposed, while the relationship with exposure to rising input costs takes longer to appear given that these effects only arise as the impacts of tariffs are passed through supply chains.

We calculate the economic significance of these estimates by comparing an industry at the 75th percentile of exposure to the three tariff channels to an industry at the 25th percentile. In this comparison, the industry more exposed to the rising input cost channel experiences a relative reduction in manufacturing employment of -2.0 percent, relative to the less exposed industry. Including the other two channels boosts this effect to a -2.7 percent relative reduction in manufacturing employment, as the negative contribution from retaliatory tariffs (-1.1 percent) more than outweighs the (somewhat less precisely estimated) positive contribution from the import protection effect (0.4 percent).[10]

Table 1: Point Estimates of Cumulative Effect by Channel

Variable	Employment	Industrial Production	Producer Prices	Hires	Separations
Import Protection	0.310*	-0.491	-1.266	0.469	0.156
	(0.171)	(1.004)	(0.758)	(1.540)	(1.511)
Rising Input Costs	-3.085***	-1.216	6.538***	-17.351**	3.369
	(0.867)	(2.690)	(1.888)	(6.336)	(2.160)
Export Retaliation	-4.479**	2.732	1.954	-5.190	13.155***
	(1.679)	(2.370)	(3.868)	(9.385)	(4.350)
Industry Fixed Effects	yes	yes	yes	yes	yes
Number of Industries	76	84	82	76	76
Frequency	Month	Month	Month	Quarter	Quarter
Observations	2,508	2,772	2,706	836	836

Sources: Federal Reserve Board, Bureau of Labor Statistics, authors' calculations.
Notes: Table displays coefficient estimates and standard errors of the Finkelstein (2007) approach presented in equation (7) in the text. Estimates for employment are weighted by December 2017 employment, estimates for industrial production and producer prices are weighted by December 2017 value added, and estimates for hires and separations are weighted by fourth quarter 2017 employment. Standard errors (in parentheses) are clustered by 3-digit NAICS industry. $*\ p < 0.10$, $**\ p < 0.05$, $***\ p < 0.01$.

[10] We find that these results are robust to inclusion of controls for trade policy uncertainty from Caldara et al. (2019) in Appendix Section B.6 and discuss ways that our approach controls for heterogeneous effects of business cycle shocks in Appendix Section B.7.

Column 2 of Table 1 and Panel (b) of Figure 3 present estimates pertaining to the relationship between tariffs and industrial production. Here, we see little evidence of significant impacts from the tariffs. Estimates in column 2 of Table 1 are not statistically different from zero, and coefficients displayed in Figure 3 are little-changed, on net, following the imposition of tariffs.[11]

Finally, column 3 of Table 1 indicates that new tariffs are associated with a statistically significant relative increase in producer prices due to exposure to rising input costs. In terms of economic significance, an interquartile shift in exposure to rising input costs is associated with a 3.9 percent relative increase in factory-gate prices. Including the other statistically insignificant channels implies a 3.3 percent relative increase in factory-gate prices. These results are consistent with Amiti, Redding and Weinstein (2019) who find a role for input tariffs, in addition to tariffs on output, in increasing U.S. prices. In terms of timing, the left column of Panel (c) of Figure 3 indicates that the positive relationship between exposure to rising input costs and producer prices becomes apparent almost immediately after the first round of U.S. tariffs is imposed.

3.3 Margins of Employment Adjustment

The employment effects we identify above could result from increased layoffs or slowdowns in hiring by affected firms, and analyzing differences along these margins provides important supporting information on employment adjustments to tariff shocks. To explore which of these margins accounts for our results, we use data from the Census Bureau's Quarterly Workforce Indicators, which reports the number of hires and separations, by quarter, for all U.S. manufacturers at the four-digit NAICS industry level.

We employ the same estimation strategy as in Section 3, adapted to quarterly data. Here, the dependent variable is the log level of either hires or separations for industry i in quarter q. The industry-level measures are identical to those in equation 6, but are interacted with quarter dummies, rather than month dummies. We continue to cluster standard errors at the three-digit NAICS level.

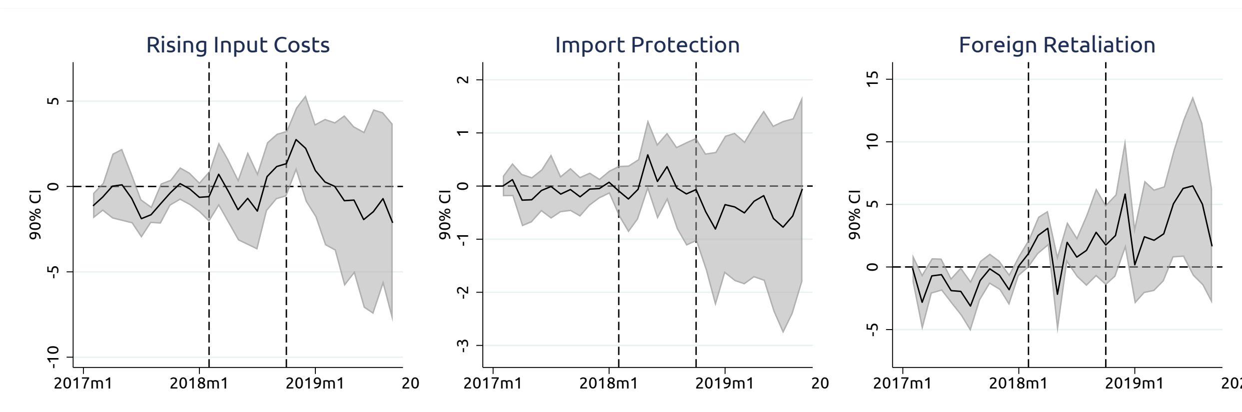
Columns 4 and 5 of Table 1 display results of applying the Finkelstein (2007) approach to the resulting coefficient estimates. The estimates indicate that exposure to tariffs is associated with a reduction in hiring due to higher exposure to the rising input cost channel and an increase in separations due to export retaliation. In terms of the relative importance of the hiring and separation margins, the impact of an interquartile shift in exposure to each channel on hires is about twice the magnitude of the effect on separations.

[11] Appendix B.11 presents evidence that this lack of response in terms of production occurs, at least in part, because the tariffs were imposed at a time when manufacturers held historically high levels of unfilled orders.

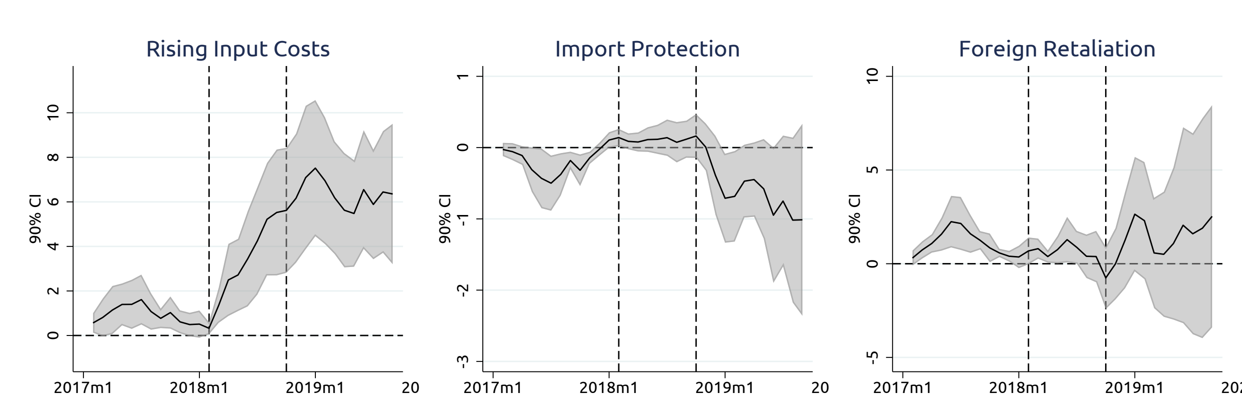
Figure 3: Effects of Cumulative Tariffs (Detrended)

(a) Employment

(b) Industrial Production (Output)



(c) Producer Price Index



Sources: Federal Reserve Board (FRB), U.S. Department of Labor, Bureau of Labor Statistics; authors' calculations.

Notes: Each panel displays results of a separate regression for the noted detrended dependent variable, with each column corresponding to the three tariff channels in equation (6). Solid lines indicate coefficient estimates and shaded areas represent 90 percent confidence intervals. The two vertical dashed lines are at February 2018 and September 2018, the times of the first and last waves of new 2018 tariffs. Estimates for employment are weighted by December 2017 employment and estimates for industrial production and producer prices are weighted by December 2017 value added. Standard errors are clustered at the three-digit NAICS level.

4 Broader Effects of Tariffs on Manufacturing

We next consider whether the negative relationship between tariffs and manufacturing employment is sufficiently large to have implications for county-level unemployment rates. This exercise provides information on the extent of difficulty faced by displaced manufacturing workers in finding employment in other sectors and is particularly important as the impact of tariffs could be concentrated in specific areas of the United States.

To examine the relationship between tariffs and unemployment rates, we turn to a geographic analysis. We construct standard Bartik-type measures of county-level exposure to the three tariff channels described above, based on the industry structure of each county in 2016, as reported by the Census Bureau's County Business Patterns.[12] Data on county-level unemployment rates are from the BLS's Local Area Unemployment Statistics. Our empirical approach mirrors that used to estimate equation (6) in Section 3, but using county-month-level data in place of industry-month-level data:

$$
\begin{aligned}
y_{kt} = \quad & \alpha + \sum_t \gamma_t \mathbf{1}(M_t = t)(\text{Import Protection}_k) + \sum_t \theta_t \mathbf{1}(M_t = t)(\text{Input Cost}_k) \text{ ...} \\
& + \sum_t \lambda_t \mathbf{1}(M_t = t)(\text{Export Retaliation}_k) + \sum_t \Big(\mathbf{1}(M_t = t) \times \mathbf{X_k'}\boldsymbol{\beta_t}\Big) + \delta_k + \delta_t + \varepsilon_{kt}.
\end{aligned} \tag{8}
$$

The dependent variable (y_{kt}) is the county-month-level unemployment rate, and the independent variables are interactions of month dummies with the county-level measures of each of the three tariff channels, the three measures of international exposure described above, and the county's manufacturing employment share. Including controls for the manufacturing employment share captures shocks operating through a county's overall manufacturing intensity, thereby allowing the tariff channel measures to isolate effects that are due solely to tariffs. Equation 8 also includes county and month fixed effects, and standard errors are clustered at the state level.

We report results of estimating equation 8 in terms of the Finkelstein (2007) approach in Table 2. As indicated in the first column of the table, we find a positive and statistically significant relationship between the county-level unemployment rate and exposure to the rising input cost channel, with an interquartile shift in exposure associated with a relative increase in the unemployment rate of 0.17 percentage point. While this increase is modest in size, it suggests that the decline in manufacturing employment due to the imposition of tariffs is not readily absorbed by gains in other industries, at least in the short-term. This result provides further evidence of the presence of substantial adjustment costs for workers attempting to move between industries or geographic areas (Ebenstein et al. (2014), Artuç,

[12] See Appendix Section B.13 for details on data sources and calculation of county-level exposure measures.

Table 2: Point Estimates of Cumulative Effect by Channel:

Variable	Unemployment Rate (1)	(2)
Rising Input Costs	63.77**	110.65***
	(31.61)	(25.45)
Import Protection	9.83	19.46**
	(8.33)	(7.37)
Export Retaliation	51.59	101.41**
	(33.05)	(35.77)
County Fixed Effects	yes	no
Industry Fixed Effects	no	yes
Month Fixed Effects	yes	yes
Number of Counties	3,131	n/a
Observations	103,356	2,508

Sources: U.S. Department of Labor, Bureau of Labor Statistics; authors' calculations.
Notes: Table displays results of the Finkelstein (2007) approach described in equation 7, based on OLS regressions of unemployment rates on measures of exposure to the rising input cost, import protection, and export retaliation channels of tariffs. Column (1) reports results at the county-level, while column (2) reports results after translating to a shock-level (industry-level) specification following Borusyak, Hull and Jaravel (Forthcoming). Estimates are weighted by December 2017 labor force. Standard errors (in parentheses) are clustered at the state-level in the column (1) and at the 3-digit NAICS industry level in column (2). $* \, p < 0.10$, $** \, p < 0.05$, $*** \, p < 0.01$.

Chaudhuri and McLaren (2010), Caliendo and Parro (2014), and Acemoglu et al. (2016)).

In a setting where we use prior-year employment shares to allocate the industry-level shock, this exercise has a natural interpretation that follows the growing literature utilizing Bartik or shift-share instruments. We follow the correction procedures outlined in Borusyak, Hull and Jaravel (Forthcoming) and convert employment weighted averages across counties to then run industry-level regressions with corrected standard errors.[13] Results are shown in column 2 of Table 2 and are qualitatively similar in this form; now higher exposure to both rising input costs and export retaliation are associated with relative increases in unemployment. While there is also a positive relationship between import protection and unemployment rates with this approach, the implied effect is small, at roughly a tenth the size of the combined effects of the other two channels.[14]

[13]Although our setting is a shift-share in reduced form, unlike the IV applications highlighted in their paper, Borusyak, Hull and Jaravel (Forthcoming) emphasize that the re-weighting approach is valid in either case.

[14]It is clear that the equivalence result highlighted in Borusyak, Hull and Jaravel (Forthcoming) doesn't hold in our setting, which is unsurprising in light of the multiple sets of shocks and controls that we utilize.

5 Conclusion

This paper examines the relationship between three aspects of the 2018-2019 tariffs and outcomes in the U.S. manufacturing sector and broader labor market. We find that the tariffs are associated with relative reductions in manufacturing employment, as a small and imprecisely estimated boost from import protection is more than offset by larger drags from the effects of retaliatory tariffs and, especially, exposure to rising input costs. Exposure to rising input costs is also associated with relative increases in producer prices. Examination of broader labor market outcomes reveals that tariffs are associated with relative increases in unemployment rates. While the longer-term effects of the tariffs may differ from those that we estimate here, the results indicate that the traditional use of trade policy as a tool for the protection and promotion of domestic manufacturing is complicated by the presence of globally interconnnected supply chains.

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Appendix

A Theory

In this Appendix, we appeal to an existing model to discuss how the empirical measures of tariff effects we consider in this paper relate to theoretically-derived analogues. While there are a range of international trade models with input-output linkages that could rationalize our measures, a recent well-suited example comes from Adão, Arkolakis and Esposito (2020), which examines the effect of international trade shocks on spatially connected markets. Most relevantly for our purposes, Adão, Arkolakis and Esposito (2020) derives relationships between the shift share measures commonly used in empirical research and the partial and general equilibrium effects of trade shocks. Moreover, given our focus on several channels through which tariffs can affect outcomes, the extension of the model in Appendix C.5 that includes input-output linkages, as in Caliendo and Parro (2014), is of particular importance.

Because the theoretical framework we present here is taken directly from Adão, Arkolakis and Esposito (2020), we do not replicate the derivations of the model, and instead refer the interested reader to that paper (and online Appendix C.5 in particular) for more details. In the discussion that follows, we discuss how the model in Adão, Arkolakis and Esposito (2020) provides a theoretical backing for the empirical measures constructed in section 2.5 in the main text.

We focus attention on the equations describing comparative statics in the model, a key emphasis of Adão, Arkolakis and Esposito (2020). Specifically, Adão, Arkolakis and Esposito (2020) highlight how exogenous changes in bilateral trade costs, $\hat{\tau}_{ij,s}$, from country i to country j in sector s affect other outcomes in both partial equilibrium and general equilibrium. In comparative static exercises applied to the version of the model including intermediate inputs, there are three channels of partial equilibrium shifts from the shock to trade costs $\eta_j(\eta_j^R, \eta_j^C, \eta_j^M)$.

The first of these partial equilibrium shifts from Adão, Arkolakis and Esposito (2020) details how changes in bilateral trade costs affecting sector k output impact revenues in country j. It is given by

$$\hat{\eta}_{j,k}^R = -\,\varepsilon_k \sum_i y_{ji,k} \left(\hat{\tau}_{ji,k} + \sum_o x_{oi,k} \hat{\tau}_{oi,k} \right) \tag{A1}$$

where $y_{ji,k}$ is the share of sector k revenue of country j that comes from country i, and x is defined similarly in terms of spending. In the application to the tariff escalation highlighted in this paper, we focus on the first term only as the second term ends up being second order in magnitude.[15] Focusing on this first term:

[15] To see this, consider the example of Chinese retaliatory tariffs on the U.S., with $\hat{\tau}_{ji,k} > 0$ for $j = \{U.S.\}$

$$\hat{\eta}^R_{j,k} = -\,\varepsilon_k \sum_i y_{ji,k}\hat{\tau}_{ji,k}, \tag{A2}$$

where $\varepsilon_k > 0$ is the trade elasticity. In words, this measure weights the country i tariff changes on country j output by the share of j sales to i, and (given the negative sign) indicates that increases in tariffs affecting domestic output lead to revenue losses. In this sense, equation (A2) is similar to the empirical measure for export retaliation in equation (2) in the main text.

The second shift described in the expanded model of Adão, Arkolakis and Esposito (2020), with intermediate inputs, is $(\hat{\eta}^C_i)$. This measure is defined at the overall market level as

$$\hat{\eta}^C_i = \sum_{o,k} \xi_{i,k} x_{oi,k} \hat{\tau}_{oi,k},$$

where $\xi_{i,k}$ is the spending share of i on goods from sector k. Our industry-level measure, which we denote as $\hat{\eta}^C_{i,k}$, is the second term in the equation below:

$$= \sum_k \xi_{i,k} \underbrace{\sum_o x_{oi,k}\hat{\tau}_{oi,k}}_{\hat{\eta}^C_{i,k}}$$

After substituting in the definition of $x_{oi,k}$

$$x_{oi,k} = \frac{\left(\frac{\tau_{oi,k} p_{o,k}}{\Psi_o(\mathbf{L})}\right)^{-\varepsilon_k}}{\sum_j \left(\frac{\tau_{ji,k} p_{j,k}}{\Psi_j(\mathbf{L})}\right)^{-\varepsilon_k}}, \tag{A3}$$

which describes the spending share in country i, we can re-organize the industry-level component $\hat{\eta}^C_{i,k}$ as follows:

$$\begin{aligned}\hat{\eta}^C_{i,k} &= \sum_o \left(\frac{\left(\frac{\tau_{oi,k} p_{o,k}}{\Psi_o(\mathbf{L})}\right)^{-\varepsilon_k}}{\sum_j \left(\frac{\tau_{ji,k} p_{j,k}}{\Psi_j(\mathbf{L})}\right)^{-\varepsilon_k}} \hat{\tau}_{oi,k} \right) \\ &= \frac{\sum_o \left(\frac{\tau_{oi,k} p_{o,k}}{\Psi_o(\mathbf{L})}\right)^{-\varepsilon_k} \hat{\tau}_{oi,k}}{\sum_j \left(\frac{\tau_{ji,k} p_{j,k}}{\Psi_j(\mathbf{L})}\right)^{-\varepsilon_k}} \end{aligned} \tag{A4}$$

Once again, this equation simply weights the changes in bilateral trade costs by the respective country shares within a given sector. In the context of our focus on the manufacturing sector,

and $i = \{China\}$ only, and hence $\hat{\tau}_{oi,k} = 0\ \forall o \neq \{U.S.\}$. Thus, the two shares $y_{ji,k}$ and $x_{ji,k}$ multiplied together combined with the $\hat{\tau}_{ji,k}$.

the change in bilateral trade costs owing to a rise in own-country tariffs ($\hat{\tau}_{oi,k}$ above) implies the higher prices by domestic firms that forms the basis of import protection. Equation (A4), therefore, is similar to our empirical measure for import protection in equation (1) in the main text.

Finally, the third shift ($\hat{\eta}^M_{i,s}$) described in the Appendix to Adão, Arkolakis and Esposito (2020) identifies the impact of increased input costs for each sector-market:

$$\hat{\eta}^M_{i,s} = \sum_{o,k} \theta_{ik,s} x_{oi,k} \hat{\tau}_{oi,k}, \tag{A5}$$

where, importantly, $\theta_{ik,s}$ governs the input shares of sector k in the production of sector s in country i. Expanding out equation (A5) as above and rearranging yields:

$$\begin{aligned} &= \sum_k \theta_{ik,s} \sum_o x_{oi,k} \hat{\tau}_{oi,k} \\ &= \sum_k \theta_{ik,s} \sum_o \left(\frac{\left(\frac{\tau_{ji,k} p_{j,k}}{\Psi_j(\mathbf{L})}\right)^{-\varepsilon_k}}{\sum_j \left(\frac{\tau_{ji,k} p_{j,k}}{\Psi_j(\mathbf{L})}\right)^{-\varepsilon_k}} \hat{\tau}_{oi,k} \right) \\ &= \sum_k \theta_{ik,s} \frac{\sum_o \left(\frac{\tau_{ji,k} p_{j,k}}{\Psi_j(\mathbf{L})}\right)^{-\varepsilon_k} \hat{\tau}_{oi,k}}{\sum_j \left(\frac{\tau_{ji,k} p_{j,k}}{\Psi_j(\mathbf{L})}\right)^{-\varepsilon_k}}. \end{aligned} \tag{A6}$$

This equation says that the shocks to bilateral trade costs ($\hat{\tau}_{oi,k}$) for a given country o and product k are weighted by the corresponding shares of country-origin (which include domestic origin), and then further weighted by their use by sector s according to the input shares $\theta_{ik,s}$. Thus, equation (A6) provides an analogue to our empirical measure for rising input costs in equation (5) in the main text.

B Additional Details on Data and Results

This section provides additional details on the data used to construct key variables in the paper, while also providing supporting empirical results not presented in the main text.

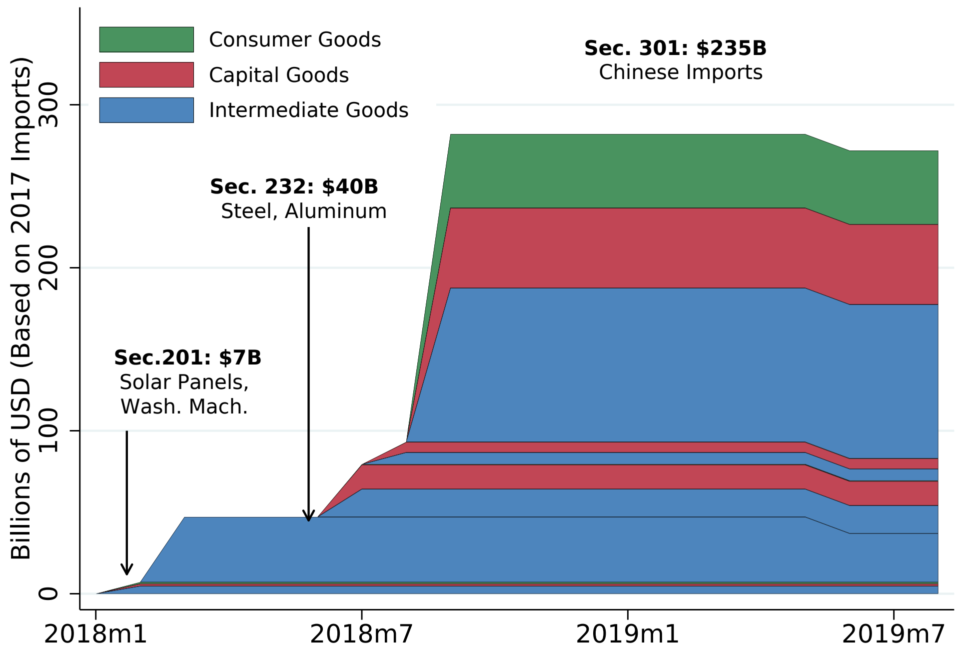
B.1 Composition of U.S. Import Tariffs

For a rough split of the U.S. import tariffs along dimensions of intermediate vs final use, we apply the United Nations Broad Economic Categories (BEC) classification (see also Bown, Jung and Lu (2019*b*) for a similar breakdown).[16] Figure B1 shows that the early U.S. tariffs

[16] Of course, the BEC classification does not substitute for analysis using input-output tables, as one U.S. industry's output can be another industry's intermediate input.

predominantly covered intermediate goods, represented by the blue areas of the section 232 and initial section 301 phases of U.S. tariffs, as well as capital goods, shown in red.

Figure B1: Composition of New U.S. Import Tariffs: 2018-2019



Source: USITC for 2017 import values.
Notes: See Table B1 for details on the set of relevant products and trade values. Classification comes from the Broad Economic Categories from the United Nations (further details are available here).

B.2 Data and Further Details on Product-Country Pairs Subject to New Tariffs

This section describes data sources and provides additional detail regarding determination of which products and countries were subject to new tariffs. We use publicly available data on the lists of products covered by U.S. import tariffs and foreign retaliatory tariffs. For U.S. tariffs, product lists are from the United States Trade Representative and the U.S. Federal Register. For retaliatory tariffs by U.S. trade partners, data are drawn from the relevant government agencies including the Canadian Department of Finance, the European Commission, as well as the World Trade Organization. These lists of affected products have been helpfully collected by other researchers who have made them available for public use.[17] Table B1 provides links to all lists of affected products.

We map the Harmonized System (HS) codes covered by tariffs described above to the North American Industry Classification System (NAICS) using the concordance developed

[17] See, for example, Bown and Kolb (2019) and the website maintained by the Crowell-Moring International Trade law firm.

Table B1: New U.S. Import Tariffs by Trade Action and Wave

Import Tariff	Reference for Affected Products	2017 Import Volume	Reported by Government	Other Estimates	Source for Other Estimates
		Billions of U.S. Dollars			
Sec. 201: Solar Panels		7	8.5		
Sec. 201: Washing Machines		1.85	1.8		
Sec. 232: Steel	Link	27.7	10.2	29	Source
Sec. 232: Aluminum	Link	17.4	7.7	17	Source
Sec. 301 Part 1	Link	32.3	34		
Sec. 301 Part 2	Link	13.7	16		
Sec. 301 Part 1+2		46.0	50	45.7	Source
Section 301 Part 3	Link	189	200	177	Source

Notes: Table reports the value of trade affected in each round of tariffs according to authors' calculations (2017 Import Volume), as well as estimates reported by the U.S. government and other researchers.

by Pierce and Schott (2012). For U.S. import tariffs, this requires a simple application of the concordance. For tariffs imposed by U.S. trade partners, this process is complicated by the fact that the import product codes published by foreign governments cannot be matched to the Schedule B system used for U.S. exports below the six-digit HS level. Therefore, for foreign retaliatory tariffs, we treat an entire six-digit HS code as being covered by tariffs if any product with that six-digit HS prefix is covered by a tariff, following Blanchard, Bown and Chor (2019), Waugh (2019) and Bown, Jung and Lu (2019*a*). We find that this assumption is justified because the value of U.S. exports that we classify as being covered by retaliatory tariffs lines up well with those calculated by other researchers as well as those announced by U.S. trade partners, as reported in Table B2.

B.3 Tables of Highly Exposed Industries and Kernel Densities for Each Tariff Channel

This section presents tables of the top ten industries in terms of exposure to each of the three tariff channel measures. The presence of some industries in all three tables highlights the importance of controlling for all three channel measures simultaneously. For example, our measures indicate that household appliance manufacturing (NAICS 3352) was highly exposed to all three channels.

Table B3 lists the top ten industries for the measure of import protection. The list includes industries protected by the China-specific Section 301 tariffs, such as electric lighting equipment (NAICS 3351), household and institutional furniture and kitchen cabinets (NAICS 3371), and other electrical equipment and component (NAICS 3359). Also prominent in the list are industries affected by the global tariffs—Section 232 tariffs on steel and

Table B2: New Retaliatory Tariffs on U.S. Exports by Trade Action and Wave

Retaliatory Tariff	Reference for Affected Products	2017 Export Volume	Reported by Government	Other Estimates	Source for Other Estimates
		Billions of U.S. Dollars			
China on US – Apr. 2018	Link	2.44	2.4	2.39	Source
EU on US – Jun. 2018	Link	4.23	3.2	3.24	Source
Canada on US – Jul. 2018	Link	17.8	12.8	12.76	Source
China on US – Jul. 2018	Link	29.2	34		
China on US – Aug. 2018	Link	21.9	16		
China on US – Jul.+Aug.		51.1	50	49.8	Source
China on US – Sep. 2018	Link	52	60	53.4	Source
Mexico on US – Jun. 2018	Link	4.51	3.8		
India on US – Jan. 2019	Link	0.89	1.3	1.3	Source
Turkey on US – Jun. 2018	Link	1.56	1.8		
Russia on US – Aug. 2018	Link	0.27	0.43		

Notes: Table reports the value of trade affected in each round of tariffs according to authors' calculations (2017 Export Volume), as well as estimates reported by governments of U.S. trading partners and other researchers.

aluminum and the Section 201 tariffs on washing machines.

The ten industries most affected by new foreign retaliatory tariffs are shown in Table B4. This list also includes a mixture of products subject to retaliatory tariffs by China, as well as metals-producing industries subject to tariffs by a broader set of retaliating trade partners.[18]

Table B5 lists the top U.S. industries affected by increased costs from recent imported input tariffs. As is apparent in the table, all of these industries are heavily dependent on various metals for domestic production.[19]

For further detail on the distribution of exposure to the three tariff channels considered in this paper, Figure B2 shows density estimates across the 76 manufacturing industries for which manufacturing employment data are available.

B.4 Level of Aggregation

We conduct the analysis largely at the four-digit NAICS industry level, which is the most detailed level at which comprehensive data for industrial production, producer prices, em-

[18] This measure of retaliatory tariffs includes retaliatory tariffs by China on U.S. exports of motor vehicles (NAICS 3361), which were imposed in July of 2018, but then suspended in January of 2019.

[19] The Section 201 tariffs on solar panels are excluded from the rising input cost channel because the level of aggregation in the input-output tables does not allow them to be separated from semiconductors.

Table B3: Top Ten Industries by Exposure to New Import Protection

Rank	NAICS	Industry Description	Import Protection Measure
1	3351	Electric Lighting Equipment	7.4%
2	331313	Primary Aluminum Production	6.7%
3	3371	Household and Institutional Furniture and Kitchen Cabinet	6.0%
4	3344	Semiconductor and Other Electronic Component	5.4%
5	3311	Iron and Steel Mills and Ferroalloy Mfg	5.2%
6	3352	Household Appliance Manufacturing	4.3%
7	3359	Other Electrical Equipment & Component	4.1%
8	3160	Leather and Allied Product	3.7%
9	3332	Industrial Machinery	3.6%
10	3322	Cutlery and Handtool Manufacturing	3.6%

Sources: Authors' calculations based on equation (1) in the text.
Notes: This measure corresponds to the cumulative coverage of all three 2018-2019 tariff actions.

Table B4: Top Ten Industries by Exposure to New Export Retaliation

Rank	NAICS	Industry Description	Foreign Retaliation Measure
1	3346	Manufacturing and Reproducing Magnetic & Optical Media	1.71%
2	3311	Iron and Steel Mills and Ferroalloy Mfg	1.67%
3	3361	Motor Vehicle Manufacturing	1.23%
4	3160	Leather and Allied Product	1.06%
5	33131B	Aluminum Sheet/Plate/Foil & Rolling/Drawing/Extruding	0.96%
6	3211	Sawmills and Wood Preservation	0.95%
7	3343	Audio and Video Equipment	0.84%
8	3341	Computer and Peripheral Equipment	0.79%
9	3369	Other Transportation Equipment	0.74%
10	3352	Household Appliance Manufacturing	0.71%

Sources: Authors' calculations based on equation (2) in the text.
Notes: This measure corresponds to the cumulative coverage of all three 2018-2019 tariff actions.

ployment, and input-output relationships are typically available at a consistent level of aggregation. There are minor differences in availability of data at the four-digit industry level across the different outcome variables—the BLS employment data sometimes combine small four-digit industries—and data are only available at the three-digit NAICS level for Apparel Manufacturing (NAICS 315) and Leather and Allied Product Manufacturing (NAICS 316).[20] Ultimately, our baseline samples, which each cover the entire manufacturing sector at slightly different levels of aggregation, contain 76 industries for employment, 84 industries

[20] Results are qualitatively identical if NAICS 315 and 316 are excluded from the sample, given their small size.

Table B5: Top Ten Industries by Exposure to Rising Input Costs

Rank	**NAICS**	**Industry Description**	**Rising Input Cost Measure**
1	3312	Steel Product Mfg from Purchased Steel	2.23%
2	33131B	Aluminum Sheet/Plate/Foil & Rolling/Drawing/Extruding	1.94%
3	3321	Forging and Stamping	1.86%
4	3324	Boiler, Tank, and Shipping Container	1.53%
5	3323	Architectural and Structural Metals	1.39%
6	3332	Industrial Machinery Manufacturing	1.29%
7	3339	Other General Purpose Machinery Manufacturing	1.29%
8	3352	Household Appliance Manufacturing	1.26%
9	3369	Other Transportation Equipment	1.26%
10	3363	Motor Vehicle Parts Manufacturing	1.16%

Sources: Authors' calculations based on equation (5) in the text.
Notes: This measure corresponds to the cumulative coverage of all three 2018-2019 tariff actions.

for industrial production, and 82 industries for producer prices.[21] While there is almost certainly heterogeneity in the extent of exposure to each of the three tariff channels for the finer industries, firms, and plants, within our four-digit NAICS industries, our baseline estimates provide the net effect of these heterogeneous responses. Furthermore, the presence of heterogeneous responses within four-digit NAICS industries likely biases us away from finding any statistically significant relationships between tariffs and industry-level outcomes.

B.5 Control Variables

Here, we report coefficient estimates and 90 percent confidence intervals for the control variables used in equation (6). These variables include interactions of month dummies with industry export share of output, industry import share of domestic absorption, and industry import share of costs. These first three controls are intended to capture features of international exposure that are not directly related to tariffs, such as exchange rate movements and overall foreign growth. These variables may also capture some of the potential impact from increased uncertainty on international markets. We also report estimates for interactions of month dummies with industry capital intensity (capital-labor ratio), to capture different responses to non-tariff shocks by industries with differing capital intensities. Figure B3 reports these results pertaining to employment, industrial production, and PPIs.

[21] Industrial production has the largest number of industries because detail is available to separate aluminum manufacturing (NAICS 3313) into three sub-industries that are relevant given the set of tariffs we study: Primary aluminum production (NAICS 331313), secondary smelting and alloying of aluminum (NAICS 331314), and aluminum product (sheet, plate, foil, etc.) production. This split takes into account that while all three of these groups stand to benefit from tariffs on their output, the latter two are also subject to tariffs on their inputs, implying different overall effects of tariffs. We note, however, that use of this additional detail does not have substantive effects on our estimates—we find little relationship between

B.6 Trade Policy Uncertainty

Much of the discussion of the effects of the 2018-2019 tariffs has focused on the role of uncertainty about trade policy (Caldara et al. (2019)), and a recent literature has documented substantial effects on economic activity of trade policy uncertainty and its resolution (Pierce and Schott (2016), Handley and Limao (2017), Crowley and Exton (2018)). Given that tariffs were actually imposed on the inputs or outputs of nearly every U.S. goods-producing industry, separating the effects of uncertainty from the realized changes in tariff rates is difficult. Here, we explore the effects of augmenting equation (6) with a commonly-cited measure of trade policy uncertainty related to the 2018-2019 tariffs from Caldara et al. (2019).

Caldara et al. (2019)'s measure of trade policy uncertainty is based on a textual analysis of the quarterly earnings calls of publicly traded U.S. firms. After classifying firms according to their Fama-French 12 industry definition, Caldara et al. (2019) measure the frequency of references to trade policy and uncertainty-related terms by industry, for each quarter. Because Caldara et al. (2019)'s measure of trade policy uncertainty is only defined through the second quarter of 2019, our analysis in this robustness check ends in June 2019, versus September 2019 in our baseline results. Results are presented in Table B6, and to conserve space, we report only the results of regressions using manufacturing employment as the dependent variable.

As indicated in the table, relationships between realized tariff changes and employment when controlling for trade policy uncertainty are highly similar to those reported in Table 1, and the coefficient on the measure of trade policy uncertainty is not statistically significant at conventional levels. Therefore, while we caution that the Caldara et al. (2019) measure of trade policy uncertainty is defined at a more aggregate industry level (Fama-French 12) and time frequency (quarterly) than our dependent variable, these results provide support for the idea that actual changes in tariffs are associated with changes in economic activity that are distinct from effects of trade policy uncertainty.

B.7 The Impact of Business Cycle Shocks

An alternative explanation of the slowdown in manufacturing activity observed after the start of the 2018-2019 tariffs is that it reflects a slowing in general economic activity, which also happens to be present in the manufacturing sector. However, conditions outside the manufacturing sector at this time, along with features of our empirical strategy, make this explanation unlikely. First, private nonmanufacturing employment continued to increase throughout our sample period even as manufacturing employment stagnated (see Figure 1), suggesting that the manufacturing slowdown was not broad-based. In addition, our

tariffs and industrial production whether the additional detail is used or not.

Table B6: Point Estimates of Cumulative Effect by Channel: With Trade Policy Uncertainty

Variable	
Import Protection	0.225
	(0.159)
Rising Input Costs	-1.942***
	(0.616)
Export Retaliation	-3.553**
	(1.429)
Trade Policy Uncertainty	-0.00964
	(0.02446)
Industry Fixed Effects	yes
Number of Industries	76
Observations	2,508

Sources: Federal Reserve Board (FRB), U.S. Department of Labor, Bureau of Labor Statistics; authors' calculations.
Notes: For import protection, rising input costs, and export retaliation, the table displays coefficient estimates and standard errors of the Finkelstein (2007) approach presented in equation (7) in the text. For trade policy uncertainty, the table displays the coefficient estimate and standard error of the time-varying industry-level measure of trade policy uncertainty based on Caldara et al. (2019). Results are weighted by employment as of December 2017. Standard errors (in parentheses) are clustered by 3-digit NAICS industry. $* \, p < 0.10$, $** \, p < 0.05$, $*** \, p < 0.01$.

empirical strategy controls for the role of business cycle shocks in two ways. To the extent that a negative aggregate shock affects all manufacturing industries identically, it will be captured by the month fixed effects in equation 6. Moreover, even if business cycle shocks have differential effects on industries with varying levels of international exposure—such as the highly cyclical and also highly tradable durable goods industries—this heterogeneity would be captured by the interactions of month dummies with the three measures of general trade exposure and industry-level capital intensity. Our finding of statistically significant relationships between the tariff channel measures and industry-level outcomes, even after including controls that would capture business cycle shocks, is strong evidence of a role for tariffs in the manufacturing slowdown.

B.8 Alternative Specifications

Figure B4 presents the raw results from estimating equation (6) without accounting for pre-trends in the dependent variable. As indicated in the figure, we find clear evidence of differing pre-trends across industries prior to the introduction of tariffs, which appears, for example, as the pre-tariff upward trend in coefficient estimates for the relationship between exposure to rising input costs and employment in the left column of Panel (a). The figure also highlights clear breaks in pre-existing trends that occur at the time that tariffs are put into place, as seen by the flattening and ultimate decline in coefficient estimates in the same left column of Panel (a). As discussed in Finkelstein (2007), these breaks in trend represent the impact on the outcome variables that is attributable to the change in policy. In the main text, we use either the approach developed in Finkelstein (2007) or industry-level detrending to isolate this impact of the tariff changes by netting out pre-trends.

B.9 Univariate Results

Table B7 presents results of regressions of the three outcome variables on individual tariff channel measures, one at a time, as opposed to including the three channels together in the same regression. There are some similarities between these "univariate" regression results and the main results shown in Table 1. Table B7 still reports a negative relationship between the rising input cost and channel and employment, with a positive relationship for producer prices. There are also important differences, however. The results for industrial production actually report a positive relationship between export retaliation and industrial production, but this effect is not present when the other channels are present, highlighting the importance of controlling for all tariff channels together.

Table B7: Univariate Point Estimates of Cumulative Effect by Channel:

Variable	Employment			Industrial Production			Producer Prices		
Import Protection	0.061			0.183			1.508		
	(0.174)			(0.692)			(1.027)		
Rising Input Costs		-2.456***			-1.635			8.077*	
		(0.853)			(1.962)			(4.542)	
Export Retaliation			-2.904			4.943***			2.957
			(2.501)			(1.524)			(5.415)

Sources: Federal Reserve Board (FRB), U.S. Department of Labor, Bureau of Labor Statistics; authors' calculations.
Notes: Table displays coefficient estimates and standard errors of the Finkelstein (2007) approach presented in equation (7) in the text. Estimates for employment are weighted by December 2017 employment and estimates for industrial production and producer prices are weighted by December 2017 value added. Standard errors (in parentheses) are clustered by 3-digit NAICS industry. $* \, p < 0.10$, $** \, p < 0.05$, $*** \, p < 0.01$.

B.10 Results by Tariff Wave

The main results presented in Table 1 calculate exposure to three tariff channels based on cumulative values of affected trade, covering all tariffs imposed during our sample period. Table B8, on the other hand, shows the results of regressions that include interactions of month dummies with separate measures for each of the individual waves of tariffs. Each column of Table B8, therefore, shows the results of a single regression.

The table yields several findings on the effects of individual tariff waves. First, in terms of employment (column 1) we find that exposure to rising input costs from the March 2018 steel and aluminum tariffs is associated with a relative decline in employment, as is export retaliation to those tariffs in the following month. These results align very closely with the baseline results presented in Table 1. Regarding industrial production (column 2)—for which we do not find any relationship with tariffs in the baseline results—we find that exposure to rising input costs from the September 2018 U.S. Section 301 tariffs on China is associated with a relative decrease in IP, while import protection from the March 2018 steel and aluminum tariffs is associated with a relative increase, as is the export retaliation in August 2018. Lastly, in terms of PPIs, we find that exposure to rising input costs from the September 2018 U.S. tariffs are associated with a relative increase in producer prices, that foreign retaliatory tariffs in April and August are associated with a relative decline in producer prices (while those in July are associated with a relative gain), and that higher import protection in August and September is associated with a relative decrease in PPIs.

Despite the increased detail shown in Table B8, we report the cumulative values of affected trade as the baseline in the main text due to the inherent uncertainty in choosing specific dates to identify the effects of the range of tariff waves, and because these estimates may be sensitive to the correlation between exposure across different waves.

B.11 Tariffs, Hiring, and the Lack of Relationship for IP

One interesting feature of the results discussed in Section 3 is the lack of a relationship between exposure to tariffs and industrial production, given the strong relationship present for employment. We find evidence that this difference arises, at least in part, because the tariffs were imposed at a time when manufacturers held historically high levels of unfilled orders—as shown by the dashed red line in Figure B5—which supported output.[22] When the index for *new* orders of manufactured goods (black line in Figure B5) plunged as new tariffs were imposed, manufacturers faced a situation of high current demand from orders already on their books, combined with sharply declining future demand.

One potential response by firms in this situation would be to continue to produce at prior levels, while forgoing hiring that would have otherwise taken place, with the extent of this response varying according to exposure to tariffs. Aggregate data on hiring and layoffs in

[22] The Institute for Supply Management's (ISM) Manufacturing Orders Backlog Index reached its highest level in 14 years in the first half of 2018. This index is constructed based on survey responses of purchasing and supply executives indicating whether their level of orders backlogs had increased, decreased, or remained the same over the past month. Industry detail is not available within broad industry classes that are roughly equivalent to three-digit NAICS industry groups. See Institute for Supply Management (2020) for further information.

Table B8: Point Estimates by Tariff Wave

Variable	Employment	Industrial Production	Producer Prices
Export Retaliation Apr. 2018	-53.331**	41.801	-100.726**
	(21.172)	(63.326)	(40.310)
Export Retaliation Aug. 2018	-1.880	19.904**	-12.727**
	(5.472)	(8.048)	(5.329)
Export Retaliation Jul. 2018	-2.666	-6.161	12.284***
	(3.633)	(5.916)	(4.178)
Export Retaliation Jun. 2018	15.867	-2.647	10.296
	(12.224)	(14.178)	(6.395)
Export Retaliation Sep. 2018	-1.216	-0.237	-9.757
	(1.870)	(3.301)	(6.912)
Import Protection Aug. 2018	-1.648	-1.380	-8.106*
	(3.095)	(5.240)	(4.043)
Import Protection Feb. 2018	-3.416	-3.853	8.944
	(3.357)	(13.108)	(6.148)
Import Protection Jul. 2018	2.080	-2.045	5.720*
	(4.914)	(3.935)	(2.866)
Import Protection Mar. 2018	0.898	5.901***	-3.103
	(1.516)	(1.677)	(1.875)
Import Protection Sep. 2018	0.123	0.045	-1.840**
	(0.401)	(0.730)	(0.764)
Rising Input Costs Aug. 2018	-2.846	14.646	-6.074
	(8.798)	(16.728)	(18.796)
Rising Input Costs Feb. 2018	25.296	-15.257	-17.986
	(21.933)	(95.052)	(38.130)
Rising Input Costs Jul. 2018	-7.008	1.257	-1.418
	(16.342)	(19.527)	(17.034)
Rising Input Costs Mar. 2018	-3.469***	-0.885	4.848
	(1.071)	(2.133)	(3.433)
Rising Input Costs Sep. 2018	-5.706*	-11.376*	11.080**
	(2.996)	(5.991)	(4.394)

Sources: Federal Reserve Board (FRB), U.S. Department of Labor, Bureau of Labor Statistics; authors' calculations.
Notes: Table displays coefficient estimates and standard errors of the Finkelstein (2007) approach presented in equation (7) in the text. Estimates for employment are weighted by December 2017 employment and estimates for industrial production and producer prices are weighted by December 2017 value added. Standard errors (in parentheses) are clustered by 3-digit NAICS industry. $* \ p < 0.10$, $** \ p < 0.05$, $*** \ p < 0.01$.

the manufacturing sector at the time that tariffs begin to be imposed are consistent with this response. As indicated in the panel (a) of Figure B5, the moving average of layoffs in the manufacturing sector moves roughly sideways from mid-2018 forward. By contrast, after increasing throughout 2017, hires peak in 2018 and then move steadily down.

Section 3.3 provides a more formal industry-level examination of the relationship between tariffs and the reduction in aggregate hiring using data from the Census Bureau's Quarterly Workforce Indicators.[23] As described in that section, we do find that higher exposure to tariffs—particularly the rising input cost channel—is associated with a reduction in hiring. We also find that higher exposure to the export retaliation channel is associated with an increase in separations, but from a quantitative perspective—using the inter-quartile shift of each channel described above—the effect of these tariffs on hires is about twice the magnitude of the effect on separations. In sum, the results from Section 3.3 are consistent with firms' employment adjustment to tariffs taking place predominantly via a slowdown in hiring even as they maintain production to fulfill existing orders, providing an explanation for the lack of a relationship between tariff exposure and industrial production, even as we find a negative relationship for employment.

B.12 Examining Potential Spillovers to Downstream Nonmanufacturing Industries

In the same way that manufacturing firms are affected by tariffs on imported intermediate inputs, nonmanufacturing industries that use manufactured goods as inputs may face similar effects. In this section, we estimate the relationship between exposure to rising input costs and employment in nonmanufacturing industries. We focus on employment as the outcome variable because detailed data on producer prices and monthly output are unavailable for nonmanufacturing industries. We focus on exposure to rising input costs because services industries are neither protected by U.S. tariffs nor subject to retaliatory tariffs by U.S. trading partners.[24] We address the case of retaliatory tariffs on non-manufacturing goods-producing industries—particularly agriculture—in further detail below.

Our empirical approach is similar to that used to examine the manufacturing sector, but restricted to the input costs channel given the data limitations described above:

$$y_{it} = \alpha + \sum_t \theta_t \mathbf{1}(M_t = t)(\text{Input Cost}_i) + \delta_i + \delta_t + \varepsilon_{it}. \tag{B7}$$

Here, y_{it} is industry-month-level employment and Input Cost$_i$ is industry-level exposure to

[23] Note that five percent of total U.S. hires and separations are suppressed for data confidentiality reasons at the state-NAICS4-quarter level in 2017 and 2018.

[24] There were some instances of non-tariff retaliation by U.S. trading partners, such as China's brief effective banning of imports of U.S. crude oil, which could have also affected nonmanufacturing industries. Because these non-tariff barriers were small relative to the size of tariff increases, and because they are difficult to detect and measure, they are not explicitly included in this analysis.

the rising input cost channel. The sample includes all nonmanufacturing industries. Table B9 displays coefficient estimates and standard errors based on the application of the Finkelstein (2007) approach to equation (B7).

For comparison purposes, the first column of Table B9 reports results for manufacturing industries, and column two reports results for nonmanufacturing industries.[25] As indicated in the second column, we find a negative but statistically insignificant (p-value of 0.15) relationship between exposure to rising input costs and employment at downstream nonmanufacturing industries, a relationship that is substantially less precisely estimated than that for manufacturing industries.[26] There are a number of reasons why one might expect the input cost measure of tariff exposure to be less salient for non-manufacturing industries than for manufacturing industries. First, manufactured goods make up a far lower share of input costs for nonmanufacturing industries than for manufacturing industries. The average manufacturing industry has an exposure to input tariffs that is nearly an order of magnitude higher than that for the average nonmanufacturing industry (0.026 percent of costs vs. 0.0029 percent of costs, respectively), and the top 43 industries in terms of exposure to tariffs via input costs are all manufacturing industries. Second, it may simply take more time for tariffs on manufactured goods to work their way through supply chains and yield tangible effects on nonmanufacturing industries. Therefore, the impact on these industries may become more precisely estimated or larger in magnitude as input tariffs are sustained for a longer period of time.

B.13 County-Level Exposure to Tariff Channels

This section provides further details on data and variable calculation for the county-level analysis presented in Section 4 of the paper. Several recent papers have analyzed this geographic dimension of the 2018-2019 tariffs. Fajgelbaum et al. (2020) and Blanchard, Bown and Chor (2019) consider the political economy aspects of the tariffs, with the former finding that import protection favored politically competitive counties and the latter finding that retaliatory tariffs influenced the 2018 Congressional elections.[27] Waugh (2019) calculates a measure of employment-weighted county-level exposure to tariff changes and finds that

[25]Note that estimates for manufacturing industries in the first column of Table B9 are the result of estimating equation B7. Because these results are based on only the rising input cost channel, they naturally differ from those reported in Table 1, which include all three tariff channels simultaneously.

[26]The negative relationship between input tariffs and nonmanufacturing employment aligns with Bown et al. (2020) and Barattieri and Cacciatore (2020), who find that downstream nonmanufacturing industries experience notable effects on employment related to antidumping duties on manufacturing industries. The comparative strength and precision of these other findings may be due in part to the large magnitude of the duty rates applied in antidumping investigations, which can exceed 100 percent, as well as to the sample period spanning multiple decades.

[27]While these papers note that tariffs may have been targeted based on *future political considerations*, there is no evidence that tariffs were targeted—either by the U.S. or its trading partners—based on *industry performance*.

Table B9: Effects of Exposure to Rising Input Costs Via Tariffs on Nonmanufacturing Employment

Variable	Mfg. Industries	Nonmfg. Industries
Rising Input Costs	-2.455***	-2.928
	(0.853)	(2.002)
Industry Fixed Effects	yes	yes
Number of Industries	76	175
Observations	2,508	5,775

Sources: U.S. Department of Labor, Bureau of Labor Statistics; authors' calculations.
Notes: Table displays coefficient estimates and standard errors of the Finkelstein (2007) approach applied to results from estimating equation (B7). Results are weighted by employment as of December 2017. Standard errors (in parentheses) are clustered by 3-digit NAICS industry. $* \; p < 0.10$, $** \; p < 0.05$, $* * * \; p < 0.01$.

counties more exposed to retaliatory tariffs exhibit relative declines in consumption expenditures. Goswami (2020) uses Waugh (2019)'s approach of calculating geographic exposure to tariffs and finds that retaliatory tariffs are associated with a decline in commuting zone-level employment growth, while import tariffs had no immediate effect.

Here, we calculate county-level measures of exposure to each of the three tariff channels described above. To do so, we apply the industry-level measures of each tariff channel described in Section 2.3 to each county's industrial structure based on data from the Census Bureau's County Business Patterns.[28] Specifically, for an individual county k, we define exposure to each of the three tariff channels as the employment-weighted averages of exposure of the industries present in each county:

$$\text{Channel}_k = \sum_i \left(\frac{m_{ik}}{m_k}\right) \text{Channel}_i, \tag{B8}$$

where m_{ik} is employment in industry i in county k in 2016, and the three channels are once again exposure to rising input costs, import protection, and export retaliation.

When constructing these county-level measures, all industries, whether manufacturing or nonmanufacturing, have varying levels of exposure to the rising input cost channel via their input-output structures, as discussed in Section B.12. Manufacturing industries are also exposed to the import protection and export retaliation channels via U.S. tariffs on their output, and retaliatory tariffs on their exports. Services industries, by contrast, have zero

[28] The latest available year for these data is 2016. To address the well-known issues of data suppression due to confidentiality requirements, we use the CBP version with imputations created by Eckert et al. (2020).

exposure to these channels, by definition, as their output is not subject to tariffs. While non-manufacturing goods-producing industries—i.e. logging, mining, and agriculture—received very modest import protection and were subject to export retaliation, we are unable to include their exposure to these channels because there is not a readily comparable analogue of the Annual Survey of Manufactures to measure industry-level shipments for these industries.[29] While new U.S. import protection on these industries was inconsequential (less than 1 percent of the value of trade covered by new tariffs, based on 2017 value) this is more relevant for retaliatory tariffs, as a large component of these tariffs targeted agricultural products (roughly 15 percent of the value of new retaliatory tariffs on exports by 2017 value). Therefore, while our county-level analysis accounts well for spillovers of manufacturing tariffs to other sectors, it will not reflect the direct effects of the retaliatory tariffs on agriculture and mining that have been found to be important in Waugh (2019). In this sense, our estimates of the impact of export retaliation may be conservative.

The county-level distributions of the three tariff channels are summarized in Figure B6, below. The maps highlight once again the importance of simultaneously considering the multiple effects of tariffs. For example, as shown in panel (a), clusters of counties in the industrial Midwest and Southeast are apparent as being the most highly protected by import protection, which might benefit industries in those areas. However, as shown in panels (b) and (c), these areas are also among those that are most subject to exposure to both export retaliation and rising input costs. More precisely, the correlations between the import protection channel and the rising input cost and export retaliation channels are 0.73 and 0.52, respectively.

These correlations are higher than their industry-level analogues because each county-level measure of tariff exposure is related, in part, to the extent of manufacturing activity in a county. Therefore, to ensure that we accurately estimate the relationship between exposure to *tariffs* and the unemployment rate, in the regression below, we will include controls for each county's manufacturing share of employment. As a result, coefficients on the tariff channel variables will capture the effects of variation in tariff exposure holding constant the extent of a county's manufacturing activity.

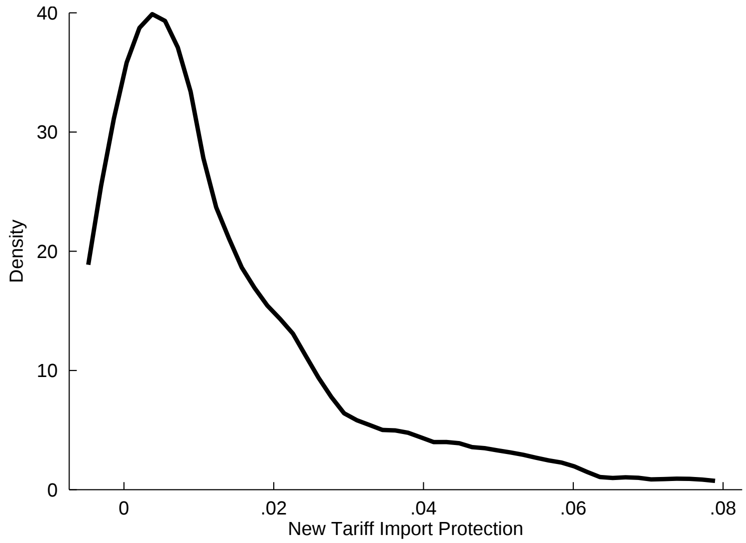
We use these county-level measures of each channel to examine the relationship between exposure to tariff changes and a broader measure of labor market outcomes, the unemployment rate. Unemployment rate data are from the BLS's Local Area Unemployment Statistics (LAUS), which collects information on labor market outcomes at the county-level.[30]

[29] Waugh (2019) and Goswami (2020) use an alternative approach to measure exposure to tariffs, based on employment-weighted average changes in tariffs for the industries in each county. That measure does not account for the value of imports or exports covered by tariffs and is not normalized by the value of shipments or domestic absorption.

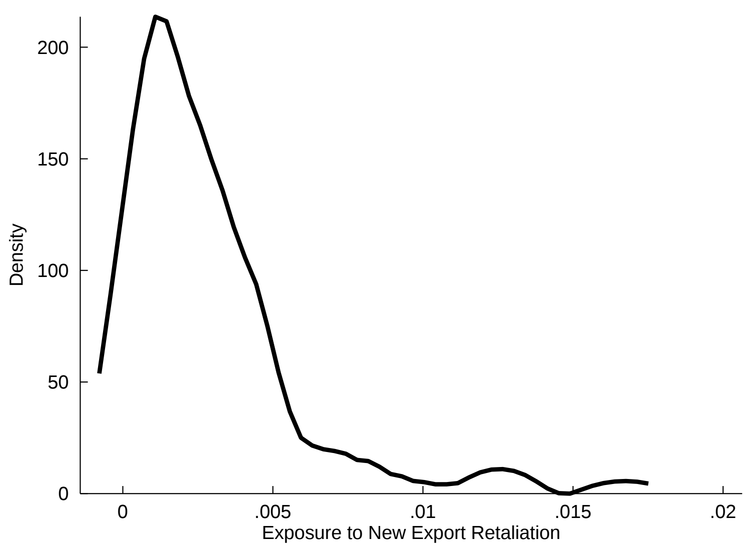
[30] We seasonally adjust these data using the standard Census Bureau X-13 seasonal adjustment program available at https://www.census.gov/srd/www/x13as/.

Figure B2: Density Estimates of Tariff Exposure Channels Across Manufacturing

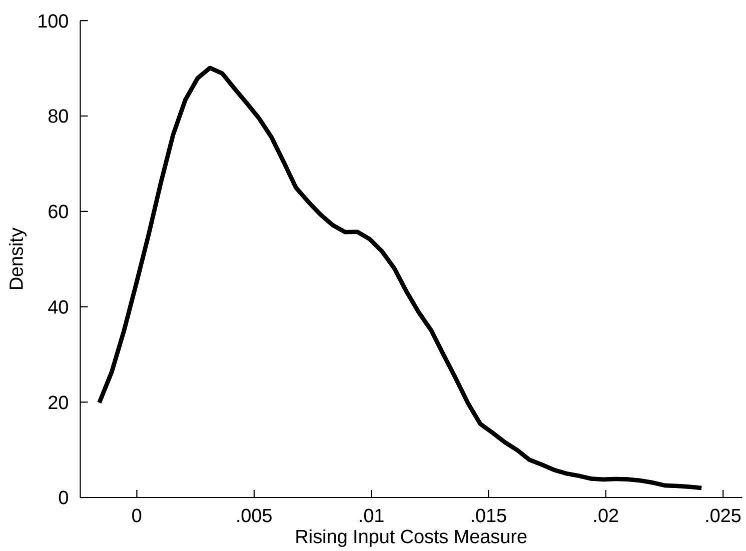
(a) Import Protection



(b) Export Retaliation



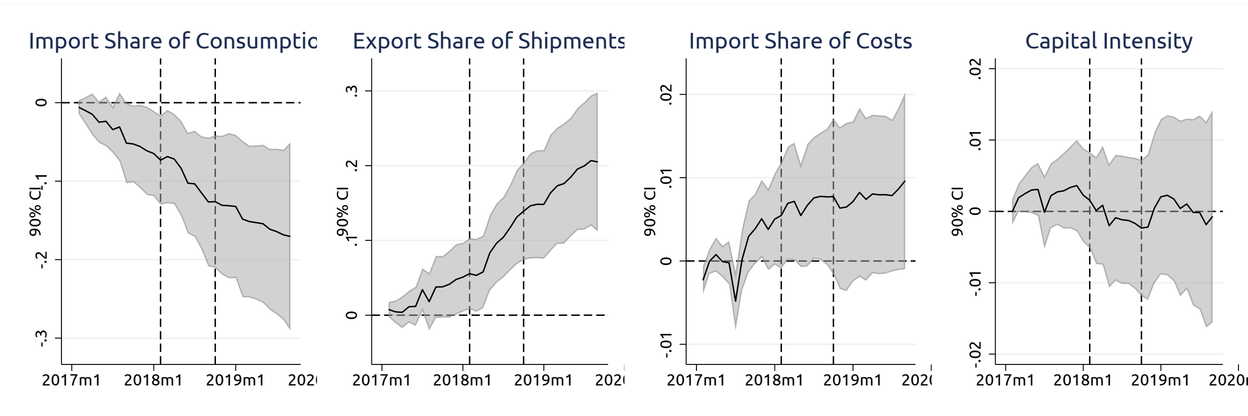
(c) Rising Input Costs



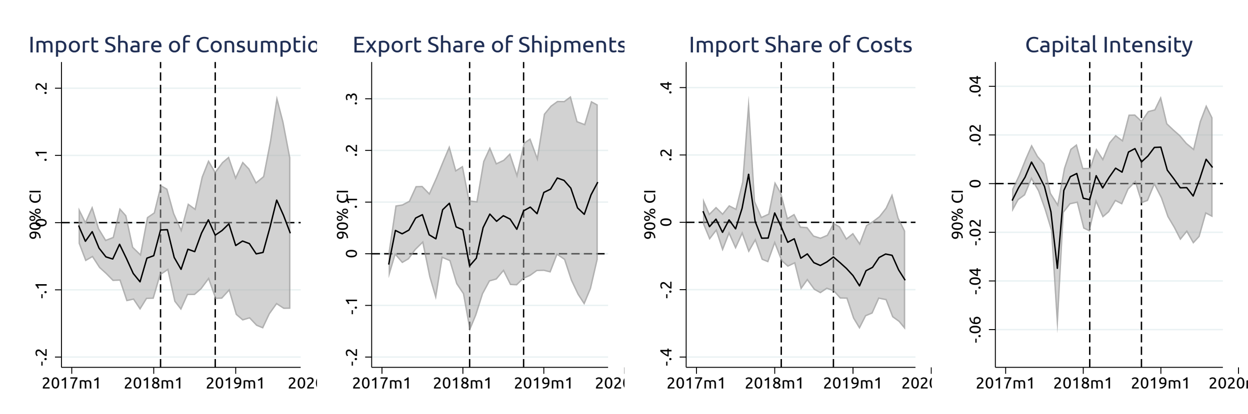
Notes: Figures display densities of industry-level measures of exposure to each tariff channel.

Figure B3: Coefficient Estimates for Control Variables

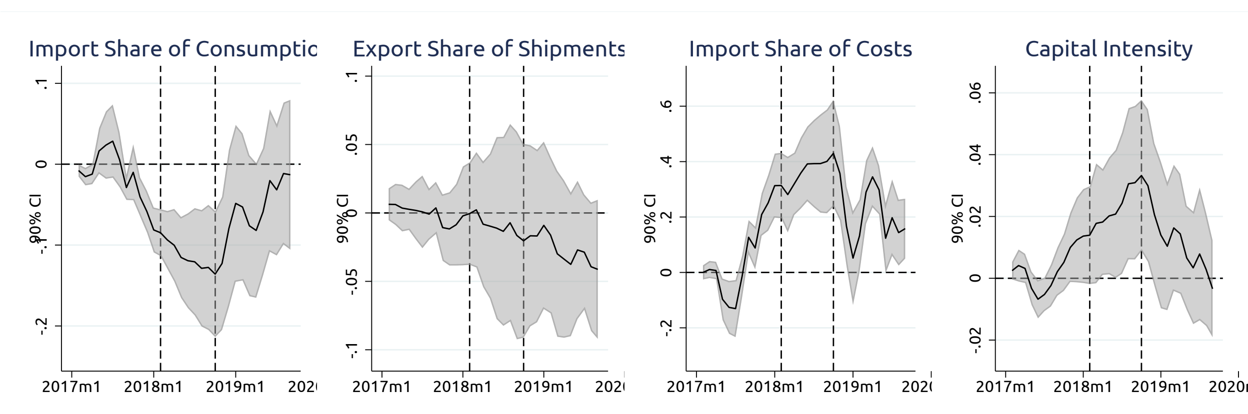
(a) Employment



(b) Industrial Production (Output)



(c) Producer Price Index

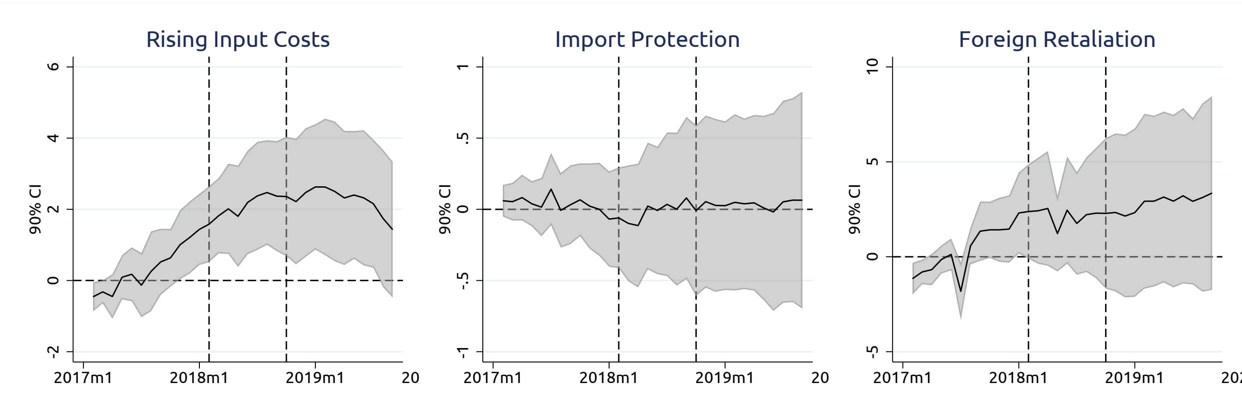


Sources: Federal Reserve Board (FRB), U.S. Department of Labor, Bureau of Labor Statistics; authors' calculations.

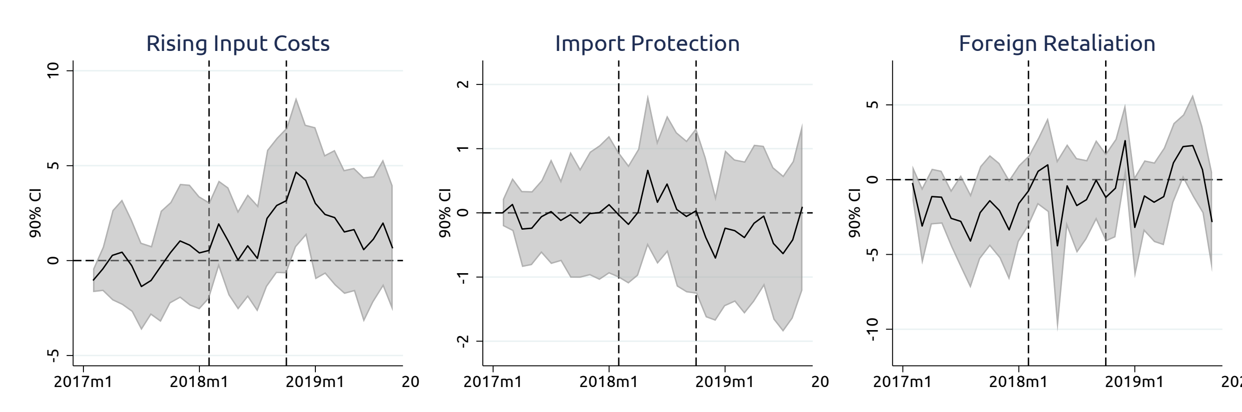
Notes: Each panel displays coefficient estimates (solid lines) and 90 percent confidence intervals (shaded areas) of interactions of month dummies with import share of absorption, export share of shipments, import share of costs, and capital intensity. Each panel represents the result of a different regression, and dependent variables for each regression are noted in panel titles. The two vertical dashed lines are at February 2018 and September 2018, the times of the first and last waves of new 2018 tariffs. Estimates for employment are weighted by December 2017 employment and estimates for industrial production and producer prices are weighted by December 2017 value added. Standard errors are clustered at the three-digit NAICS level.

Figure B4: Effects of Cumulative Tariffs, Non-Detrended Outcome Variables

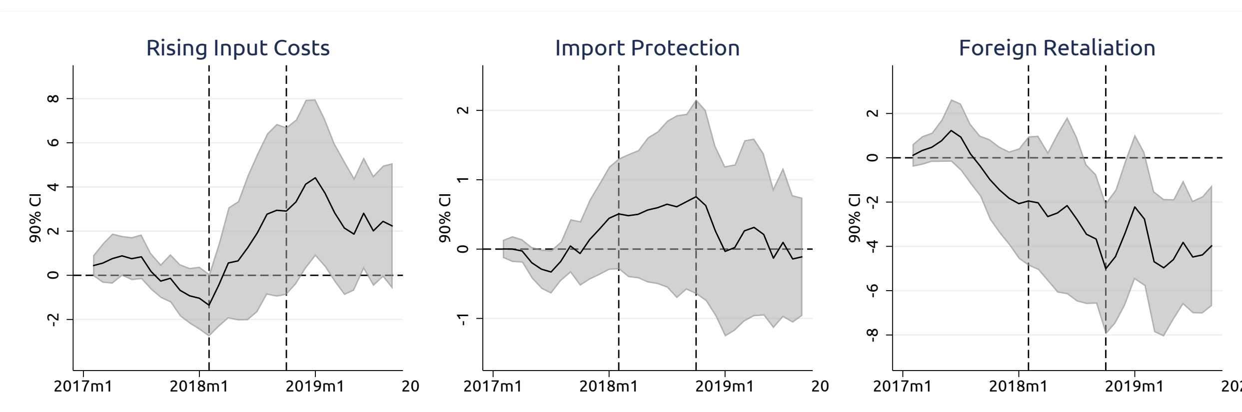
(a) Employment



(b) Industrial Production (Output)



(c) Producer Price Index

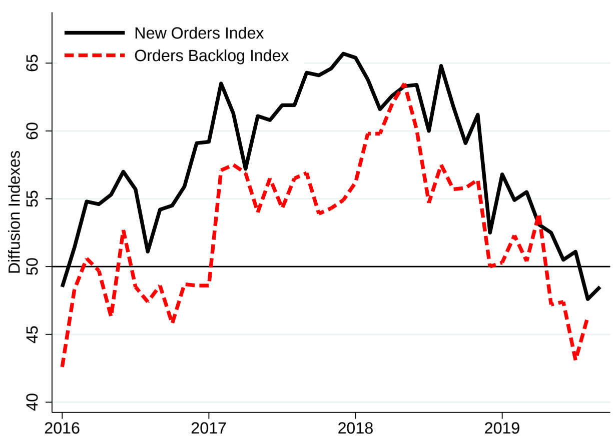


Sources: Federal Reserve Board (FRB), U.S. Department of Labor, Bureau of Labor Statistics; authors' calculations.

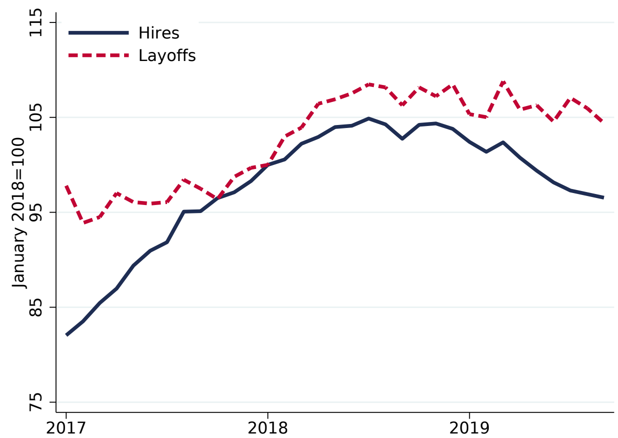
Notes: Each panel displays results of a separate regression for the noted dependent variable, with each column corresponding to the three tariff channels in equation (6). Solid lines indicate coefficient estimates and shaded areas represent 90 percent confidence intervals. The two vertical dashed lines are at February 2018 and September 2018, the times of the first and last waves of 2018 tariffs we study. Estimates for employment are weighted by December 2017 employment and estimates for industrial production and producer prices are weighted by December 2017 value added.

Figure B5: Manufacturing Orders, Hires, and Layoffs

(a) Orders Backlog and New Orders Indexes



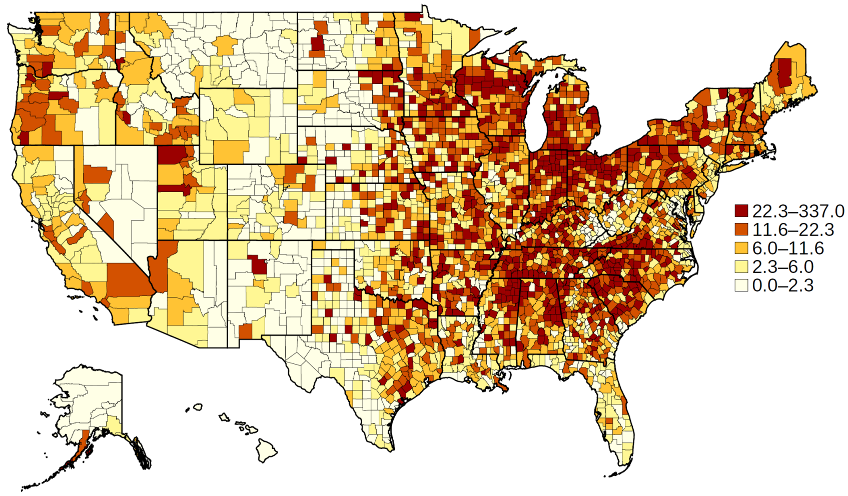
(b) Hires and Layoffs



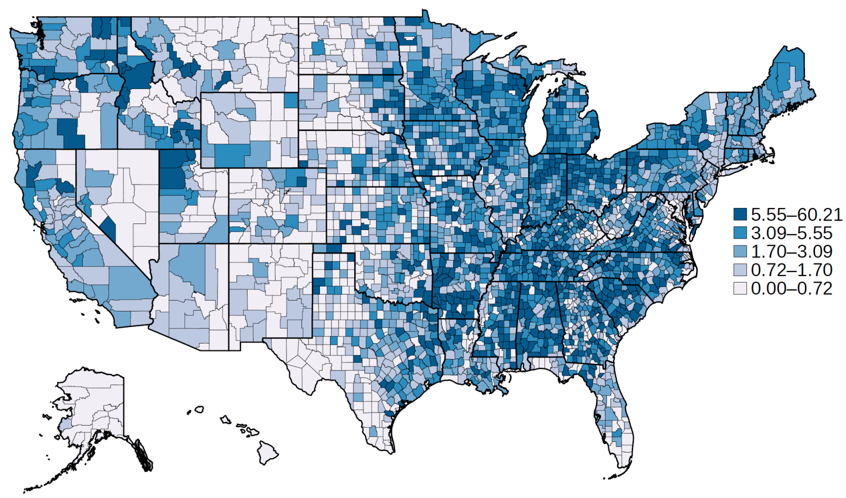
Source: Institute for Supply Management, Bureau of Labor Statistics.
Notes: Panel (a) displays diffusion indexes of Manufacturing Orders Backlog (red dashed line) and Manufacturing New Orders indexes (black line) for the period from January 2016 through September 2019. Panel (b) displays the six-month moving average of manufacturing hires and layoffs from the BLS's Job Openings and Labor Turnover Survey, indexed to 100 in January 2018.

Figure B6: County-Level Distribution of Tariffs

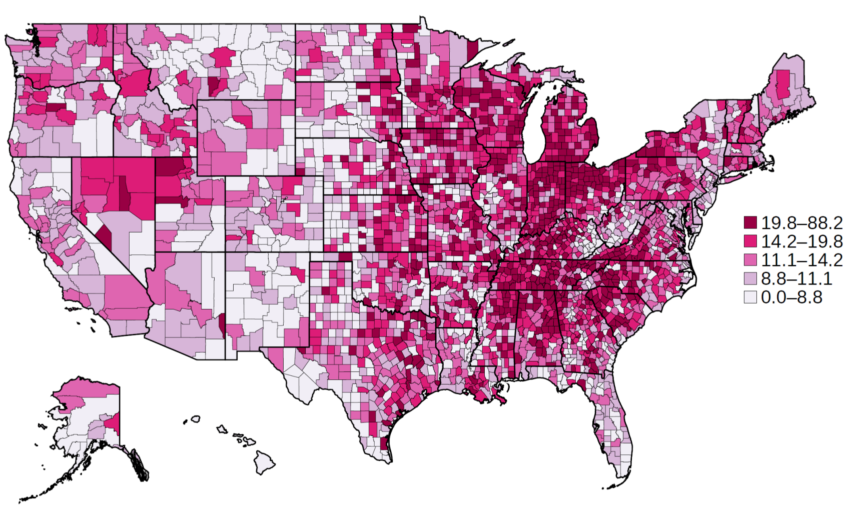
(a) Manufacturing Import Protection, by County



(b) Export Retaliation on Manufacturing, by County



(c) Rising Input Costs, by County



Sources: Author's calculations using County Business Patterns (U.S. Census Bureau), Eckert et al. (2020) and sources highlighted in Section 2.3.
Notes: Maps display county-level measures of exposure to the import protection, export retaliation and rising input cost tariff channels. Note that measures are multiplied by 100 for greater legibility. County-level measures are employment weighted-averages (as shown in equation (B8)) of industry-level exposure defined in equations (5), (2), and (1) above.