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Abstract

In this paper, we follow the micro-to-macro approach of Fajgelbaum et al. (2020) and analyze the impacts of the 2018–2019 U.S.-China trade war on the Chinese economy. We use highly disaggregated trade and tariff data with monthly frequency to identify the demand/supply elasticities of Chinese imports/exports, combined with a general equilibrium model for the Chinese economy (that takes into account input-output linkages, and regional heterogeneity in employment and sector specialization) to quantify the partial and general equilibrium effects of the tariff war. This complements the studies focused on the ex post response of the U.S. economy by Amiti et al. (2019), Flaaen et al. (2020), Fajgelbaum et al. (2020), and Cavallo et al. (2021).

Key Words: Chinese Economy; Tariff War; Elasticity Estimation; Regional Labor Market Adjustment; Welfare Analysis.

JEL Classification: F13; F14; F16; F17.

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1 Introduction

During 2018–2019, in an unprecedented manner since the 1930s, the U.S. Trump administration imposed seven rounds of tariff increases that affected Chinese exports. This includes the first round in February 2018, on solar panel and washing machine imports, and the second, targeting iron, aluminum and steel products. They were followed by three rounds of tariff hikes in 2018 and two in 2019, targeting imports specifically from China. All told, these seven rounds of tariff increases affected $325.1 billion (14.27%) of Chinese exports across 6428 HS-8 products (using 2017 pre-war trade values). The U.S. statutory tariff rate on these Chinese products increased from 3.55% to 28.53% (simple average).

In return, China raised tariffs on U.S. products (four rounds in 2018 and two in 2019). All told, 5833 distinct HS-8 products imported from the U.S. were targeted during the period 2018:1–2019:12. In 2017 trade values, these affected $109.3 billion (or 5.93%) of Chinese imports. The retaliation tariff rate increased from 6.46% to 21.27% (simple average). As China raised its tariffs against U.S. products, it also unilaterally lowered its Most-Favored-Nation (MFN) tariff rates on imports from non-U.S. sources where the MFN rate applied. This took place in four rounds during 2018:5–11. All told, the lists covered 3054 products, with a pre-war trade value of $145.7 billion (or 7.90% of Chinese imports in 2017). The tariff rate across these products decreased from 9.89% to 6.82% (simple average).

In the literature, Amiti et al. (2019), Flaaen et al. (2020), Fajgelbaum et al. (2020), and Cavallo et al. (2021) have evaluated the ex-post impacts on the U.S. economy of the 2018–2019 trade war (in terms of prices, import/export quantities, real wages, or welfare), given events up to 2018:12, 2019:1, 2019:4, and 2020:2, respectively. These studies generally employed highly disaggregated product and tariff line classifications, with a strong focus on identifying the U.S. demand and supply structure at the micro product/variety level and their corresponding elasticities. On the other hand, studies by Charbonneau and Landry (2018), Guo et al. (2018) and Itakura (2020) conducted ex ante predictions of the trade-war effects using, respectively, the quantitative models of Caliendo and Parro (2015) and the GTAP CGE model (based on tariff changes imposed in the early phase of the trade war and/or proposed tariff changes at the time of their studies). Given the nature of their modeling frameworks, the trade and tariff changes are typically organized at the sector level, with emphasis on general equilibrium adjustment across sectors and countries. Li et al. (2020) similarly examined the welfare impacts of the trade war based on the GTAP model, but with analysis incorporating the tariff revisions as of 2020:3 (after the Phase One Deal was reached between the U.S. and China on December 13, 2019). The trade elasticities used in these studies were often taken from the literature based on sector-level trade analysis, or built-in parameters assumed by the GTAP models.

In this paper, we follow the micro-to-macro approach of Fajgelbaum et al. (2020), but with China now modeled as the local economy (given a detailed general equilibrium structure), while each of its trading partners is modeled in reduced form. Corresponding to the setup of Fajgelbaum et al. (2020) for the U.S. economy, the demand system we estimate for the Chinese economy includes reallocations between the domestic bundle and the imported bundle within each sector (defined as a 2-digit GB/T code, a standard Chinese industry classification system), across products (defined as 8-digit HS product codes) within each sector's imported bundle, and across varieties (defined as country-product pairs) within each imported product. This demand system is interacted with foreign export supply at the variety level, and their joint effects on prices and quantities are aggregated up the hierarchy of demand to the product and sector levels. In contrast, the import demand and export supply structures for each of China's trading partners are specified/identified only at the variety level.

To estimate this system, we compile data on China's imports (exports) from (to) each of its trading partners, in terms of both quantities and values at the 8-digit HS level, with monthly frequency for the period 2017:1–2019:12. We similarly compile the Chinese tariff rates on imports with respect to each trading partner (at the HS-8 level), and the foreign tariff rates on China's exports (at the HS-6 digit level), with monthly frequency for the same period. These are constructed using the baseline statutory tariff rates that were in place at the start of 2017, amended with tariff changes announced by the Ministry of Finance, China, or the U.S. Trade Representative during the period studied.

As suggested by Fajgelbaum et al. (2020) and Zoutman et al. (2018), the import demand and foreign export supply elasticities can be identified simultaneously using changes in tariffs as an instrument, provided that these changes are uncorrelated with demand and supply shocks. We conduct tests to verify the validity of this condition from the Chinese economy's perspective, based on tariff shocks associated with the trade war during the period 2018:1–2019:12. Tables 3 and 6 report the variety-level estimation results, and Tables 4–5 the product-level and sector-level estimation results. Overall, the elasticities we estimate for the Chinese economy are smaller in magnitude than the U.S. counterparts obtained by Fajgelbaum et al. (2020). Table A.1 summarizes the partial (direct) impacts on Chinese imports and exports, given the elasticity estimates and the tariff changes due to the trade war. Chinese imports of U.S. products targeted by the Chinese import tariff fell by 13.14% (weighted average). The MFN tariff cuts extended by China cushioned the negative impacts substantially. Chinese imports from these non-U.S. MFN sources of imports are estimated to have increased by 3.48% for targeted varieties. With the opposing effects combined, the overall change in Chinese imports of targeted varieties was muted at −3.64%. On the other hand, exports of Chinese products targeted by the U.S. tariffs fell by −24.48%. Thus, the major brunt of the tariff war on the Chinese economy was borne by its exports in partial equilibrium.

We then simulate for the Chinese economy the general equilibrium effects of the tariff shocks, given the elasticity parameters estimated above (at variety/product/sector level), and a supply-side structure calibrated to the observed labor allocation across Chinese sector-provinces, input-output structures across sectors, consumption allocation across non-tradable and tradable sectors, capital/labor/intermediate cost shares in sector-level production, and imports and exports across varieties. The system is large in dimension, including endogenous prices for each variety, product, and sector, wages for each sector-province, and final and intermediate expenditures across sectors. Thus, as in Fajgelbaum et al. (2020), the system is solved as a first-order linear approximation in log changes around the pre-war equilibrium in 2017, given the China-U.S. tariff shocks during 2018:1–2019:12.

Table 8 summarizes the effects on producers/exporters (EV^X), consumers/buyers of imports (EV^M), and tariff revenue (ΔR) in Columns (1)–(3) and the aggregate impacts in Column (4). Our analysis suggests large negative consequences of the trade war on both Chinese producers (−0.272% of China's GDP) and consumers (−0.057% of GDP), with the producers (exporters) suffering more than four times the loss of the buyers of imports. Both components further dominate the positive tariff revenue increase. As a result of the trade war, China sustained an aggregate loss of $37.898 billion, or 0.312% of its GDP. Without counter-retaliation, its loss would have been much larger, at $38.921 billion (0.321% of GDP), and would have been largely borne by producers (exporters). The retaliation against the U.S. imports shifted the burden to the Chinese buyers of imports. Further adjustment in the MFN tariff rates on non-U.S. imports lessened the loss of Chinese buyers of imports and shifted part of the burden back to the producers. Overall, the aggregate loss is significant statistically. In comparison, Fajgelbaum et al. (2020) reported much larger consumer loss (−0.27% of U.S. GDP), a positive effect on producers (0.05% of U.S. GDP), and only slightly negative aggregate effect (−0.04% of U.S. GDP) for the U.S. economy.

We then analyze the variation in exposure to the trade war across provinces in China. For this purpose, we construct the province-level exposure of tradable sectors by first computing the trade-weighted tariff changes for each GB/T-2 sector and then mapping them to provinces based on provincial employment structure. Figure 3 suggests that China tended to: (A) retaliate against the U.S. in sectors with a relatively high concentration in the outlying provinces such as Xinjiang, Hainan, and Heilongjiang; and (B) reduce MFN tariffs on sectors concentrated in provinces closer to the coast, such as Shanghai and Beijing. Overall, China's tariff increases tended to be biased toward inner provinces and turn negative in the Eastern provinces. Added to the burden, Panel (D) suggests that these provinces also faced higher tariff increase on their exports to the U.S.

Figure 4 summarizes the simulated effects of the trade war on real wage across provinces in general equilibrium. Every province experienced a reduction in the tradable real wage. Provinces with larger relative losses are concentrated in the Southeast, whose employment structures were hit more strongly by the U.S. tariff increase. The real wage losses would have been one level higher without the MFN tariff cuts by China. This contrasts with the finding in Table 8, where the MFN tariff cuts by China worsened the aggregate loss. This implies that the MFN tariff cuts helped cushion the impacts on workers/consumers via lower import prices, at the cost of producers (and the owners of capital and fixed structures), who faced greater competition in the product market. Overall, on average across provinces, the nominal wages for workers in tradable sectors decreased by 3.19%. These income losses were, however, cushioned by a lower cost of living, as the CPI of tradable goods decreased by 2.34% on average across sectors. As a result, real wages in the tradable sector fell by 0.32%.

The remainder of the paper is structured as follows. Section 2 documents the data used for the analysis and the timeline of the tariff events. Section 3 outlines the economic structure used for the analysis. Section 4 presents the estimation results of elasticities and partial equilibrium impacts on trade. Section 5 reports the simulated general equilibrium effects at the aggregate, across Chinese provinces, and across sources of imports and destination of exports. Section 6 concludes.

2 Data and Timeline

2.1 Data

We obtained the Chinese baseline tariff rates from the UN TRAINS database and its tariff rate changes from the Ministry of Finance, China. The former is available at the 10-digit Harmonized System (HS) level and the data were aggregated and matched to the latter, available at the HS-8 level. Starting with the baseline import tariff rate in January 2017, we update the rates at monthly frequency, given the official announcement by the Ministry of Finance, China, of any tariff changes. Note, however, that only tariff changes announced in association with the tariff war are used as sources of variations in the instrumental variable to identify the import demand and export supply elasticities.

We similarly obtained the baseline tariff faced by Chinese exports from the UN TRAINS database. These data are harmonized across countries up to the HS-6 digit level. The information on the U.S. tariff increase associated with the trade war is based on Fajgelbaum et al. (2019) (for tariff changes in 2018) and the Office of the United States Trade Representative (USTR) (for tariff changes in 2019). The tariff changes are aggregated from the HS-10 to the HS-6 level by simple averaging. The estimations of trade elasticities for Chinese exports are nonetheless conducted at the HS-8 level of trade (with the HS-6 tariffs assigned to all HS-8 products in the category). Because we work with monthly data and the tariff changes could be implemented anytime within a month, we scale the tariff changes by the number of days of the month they were in effect.

We obtained China's trade data with monthly frequency for the period 2017:1–2019:12 from the General Administration of Customs, China. The data on Chinese imports and exports are available at the HS-8 digit level (which we refer to as products) by the source of imports and the destination of exports. Country-product pairs are referred to as varieties. For each variety, the customs data report the quantities of imports and exports, the value of imports at the CIF price, and the value of exports at the FOB price. The import and export values are reported in current US$ values.

We classify sectors using the China Industry Classification system (GB/T 4754), which is widely used for reporting official statistics on companies and organizations throughout Mainland China. The sector-level data at the GB/T 2-digit level (denoted GB/T-2) were obtained from China's National Bureau of Statistics. These include the producer price index for industrial products (PPI); the sectoral output in monthly frequency; and the input-output (IO) tables for 2017. For the analysis in the paper, we classify a GB/T-2 sector as tradable if it is matched to at least one HS-6 code of the trade classification.

For the general equilibrium analysis, we collected the annual employment and wage data at the sector and province level from the China Labor Statistical Yearbook of 2017. It records the employment and total wages of urban units by sector and province. These are available for 31 provinces and 94 GB/T-2 sectors (covering services, agriculture, mining and manufacturing). All 39 sectors identified as tradable are covered individually in both the IO tables and the labor statistics dataset. We aggregate the remaining sectors as a single non-tradable sector, reconciling the IO tables and the labor statistics dataset. More details about the data are provided in Appendix A.

2.2 Timeline

Table 1 reports the list of tariff events enacted by the U.S. (Panel A) and China (Panel B1 and B2) during the period 2018:1–2019:12 of the trade war. For each tariff event, we identify the number of HS-8 products targeted and the quantum (and percentages) of Chinese exports and imports (in million US$) affected by the U.S. and Chinese tariff changes, respectively, based on 2017 pre-war trade flows. We summarize the extent of tariff changes in each event by the simple average of tariff rates (in percentage points) across targeted products before and after the implementation. Figure 1 illustrates the timing and the tariff changes.[1]

Panel A of Table 1 reports the seven waves of U.S. statutory tariff increases that affected Chinese exports during the period. This includes the first wave of tariff increases in February 2018 applied to solar panel and washing machine imports, and the second wave of tariffs, which targeted iron, aluminum, and steel products. They were followed by three tranches of tariff hikes in 2018 and two tranches in 2019, targeting imports specifically from China. In total, these seven rounds of tariff increase covered $325.1 billion (14.27%) of total Chinese exports across 6428 HS-8 products (using 2017 pre-war trade flows). The average U.S. statutory tariff rate on these Chinese products increased from 3.55% to 28.53%.

Panel B1 of Table 1 lists the seven rounds of China's retaliatory tariffs on U.S. products. All told, 5833 distinct HS-8 products imported from the U.S. were targeted. In 2017 trade values, these affected $109.3 billion (or 5.93%) of Chinese imports. The average retaliation tariff rate increased from 6.46% to 21.27%. The first wave of tariff increases by China against imports from the U.S. was enacted on April 2, 2018. China increased the tariff (by 15%–25%) on U.S. products (worth about $3 billion), including fruit, wine, seamless steel pipes, pork and recycled aluminum, in response to the U.S. steel and aluminum tariffs. In July and August 2018, China implemented two rounds of retaliatory tariff increases (by 25%) on U.S. products, including agricultural products, automobiles and aquatic products (List 1), and commodities such as coal, copper scrap, fuel, buses and medical equipment (List 2), respectively. In September 2018, China continued to respond to U.S. tariffs and enacted another round of tariff increases on about $60 billion worth of U.S. goods (List 3). In January 2019, China revised its lists and exempted U.S. autos (from an extra 25% tariff) and certain U.S. auto parts (from an extra 5% tariff). But as the tariff war escalated, in June and September 2019, China further increased tariffs on more than $68 billion worth of products imported from the U.S.

As China raised its tariffs against the U.S. products, it also unilaterally lowered its MFN tariff rates on imports from non-U.S. sources where MFN rates apply. Panel B2 of Table 1 summarizes four waves of China's MFN tariff cuts in May to November 2018.

[1]In estimations and welfare analysis, the tariff changes applicable to a month are scaled by the number of days the changes were in effect in a month. Refer to the Data Appendix for additional details. For illustration purposes only, in Table 1 and Figure 1, the implementation month is taken to be the current month if the implementation date is before the 15th of the month and the next month otherwise. The 'before' and 'after' simple monthly average tariff rates correspond to those in the month before and the month after the implementation month.

Products affected included pharmaceuticals (May), autos and ITA products (July), a subset of consumer goods (July) and industrial goods (November). In total, the lists covered 3054 products, with a pre-war trade value of \$145.7 billion (or 7.90% of Chinese imports in 2017). The average tariff rate across these products decreased from 9.89% to 6.82%.

Table 2 reports the summary statistics for the extent of exposure to the tariff war by GB/T-2 codes. For Chinese imports, we report the number of targeted HS-8 products and varieties, and the means and standard deviations of tariff increases across targeted varieties within GB/T-2 codes. The Chinese sectors that received the most protection from tariff increases on U.S. products were agricultural products, chemicals, fuel, metals and waste resources. In contrast, the sectors of food, textiles, articles for cultural activities, and automobiles are shown to have been subject to MFN tariff cuts to a larger extent. On the export side, the table indicates that Chinese sectors that faced the largest tariff increases by the U.S. were metals, electrical equipment, machinery and computer products.

3 Economic Structure

In this section, we set up the economic structure à la Fajgelbaum et al. (2020). Sections 3.1–3.2 describe the demand/supply structure that guides the estimation in Section 4. Section 3.3 describes the full general equilibrium system that forms the basis of the welfare analysis in Section 5.

3.1 The Demand System and Preferences

Suppose there are S tradable sectors indexed by s. Within each of these sectors, aggregate demand (from producers and consumers) follows a three-tier CES structure: in the first tier, goods are differentiated by domestic and imported bundles (denoted as D_s and M_s respectively) in each sector; in the second tier, they are differentiated by products (indexed by g) within the domestic or imported bundle; and in the third tier, by varieties (indexed by ig), differentiated by country of origin i within each imported product category.

In particular, in the first tier, the demand from consumers for consumption (C_s) and the demand from producers for intermediate inputs (I_s) follow a CES structure:

$$C_s + I_s = \left(A_{Ds}^{\frac{1}{\kappa}} D_s^{\frac{\kappa-1}{\kappa}} + A_{Ms}^{\frac{1}{\kappa}} M_s^{\frac{\kappa-1}{\kappa}} \right)^{\frac{\kappa}{\kappa-1}}, \tag{1}$$

with an elasticity of substitution κ between the domestic and imported bundles, and sector-level demand shifters (A_{Ds} and A_{Ms}) for the domestic and imported bundles, respectively.

This implies a sector-level price index: $P_s = \left(A_{Ds}P_{Ds}^{1-\kappa} + A_{Ms}P_{Ms}^{1-\kappa}\right)^{\frac{1}{1-\kappa}}$, given the price indices of domestic and imported bundles (P_{Ds} and P_{Ms}) in sector s.

In the second tier, the domestic or imported bundle (D_s or M_s) is each a CES aggregate of products within the sector (d_g, m_g), with an elasticity of substitution η and demand shifter (a_{Dg} and a_{Mg}, respectively) for $g \in \mathcal{G}_s$. This implies corresponding price indices (P_{Ds}, P_{Ms}), which are CES aggregates of, respectively, the prices of domestic and imported products (p_{D_g} and p_{M_g}) for $g \in \mathcal{G}_s$.

Finally, in the third tier, each imported product (m_g) is further a CES aggregate of varieties (m_{ig}) differentiated by country of origin i, with an elasticity of substitution σ and demand shifter a_{ig}:

$$m_g = \left(\sum_{i \in \mathcal{I}_g} a_{ig}^{\frac{1}{\sigma}} m_{ig}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{2}$$

and a corresponding price index: $p_{Mg} = \left(\sum_i a_{ig}p_{ig}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$, given the variety price p_{ig}. The above demand system implies that the values of demand for domestic goods and imported goods in sector s are:

$$P_{Ds}D_s = E_s A_{Ds}\left(\frac{P_{Ds}}{P_s}\right)^{1-\kappa}, \tag{3}$$

$$P_{Ms}M_s = E_s A_{Ms}\left(\frac{P_{Ms}}{P_s}\right)^{1-\kappa}, \tag{4}$$

where E_s is the aggregate expenditure on goods of sector s. In turn, the value of imports for product g in sector s is:

$$p_{Mg}m_g = P_{Ms}M_s a_{Mg}\left(\frac{p_{Mg}}{P_{Ms}}\right)^{1-\eta}, \tag{5}$$

and the quantity imported of product g's variety from country i is:

$$m_{ig} = m_g a_{ig}\left(\frac{p_{ig}}{p_{Mg}}\right)^{-\sigma}. \tag{6}$$

Given the ad valorem tariff rate τ_{ig} imposed on a variety and the variety's CIF price p_{ig}^* before tariff, the consumer price of the variety is:

$$p_{ig} = (1 + \tau_{ig})\, p_{ig}^*. \tag{7}$$

In the general equilibrium, to study the regional effects of tariffs, we divide China into

R regions (effectively provinces). Each region is indexed by r and the set of regions is denoted by $\mathcal{R}$. There is one non-tradable sector in addition to the set of tradable sectors described above. Tradable sectors are freely traded within China but subject to trade costs internationally. The representative consumer in each region r is assumed to have a Cobb-Douglas preference for the non-tradable and tradable goods:

$$\beta_{NT} \ln C_{NT,r} + \sum_{s \in \mathcal{S}} \beta_s \ln C_{sr}, \tag{8}$$

where $C_{NT,r}$ is the consumption of the homogeneous non-tradable good, C_{sr} is the consumption of the tradable goods of sector s, and the β's sum to one. Consumers in a region r face the price of the non-tradable good $P_{NT,r}$ and the price index P_s for each sector s.

3.2 The Foreign Counterpart

For each trading partner, its export supply to China and its import demand for Chinese product at the variety level are specified as follows to fully characterize the international markets. For a product from country i, China faces an inverse foreign export-supply curve according to:

$$p^*_{ig} = z^*_{ig} m_{ig}^{\omega^*}, \tag{9}$$

where z^*_{ig} is a foreign export supply shifter, and ω^* is the inverse foreign export supply elasticity. The larger ω^* is, the more China can extract a decrease in the supply price from the exporter and hence a larger potential gain from imposing import tariffs.

The foreign import demand for the variety from China of product g is assumed to be similar to China's import variety demand:

$$x_{ig} = a^*_{ig} \left(\left(1 + \tau^*_{ig}\right) p^X_{ig} \right)^{-\sigma^*}, \tag{10}$$

where x_{ig} is country i's demand for product g from China, a^*_{ig} is a foreign import demand shifter, τ^*_{ig} is the ad valorem tariff set by country i on China's exports of product g, p^X_{ig} is China's export supply price of product g to market i, and σ^* is the corresponding foreign import demand elasticity.

3.3 The Supply-Side Structure

Production of tradable goods in each sector-region uses workers, intermediate inputs, and a fixed factor (capital and structures). In the short run, the primary factors of production (capital and labor) are assumed to be immobile across regions and sectors.[2] In particular, the production of tradable goods in a sector-region is assumed to be:

$$Q_{sr} = Z_{sr} \left(\frac{I_{sr}}{\alpha_{Is}} \right)^{\alpha_{Is}} \left(\frac{L_{sr}}{\alpha_{Ls}} \right)^{\alpha_{Ls}}, \tag{11}$$

where Z_{sr} is the productivity of sector s in region r, I_{sr} is the use of intermediate input bundle, L_{sr} is the labor input, and α_{Is} and α_{Ls} are the cost shares of intermediate goods and labor in total sales of sector s, respectively.

The intermediate input bundle used by sector s is assumed to be a Cobb-Douglas aggregate of inputs from other sectors, with $\alpha_s^{s'}$ representing the share of input s' in total sales of sector s. This implies that the cost of the intermediate input bundle used by sector s is:

$$\phi_s \propto \prod_{s' \in S} P_{s'}^{\frac{\alpha_s^{s'}}{\alpha_{Is}}}. \tag{12}$$

The owners of the fixed factor choose inputs I_{sr} and L_{sr} to minimize the cost of production, given the cost of the intermediate input bundle ϕ_s; the wage rate w_{sr} in sector s and region r; and the production target Q_{sr}. Given the producer price p_s in sector s, the fixed factor owners then choose the production level Q_{sr} that maximizes their profit:

$$\begin{aligned} \Pi_{sr} &\equiv \max_{Q_{sr}} p_s Q_{sr} - \phi_s I_{sr}(Q_{sr}) - w_{sr} L_{sr}(Q_{sr}) \\ &= \max_{Q_{sr}} p_s Q_{sr} - (1 - \alpha_{Ks}) \left(\frac{\phi_s^{\alpha_{Is}} w_{sr}^{\alpha_{Ls}}}{Z_{sr}} Q_{sr} \right)^{\frac{1}{1-\alpha_{Ks}}}, \end{aligned} \tag{13}$$

where $\alpha_{Ks} \equiv 1 - \alpha_{Is} - \alpha_{Ls}$ is the share of capital cost in total sales of sector s. This implies an optimal output choice as a function of output and factor prices:

$$Q_{sr} = Z_{sr}^{\frac{1}{\alpha_{Ks}}} p_s^{\frac{1-\alpha_{Ks}}{\alpha_{Ks}}} \phi_s^{-\frac{\alpha_{Is}}{\alpha_{Ks}}} w_{sr}^{-\frac{\alpha_{Ls}}{\alpha_{Ks}}}, \tag{14}$$

and the national production in sector s as:

$$Q_s = \sum_{r \in \mathcal{R}} Q_{sr}. \tag{15}$$

The non-tradable sector is assumed to use only labor for production: $Q_r^{NT} = Z_r^{NT} L_r^{NT}$, where Z_r^{NT} is the labor productivity of region r in the non-tradable sector, and L_r^{NT} is the

[2] Nonetheless, in deriving the system (in log changes), Appendix B.1 also considers the scenario of labor mobility across sectors.

employment in this sector in region r.

Output by sector Q_s is assumed to be allocated across products q_g at a constant marginal rate of transformation according to:

$$\sum_{g\in\mathcal{G}_s}\frac{q_g}{z_g}=Q_s, \tag{16}$$

where z_g is a product-level productivity shock. Assuming perfect competition, this pins down the local price of the domestic variety of product g at $p_{Dg}=\frac{p_s}{z_g}$. The price of the same variety when shipped to a foreign country i is $p_{ig}^X=\delta_{ig}p_{Dg}$, given the iceberg trade cost factor δ_{ig}. The market-clearing condition for the local variety of product g requires that:

$$q_g=\underbrace{\left(a_{Dg}D_s\right)\left(\frac{p_{Dg}}{P_{Ds}}\right)^{-\eta}}_{d_g}+\sum_{i\in\mathcal{I}_g^X}\delta_{ig}\underbrace{a_{ig}^*\left(\left(1+\tau_{ig}^*\right)p_{ig}^X\right)^{-\sigma^*}}_{x_{ig}}. \tag{17}$$

Labor income and profits are assumed to be spent where they are generated. Total tariff revenue R and national trade deficit D are assumed to be distributed to each region in proportion to the population share b_r of the region. Thus, by accounting identity, final expenditures in region r are:

$$\begin{aligned}X_r &= w_{NT,r}L_{NT,r}+\sum_{s\in\mathcal{S}}w_{sr}L_{sr}+\sum_{s\in\mathcal{S}}\Pi_{sr}+b_r\left(D+R\right)\\ &= P_{NT,r}Q_{NT,r}+\sum_{s\in\mathcal{S}}\left(1-\alpha_{Is}\right)p_sQ_{sr}+b_r\left(D+R\right).\end{aligned} \tag{18}$$

Finally, the optimal output choice Q_{sr} in (14) implies an (inverse) labor demand function in sector s of region r:

$$w_{sr}=\left(\frac{Z_{sr}p_s}{\left(L_{sr}/\alpha_{Ls}\right)^{\alpha_{Ks}}\phi_s^{\alpha_{Is}}}\right)^{\frac{1}{1-\alpha_{Is}}}, \tag{19}$$

and an average wage for the tradable sectors in region r of:

$$w_r^T=\frac{\sum_{s\in S}w_{sr}L_{sr}}{\sum_{s\in S}L_{sr}}. \tag{20}$$

The wage in the non-tradable sector is then pinned down by the market-clearing condition:

$$w_r^{NT}=\frac{\beta_{NT}X_r}{L_r^{NT}}. \tag{21}$$

A general equilibrium given tariffs consists of producer prices $\{p_s\}$, import prices $\{p_{ig}^*\}$, price indices $\{p_{Mg}, P_{Ms}, P_{Ds}, P_s, \phi_s\}$, tradable sector wages $\{w_{sr}\}$ and non-tradable sector wages $\{w_r^{NT}\}$ such that (i) given these prices, consumers, producers and workers optimize their choices; (ii) domestic markets for final goods and intermediate inputs clear, international markets for imports and exports of every variety clear, and labor markets for every sector and region clear; and (iii) the government budget is balanced.

4 Identification and Estimation

In this section, we estimate the 3-tier demand system using the variation of import tariffs associated with the trade war as the instrument, and conduct pre-trend tests to support the validity of the instrument in Section 4.5.

4.1 Chinese import demand and foreign export supply elasticities at variety level (σ, ω^*)

We use variation in the Chinese import tariffs as the instrument to estimate the Chinese import demand and foreign export supply elasticities at the variety level, in the same spirit as the work of Fajgelbaum et al. (2020) for the U.S. economy using the U.S. import tariffs. The approach is based on the argument (cf. Zoutman, Gavrilova and Hopland, 2018) that if the tariff variations are uncorrelated with the unobserved import demand and export supply shocks, given the price received by foreign suppliers, an increase in tariff shifts the import demand curve downward and helps trace the foreign export supply curve. Similarly, given the price paid by buyers of imports, a tariff increase shifts the foreign export supply curve upward, which helps identify the import demand curve. Thus, one can identify the demand and supply elasticities simultaneously with the variation in tariffs as an instrument.

To increase the validity of the instrument, we exclude Chinese tariff changes that were due to free-trade agreements or due to regular adjustments (e.g., twice yearly MFN tariff revisions). Accordingly, we use only the changes in Chinese import tariffs against the U.S. products (and decreases in MFN tariffs against non-U.S. products) that were announced in association with the U.S.-China trade war during 2018:1–2019:12, as the variations in the instrument. Specifically, by adding a time subscript (t) and taking the log-difference in import demand equation (6) and foreign export supply equation (9), we may write their estimable equations as:

$$\Delta \ln m_{igt} = \psi_{ig}^{m} + \psi_{st}^{m} - \sigma \Delta \ln p_{igt} + \varepsilon_{igt}^{m}, \quad (22)$$

$$\Delta \ln p_{igt}^{*} = \psi_{ig}^{p^*} + \psi_{st}^{p^*} + \omega^* \Delta \ln m_{igt} + \varepsilon_{igt}^{p^*}, \quad (23)$$

where $\varpi = \{p^*, m\}$, and ψ^{ϖ}_{ig} and ψ^{ϖ}_{st} are variety and sector-time fixed effects, ε^m_{igt} and $\varepsilon^{p^*}_{igt}$ are the respective import demand and export supply residuals, collecting shocks to import demand $\Delta \ln a_{igt}$ and export supply $\Delta \ln z^*_{igt}$, respectively, and other unobservables not controlled for by the fixed effects. Note that in contrast to the U.S., which slapped tariffs against multiple trading partners in selected sectors and also against China in multiple products, China's tariff changes were mainly targeted at the U.S. or uniformly at non-U.S. MFN sources of imports of selected products. This implies limited variations in Chinese tariffs across sources of imports by product. Thus, we have modified the set of fixed effects (FE) controls used in Fajgelbaum et al. (2020). In particular, we drop the product-time (gt) FE—as there are limited variations left across i within gt in the case of Chinese import tariffs—and replace the remaining set of FEs (is, it) with (ig, st). Thus, we rely on within-variety time variations in tariffs as the source of identification, and use sector-time FEs to control for systematic bias in the sectoral pattern of Chinese trade policies or trade flows across time.

Following the identification strategy described above, we estimate the import demand elasticity σ and the foreign (inverse) export supply elasticity ω^* by instrumenting changes in the duty-inclusive price $\Delta \ln p_{igt}$ and in the import quantity $\Delta \ln m_{igt}$ with variations in the tariff $\Delta \ln(1 + \tau_{igt})$ in equations (22) and (23), respectively. The estimation results are reported in Table 3. Columns (1) to (4) report the reduced-form regressions of different trade outcomes (before-duty import value, import quantity, before-duty unit value and duty-inclusive unit value) on the tariff changes $\Delta \ln(1 + \tau_{igt})$ due to the trade war. Column (5) reports the IV regression estimation of foreign (inverse) export supply elasticity $\hat{\omega}^*$ based on equation (23), with its first-stage estimation in Column (2). Column (6) reports the IV regression estimation of import demand elasticity $\hat{\sigma}$ based on equation (22), with its first-stage estimation in Column (4).

Columns (1) and (2) show that the import value (before-duty) and quantity respond to tariff changes negatively in very similar magnitudes. The result in Column (3) further indicates that the before-duty unit values do not respond to tariff changes, suggesting a complete pass-through of tariffs to duty-inclusive prices. This is consistent with the result in Column (4), where the duty-inclusive unit value responds to tariffs with elasticity close to one.[3]

The IV estimate of ω^* in Column (5) is statistically insignificant and numerically negligible. This implies that we cannot reject a horizontal foreign export supply curve, consistent

[3]Since we measure the duty-inclusive price as the product of duty-exclusive price and the tariff factor: $p_{igt} \equiv p^*_{igt}(1 + \tau_{igt})$, the estimate in Column (4), by construction, equals one plus the estimate in Column (3), subject to sample attrition across the two estimations.

with the finding of a complete pass-through of tariffs in the reduced-form regressions. Column (6) reports the IV estimation of import demand elasticity σ. It is statistically significant at $\hat{\sigma} = 1.120$ (std. err. = 0.3158). Given these two elasticity estimates, we can calculate the partial (direct) impact on the import value of the targeted varieties. The results are summarized in Table A.1. Specifically, if we consider China's retaliatory tariffs against the U.S. products, the weighted average change in import value of the targeted U.S. products would be:

$$\begin{aligned}\overline{\Delta \ln \left(p_{ig}^{*} m_{ig}\right)}^{wa} &\equiv \sum_{ig} -\hat{\sigma} \frac{1+\hat{\omega}^{*}}{1+\hat{\omega}^{*}\hat{\sigma}} \Delta \ln \left(1+\tau_{ig}\right) \cdot \left(p_{ig}^{*} m_{ig}\right) / \sum_{ig} \left(p_{ig}^{*} m_{ig}\right) \\ &\equiv \underbrace{-\hat{\sigma} \frac{1+\hat{\omega}^{*}}{1+\hat{\omega}^{*}\hat{\sigma}}}_{-1.121} \underbrace{\overline{\Delta \ln \left(1+\tau_{ig}\right)}^{wa}}_{11.72\%} = -13.14\%,\end{aligned}$$

where the response ratio $-\hat{\sigma}\frac{1+\hat{\omega}^{*}}{1+\hat{\omega}^{*}\hat{\sigma}}$ is implied by the variety-level import demand and export supply equations (22) and (23). The calculations use the elasticity estimates reported in Table 3, the pre-war duty-exclusive trade value of 2017 (as weights) and the latest revised tariff change for each variety observed during the period 2018:1–2019:12 (as the shock). Similar calculations suggest that the Chinese MFN tariff cuts (-3.10% on average across targeted varieties) associated with the tariff war imply a positive direct impact on import values of 3.48%. Together, these imply a combined impact of -3.64% on Chinese import value in partial equilibrium, based on the relative import values of China from the U.S. and from the non-U.S. MFN sources in 2017. The MFN tariff cuts thus helped cushion the drop in Chinese imports substantially.

4.2 Demand elasticity across products (η)

To estimate the demand elasticity η across products, we add the time subscript and take the log-difference over time of equation (5) such that:

$$\Delta \ln s_{Mgt} = \psi_{st} + (1-\eta)\Delta \ln p_{Mgt} + \varepsilon_{Mgt}, \tag{24}$$

where $s_{Mgt} \equiv \frac{p_{Mgt} m_{gt}}{P_{Mst} M_{st}}$ denotes the import share of product g in sector s; ψ_{st} is a sector-time fixed-effect term that helps control for the effect of sector-level import price index $-(1-\eta)\Delta \ln P_{Mst}$, among other time-variant sector-level unobservables; and the residual term ε_{Mgt} absorbs the product-level import demand shock $\Delta \ln a_{Mgt}$ and remaining unobservables.

Note that the import share of each product s_{Mgt} is observed in the data. The product-level import price index is constructed by aggregating the variety-level prices, and taking into account entry and exit of varieties, as in Feenstra (1994):

$$\Delta \ln p_{Mgt} = \frac{1}{1-\sigma} \ln \left(\sum_{i \in \mathcal{C}_{gt}} s_{igt} \, e^{(1-\sigma)\Delta \ln\left(p^*_{igt}(1+\tau_{igt})\right)+\Delta \ln a_{igt}} \right) - \frac{1}{1-\sigma} \ln \left(\frac{S_{g,t}\left(\mathcal{C}_{gt}\right)}{S_{g,t-1}\left(\mathcal{C}_{gt}\right)} \right), \quad (25)$$

where $\mathcal{C}_{gt}$ is the set of continuing imported varieties of product g between periods $t-1$ and t, $s_{igt} \equiv \frac{p_{igt}m_{igt}}{\sum_{i' \in \mathcal{C}_{gt}} p_{i'gt}m_{i'gt}}$ is the share of continuing imported varieties that originate from country i in period t, and $S_{g,t}(\mathcal{C}) \equiv \frac{\sum_{i' \in \mathcal{C}} p_{i'gt}m_{i'gt}}{\sum_{i' \in \mathcal{I}_{gt}} p_{i'gt}m_{i'gt}}$ is the share of all imported varieties $\mathcal{I}_{gt}$ of good g at time t accounted for by the varieties in set $\mathcal{C}$. The first term in equation (25) corresponds to the conventional price index for the set $\mathcal{C}_{gt}$ of continuing imported varieties. The second term adjusts the price index for the effect of entry and exit of varieties.[4] In the construction of the product-level price index, we use the estimated σ and the corresponding residuals (which reflect mean-zero demand shocks $\Delta \ln a_{igt}$) of equation (22) from Section 4.1.

Applying the same logic as in the estimation of variety-level elasticities σ and ω^*, we use product-level tariff changes as the instrument for $\Delta \ln p_{Mgt}$. We construct the IV by the simple average (instead of import-value weighted average) of the tariff changes across the continuing imported varieties:[5]

$$\Delta \ln Z_{Mgt} \equiv \ln \left(\frac{1}{N^c_{gt}} \sum_{i \in \mathcal{C}_{gt}} e^{\Delta \ln(1+\tau_{igt})} \right), \quad (26)$$

where N^c_{gt} is the number of continuing imported varieties of product g between $t-1$ and t.

Table 4 reports the estimation results of equation (24). Column (1) shows the impact of the instrument on the product-level trade share: higher product-level tariffs lower the import share of the targeted products. This implies that diversion to non-U.S. varieties is less than sufficient to offset the decrease in imports from the U.S. within the same product category. Column (2) provides the first-stage result of the IV regression of (24): the sign of the coefficient is positive as expected, since the product-level import price index is aggregated from duty-inclusive variety prices. Column (3) reports the IV estimate of the coefficient of the product-level import demand equation (24), which implies an elasticity estimate of $\hat{\eta} = 1.087$. The bootstrapped confidence interval for η, which accounts for the variance of $\hat{\sigma}$ and the demand shocks from the previous step in Section 4.1, is [1.041,1.131].

[4] Equation (25) can be derived from the product-level import price index $p_{Mg} = \left(\sum_i a_{ig} p_{ig}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ and the variety demand equation (6).

[5] As argued by Fajgelbaum et al. (2020), this avoids mechanical correlation of the instrument with the product-level trade share.

4.3 Demand elasticity across domestic and imported bundles (κ)

We further estimate the top-tier elasticity of substitution, κ, between the domestic and imported bundles within a sector. Taking the ratio of the expenditures on the imported bundle (4) and the domestic bundle (3), we have:

$$\Delta \ln \left(\frac{P_{Mst} M_{st}}{P_{Dst} D_{st}} \right) = \psi_s + \psi_t + (1-\kappa) \Delta \ln \left(\frac{P_{Mst}}{P_{Dst}} \right) + \varepsilon_{st}, \tag{27}$$

where ψ_s and ψ_t are sector and time fixed effects, used to help control for unobservables across sectors and time, respectively; while the residual ε_{st} absorbs the remaining relative demand shocks to imported and domestic bundles $\Delta \ln (A_{Mst}/A_{Dst})$. The monthly change in the expenditures on domestic goods of sector s, $\Delta \ln P_{Dst} D_{st}$, is not observable in the data. We use the difference between the changes in the sectoral production and exports as its proxy. The change in domestic sectoral price index, $\Delta \ln P_{Dst}$, is measured by the change in producer price index (PPI), $\Delta \ln p_{st}$, as implied by the theoretical setup. The change in the sectoral import price index, $\Delta \ln P_{Mst}$, is constructed from product-level import prices, $\Delta \ln p_{Mgt}$, in a similar manner as in equation (25):

$$\Delta \ln P_{Mst} = \frac{1}{1-\eta} \ln \left(\sum_{g \in \mathcal{C}_{st}} s_{gt} \; e^{(1-\eta)\Delta \ln p_{Mgt} + \Delta \ln \left(a_{Mgt} \right)} \right) - \frac{1}{1-\eta} \ln \left(\frac{S_{s,t} \left(\mathcal{C}_{st} \right)}{S_{s,t-1} \left(\mathcal{C}_{st} \right)} \right), \tag{28}$$

where $\mathcal{C}_{st}$ is the set of continuing imported products in sector s between periods $t-1$ and t, s_{gt} is product g's share in the set of continuing imported products of sector s, and $S_{s,t}(\mathcal{C})$ is the share of total import value of sector s at time t accounted for by products in set $\mathcal{C}$.[6] The required inputs, η and $\Delta \ln a_{Mgt}$, in (28) are based on their counterparts from the product-level estimation of equation (24) in Section 4.2. The change in relative price of imports $\Delta \ln \frac{P_{Mst}}{P_{Dst}}$ is similarly instrumented by the simple average of tariff changes across the continuing imported products in sector s:

$$\Delta \ln Z_{Mst} \equiv \ln \left(\frac{1}{N_{st}^c} \sum_{g \in \mathcal{C}_{st}} e^{\Delta \ln Z_{Mgt}} \right), \tag{29}$$

where N_{st}^c is the number of continuing imported products in sector s between $t-1$ and t, and $\Delta \ln Z_{Mgt}$ is the instrument defined in (26).

The estimation results are summarized in Table 5. Column (1) reports the estimated

[6] That is, $s_{gt} \equiv \frac{p_{Mgt} m_{gt}}{\sum_{g' \in \mathcal{C}_{st}} p_{Mg't} m_{g't}}$, and $S_{s,t}(\mathcal{C}) \equiv \frac{\sum_{g' \in \mathcal{C}} p_{Mg't} m_{g't}}{\sum_{g' \in \mathcal{G}_{st}} p_{Mg't} m_{g't}}$, where $\mathcal{G}_{st}$ is the set of all products available in sector s at time t.

impact of the average sector-level import tariff changes on the sectoral relative import expenditures. Columns (2) and (3) report the first and second stages of the IV estimation of (27), respectively. The estimated coefficients of the two reduced-form specifications in Columns (1) and (2) have the expected signs, but are imprecisely estimated. The IV estimate in Column (3) implies a statistically significant $\hat{\kappa} = 1.173$. The bootstrapped confidence interval for $\hat{\kappa}$, which takes into account the errors in the estimates $\{\hat{\sigma}, \hat{\eta}\}$ and the demand shocks from the previous stages, is [0.541,1.385].

4.4 Foreign import demand and Chinese export supply elasticities at variety level (σ^*, ω)

The foreign import demand and Chinese export supply structures at the variety level are estimated based on the same concept as in Section 4.1. Taking log changes of the foreign import demand equation (10) across time, we have:

$$\Delta \ln x_{igt} = \psi^x_{ig} + \psi^x_{st} - \sigma^* \Delta \ln \left(\left(1 + \tau^*_{igt} \right) p^X_{igt} \right) + \varepsilon^x_{igt}, \tag{30}$$

where we used ψ^x_{ig} and ψ^x_{st} to control for potentially unobserved product-destination and sector-time FEs; while the residual ε^x_{igt} absorbs remaining shifts in the foreign demand for Chinese products $\Delta \ln a^*_{igt}$. Assume that the export supply of China has a symmetric structure with the foreign export supply, that is, $p^X_{ig} = z_{ig} x^{\omega}_{ig}$, where ω is the inverse export supply elasticity of China and z_{ig} is the product-destination export supply shifter. This implies an estimable equation:

$$\Delta \ln p^X_{igt} = \psi^{p^X}_{ig} + \psi^{p^X}_{st} + \omega \Delta \ln x_{igt} + \varepsilon^{p^X}_{igt}, \tag{31}$$

where we have included the same set of FE controls as in (30); with the residual $\varepsilon^{p^X}_{igt}$ capturing remaining variations in the Chinese export supply shifters $\Delta \ln z_{igt}$, after controlling for the fixed effects. By analogous arguments as in Section 4.1, we use the variation in foreign tariffs due to the trade war as the instrument for the independent variables in equations (30)–(31) to identify σ^* and ω. For this set of estimations, we use only observations with ig corresponding to the U.S. destination, because the U.S. is the only trading partner that raised tariffs against China in this trade war episode. This also limits the set of FEs we can include (product-destination FEs reduced to product FEs) in this case, compared with Fajgelbaum et al. (2020) for the U.S. economy.

Table 6 reports the estimation results. The pattern of these estimates is quite similar to those of σ and ω^* in Table 3: Columns (1) and (2) show that the export value and quantity fell with tariff increases implemented by the U.S., and Columns (3) and (4) imply that Chinese exporters did not change their supply price; the incidence of the U.S. tariff increases was largely borne by the U.S. buyers of imports. Column (5) reports the IV estimation of equation (31) with its first stage in Column (2). The estimate ($\hat{\omega} = -0.055$) is statistically insignificant, consistent with the reduced-form result that the U.S. faced a horizontal Chinese export supply curve. Column (6) reports the IV estimation of equation (30) with its first stage in Column (4). The result implies that $\hat{\sigma}^* = 1.012$ (std. err. = 0.1786), with a bootstrapped confidence interval of [0.161,1.302].

Given the elasticity estimates, we can calculate the partial (direct) impact on the Chinese export value of targeted products in similar ways as for Chinese imports. In particular, the weighted average change in Chinese export values across targeted products is:

$$\begin{aligned}
\overline{\Delta \ln \left(p_{ig}^{X} x_{ig}\right)}^{wa} &\equiv \sum_{ig} -\hat{\sigma}^* \frac{1+\hat{\omega}}{1+\hat{\omega}\hat{\sigma}^*} \Delta \ln \left(1+\tau_{ig}^*\right) \cdot \left(p_{ig}^{X} x_{ig}\right) / \sum_{ig} \left(p_{ig}^{X} x_{ig}\right) \\
&\equiv \underbrace{-\hat{\sigma}^* \frac{1+\hat{\omega}}{1+\hat{\omega}\hat{\sigma}^*}}_{-1.0127} \underbrace{\overline{\Delta \ln \left(1+\tau_{ig}^*\right)}^{wa}}_{24.18\%} = -24.48\%,
\end{aligned}$$

where the response ratio $-\hat{\sigma}^* \frac{1+\hat{\omega}}{1+\hat{\omega}\hat{\sigma}^*}$ is implied by the foreign import demand and Chinese export supply equations (30) and (31). The calculations use the elasticity estimates reported in Table 6, the pre-war duty-exclusive trade value of 2017 (as weights), and the latest revised tariff change for each variety observed during the period 2018:1–2019:12 (as the shock). The results are summarized in Table A.1.

4.5 Pre-trend test

The identification of the import demand and export supply elasticities using tariff changes as the instrument requires the tariff variation to be uncorrelated with the demand and supply shocks. In this section, we conduct pre-trend tests to verify the potential validity of this approach. We show that the tariff changes associated with the trade war (the 18 events listed in Table 1) are not systematically correlated with the pre-war trends of the import and export outcomes in terms of values, quantities, before-duty prices and duty-inclusive prices.

Specifically, we compute the average monthly change of these outcome variables during 2017:1–2017:12, and regress them against the latest revised tariff change for each variety during the period of 2018:1–2019:12:

$$\overline{\Delta \ln y_{ig,2017}} = FE + \beta \Delta \ln \left(1+\tau_{ig}\right) + \epsilon_{ig}. \tag{32}$$

The test is conducted for each of the three sets of events—China's retaliatory tariff changes against the U.S., China's tariff cuts on non-U.S. MFN sources of imports, and the U.S. tariff increases against Chinese products. We include suitable sets of fixed effects that are in line with the specifications used for the elasticity estimations in Sections 4.1 and 4.4, but obviously have to drop the time dimension (st to s), and also FEs with the country dimension (i) when the set of tariff events is targeted at the U.S. or China alone. The results are summarized in Table 7.

Panel A1 shows the pre-trend test where we consider China's retaliatory tariff increase against U.S. products. Since all targeted varieties are U.S. products, there are no variations across origins in this case (ig being equivalent to g); thus, only fixed effects along the sector (s) dimension are controlled for. The results indicate that all pre-war Chinese import outcome variables (with respect to the U.S. as the source of imports) are not systematically correlated with the subsequent tariff increase China imposed against the U.S. products. Panel A2 reports the pre-trend test for China's tariff changes against non-U.S. sources of imports during the trade war. Note that MFN tariff cuts do not apply to all non-U.S. sources of imports (e.g., they are not applicable to FTA trading partners of China). With the extra variations in trade flows and tariffs across trading partners, we control for country-sector (is) and product (g) fixed effects in this case. We do not observe statistically significant correlations between pre-war Chinese imports from non-U.S. sources and China's subsequent MFN tariff cuts during the trade war. Finally, in Panel B, we conduct the pre-trend test for the U.S. tariff increase against Chinese products. For the same reason as in Panel A1, we include only sector (s) fixed effects. The estimated coefficients are insignificant statistically, suggesting that the pre-war export trends of Chinese products are not systematically correlated with subsequent increases in the U.S. tariff against China during the trade war.

4.6 Dynamic Specification Tests

In this section, we examine whether there exist anticipatory and delayed responses to changes in tariffs during the trade war. This would imply potential downward bias in the elasticity estimates using regressions based on contemporaneous variations in tariffs and trade. To this end, we allow for leads and lags in variety-level reduced-form regressions, controlling for the same set of FEs as in the main estimations:

$$\Delta \ln y_{igt} = \psi_{ig} + \psi_{st} + \sum_{m=-L}^{m=\ell} \beta_m^y [\ln(1+\tau_{ig,t-m}) - \ln(1+\tau_{ig,t-m-1})] + \epsilon_{igt}, \tag{33}$$

where L indicates the maximum leads and ℓ the maximum lags (in months) in the response of trade outcome $\Delta \ln y_{igt}$ to the tariff changes. In the following exercise, we set $\ell = L = 6$.

Figure 2(A) reports the cumulative estimated coefficients from regression of (33) for before-duty import values, quantities, before-duty unit values, and duty-inclusive unit values of Chinese imports at the variety level. There are no significant anticipatory effects in the duty-inclusive unit value and the import quantity, the two key variations used in estimations of σ in (22) and ω^* in (23), respectively. There also exist no significant delayed effects in the duty-inclusive unit value, as its cumulative effects after the tariff changes remain steady and quantitatively very similar to the contemporaneous effect. This supports the potential validity of the import demand elasticity estimate ($\hat{\sigma}$). Similarly, there exist no quantitatively large delayed effects in the import quantity. Third, the before-duty price does not decline before or after the tariff changes statistically, supporting the conclusion of a complete pass-through at the variety level.

Figure 2(B) reports the results for Chinese exports (with respect to the U.S. market, and the U.S. tariffs against Chinese products). The patterns are similar to those for imports overall. We find no evidence of tariff anticipatory/delayed effects on Chinese export quantities, the key variation used in the estimation of export supply elasticity ω in (31). The cumulative responses in the Chinese export quantity mostly reflect its contemporaneous response in the month of tariff changes. On the other hand, there appear to be some irregular anticipatory effects in the before-duty unit value five months before tariff changes; however, instead of declining as theory would suggest, it increases. Overall, there are no significant adjustments in the before-duty unit value over the 12-month horizon. The duty-inclusive unit value, by construct, is equivalent to the before-duty unit value before the month of tariff changes and hence is subject to the same caveat discussed above. Other than that, its cumulative responses upon tariff changes are similar to the contemporaneous impact (in the month of tariff changes) and hence exhibit no delayed effects. Overall, the pattern in the response of the duty-inclusive unit value does not invalidate the use of contemporaneous variations in tariffs and duty-inclusive unit values for the estimation of foreign demand elasticity σ^* in (30). In view of the caveat observed above, one may choose to adopt a more cautious approach and use the counterpart estimate (2.53) of the U.S. import demand elasticity from the U.S. perspective reported in Fajgelbaum et al. (2020), in place of our estimate (1.012) of the foreign import demand elasticity from the Chinese perspective. This would imply even larger negative welfare effects on Chinese producers of exports (given larger declines in export quantities, and as a result, larger downward adjustment in producer prices in general equilibrium). Thus, we can consider the welfare effects we report below in Section 5 (based on our estimate) as plausibly conservative figures.

5 Welfare Analysis

We now present the general-equilibrium impacts of the trade war on the Chinese economy. Given the tariff shocks, the changes in the endogenous variables are imputed based on first-order approximations of the economic structure set up in Section 3 around the pre-war equilibrium in 2017. This choice of first-order approximations (instead of exact hat algebras) is largely driven by the high dimensionality of the current setup (as detailed below).

Specifically, denote $\hat{x} \equiv d \ln x$. The system can be written in terms of the change in each endogenous variable $\{\hat{w}_{sr}, \hat{w}_r^T, \hat{w}_r^{NT}, \hat{L}_r^T, \hat{p}_s, \hat{\phi}_s, \hat{P}_s, \hat{P}_{Ms}, \hat{p}_{Mg}, \hat{p}_{ig}, \hat{R}, \hat{E}_s, \hat{X}, \hat{Y}, \widehat{P_s I_s}, \widehat{p_s Q_s}, \hat{X}_r\}$, given shocks to Chinese and foreign tariffs, $\{d\tau_{ig}, d\tau_{ig}^*\}$, as a result of first-order approximations. The characterization of the system of equations is provided in Appendix B.1. The numerical implementation is carried out by solving the linear system (B.1)–(B.4), (B.7)–(B.11), (B.14), (B.18)–(B.23), and (B.24) in the reduced form of $\hat{x} = A^{-1}y$, where $\hat{x}$ is a column vector consisting of changes in the endogenous variables, y is a column vector with functions of the given tariff shocks, and A collects the parameters of the economic structure. These include: *i*) demand-side Cobb-Douglas allocation shares (β_s, β_{NT}) for 39 tradable sectors and 1 non-tradable sector, and CES demand elasticities (σ, η, κ) across varieties, products and domestic/imported bundles; *ii*) supply-side Cobb-Douglas input shares $(\alpha_{Ls}, \alpha_{Is}, \alpha_s^{s'})$ of labor and intermediates; *iii*) distributions of sales and employment across sectors and 31 provinces; *iv*) imports and exports across varieties from and to 119 trading partners; and *v*) variety-level foreign demand (σ^*) and supply (ω^*) elasticities.

We use the 2017 Chinese input-output (IO) tables, China Labor Statistical Yearbook of 2017, and the Chinese customs data for 2017, as documented in Appendix A, to parameterize the allocation shares. For the elasticities, we adopt their estimates from Section 4, and set them to zero for statistically insignificant estimates (i.e., $\omega^* = 0$). The shocks to the Chinese and U.S. tariffs, $\{d\tau_{ig}, d\tau_{ig}^*\}$, are measured by the latest revised tariff change for each variety observed during the period 2018:1–2019:12. As a result, we match the model to 2017 data on Chinese economic activities for 31 provinces, 39 tradable sectors (at the level of GB/T-2 digit codes), 1 non-tradable sector, 119 trading partners, 5,362 imported HS-8 products, 122,482 imported varieties (unique product-country-origins), 5,432 exported products, and 374,213 unique product-export-destinations.[7] In sum, the vector $\hat{x}$ includes 663,248 endogenous variables, where 656,166 of them correspond to the variety prices $\hat{p}_{ig}$.[8] Further details about the implementation are provided in Appendix B.2.

[7]The count is based on observations with positive trade value before the trade war.

[8]The count is based on a balanced panel of country-by-product, considering all the trading partners and products observed before and after the war in imports (and exports, respectively).

5.1 Aggregate Effects

Given the tariff shocks to the pre-war equilibrium in 2017, and the changes in the endogenous variables calculated from the system described above, the welfare impact for each primary factor (capital and labor) can be measured as the change in income at initial prices (before the tariff war) that would have left that factor indifferent to the changes in tariffs that took place. Adding up the equivalent variations across all primary factors (capital and labor in each province) gives the aggregate equivalent variation EV, or change in aggregate real income. This term can be rewritten as the change in income due to the cost difference in attaining the initial utility level given the price changes (following Dixit and Norman, 1980):

$$EV = \underbrace{\sum_{s}\sum_{g\in\mathcal{G}_s}\sum_{i\in\mathcal{I}_g} x_{ig}\Delta p_{ig}^{X}}_{EV^X} - \underbrace{\sum_{s}\sum_{g\in\mathcal{G}_s}\sum_{i\in\mathcal{I}_g} m_{ig}\Delta p_{ig}}_{EV^M} + \Delta R, \tag{34}$$

where EV^X is the increase in the value of the pre-war export basket, EV^M is the drop in income due to increase in the duty-inclusive cost of the pre-war import basket, and ΔR is the change in tariff revenue.

Table 8 reports the decomposition by EV^X, EV^M, and tariff revenue (ΔR) in Columns (1)–(3) and the aggregate impacts in Column (4). The top panel reports the effects from the 2018–2019 trade war. The bottom two panels study two alternative hypothetical scenarios, where China retaliated against the U.S. but did not implement MFN tariff cuts, and where China did not retaliate against the U.S. or implement MFN tariff cuts. Each panel reports the monetary equivalent on an annual basis at 2017 prices in billions of US dollars, and the numbers relative to 2017 GDP of China.

The first column shows a decrease of EV^X of \$32.968 billion (0.272% of China's GDP) due to the trade war. This aggregate number equals a model-implied 2.510% decrease in the export price index times a 10.821% observed share of exports of agricultural and industrial sectors in GDP. This implies that the diversion of demand away from China's products (due to higher U.S. tariffs against China and due to China's lower MFN tariffs on non-U.S. sources of imports) dominates potential reallocation toward Chinese products (in response to China's higher tariffs against U.S. products). The drop in the export price indices and the decrease of EV^X would have been less, at \$29.899 billion (0.246% of GDP) if China had not lowered its MFN tariffs on non-U.S. sources of imports during the trade war. On the other hand, the decrease in the export price index would have been more severe if China had not retaliated against the U.S. (and had not changed its MFN tariffs accordingly). This scenario corresponds to a decrease of EV^X of \$37.254 billion (0.307% of GDP).

The next column shows that Chinese buyers of imports sustained an aggregate loss of \$6.906 billion (0.057% of GDP) because of the trade war. The loss would have been larger at \$11.002 billion (0.091% of GDP) if the Chinese government had not lowered MFN tariffs on non-U.S. sources of imports when it increased tariffs against U.S. products. The loss of buyers of imports, on the other hand, would have been negligible and statistically insignificant at \$0.000 billion (0.000% of GDP) if China had not counter-responded to the U.S. tariff hike. This is consistent with a horizontal foreign supply elasticity ω^*, so import price changes that consumers face reflect mainly import tariff changes, which in the last scenario are nil.

The final component of the decomposition implies an increase in tariff revenue of \$1.976 billion (0.016% of GDP). The tariff revenue increase would have approximately tripled at \$5.728 (0.047% of GDP)—with the increase in tariffs against the U.S.—if China had not also lowered MFN tariffs. In the third scenario, without counter-retaliation by China, the tariff revenue is shown to decrease, reflecting a decrease in import volume due to general equilibrium effects of U.S. tariffs on the Chinese economy.

In sum, these numbers imply large negative consequences of the trade war on both Chinese producers and consumers, dominating the positive tariff revenue increase. The loss of the producers (exporters) is more than four times the loss of the buyers of imports. Column (4) suggests an aggregate loss of \$37.898 billion, or 0.312% of China's GDP, as a result of the trade war. Without the counter-retaliation, the loss would have been much larger, at \$38.921 billion (0.321% of GDP), and mostly borne by producers (exporters). The retaliation against the U.S. imports shifted the burden to the Chinese buyers of imports (as seen in the transition from the third to the second scenario). With further adjustment in the MFN tariff rates on non-U.S. sources of imports, this lessened the loss of Chinese buyers of imports and shifted part of the burden back to the producers. Overall, the aggregate loss in EV is significant statistically, except in the second scenario.

5.2 Regional Effects

We now report the distributional impacts of the trade war across Chinese provinces, from workers' versus all primary factors' perspectives. Chinese import tariffs could negatively affect primary factor owners as consumers of imports. They could also lower the nominal return to primary factors, as the costs of intermediate inputs increase with the import tariffs. The costs of intermediate inputs could increase more in provinces whose production is more concentrated in sectors that use proportionally more inputs targeted by Chinese tariff increases. Simultaneously, the nominal return to primary factors could be negatively affected to larger extents in regions whose production is more concentrated in sectors targeted by the

U.S. tariffs (through changes in the producer and export prices), less protected by China's retaliatory tariffs against the U.S., or subject to China's MFN tariff reductions.

Figure 3 illustrates the variation in exposure to the trade war across provinces in China: (A) due to China's tariff increases on U.S. products; (B) due to China's MFN tariff cuts; (C) due to the combination of the first two; and (D) due to the U.S. tariff increases on Chinese products. We construct the province-level exposure to tariff shocks by: *i*) computing the trade-weighted tariff changes of each GB/T-2 sector across varieties within the sector, using the 2017 trade shares; and *ii*) computing the wage-bill-weighted tariff changes for each province given the province's employment structure across sectors.[9]

Figure 3 suggests that China tended to: (A) retaliate against the U.S. in sectors with a relatively high concentration in the outlying provinces such as Xinjiang, Hainan, and Heilongjiang; and (B) reduce MFN tariffs on sectors concentrated in provinces closer to the coast such as Shanghai and Beijing. Overall, China's tariff increases tended to be biased toward inland provinces and turn negative in the Eastern provinces. Added to the burden, Panel (D) suggests that these provinces also faced higher tariff increases on their exports to the U.S.

Figure 4 shows the effects of the trade war on real wages across provinces. The first map (A) shows the province-level reduction in real wages in tradable sectors due to the trade war, and the second map (B) shows real wage losses in the hypothetical scenario where China had not reduced MFN tariffs. Every province experienced a reduction in the tradable real wage. Provinces with larger relative losses are concentrated in the Southeast, whose employment structures were hit more strongly by the U.S. tariff increase. Map (B) suggests that the real wage losses would have been one level higher without the MFN tariff cuts by China. This contrasts with the finding in Table 8, where the MFN tariff cuts by China worsened the aggregate loss. This implies that the MFN tariff cuts helped cushion the impacts on workers/consumers via lower import prices, at the cost of producers (and the owners of capital and fixed structures), who faced steeper competition in the product market.

Overall, on average across provinces, the nominal wages for workers in tradable sectors decreased by 3.19% (std. dev. = 0.08%). These income losses were, however, cushioned by a reduced cost of living, as the CPI of tradable goods decreased by 2.34% on average across sectors, reflecting an average 0.53% increase in import prices and 2.69% decrease in prices of domestic goods. As a result, real wages in the tradable sector fell by 0.32% (std. dev. =

[9] The exposure of region r to the Chinese import tariff changes is $\Delta\tau_r = \sum_{s\in S}\left(\frac{w_{sr}L_{sr}}{w_{Tr}L_r^T}\right)\frac{\sum_{g\in G_s}\sum_{i\in\mathcal{I}_g}p^*_{ig}m_{ig}\Delta\tau_{ig}}{\sum_{g'\in G_s}\sum_{i'\in\mathcal{I}_{g'}}p^*_{i'g'}m_{i'g'}}$, and the exposure to the U.S. tariff changes is $\Delta\tau^*_r = \sum_{s\in S}\left(\frac{w_{sr}L_{sr}}{w_{Tr}L_r^T}\right)\frac{\sum_{g\in G_s}\sum_{i\in\mathcal{I}_g}p^X_{ig}x_{ig}\Delta\tau^*_{ig}}{\sum_{g'\in G_s}\sum_{i'\in\mathcal{I}_{g'}}p^X_{i'g'}x_{i'g'}}$, where $w_r^T L_r^T$ are total tradable wages in province r.

0.04%).

Figure 5 sums up the total real expenditures of both capital owners and workers (i.e., profits and wage incomes in addition to tariff revenue transfer) for each province, and reports their simulated responses to the tariff war, with and without the MFN tariff cuts. The impacts of the full trade war are similar in percentage terms of real wages or real expenditures, as seen in Panel (A) of Figures 4 and 5. However, the large contrast between Panel (B) of Figure 4 and that of Figure 5 echoes the re-distributional effects of MFN tariff cuts from the producers of exports (EV^X) to the buyers of imports (EV^M), as highlighted in Section 5.1. The losses in real expenditures across provinces are mitigated while the losses in real wages are aggravated, without the MFN tariff cuts. Thus, the MFN tariff cuts in a way are used by the Chinese government to redistribute real incomes from capital owners to workers, at a greater cost to the aggregate welfare.

5.3 Trade Diversion Effects

In this section, we report the model-implied trade diversion effects of the trade war. Formulas are provided in Appendix B.3. Table 9 summarizes the diversion of Chinese imports and exports due to the trade war. As China increased tariffs on U.S. products and decreased MFN tariffs against the other trading partners, Chinese imports were diverted from U.S. toward non-U.S. sources. The share of imports from the U.S. dropped from 9.15% to 8.21%. Chinese imports were mainly diverted toward countries in Europe and Asia, and in particular, Germany and Japan. Although China reduced imports from all sources due to general-equilibrium effects, the drop was proportionally less with respect to countries in Europe.

On the other hand, facing the U.S. tariff increase, China diverted its exports toward other markets. The share of exports to the U.S. declined from 19.16% to 16.16%. Meanwhile, its exports to destinations other than the U.S. generally increased by around 0.03%. Thus, as a result of the trade war, China tilted its sources of inputs toward countries in Europe and Asia (19.19% to 19.54%; 52.48% to 52.93%), and also relied more on countries in Europe and Asia as its markets (18.89% to 19.59%; 48.68% to 50.48%).

6 Conclusion

The U.S.-China tariff war escalated in a short span of 24 months during 2018:1–2019:12 before the Phase One Deal was reached in 2019:12. This paper provides an ex post analysis of the micro and macro responses of the Chinese economy to the tariff shocks of that period. This complements the studies by Amiti et al. (2019), Flaaen et al. (2020), Fajgelbaum et al.

(2020), and Cavallo et al. (2021) for the U.S. economy.

In the first step, we use monthly variations during 2018:1–2019:12 in Chinese imports and exports of HS-8 digit products by source and destination countries to identify the elasticities of the Chinese economy's import demand and export supply at the product-country (i.e., variety) level. The identification relies on monthly variations in tariff rates that are uncorrelated with the unobserved demand and supply shocks of the corresponding variety. The tariff shocks associated with the tariff war are taken as the ideal instrument given its unprecedented and uncertain nature. The validity of the instrument was verified with pre-trend and dynamic tests. The resulting elasticity estimates provide a first view of the direct effects of the tariff war on Chinese imports and exports at the variety level.

In the second step, the estimated demand structure is embedded in a general equilibrium model with a supply-side structure calibrated to the Chinese economy. In particular, goods markets (for final demand and intermediate use) are integrated across Chinese provinces but primary inputs (labor and fixed structures) are confined to their current sector-province of employment in the short run. The effects of the tariff shocks on the demand for Chinese and foreign varieties aggregate up via the 3-tier demand system in China, and influence the Chinese producer prices across sectors and the real wages across sector-provinces. The exposure of a sector-province to the tariff war depends on a sector's exposure to the tariff shocks and a province's production structure across sectors.

The tariff war imposed a large welfare loss on Chinese producers/exporters (US$ 32.968 billion) and on buyers of imports (US$ 6.906 billion), with a net loss of aggregate welfare (US$ 37.898 billion) after taking into account the higher tariff revenue. The Chinese initiative to lower MFN tariffs as it raised tariffs against the U.S. products led to larger aggregate welfare losses at the cost of producers, but appeared to be an effective redistributive policy to cushion the impacts on consumers/workers. The loss of consumers/buyers of imports would have been higher (US$ 11.002 billion) and the average real wage in tradable sectors would have dropped by more (0.38% vs. 0.32%) if not for the MFN tariff cuts. The analysis also indicates that the provinces that are closer to the coast were hit harder (in terms of real wages in tradable sectors or real expenditures) by the tariff war. This occurred not only because these provinces were proportionally more specialized in products targeted by the U.S. tariff hike, but also because the Chinese government tended to lower MFN tariffs on products produced by these provinces. Finally, due to the tariff war, the Chinese economy reduced its share of imports from the U.S. (from 9.15% to 8.21%). At the same time, the share of its exports to the U.S. market dropped from 19.16% to 16.16%. Trade tended to be diverted toward countries in Europe and Asia (as sources of imports and as markets for exports).

Some comments are in order. First, similarly to Fajgelbaum et al. (2020), our estimates suggest horizontal foreign export supply and Chinese export supply curves at the variety level. Hence, the incidence of import tariffs is borne entirely by the importing country at the variety level (although foreign tariffs on Chinese exports can still affect Chinese producer/export prices through general equilibrium adjustments in the Chinese economy). This implies less policy room for China to retaliate for terms-of-trade gains, and might help explain the moderate increase in Chinese tariff rates for a majority of products included in its targeted list, and its move to lower MFN tariffs. Second, a potential caveat to the above finding is the nature of estimation specification, where sector-time fixed effects are controlled for. This is likely to reduce the magnitude of elasticity estimates, if the sector-time fixed effects used to control for unobservables also absorb a significant source of variations in variety-level imports/exports. Third, the general equilibrium structure used has a high resolution with respect to modeling of product/labor markets for the local economy and their supply response. The setup, however, has a very simple structure for the rest of the world (with only supply and demand responses specified at the variety level), and cannot accommodate general equilibrium adjustments in foreign countries or across countries. For example, it cannot address the repercussion of the trade war on the regional or global value chain in which China plays a critical role. Fourth, the model used is static in nature, and thus cannot address potential impacts in the long run due to factor reallocations across regions within the country. We leave these generalizations to future research.

References

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

Caliendo, L., Parro, F., 2015. Estimates of the trade and welfare effects of NAFTA. Review of Economic Studies 82, 1–44.

Cavallo, A., et al., 2021. Tariff pass-through at the border and at the store: Evidence from US trade policy. American Economic Review: Insights 3, 19–34.

Charbonneau, K. B., Landry, A., 2018. The trade war in numbers. Bank of Canada Staff Working Paper, No. 2018-57, Bank of Canada, Ottawa.

Dixit, A., Norman, V., 1980. Theory of International Trade: A Dual, General Equilibrium Approach. Cambridge.

Fajgelbaum, P. D., et al., 2019. Replication data for: 'The Return to Protectionism'. Harvard Dataverse, doi 10.

—, 2020. The return to protectionism. Quarterly Journal of Economics 135, 1–55.

Feenstra, R. C., 1994. New product varieties and the measurement of international prices. American Economic Review 84, 157–177.

Flaaen, A., Hortaçsu, A., Tintelnot, F., 2020. The production relocation and price effects of U.S. trade policy: The case of washing machines. American Economic Review 110, 2103–2127.

Guo, M., et al., 2018. The day after tomorrow: Evaluating the burden of Trump's trade war. Asian Economic Papers 17, 101–120.

Itakura, K., 2020. Evaluating the impact of the US-China trade war. Asian Economic Policy Review 15, 77–93.

Li, M., Balistreri, E. J., Zhang, W., 2020. The US-China trade war: Tariff data and general equilibrium analysis. Journal of Asian Economics 69, xx–xx.

Sheng, B., 2002. The Political Economic Aanalysis of Chinese Foreign Trade Policy (in Chinese). Shanghai Sanlian Bookstore.

Zoutman, F. T., Gavrilova, E., Hopland, A. O., 2018. Estimating both supply and demand elasticities using variation in a single tax rate. Econometrica 86, 763–771.

A Data Appendix

A.1 Definitions

Products, varieties and sectors are defined as follows in the analysis:

- Products are defined at the Harmonized System 8-digit level (denoted as HS-8). For example, the HS 8-digit code 40131000 covers the product "inner tubes of rubber used on motor cars."
- Varieties are defined at the product-country level. For example, imports (exports) of "inner tubes of rubber used on motor cars" from (to) the U.S. are a distinct variety.
- Sectors are defined according to the China Industry Classification system (GB/T 4754) at the 2-digit level (denoted as GB/T-2). For example, the GB/T-2 code 29 covers "manufacture of rubber and plastics products."

A.2 Variety-level Data on Trade and Tariffs

A.2.1 Trade Data

We obtain China's trade data in monthly frequency for the period 2017:1–2019:12 from the General Administration of Customs, China.[10] We observe the Chinese imports and exports at the HS-8 digit level by the source of imports and the destination of exports (i.e., at the variety level). For each variety, the customs data report the quantities of imports and exports, the value of imports at the CIF price, and the value of exports at the FOB price. The import and export values are reported in current US$ values.

A.2.2 Tariff Data

Our tariff data comprise two main components, the baseline tariff rates applied to Chinese imports and exports, and tariff changes associated with the U.S.-China trade war. For the Chinese baseline tariff rates, we downloaded the annual tariff schedule of China from the UN TRAINS database via the World Integrated Trade Solution (WITS).[11] Given the tariff rates available at the HS-10 level, we assume that the most-favored-nation (MFN) rate is applied to imports from WTO members, the preferential rate is applied to trading partners with which China has any preferential trade agreement (PTA) in place, and the general duty rate

[10] http://www.customs.gov.cn/.

[11] http://wits.worldbank.org/WITS/WITS/QuickQuery/Tariff-ViewAndExportRawData/TariffViewAndExportRawData.aspx?Page=TariffViewAndExportRawData.

(GDR) is applied to the rest of the world. We then take the simple average of the HS-10 level tariff rates as the HS-8 level tariff rate. This aggregation is due to the fact that the tariff rate changes (or tariff rates in general) published by the Chinese Ministry of Finance are only available at the HS-8 level.[12] We cross-check, correct and supplement the missing values of the data obtained from TRAINS with the annual tariff schedules released by the Ministry of Finance. After constructing the baseline import tariff rate for January 2017, we then update the rates in monthly frequency, given the official announcement by the Ministry of Finance of any tariff changes (tariff increases against the U.S. or MFN tariff cuts against the other WTO members).[13] These tariff changes are specified at the HS-8 level.[14]

For tariffs faced by Chinese exports, we compile the annual tariff rates imposed by Chinese trading partners from the UN TRAINS database.[15] In particular, we use the simple average of Effectively Applied (AHS) tariff rates by Chinese trading partners against China. These are available at the HS-6 digit level. For tariff changes associated with the trade war, we obtain that part of information from Fajgelbaum et al. (2019) (for tariff changes in 2018) and the Office of the United States Trade Representative (USTR)[16] (for tariff changes in 2019). The tariff changes are aggregated from the HS-10 to the HS-6 level based on simple average. The use of the HS-6 digit for tariffs faced by Chinese exports is because the HS codes are only harmonized across countries up to the level of HS-6 codes. The estimations of trade elasticities for Chinese exports are nonetheless conducted at the HS-8 level of trade (with the HS-6 tariffs assigned to all HS-8 products in the category). Thus, the same caveat noted by Fajgelbaum et al. (2020) applies, that we may overestimate the value of Chinese exports subject to tariffs and underestimate the foreign import demand elasticity.

Following Fajgelbaum et al. (2020), we scale tariff increases by the number of days of the month they were in effect. For example, a 15 p.p. tariff increase enacted on the 20th day of a 30-day month is assigned a 5 p.p. tariff increase (15 * 10/30 = 5) in the initial month, and an additional 10 p.p. increase in the subsequent month.

[12] http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/index_3.html.

[13] http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/index_3.html.

[14] Beside the tariff changes associated with the trade war, in constructing the applied tariff rates we also record other tariff revisions. These include annual MFN rate adjustments (normally twice a year, in January and July), tariff reductions resulting from longstanding treaty commitments, new PTAs signed between China and its trading partners, or the removal of import tariff barriers for certain products due to its 13th Five-Year Plan for National Economic and Social Development. These other tariff revisions are used to construct a more precise measure of the applied tariff rate. Their variations, however, are not used in the construction of the instrumental variables, i.e., not used as the source of identification of the elasticities.

[15] http://wits.worldbank.org/WITS/WITS/AdvanceQuery/TariffAndTradeAnalysis/AdvancedQueryDefinition.aspx?Page=TariffandTradeAnalysis.

[16] https://ustr.gov/.

A.3 Sector-level Data

We classify sectors using the China Industry Classification system (GB/T 4754), which is widely used in the collection of official statistics on companies and organizations throughout Mainland China. The sector-level data at the GB/T 2-digit level (denoted GB/T-2) are obtained from China's National Bureau of Statistics.[17] The classification includes 97 sectors in total, and 43 sectors in agriculture, mining and manufacturing.

1. Measure of $\triangle \ln P_{Dst}$: The change in the price index of domestically produced goods is proxied by the change in the producer price index. The producer price index for industrial products (PPI) is available with monthly frequency for 40 industrial sectors.

2. Measure of $\triangle \ln(P_{Dst}D_{st})$: The monthly change in expenditures on domestically produced goods is measured as the difference between the changes in sectoral production and exports. The data on the sectoral output (quantity) are available with monthly frequency but only for major products in 27 manufacturing sectors. We normalize the output of each product relative to 2016:1, and use the simple average across products within each sector as the sectoral production index.[18] The export quantity is constructed as the ratio of export values and the producer price index. The estimations of the elasticity κ are thus based on a subset of industrial sectors where the above data are available.

3. The input-output (IO) tables are compiled for 2017. These tables quantify annual inputs and outputs of commodities by intermediate and final users in 2017, for 88 sectors.

For the analysis in the paper, we classify GB/T-2 sectors as tradable if they are matched to an HS-6 code in the trade data. For the cross-walk between GB/T sectors and HS products, we use the conversion table of Sheng (2002) (available for 36 industrial sectors), and the concordance tables from WITS (ISIC-HS)[19] and from China's National Bureau of Statistics (ISIC-GB/T)[20] (available for all economic activities). Minor modifications are further made where a product is mapped to more than one sector, using our interpretations of the official descriptions of the products and sectors. There are a total of 39 tradable sectors.

[17] http://www.stats.gov.cn/.

[18] The methodology of constructing the production index usually requires the industrial value-added of each product to be used as the weight in calculating the index, but such data are not available. Thus, in our calculation, we take the weight to be equal across the major products.

[19] https://192.86.102.134/product_concordance.html.

[20] http://www.stats.gov.cn/tjsj/tjbz/hyflbz/201710/t20171012_1541679.html.

A.4 Province-level Data

For the general equilibrium analysis, we collect the annual employment and wage data at the sector and province level from the China Labor Statistical Yearbook of 2017. It records the employment and total wages of urban units by sector and region. These are available for 31 provinces and 94 GB/T-2 sectors (covering services, agriculture, mining and manufacturing sectors). All of the 39 tradable sectors are covered individually in both the IO tables and the labor statistics dataset. We aggregate the remaining sectors as a single non-tradable sector, thus reconciling the IO tables and the labor statistics dataset.

B Appendix to Section 5 (Welfare Analysis)

The general-equilibrium (GE) system follows that of Fajgelbaum et al. (2020). We provide its full derivations in Section B.1 for ease of reference (correcting some typos of the original paper along the way), and document its implementations in the context of China in Section B.2. Section B.3 describes how we evaluate the trade diversion impact given shocks to the system.

B.1 General Equilibrium System of Changes

The model solution is derived as a system of first-order approximations around an initial equilibrium corresponding to the period before the trade war. Every market-clearing condition is expressed in log-changes. The outcome depends on endogenous variables, observed initial shares, elasticities and tariff shocks. Letting $\hat{x} \equiv d \ln x$, the system describes the log-change of each endogenous variable given shocks to Chinese and foreign tariffs, $\{d\tau_{ig}, d\tau^*_{ig}\}$. Using market-clearing conditions, the solution of the model can be expressed as a system for the changes in wages per efficiency unit $\{\hat{w}_{sr}\}$, average wages in the tradable sectors $\{\hat{w}^T_r\}$, wages in the non-tradable sector $\{\hat{w}^{NT}_r\}$, employment in the tradable sector $\{\hat{L}^T_r\}$, producer prices $\{\hat{p}_s\}$, intermediate input prices $\{\hat{\phi}_s\}$, sector price indices $\{\hat{P}_s\}$, sector-level import price indices $\{\hat{P}_{Ms}\}$, product-level import price indices $\{\hat{p}_{Mg}\}$, duty-inclusive prices of imported varieties $\{\hat{p}_{ig}\}$, tariff revenues $\hat{R}$, sector-level expenditures $\{\hat{E}_s\}$, national final consumer expenditures $\hat{X}$, national value added $\hat{Y}$, national intermediate expenditures by sector $\{\widehat{P_s I_s}\}$, national sales by sector $\{\widehat{p_s Q_s}\}$, and final consumer expenditures by region $\{\hat{X}_r\}$.

Wages, Producer Prices, Input Prices, and Tradable Employment

The first set of equations characterizes $\{\hat{w}_{sr}, \hat{w}_r^T, \hat{w}_r^{NT}, \hat{L}_r^T, \hat{p}_s, \hat{\phi}_s\}$, given $\{\hat{X}_r, \hat{E}_s, \hat{P}_s, \hat{\tau}_{ig}^*\}$. First, by (19), we have:

$$\hat{w}_{sr} = \frac{1}{1-\alpha_{Is}}\left(\hat{p}_s - \alpha_{Is}\hat{\phi}_s - \alpha_{Ks}\hat{L}_{sr}\right).$$

Define χ^I as an indicator that equals one if labor is immobile across sectors and zero otherwise. In the case where $\chi^I = 1$, it follows that:

$$\begin{aligned}
\hat{L}_{sr} &= 0,\\
\hat{w}_{sr} &= \frac{1}{1-\alpha_{Is}}\left(\hat{p}_s - \alpha_{Is}\hat{\phi}_s\right),\\
\hat{w}_r^T &\equiv \frac{dw_r^T}{w_r^T} = \frac{\sum_{s\in S} dw_{sr}L_{sr}}{\sum_{s\in S} w_{sr}L_{sr}} = \sum_{s\in S}\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\frac{dw_{sr}}{w_{sr}} = \sum_{s\in \mathcal{S}}\left(\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\right)\frac{\hat{p}_s - \alpha_{Is}\hat{\phi}_s}{1-\alpha_{Is}}.
\end{aligned}$$

In the alternative case where $\chi^I = 0$, we have instead:

$$\begin{aligned}
w_{sr} &= w_r^T,\\
\hat{w}_{sr} &= \hat{w}_r^T = \frac{1}{1-\alpha_{Is}}\left(\hat{p}_s - \alpha_{Is}\hat{\phi}_s - \alpha_{Ks}\hat{L}_{sr}\right),\\
\hat{w}_r^T &\equiv \frac{dw_r^T}{w_r^T} = \sum_{s\in S}\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\left(\frac{dw_{sr}}{w_{sr}} + \frac{dL_{sr}}{L_{sr}} - \frac{dL_r^T}{L_r^T}\right),\\
\hat{L}_r^T &\equiv \frac{dL_r^T}{L_r^T} = \frac{\sum_{s\in S} dL_{sr}}{L_r^T} = \sum_{s\in S}\frac{L_{sr}}{L_r^T}\frac{dL_{sr}}{L_{sr}}.
\end{aligned}$$

Thus, it follows that:

$$\begin{aligned}
\hat{w}_r^T &= \sum_{s\in S}\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\left(\hat{w}_{sr} + \hat{L}_{sr} - \hat{L}_r^T\right)\\
&= \sum_{s\in S}\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\hat{w}_{sr} + \sum_{s\in S}\frac{L_{sr}}{L_r^T}\hat{L}_{sr} - \hat{L}_r^T\\
&= \sum_{s\in S}\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\hat{w}_{sr}\\
\sum_{s\in S}\left(\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\right)\frac{1-\alpha_{Is}}{\alpha_{Ks}}\hat{w}_r^T &= \sum_{s\in S}\left(\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\right)\frac{1}{\alpha_{Ks}}\left(\hat{p}_s - \alpha_{Is}\hat{\phi}_s - \alpha_{Ks}\hat{L}_{sr}\right)\\
\sum_{s\in S}\left(\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\right)\frac{1-\alpha_{Is}}{\alpha_{Ks}}\hat{w}_r^T &= \sum_{s\in S}\left(\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\right)\frac{\hat{p}_s - \alpha_{Is}\hat{\phi}_s}{\alpha_{Ks}} - \hat{L}_r^T.
\end{aligned}$$

In sum, we have:

$$\hat{w}_{sr} = \chi^I \frac{\hat{p}_s - \alpha_{Is}\hat{\phi}_s}{1-\alpha_{Is}} + \left(1-\chi^I\right)\hat{w}_r^T, \tag{B.1}$$

$$\hat{w}_r^T = \chi^I \sum_{s\in\mathcal{S}} \left(\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\right) \frac{\hat{p}_s - \alpha_{Is}\hat{\phi}_s}{1-\alpha_{Is}} + \left(1-\chi^I\right) \frac{\sum_{s\in S}\left(\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\right)\frac{\hat{p}_s - \alpha_{Is}\hat{\phi}_s}{\alpha_{Ks}} - \hat{L}_r^T}{\sum_{s\in S}\left(\frac{w_{sr}L_{sr}}{w_r^T L_r^T}\right)\frac{1-\alpha_{Is}}{\alpha_{Ks}}}. \tag{B.2}$$

Second, by the wage rate for non-tradable sectors (21), we have:

$$\hat{w}_r^{NT} = \hat{X}_r - \hat{L}_r^{NT}$$

and by full employment in each region, it follows that:

$$\hat{L}_r^T = -\frac{L_r^{NT}}{L_r^T}\hat{L}_r^{NT}.$$

Thus, in sum:

$$\hat{w}_r^{NT} = \chi^I \hat{X}_r + \left(1-\chi^I\right)\hat{w}_r^T, \tag{B.3}$$

$$\hat{L}_r^T = \left(1-\chi^I\right)\left(\hat{w}_r^T - \hat{X}_r\right)\frac{L_r^{NT}}{L_r^T}. \tag{B.4}$$

Third, note that by the setup, $p_{Dg} = \frac{p_s}{z_g}$; $p_{ig}^X = \delta_{ig}\, p_{Dg}$; and $P_{Ds} = \left(\sum_{g\in\mathcal{G}_s} a_{Dg} p_{D_g}^{1-\eta}\right)^{\frac{1}{1-\eta}}$ holds. It follows that $\hat{p}_{Dg} = \hat{p}_{ig}^X = \hat{P}_{Ds} = \hat{p}_s$. By (16) and (17), we have:

$$\begin{aligned}\hat{Q}_s &= \sum_{g\in\mathcal{G}_s}\frac{d_g/z_g}{Q_s}\hat{d}_g + \sum_{g\in\mathcal{G}_s}\sum_{i\in\mathcal{I}_g}\frac{\delta_{ig}x_{ig}/z_g}{Q_s}\hat{x}_{ig},\\ &= \sum_{g\in\mathcal{G}_s}\frac{p_{Dg}d_g}{p_s Q_s}\hat{d}_g + \sum_{g\in\mathcal{G}_s}\sum_{i\in\mathcal{I}_g}\frac{p_{ig}^X x_{ig}}{p_s Q_s}\hat{x}_{ig}.\end{aligned}$$

Further, by equations (16)–(17), (3) and (10), we have:

$$\begin{aligned}\hat{d}_g &= \hat{D}_s = \hat{E}_s + (\kappa-1)\hat{P}_s - \kappa\hat{p}_s, \;\; \forall\, g\in\mathcal{G}_s\\ \hat{x}_{ig} &= -\sigma^*\left(\frac{d\tau_{ig}^*}{1+\tau_{ig}^*} + \hat{p}_s\right).\end{aligned}$$

Given that $\sum_{g\in\mathcal{G}_s} p_{Dg} d_g = P_{Ds} D_s$, it follows that:

$$\hat{Q}_s = \frac{P_{Ds}D_s}{p_s Q_s}\left(\hat{E}_s + (\kappa-1)\hat{P}_s - \kappa\hat{p}_s\right) - \sum_{g\in\mathcal{G}_s}\sum_{i\in\mathcal{I}_g}\frac{p^X_{ig}x_{ig}}{p_s Q_s}\sigma^*\left(\frac{d\tau^*_{ig}}{1+\tau^*_{ig}} + \hat{p}_s\right). \tag{B.5}$$

Further, by (15) and (14), we have:

$$\begin{aligned}
\hat{Q}_s &= \sum_{r\in\mathcal{R}}\frac{Q_{sr}}{Q_s}\hat{Q}_{sr} \\
&= \sum_{r\in\mathcal{R}}\frac{Q_{sr}}{Q_s}\left(\frac{1-\alpha_{Ks}}{\alpha_{Ks}}\hat{p}_s - \frac{\alpha_{Is}}{\alpha_{Ks}}\hat{\phi}_s - \frac{\alpha_{Ls}}{\alpha_{Ks}}\hat{w}_{sr}\right) \\
&= \frac{1-\alpha_{Ks}}{\alpha_{Ks}}\hat{p}_s - \frac{\alpha_{Is}}{\alpha_{Ks}}\hat{\phi}_s - \sum_{r\in\mathcal{R}}\frac{p_s Q_{sr}}{p_s Q_s}\frac{\alpha_{Ls}}{\alpha_{Ks}}\hat{w}_{sr}.
\end{aligned} \tag{B.6}$$

Finally, combining (B.5) and (B.6) yields:

$$\hat{p}_s = \frac{\frac{P_{Ds}D_s}{p_s Q_s}\left(\hat{E}_s + (\kappa-1)\hat{P}_s\right) + \frac{\alpha_{Is}}{\alpha_{Ks}}\hat{\phi}_s + \sum_{r\in\mathcal{R}}\frac{p_s Q_{sr}}{p_s Q_s}\frac{\alpha_{Ls}}{\alpha_{Ks}}\hat{w}_{sr} - \sigma^*\sum_{g\in G_s}\sum_{i\in\mathcal{I}_g}\frac{p^X_{ig}x_{ig}}{p_s Q_s}\frac{d\tau^*_{ig}}{1+\tau^*_{ig}}}{\frac{1-\alpha_{Ks}}{\alpha_{Ks}} + \frac{P_{Ds}D_s}{p_s Q_s}\kappa + \left(1 - \frac{P_{Ds}D_s}{p_s Q_s}\right)\sigma^*}, \tag{B.7}$$

where by (12), the change in the price index of intermediates is:

$$\hat{\phi}_s = \sum_{s'\in\mathcal{S}}\frac{\alpha^{s'}_s}{\alpha_{Is}}\hat{P}_{s'}. \tag{B.8}$$

Consumer Prices, Import Prices, and Tariff Revenue

The second set of equations characterizes $\{\hat{P}_s, \hat{P}_{Ms}, \hat{p}_{Mg}, \hat{p}_{ig}, \hat{R}\}$ given $\{\hat{E}_s, d\tau_{ig}\}$. First, given that $P_s = \left(A_{Ds}P^{1-\kappa}_{Ds} + A_{Ms}P^{1-\kappa}_{Ms}\right)^{\frac{1}{1-\kappa}}$, the sector price index changes according to a weighted average of producer prices and the import price index:

$$\hat{P}_s = \frac{P_{Ds}D_s}{E_s}\hat{p}_s + \left(1 - \frac{P_{Ds}D_s}{E_s}\right)\hat{P}_{Ms}. \tag{B.9}$$

Next, given that $P_{Ms} = \left(\sum_{g\in\mathcal{G}_s} a_{Mg}p^{1-\eta}_{M_g}\right)^{\frac{1}{1-\eta}}$, the import price index in sector s changes according to:

$$\hat{P}_{Ms} = \sum_{g\in G_s}\left(\frac{p_{Mg}m_g}{P_{Ms}M_s}\right)\hat{p}_{Mg}, \tag{B.10}$$

and by $p_{Mg} = \left(\sum_i a_{ig} p_{ig}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$, the product-level import price index changes according to:

$$\hat{p}_{Mg} = \sum_{i \in \mathcal{I}_g} \left(\frac{p_{ig} m_{ig}}{p_{Mg} m_g} \right) \hat{p}_{ig}. \tag{B.11}$$

Further, from (6), (5), and (3), we have:

$$\begin{aligned} \hat{m}_{ig} &= \hat{m}_g + \sigma \hat{p}_{Mg} - \sigma \hat{p}_{ig} \\ &= \hat{M}_s + \eta \hat{P}_{Ms} + (\sigma - \eta)\, \hat{p}_{Mg} - \sigma \hat{p}_{ig} \\ &= \hat{E}_s + (\kappa - 1)\, \hat{P}_s + (\eta - \kappa)\, \hat{P}_{Ms} + (\sigma - \eta)\, \hat{p}_{Mg} - \sigma \hat{p}_{ig}. \end{aligned} \tag{B.12}$$

From the foreign export supply (9) and the price relationship (7), we also have:

$$\hat{m}_{ig} = \frac{1}{\omega^*} \left(\hat{p}_{ig} - \frac{d\tau_{ig}}{1 + \tau_{ig}} \right). \tag{B.13}$$

Combining (B.12) and (B.13), it follows that:

$$\hat{p}_{ig} = \frac{\omega^*}{1 + \omega^* \sigma} \left(\hat{E}_s + (\kappa - 1)\hat{P}_s + (\eta - \kappa)\hat{P}_{Ms} + (\sigma - \eta)\hat{p}_{Mg} \right) + \frac{1}{1 + \omega^* \sigma} \frac{d\tau_{ig}}{1 + \tau_{ig}}. \tag{B.14}$$

Lastly, recall the definition of tariff revenue,

$$R = \sum_{s \in \mathcal{S}} \sum_{g \in G_s} \sum_{i \in \mathcal{I}_g} \tau_{ig} p_{ig}^* m_{ig}. \tag{B.15}$$

Taking the second-order total differentiation gives:

$$\begin{aligned} dR &= \sum_s \sum_g \sum_i \left(p_{ig}^* m_{ig} d\tau_{ig} + \tau_{ig} m_{ig} dp_{ig}^* + \tau_{ig} p_{ig}^* dm_{ig} \right) \\ &\quad + \frac{1}{2} \sum_s \sum_g \sum_i \left(2 m_{ig} dp_{ig}^* d\tau_{ig} + 2 p_{ig}^* dm_{ig} d\tau_{ig} + 2 \tau_{ig} dp_{ig}^* dm_{ig} \right) \\ &= \sum_s \sum_g \sum_i p_{ig}^* m_{ig} d\tau_{ig} + \sum_s \sum_g \sum_i \tau_{ig} p_{ig}^* m_{ig} \left(\hat{p}_{ig}^* + \hat{m}_{ig} \right) + \sum_s \sum_g \sum_i d\tau_{ig} p_{ig}^* m_{ig} \left(\hat{p}_{ig}^* + \hat{m}_{ig} \right) \\ &\quad + \frac{1}{2} \sum_s \sum_g \sum_i \tau_{ig} d^2 \left(p_{ig}^* m_{ig} \right). \end{aligned} \tag{B.16}$$

It follows that:

$$\hat{R}=\sum_{s}\sum_{g\in G_s}\sum_{i}\frac{p^*_{ig}m_{ig}}{R}d\tau_{ig}+\sum_{s}\sum_{g\in G_s}\sum_{i}\frac{p^*_{ig}m_{ig}}{R}\left(\tau_{ig}+d\tau_{ig}\right)\left(\hat{p}^*_{ig}+\hat{m}_{ig}\right)+\frac{1}{2}\sum_{s}\sum_{g\in G_s}\sum_{i}\frac{\tau_{ig}}{R}d^2\left(p^*_{ig}m_{ig}\right). \tag{B.17}$$

We set the last term $\tau_{ig}d^2\left(p^*_{ig}m_{ig}\right)$ to 0, provided that the initial tariffs τ_{ig} are reasonably small. Using the solutions for $\hat{p}_{ig}$ and $\hat{m}_{ig}$ from equations (B.14) and (B.13), in addition to (7), we get:

$$\begin{aligned}\hat{R} &= \sum_{s}\sum_{g\in G_s}\sum_{i}\left(\tau_{ig}+d\tau_{ig}\right)\frac{p^*_{ig}m_{ig}}{R}\frac{1+\omega^*}{1+\omega^*\sigma}\left(\hat{E}_s+(\kappa-1)\hat{P}_s+(\eta-\kappa)\hat{P}_{Ms}+(\sigma-\eta)\hat{p}_{Mg}\right)\\ &+ \sum_{s}\sum_{g\in G_s}\sum_{i}\left(1-\tau_{ig}\frac{\sigma-1}{1+\omega^*\sigma}\right)\frac{p^*_{ig}m_{ig}}{R}\frac{d\tau_{ig}}{1+\tau_{ig}}\\ &- \sum_{s}\sum_{g\in G_s}\sum_{i}\frac{p_{ig}m_{ig}}{R}\sigma\frac{1+\omega^*}{1+\omega^*\sigma}\left(\frac{d\tau_{ig}}{1+\tau_{ig}}\right)^2.\end{aligned} \tag{B.18}$$

Sector and Region Demand Shifters

The third set of equations characterizes the sector and region level expenditure shifters $\{\hat{E}_s,\hat{X}_r\}$ given $\{\hat{R},\hat{p}_s,\hat{\phi}_s,\hat{w}^{NT}_r,\hat{w}_{sr}\}$. The expenditure in sector s is defined as $E_s=P_sC_s+P_sI_s$, and from (8) we have $P_sC_s=\beta_sX$, where X is the total national expenditure, defined as $X=Y+R+D$, where D is the trade deficit. We assume that the national trade deficit is determined by factors outside the model and remains unchanged. Thus, it follows that:

$$\hat{E}_s \equiv \frac{P_sC_s}{E_s}\hat{X}+\left(1-\frac{P_sC_s}{E_s}\right)\widehat{P_sI_s}, \tag{B.19}$$

$$\hat{X} = \frac{Y}{X}\hat{Y}+\frac{R}{X}\hat{R}. \tag{B.20}$$

Since we assume that the non-tradable sectors use only labor as input, this implies that the national income equals $Y=\sum_{r\in\mathcal{R}}P_{NT,r}Q_{NT,r}+\sum_{s\in\mathcal{S}}\left(1-\alpha_{Is}\right)p_sQ_s$. Hence,

$$\hat{Y}=\sum_{r\in\mathcal{R}}\left(\frac{P_{NT,r}Q_{NT,r}}{Y}\right)\hat{X}_r+\sum_{s\in\mathcal{S}}\left(1-\alpha_{Is}\right)\left(\frac{p_sQ_s}{Y}\right)\sum_{r\in\mathcal{R}}\left(\frac{p_sQ_{sr}}{p_sQ_s}\right)\left(\hat{p}_s+\hat{Q}_{sr}\right). \tag{B.21}$$

The total demand for intermediates of sector s is defined as:

$$P_sI_s=\sum_{s'\in\mathcal{S}}\alpha^s_{s'}p_{s'}Q_{s'},$$

so that

$$\widehat{P_s I_s} = \sum_{s' \in \mathcal{S}} \alpha^s_{s'} \sum_{r \in \mathcal{R}} \frac{p_{s'} Q_{s'r}}{P_s I_s} \left(\hat{p}_{s'} + \hat{Q}_{s'r} \right). \tag{B.22}$$

Using (14) for Q_{sr}, we have:

$$\hat{p}_s + \hat{Q}_{sr} = \frac{1}{\alpha_{Ks}} \hat{p}_s - \frac{\alpha_{Is}}{\alpha_{Ks}} \hat{\phi}_s - \frac{\alpha_{Ls}}{\alpha_{Ks}} \hat{w}_{sr}. \tag{B.23}$$

By (8), we have $P_{NT,r} Q_{NT,r} = \beta_{NT} X_r$. Thus, using (18), the change of expenditures in region r can be expressed as:

$$\hat{X}_r = \frac{\sum_{s \in \mathcal{S}} \frac{p_s Q_{sr}}{X_r} (1 - \alpha_{Is}) \left(\hat{p}_s + \hat{Q}_{sr} \right) + \frac{b_r R}{X_r} \hat{R}}{1 - \frac{P_{NT,r} Q_{NT,r}}{X_r}}. \tag{B.24}$$

B.2 Implementation

We use the 2017 Chinese input-output (IO) tables, China Labor Statistical Yearbook of 2017, and the Chinese customs data for 2017, as documented in Appendix A, to parameterize the allocation shares. We basically follow the same steps as in Fajgelbaum et al. (2020) to construct the shares. Differences in the Chinese context are highlighted below. The share of expenditures on the non-tradable good is set at $\beta_{NT} = 0.6$, such that the model matches the observed 18% share of imports in GDP. Implementing the system also requires information on labor income and employment shares by regions. We allocate the sectoral labor compensation (from the IO tables) across Chinese provinces using the sector-province labor compensation shares (from China Labor Statistical Yearbook of 2017). All 31 provinces have positive employment in both tradable and non-tradable sectors. Finally, for information on import and export flows by variety, we reconcile the sector-level trade flows from the IO tables and the variety-level trade flows from the customs data, by allocating the sector-level import and export flows (from the IO tables) across varieties using the import and export shares at the variety level within each GB/T-2 sector (observed in the Chinese customs data).

B.3 Trade Diversion Impacts

Note that the change in Chinese imports from a trading partner i across all products in sector s is:

$$\sum_{g \in \mathcal{G}_s} \widehat{p^*_{ig} m_{ig}} = \sum_{g \in \mathcal{G}_s} \left(\frac{p^*_{ig} m_{ig}}{\sum_{g \in \mathcal{G}_s} p^*_{ig} m_g} (\hat{p}^*_{ig} + \hat{m}_{ig}) \right), \tag{B.25}$$

and across all tradable sectors is:

$$\widehat{\sum_{s\in\mathcal{S}}\sum_{g\in\mathcal{G}_s} p^*_{ig}}m_{ig} = \sum_{s\in\mathcal{S}}\sum_{g\in\mathcal{G}_s}\left(\frac{p^*_{ig}m_{ig}}{\sum_{s\in\mathcal{S}}\sum_{g\in\mathcal{G}_s}p^*_{ig}m_{ig}}(\hat{p}^*_{ig}+\hat{m}_{ig})\right). \tag{B.26}$$

By aggregating across trading partners within a set of countries $i\in\mathcal{I}_o$, the corresponding expressions are:

$$\begin{aligned}\widehat{\sum_{i\in\mathcal{I}_o}\sum_{g\in\mathcal{G}_s} p^*_{ig}}m_{ig} &= \sum_{i\in\mathcal{I}_o}\sum_{g\in\mathcal{G}_s}\left(\frac{p^*_{ig}m_{ig}}{\sum_{i\in\mathcal{I}_o}\sum_{g\in\mathcal{G}_s}p^*_{ig}m_{ig}}(\hat{p}^*_{ig}+\hat{m}_{ig})\right), &\text{(B.27)}\\ \widehat{\sum_{s\in\mathcal{S}}\sum_{i\in\mathcal{I}_o}\sum_{g\in\mathcal{G}_s} p^*_{ig}}m_{ig} &= \sum_{s\in\mathcal{S}}\sum_{i\in\mathcal{I}_o}\sum_{g\in\mathcal{G}_s}\left(\frac{p^*_{ig}m_{ig}}{\sum_{s\in\mathcal{S}}\sum_{i\in\mathcal{I}_o}\sum_{g\in\mathcal{G}_s}p^*_{ig}m_{ig}}(\hat{p}^*_{ig}+\hat{m}_{ig})\right). &\text{(B.28)}\end{aligned}$$

Next, using (10), we have:

$$\begin{aligned}\hat{x}_{ig} &= -\sigma^*\hat{p}^X_{ig} = -\sigma^*\hat{p}_s, &&\text{for } i\neq US;\\ \hat{x}_{ig} &= -\sigma^*\left(\frac{d\tau^*_{ig}}{1+\tau^*_{ig}}+\hat{p}_s\right), &&\text{for } i=US.\end{aligned}$$

Thus, for each $s\in S$ and destination $i\neq US$, the change in Chinese exports is:

$$\begin{aligned}\widehat{EX}_{-US,s} &= \widehat{\sum_{i\neq US}\sum_{g\in\mathcal{G}_s}p^X_{ig}}x_{ig} = \sum_{i\neq US}\sum_{g\in\mathcal{G}_s}\left(\frac{p^X_{ig}x_{ig}}{\sum_{i\neq US}\sum_{g\in\mathcal{G}_s}p^X_{ig}x_{ig}}(\hat{p}^X_{ig}+\hat{x}_{ig})\right)\\ &= \sum_{i\neq US}\sum_{g\in\mathcal{G}_s}\left(\frac{p^X_{ig}x_{ig}}{\sum_{i\neq US}\sum_{g\in\mathcal{G}_s}p^X_{ig}x_{ig}}(1-\sigma^*)\hat{p}_s\right), \end{aligned}\tag{B.29}$$

and for $i=US$:

$$\begin{aligned}\widehat{EX}_{US,s} &= \widehat{\sum_{g\in\mathcal{G}_s}p^X_{ig}x_{ig}} = \sum_{g\in\mathcal{G}_s}\left(\frac{p^X_{ig}x_{ig}}{\sum_{g\in\mathcal{G}_s}p^X_{ig}x_{ig}}(\hat{p}^X_{ig}+\hat{x}_{ig})\right)\\ &= \sum_{g\in\mathcal{G}_s}\left(\frac{p^X_{ig}x_{ig}}{\sum_{g\in\mathcal{G}_s}p^X_{ig}x_{ig}}\left((1-\sigma^*)\hat{p}_s-\sigma^*\frac{d\tau^*_{ig}}{1+\tau^*_{ig}}\right)\right). \end{aligned}\tag{B.30}$$

The change in Chinese exports of all tradable sectors can be similarly aggregated from the sector-level exports.

Table 1: Trade War Events during 2018–2019

Event	Effective Date	Products	Trade Value in 2017		Tariff (%)	
		(# HS-8)	(million US$)	(%)	before	after
Panel A. Tariff increase on Chinese products enacted by U.S.						
1	February 7, 2018	12	983	0.04	1.11	31.11
2	March 27, 2018	158	2,868	0.13	7.17	22.99
3	July 6, 2018	957	59,890	2.63	1.38	26.91
4	August 23, 2018	345	19,810	0.87	15.39	34.60
5	September 24, 2018	3829	189,400	8.32	7.56	14.96
6	May 10, 2019	—”—	—”—	–”–	14.96	29.99
7	September 1, 2019	1859	131,400	5.77	12.59	22.60
Panel B1. China’s retaliatory tariffs on U.S. products						
1	April 2, 2018	93	2,970	0.17	11.15	27.75
2	July 6, 2018	267	33,830	1.98	12.81	35.56
3	August 23, 2018	201	14,110	0.83	14.16	32.82
4	September 24, 2018	5190	58,160	3.41	9.91	16.43
5	January 1, 2019	120	14,250	0.83	24.39	13.53
6	June 1, 2019	4545	40,220	2.35	10.3	17.13
7	September 1, 2019	1153	28,670	1.68	9.63	18.47
Panel B2. China’s MFN tariff cuts						
8	May 1, 2018	26	13,710	0.8	2.12	0
9	July 1, 2018	151	59,590	3.49	11.03	7.01
10	July 1, 2018	1376	36,030	2.11	13.69	7.01
11	November 1, 2018	1532	59,610	3.49	9.57	7.95

Note: The table reports tariff events implemented by the U.S. (Panel A) and China (Panel B), which are used as sources of identification in the estimations of demand and supply elasticities in Section 4. In addition to the retaliation against U.S. products (Panel B1), China also implemented MFN tariff cuts in response (Panel B2). The columns display: the number of HS-8 products affected; the value of trade affected (in million US$); the corresponding shares (%) in 2017; and the simple monthly average tariff rates (in percentage points) across targeted products in the month before and the month after the implementation month (which is taken to be the current month if the implementation date is before the 15th of the month and the next month otherwise). The denominator of trade share is the 2017 annual US$ value of total Chinese exports (imports) in Panel A (Panel B), respectively. See the text for data sources. In Panel A, Event 6 applies to the same set of products as Event 5 but with an upward revision of the tariff rates.

Table 2: Sector-Level Tariff Variations

		Imports (Chinese tariffs)				Exports (U.S. tariffs)			
				Δ Tariffs				Δ Tariffs	
Sector	GB/T-2	# Products	# Varieties	Mean	Std. dev.	# Products	# Varieties	Mean	Std. dev.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Agricultural Products	1-5	77	121	0.15	0.10	94	94	0.24	0.11
Mining	6-12	126	410	0.09	0.13	71	71	0.21	0.07
Processing of Food from Agricultural Products	13	448	1687	0.07	0.21	371	371	0.21	0.09
Manufacture of Foods	14	174	1564	-0.01	0.15	143	143	0.22	0.09
Manufacture of Liquor, Beverages	15	75	790	-0.03	0.19	74	74	0.13	0.08
Manufacture of Tobacco	16	8	43	0.10	0.14	6	6	0.19	0.13
Manufacture of Textiles	17	740	13225	-0.02	0.11	777	777	0.20	0.08
Manufacture of Wearing Apparel and Accessories	18	160	5334	-0.06	0.10	158	158	0.12	0.06
Manufacture of Leather Products and Footwear	19	138	3320	-0.04	0.10	139	139	0.16	0.09
Manufacture of Wood Products	20	126	788	0.04	0.12	128	128	0.21	0.09
Manufacture of Furniture	21	31	234	0.08	0.13	34	34	0.25	0.04
Manufacture of Paper and Paper Products	22	121	2412	0.03	0.09	120	120	0.24	0.05
Printing and Reproduction of Recording Media	23	35	796	0.03	0.09	36	36	0.13	0.06
Manufacture of Articles for Culture Activities	24	210	4146	-0.05	0.12	195	195	0.15	0.08
Processing of Petroleum, Coking	25	41	114	0.17	0.12	27	27	0.23	0.05
Manufacture of Raw Chemical Materials	26	903	4254	0.08	0.11	876	876	0.23	0.08
Manufacture of Medicines	27	151	458	0.07	0.11	55	55	0.24	0.07
Manufacture of Chemical Fibers	28	54	54	0.17	0.08	64	64	0.20	0.09
Manufacture of Rubber and Plastics Products	29	154	1329	0.06	0.11	156	156	0.24	0.06
Manufacture of Non-metallic Mineral Products	30	232	3212	0.02	0.11	240	240	0.23	0.06
Smelting and Pressing of Ferrous Metals	31	223	1053	0.13	0.13	239	239	0.31	0.07
Smelting and Pressing of Non-ferrous Metals	32	177	400	0.15	0.09	130	130	0.22	0.06
Manufacture of Metal Products	33	299	4844	0.02	0.12	293	293	0.23	0.07
Manufacture of General Purpose Machinery	34	470	4232	0.07	0.11	509	509	0.27	0.11
Manufacture of Special Purpose Machinery	35	406	2123	0.08	0.12	454	454	0.24	0.12
Manufacture of Automobiles	36	180	2624	-0.03	0.09	160	160	0.23	0.09
Manufacture of Transport Equipment	37	64	440	0.06	0.14	101	101	0.24	0.10
Manufacture of Electrical Machinery	38	302	4057	0.00	0.13	276	276	0.29	0.12
Manufacture of Computers / Electronic Equipment	39	228	656	0.06	0.15	227	227	0.26	0.16
Manufacture of Measuring Instruments/Machinery	40	176	1012	0.04	0.11	205	205	0.28	0.15
Other Manufactures	41	57	1229	-0.04	0.12	40	40	0.14	0.07
Utilization of Waste Resources	42	26	55	0.23	0.10	30	30	0.19	0.08

Note: The table shows the mean and standard deviation of tariff changes for Chinese imports and exports across 2-digit GB/T sectors. A tariff change of 0.10 indicates a 10 percentage point increase. For imports, China implemented both retaliatory tariff increases against the U.S., and MFN tariff cuts on sources of imports where MFN rates apply. Sectors with the same number of targeted varieties and products in Columns (3) and (4) reflect import tariff increase targeting U.S. products without accompanying decrease in MFN tariffs. For Chinese exports, which faced only U.S. tariff increases, the number of products targeted by trading partners is equal to that of varieties targeted. Due to space constraints, we aggregate sectors of Agricultural products and of Mining.

Table 3: Estimation of Variety-level Elasticities—Import Demand (σ) and Foreign Export Supply (ω^*)

	$\Delta \ln p^*_{igt} m_{igt}$ (1)	$\Delta \ln m_{igt}$ (2)	$\Delta \ln p^*_{igt}$ (3)	$\Delta \ln p_{igt}$ (4)	$\Delta \ln p^*_{igt}$ (5)	$\Delta \ln m_{igt}$ (6)
$\Delta \ln(1+\tau_{igt})$	-1.133***	-1.121***	0.009	1.004***		
	(0.2940)	(0.2214)	(0.1740)	(0.1770)		
$\Delta \ln m_{igt}$					-0.008	
					(0.1549)	
$\Delta \ln p_{igt}$						-1.120***
						(0.3158)
Country × Product FE	Y	Y	Y	Y	Y	Y
Sector × Time FE	Y	Y	Y	Y	Y	Y
1st-stage F					40.179	81.805
Bootstrap CI					[-0.146,0.204]	[0.853,1.432]
R^2	0.038	0.027	0.035	0.027	0.012	0.192
N	2,207,210	2,129,628	2,129,660	2,129,138	2,129,628	2,129,138

Note: The table reports the variety-level import responses to import tariffs. Columns (1) to (4) report the reduced-form regression of different trade outcomes (before-duty import value, import quantity, before-duty unit value and duty-inclusive unit value) on the tariff changes. Column (5) reports the IV regression estimation of foreign (inverse) export supply elasticity $\hat{\omega}^*$ based on equation (23), with its first-stage estimation in Column (2). Column (6) reports the IV regression estimation of import demand elasticity $\hat{\sigma}$ based on equation (22), with its first-stage estimation in Column (4). Robust standard errors (in parentheses) are clustered at the product and country level. 90% bootstrap confidence intervals of ($\hat{\omega}^*$ and $\hat{\sigma}$) were constructed from 1000 samples. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. Sample: monthly variety-level import data from 2017:1 to 2019:12.

Table 4: Estimation of Product-level Elasticity

	$\Delta \ln s_{Mgt}$ (1)	$\Delta \ln p_{Mgt}$ (2)	$\Delta \ln s_{Mgt}$ (3)
$\Delta \ln Z_{Mgt}$	-1.537**	17.639***	
	(0.6271)	(6.2563)	
$\Delta \ln p_{Mgt}$			-0.087***
			(0.0230)
Sector × Time FE	Y	Y	Y
1st-stage F			19.187
$\hat{\eta}$ (se[$\hat{\eta}$])			1.087 (0.0230)
Bootstrap CI			[1.041,1.131]
R^2	0.015	0.010	0.351
N	226,372	226,372	226,372

Note: The table reports product-level import responses to import tariffs. Column (1) reports the reduced-form regression of each imported product's share within sectoral imports, s_{Mgt}, on the product-level instrument, Z_{Mgt}. Column (2) reports the regression of the product-level import price index p_{Mgt} on Z_{Mgt}. Column (3) reports the IV estimation of product-level elasticity based on equation (24), with its first-stage estimation in Column (2). The product-level import price index is constructed using $\hat{\sigma}$ from Column (6) of Table 3 according to equation (25), and the instrument is constructed using equation (26). Robust standard errors (in parentheses) are clustered at the product level. 90% bootstrap confidence intervals of $\hat{\eta}$ were constructed from 1000 samples. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. Sample: monthly product-level import data from 2017:1 to 2019:12.

Table 5: Estimation of Sector-level Elasticity

	$\Delta \ln \frac{P_{Mst} M_{st}}{P_{Dst} D_{st}}$ (1)	$\Delta \ln \frac{P_{Mst}}{p_{st}}$ (2)	$\Delta \ln \frac{P_{Mst} M_{st}}{P_{Dst} D_{st}}$ (3)
$\Delta \ln Z_{Mst}$	-15.055	86.888	
	(9.7353)	(201.2985)	
$\Delta \frac{P_{Mst}}{p_{st}}$			-0.173
			(0.3208)
Sector FE	Y	Y	Y
Time FE	Y	Y	Y
1st-stage F			0.546
$\hat{\kappa}(se[\hat{\kappa}])$			1.173 (0.3208)
Bootstrap CI			[0.541,1.385]
R^2	0.194	0.232	-
N	850	850	850

Note: The table reports sector-level import responses to import tariffs. Column (1) reports the reduced-form regression of the ratio of the expenditure on foreign goods and domestic goods, $\frac{P_{Mst} M_{st}}{P_{Dst} D_{st}}$, on the sector-level instrument, Z_{Mst}. Column (2) reports the regression of the ratio of sector-level import price index and domestic price index $\frac{P_{Mst}}{p_{st}}$ on Z_{Mst}. Column (3) reports the IV estimation of sector-level elasticity based on equation (27), with its first-stage estimation in Column (2). The sector import price index is constructed using $\hat{\sigma}$ from Column (6) of Table 3, and $\hat{\eta}$ from Column (3) of Table 4, according to equation (28), and the instrument is constructed using equation (29). Robust standard errors (in parentheses) are clustered at the sector level. 90% bootstrap confidence intervals of $\hat{\kappa}$ were constructed from 1000 samples. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. Sample: monthly sector-level data from 2017:1 to 2019:12.

Table 6: Estimation of Variety-level Elasticities—Foreign Import Demand (σ^*) and Chinese Export Supply (ω)

	$\Delta \ln p^X_{igt} x_{igt}$ (1)	$\Delta \ln x_{igt}$ (2)	$\Delta \ln p^X_{igt}$ (3)	$\Delta \ln p^X_{igt}(1+\tau^*_{igt})$ (4)	$\Delta \ln p^X_{igt}$ (5)	$\Delta \ln x_{igt}$ (6)
$\Delta \ln(1+\tau^*_{igt})$	-1.064***	-1.072***	0.059	1.059***		
	(0.1920)	(0.1901)	(0.1495)	(0.1495)		
$\Delta \ln x_{igt}$					-0.055	
					(0.1358)	
$\Delta \ln p^X_{igt}(1+\tau^*_{igt})$						-1.012***
						(0.1786)
Product FE	Y	Y	Y	Y	Y	Y
Sector × Time FE	Y	Y	Y	Y	Y	Y
1st-stage F					24.120	58.295
Bootstrap CI					[-0.270,0.260]	[0.161,1.302]
R^2	0.058	0.055	0.028	0.028	0.070	0.165
N	162,054	161,494	161,494	161,494	161,494	161,494

Note: The table reports the variety-level export responses to U.S. import tariffs. Columns (1)–(4) report reduced-form regressions of different export outcomes (export values, quantities, before-duty unit values, and duty-inclusive unit values) on the tariff changes. Column (5) reports the IV estimation of Chinese (inverse) export supply elasticity $\hat{\omega}$ based on equation (31), with its first-stage estimation in Column (2). Column (6) reports the IV estimation of foreign import demand elasticity $\hat{\sigma}^*$ based on equation (30), with its first-stage estimation in Column (4). Robust standard errors (in parentheses) are clustered at the HS-6 level. 90% bootstrap confidence intervals of ($\hat{\omega}$ and $\hat{\sigma}^*$) were constructed from 1000 samples. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. Sample: monthly variety-level export data from 2017:1 to 2019:12.

Table 7: Pre-trend Tests for Chinese Imports and Exports

Panel A1: China's retaliatory tariffs on U.S. products

	$\overline{\Delta \ln p^*_{ig} m_{ig}}$ (1)	$\overline{\Delta \ln m_{ig}}$ (2)	$\overline{\Delta \ln p^*_{ig}}$ (3)	$\overline{\Delta \ln p_{ig}}$ (4)
$\Delta \ln(1+\tau_{ig})$	0.052	0.070	-0.029	-0.028
	(0.1870)	(0.2249)	(0.1452)	(0.1452)
Sector FE	Y	Y	Y	Y
R^2	0.012	0.020	0.014	0.014
N	5,064	4,951	4,951	4,950

Panel A2: China's MFN tariff cuts

	$\overline{\Delta \ln p^*_{ig} m_{ig}}$ (1)	$\overline{\Delta \ln m_{ig}}$ (2)	$\overline{\Delta \ln p^*_{ig}}$ (3)	$\overline{\Delta \ln p_{ig}}$ (4)
$\Delta \ln(1+\tau_{ig})$	0.720	0.803	0.115	0.115
	(0.6089)	(0.6978)	(0.4236)	(0.4237)
Country × Sector FE	Y	Y	Y	Y
Product FE	Y	Y	Y	Y
R^2	0.144	0.144	0.132	0.132
N	66,886	64,844	64,844	64,820

Panel B: U.S. tariff increases on Chinese exports

	$\overline{\Delta \ln p^X_{ig} x_{ig}}$ (5)	$\overline{\Delta \ln x_{ig}}$ (6)	$\overline{\Delta \ln p^X_{ig}}$ (7)	$\overline{\Delta \ln p^X_{ig}(1+\tau^*_{ig})}$ (8)
$\Delta \ln(1+\tau^*_{ig})$	0.037	0.073	-0.002	0.003
	(0.1204)	(0.1118)	(0.0801)	(0.0771)
Sector FE	Y	Y	Y	Y
R^2	0.007	0.012	0.005	0.005
N	5,483	5,473	5,473	5,445

Note: The table reports pre-trend tests for Chinese imports (Panels A1 and A2) and exports (Panel B) at the variety level. The dependent variables are the average monthly change of trade outcome variables during 2017:1–2017:12 in terms of before-duty trade value, quantity, before-duty unit value and duty-inclusive unit value. Panels A1 and B regress the pre-war trade outcomes of Chinese imports from (exports to) the U.S. on the (latest revised) tariff changes during the trade war period 2018:1–2019:12. Panel A2 regresses the trade outcomes of Chinese imports from non-U.S. sources on China's tariff changes on non-U.S. sources of imports during the trade war. Robust standard errors (in parentheses) are clustered at the product level (Panels A1 and B), and product and country level (Panel A2), respectively. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. Sample: monthly variety-level import and export data from 2017:1–2017:12 for the pre-trend variables, and 2018:1–2019:12 for the tariff changes.

Table 8: Aggregate Impacts

	EV^X (1)	EV^M (2)	ΔR (3)	EV (4)
2018–2019 trade war				
change ($ b)	-32.968	-6.906	1.976	-37.898
	[-45.159, 0.786]	[-15.524, 0.874]	[1.360, 3.708]	[-52.282, -3.153]
change (% GDP)	-0.272	-0.057	0.016	-0.312
	[-0.372,0.006]	[-0.128, 0.007]	[0.011,0.031]	[-0.431, -0.026]
2018–2019 trade war (w/o China's MFN tariff cuts)				
change ($ b)	-29.899	-11.002	5.728	-35.173
	[-41.841, 8.955]	[-19.590, -3.472]	[5.149, 7.977]	[-49.934, 6.157]
change (% GDP)	-0.246	-0.091	0.047	-0.290
	[-0.345, 0.074]	[-0.161, -0.029]	[0.042, 0.066]	[-0.411, 0.051]
2018–2019 trade war (w/o retaliation by China)				
change ($ b)	-37.254	0.000	-1.667	-38.921
	[-49.834, -12.266]	[-8.296, 7.719]	[-1.756, -0.755]	[-53.614, -13.211]
change (% GDP)	-0.307	0.000	-0.014	-0.321
	[-0.410, -0.101]	[-0.068, 0.064]	[-0.014, -0.006]	[-0.442, -0.109]

Note: The table reports the aggregate impact in Column (4) and its decomposition into EV^X, EV^M, and tariff revenue (ΔR) in Columns (1)–(3). The top panel reports the effects from the 2018–2019 trade war. The bottom two panels simulate hypothetical scenarios, where China retaliated against the U.S. but did not implement MFN tariff cuts, and where China neither retaliated against the U.S. nor implemented MFN tariff cuts. The first row in each panel reports the overall impact of each term in billions of US$. The third row scales the value by 2017 GDP of China. These numbers are computed using the model described in Section 3 and Appendix B, with $\{\hat{\sigma} = 1.120, \hat{\eta} = 1.087, \hat{\kappa} = 1.173, \hat{\omega}^* = \mathbf{0}, \hat{\sigma}^* = 1.012\}$. Bootstrapped 90% confidence intervals based on 1,000 simulations of the estimated parameters are reported in brackets.

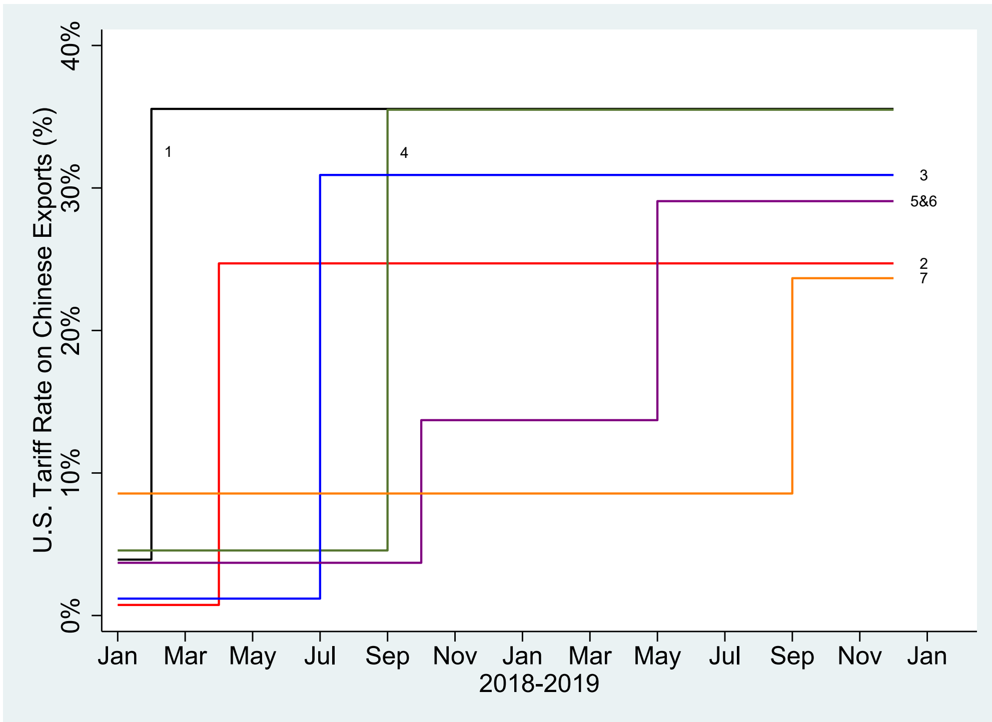
Table 9: Simulated Trade Diversion Impacts of the Trade War 2018–2019

	Δ trade volume (1)	Trade share w/o war (2)	Trade share with war (3)
Panel A. Imports			
U.S.	-13.97%	9.15%	8.21%
R.O.W.	-3.21%	90.85%	91.79%
North America	-12.11%	11.06%	10.14%
Canada	-3.36%	1.21%	1.22%
Mexico	-2.90%	0.70%	0.71%
Asia	-3.37%	52.48%	52.93%
Japan	-2.73%	9.80%	9.95%
Korea	-3.53%	10.58%	10.65%
Taiwan	-3.54%	9.26%	9.33%
ASEAN	-3.52%	12.61%	12.70%
Europe	-2.45%	19.19%	19.54%
France	-2.94%	1.61%	1.63%
Germany	-1.83%	5.74%	5.88%
The UK	-0.43%	1.30%	1.35%
Panel B. Exports			
U.S.	-18.64%	19.16%	16.16%
R.O.W.	0.03%	80.84%	83.84%
North America	-15.95%	22.15%	19.30%
Canada	0.03%	1.41%	1.46%
Mexico	0.03%	1.60%	1.66%
Asia	0.02%	48.68%	50.48%
Japan	0.03%	6.07%	6.30%
Korea	0.03%	4.56%	4.72%
Taiwan	0.00%	1.94 %	2.01%
ASEAN	0.02%	13.89%	14.40%
Europe	0.03%	18.89%	19.59%
France	0.03%	1.23%	1.27%
Germany	0.03%	3.15%	3.27%
The UK	0.03%	2.54%	2.63%

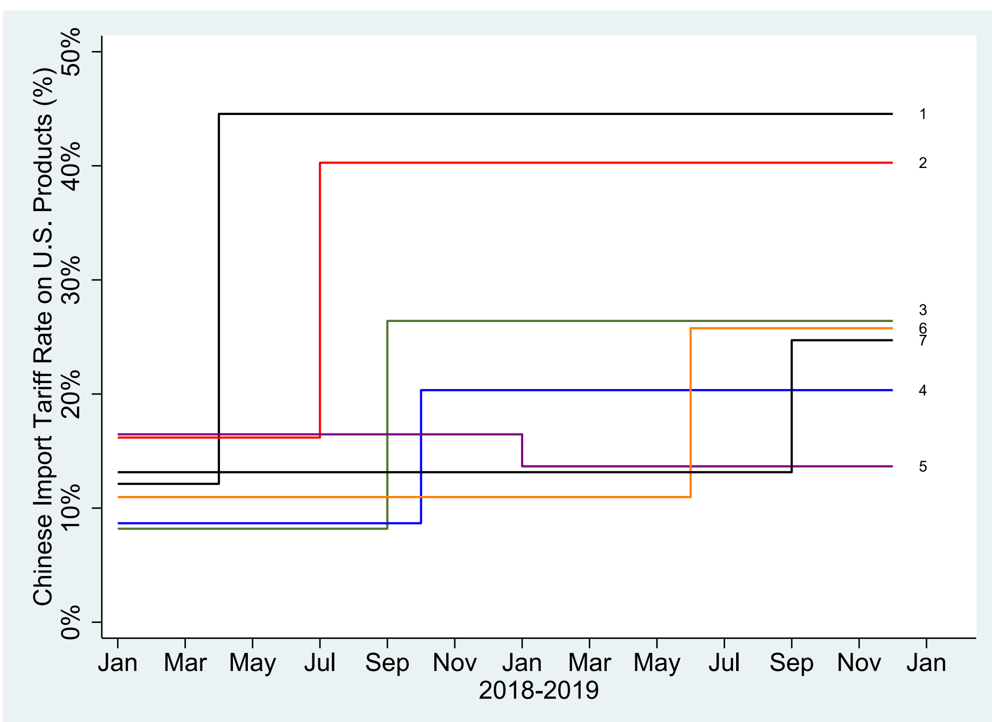
Note: The table reports the simulated changes in China's imports from and exports to its trading partners due to the trade war, using the 2017 Chinese economy given the tariff changes of 2018:1–2019:12. Section B.3 provides the formulas. Columns (2) and (3) report the trade shares by regions/countries without the trade war and as a result of the trade war.

Figure 1: Trade War Timeline

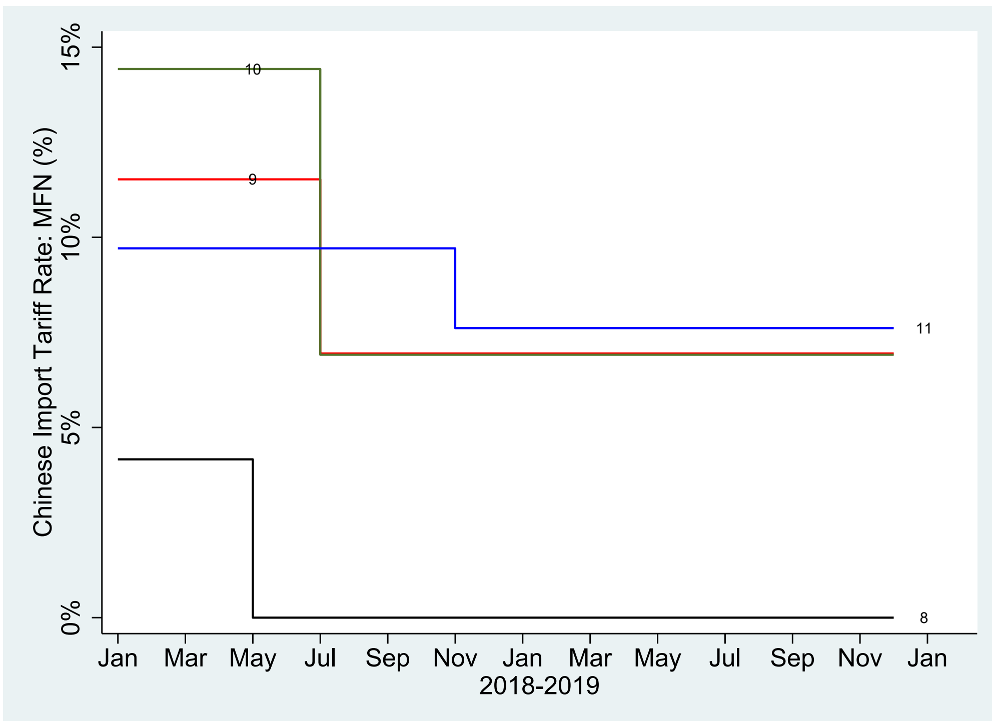
(A) U.S. tariffs on Chinese exports



(B1) Chinese retaliatory tariffs (on imports from U.S.)



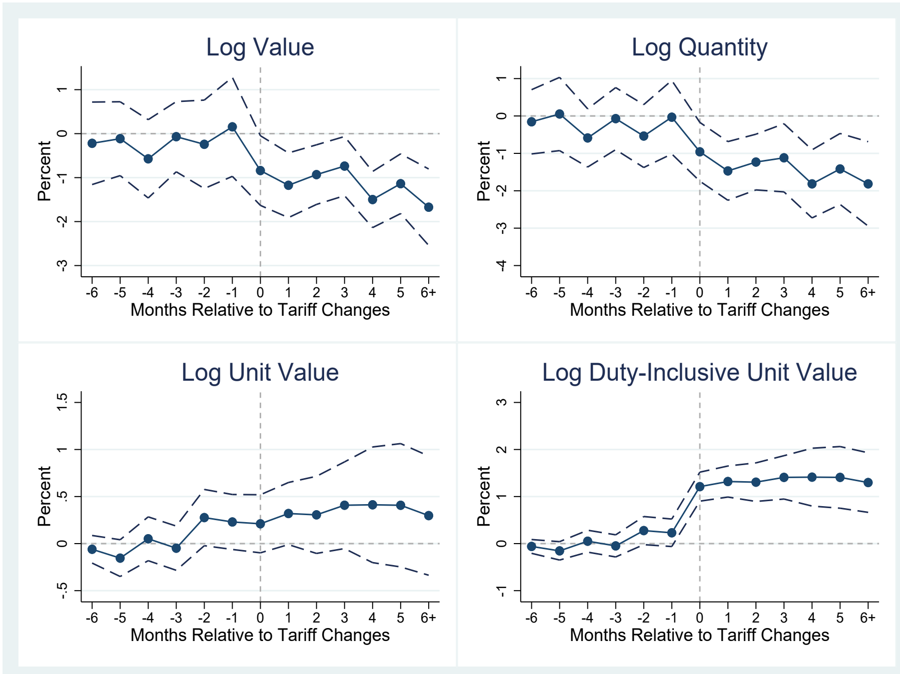
(B2) Chinese MFN tariff cut



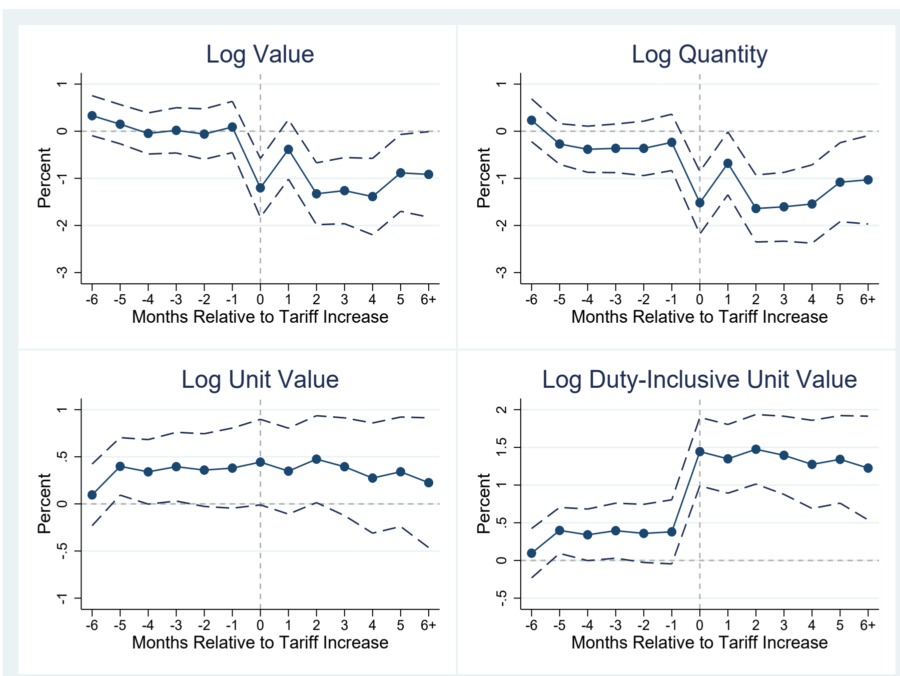
Note: The figure shows the unweighted average tariff rate of targeted import and export varieties for each tariff wave before and after they were targeted. The numbering of the events corresponds to those in Table 1. Refer to the Data Appendix for additional details on the construction of tariff rates and the scaling of tariff increases when the implementation date is not on the first day of the month. In drawing the above diagram, the implementation month is taken to be the current month if the implementation date is before the 15th of the month and the next month otherwise.

Figure 2: Dynamic Specification Tests

(A) Tariffs on Chinese Imports



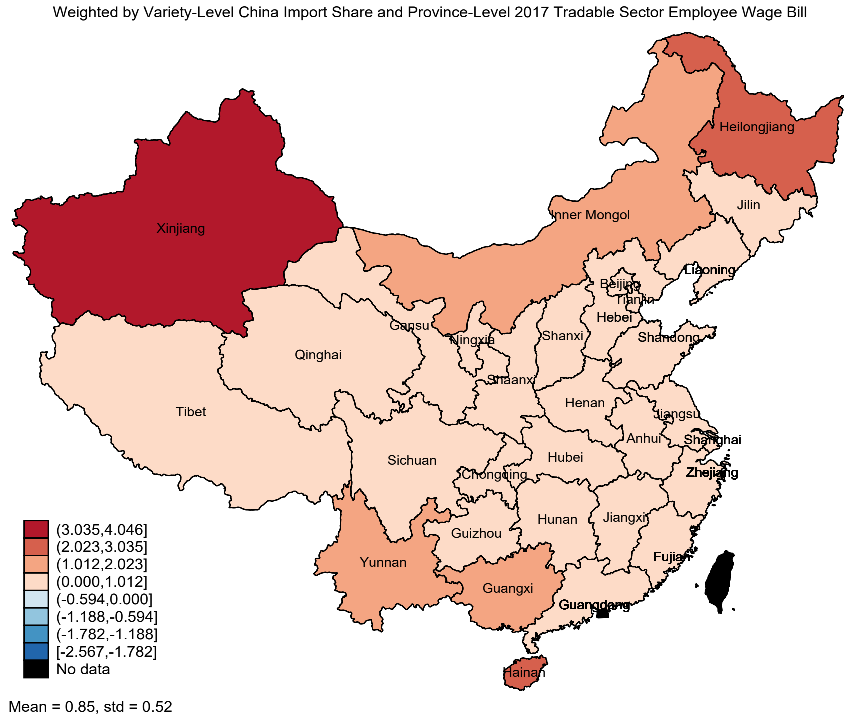
(B) Tariffs on Chinese Exports



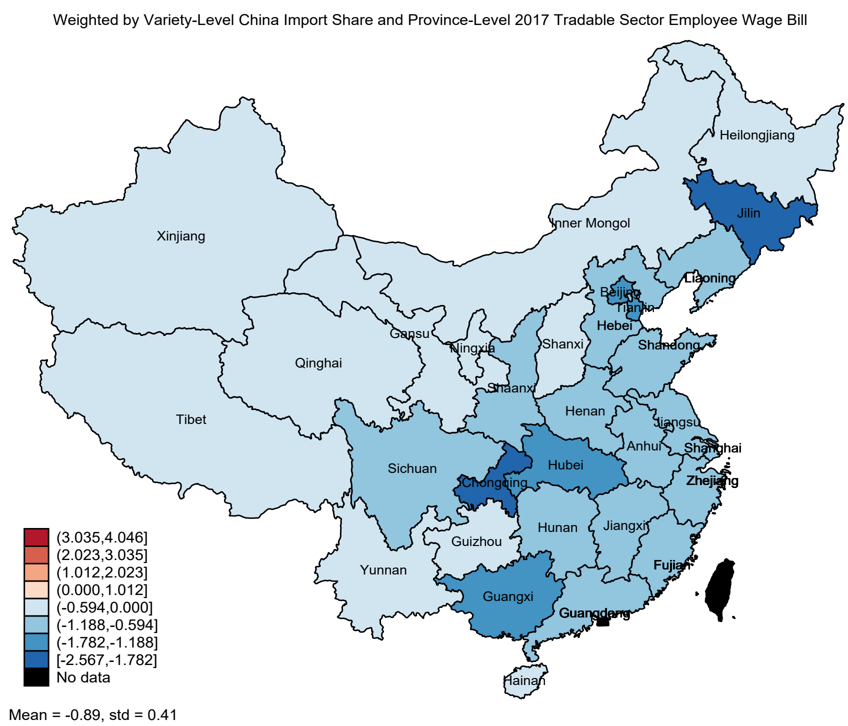
Note: Figures plot cumulative sum of β coefficients from the regression (33). Standard errors are clustered by country and HS-8 for imports; and by HS-6 for exports (with respect to the U.S. market). Error bands show 95% confidence intervals. Sample: variety-level import and export data for 2017:1–2019:12. As in Fajgelbaum et al. (2020), we replace missing leading and lagged tariff changes with zeros and include indicators for those missing values.

Figure 3: Regional Exposure to Tariff Increase of China and U.S.

(A) China's Tariff Increase on U.S. Imports, 2018–2019

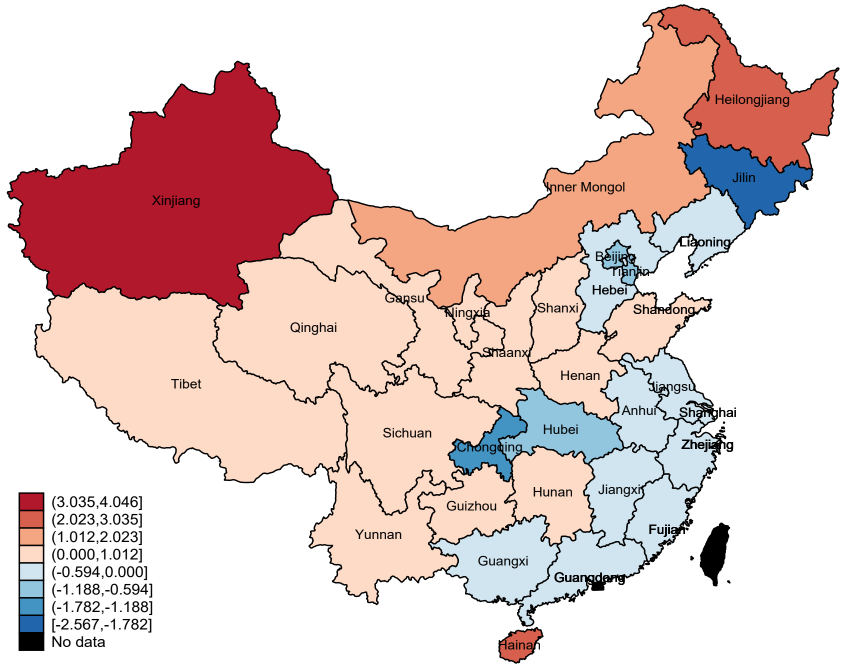


(B) China's MFN Tariff Decrease on Non-U.S. Imports, 2018–2019



(C) China's Net Tariff Increase on Imports, 2018–2019

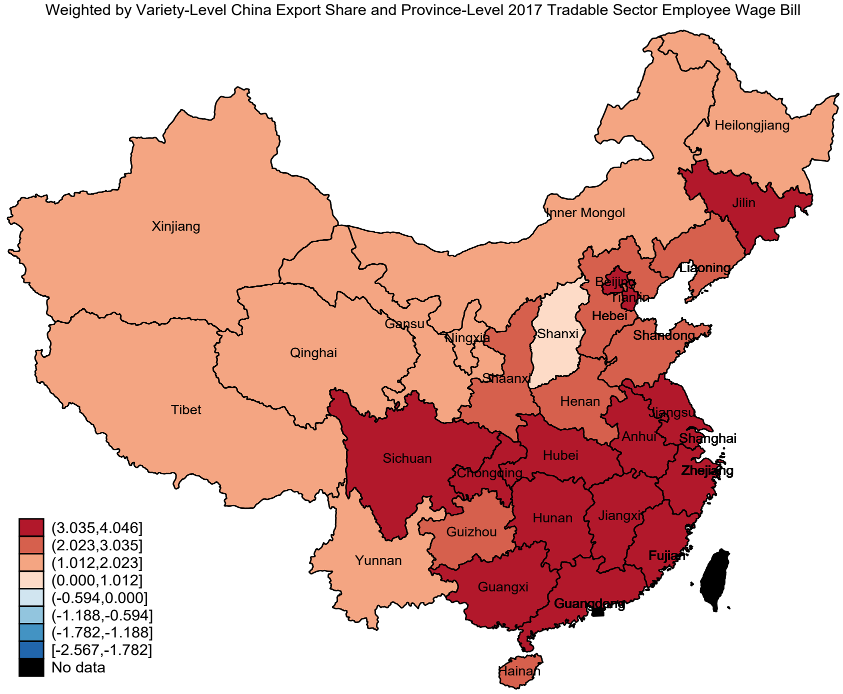
Weighted by Variety-Level China Import Share and Province-Level 2017 Tradable Sector Employee Wage Bill



Mean = 0.01 , std = 0.78

(D) U.S. Tariff Increase on China's Exports, 2018–2019

Weighted by Variety-Level China Export Share and Province-Level 2017 Tradable Sector Employee Wage Bill

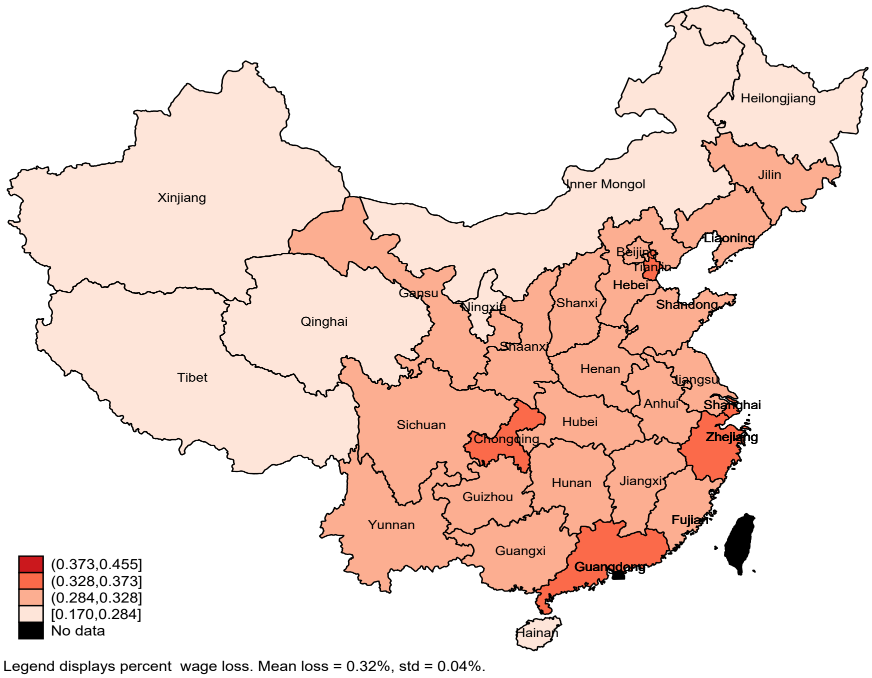


Mean = 3.21 , std = 0.87

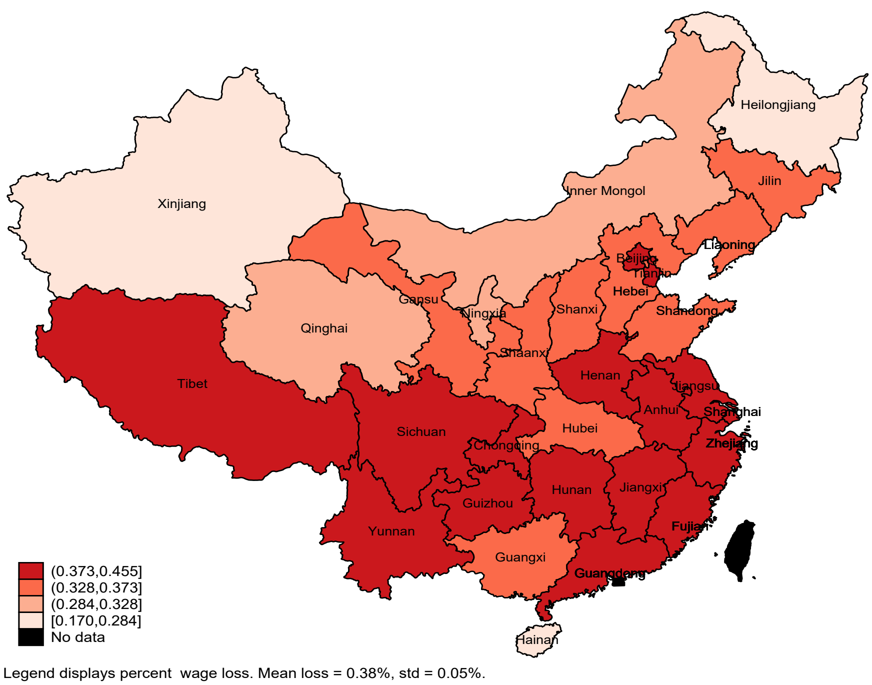
Note: The figure shows province-level exposure to China's tariff increases on U.S. imports (Panel A), China's MFN tariff decreases on non-U.S. imports (Panel B), China's net tariff increase (Panel C), and U.S. tariff increase on China's exports (Panel D), in relation to the trade war during 2018–2019, weighted by 2017 variety-level China trade shares (constructed from customs data) and by 2017 province-level tradable sector employee wage bill (constructed from China Labor Statistical Yearbook). Darker shades indicate exposure to larger tariff changes. Values indicate percentage point tariff changes.

Figure 4: Simulated Real Wage Impacts of the Trade War

(A) Tradable Real Wage Loss from Tariff Increases of China and U.S.



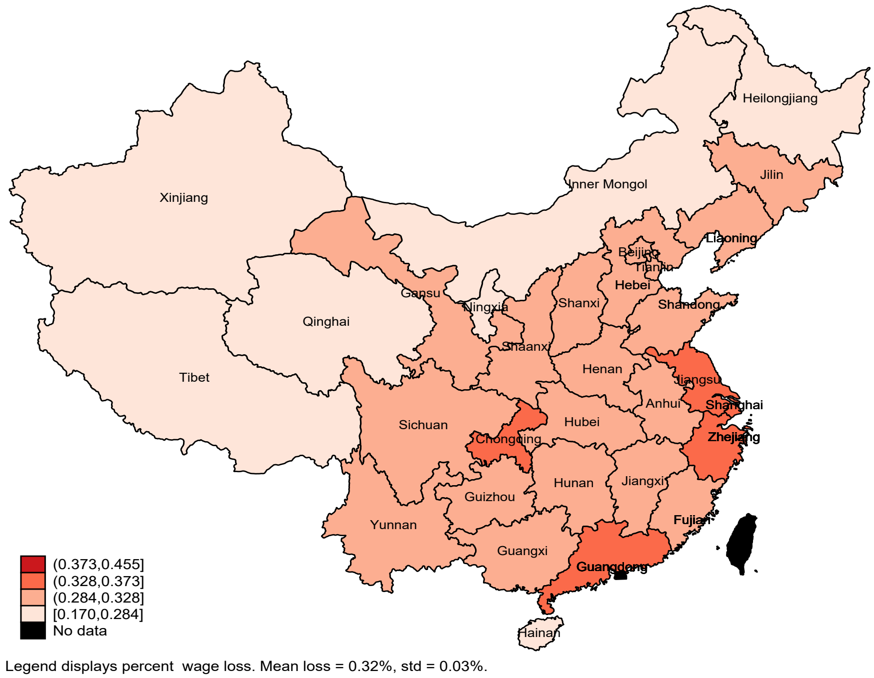
(B) Tradable Real Wage Loss from Tariff Increases of China and U.S. (w/o the MFN tariff adjustment by China)



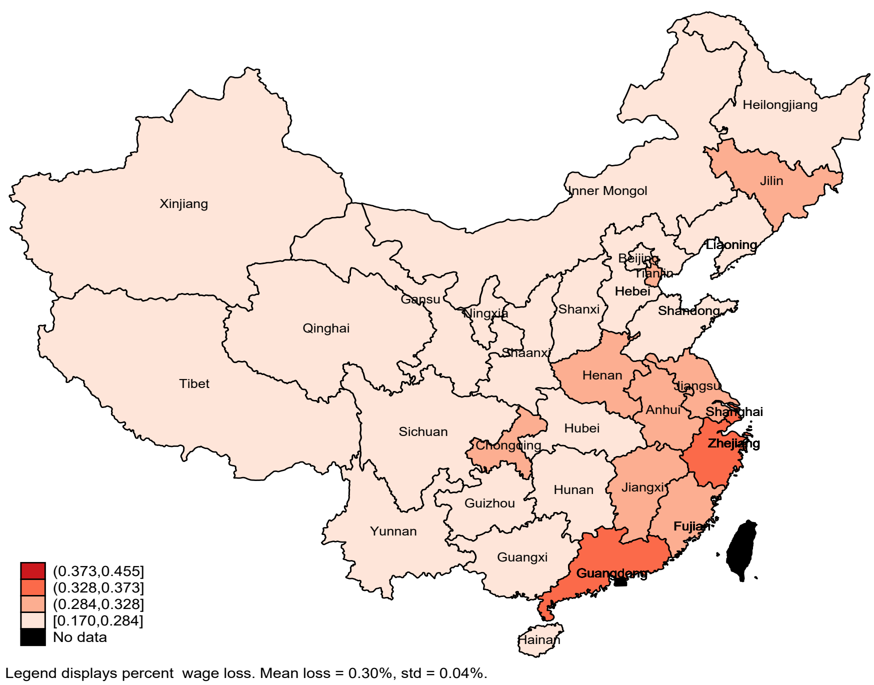
Note: The figure shows province-level mean tradable real wage losses as simulated from the model. Panel A shows losses in the full trade war scenario. Panel B shows losses in the full trade war scenario but without the MFN tariff cuts. Darker shades indicate greater losses. Values indicate percent real wage losses.

Figure 5: Simulated Real Expenditure Impacts of the Trade War

(A) Real Expenditure Loss from Tariff Increases of China and U.S.



(B) Real Expenditure Loss from Tariff Increases of China and U.S. (w/o the MFN tariff adjustment by China)



Note: The figure shows province-level mean real expenditure losses as simulated from the model. Panel A shows losses in the full trade war scenario. Panel B shows losses in the full trade war scenario but without the MFN tariff cuts. Darker shades indicate greater losses. Values indicate percent real expenditure losses.

Table A.1: Effects of Tariff Wars on China's Imports and Exports (Partial Effects)

	China's tariff increase against U.S. products		MFN tariff cuts		Combined	
IMPORT	Δ tariff	Δ import values	Δ tariff	Δ import values	Δ tariff	Δ import values
Varieties	11.72%	−13.14%	−3.10%	3.48%	3.25%	−3.64%
	U.S. tariff increase against Chinese products					
EXPORT	Δ tariff	Δ export values				
Varieties	24.18%	−24.48%				

Note: The table reports the weighted average change in the tariff rates of targeted varieties, and the implied change in the trade values of the targeted varieties. The formulas used are: i) $\overline{\Delta \ln \left(p^*_{ig} m_{ig}\right)}^{wa} \equiv \sum_{ig} -\hat{\sigma} \frac{1+\hat{\omega}^*}{1+\hat{\omega}^* \hat{\sigma}} \Delta \ln \left(1+\tau_{ig}\right) \cdot \left(p^*_{ig} m_{ig}\right) / \sum_{ig} \left(p^*_{ig} m_{ig}\right) \equiv -\hat{\sigma} \frac{1+\hat{\omega}^*}{1+\hat{\omega}^* \hat{\sigma}} \overline{\Delta \ln \left(1+\tau_{ig}\right)}^{wa}$ for imports, where the response ratio $-\hat{\sigma} \frac{1+\hat{\omega}^*}{1+\hat{\omega}^* \hat{\sigma}}$ is implied by the demand and supply equations (22) and (23); and ii) $\overline{\Delta \ln \left(p^X_{ig} x_{ig}\right)}^{wa} \equiv \sum_{ig} -\hat{\sigma}^* \frac{1+\hat{\omega}}{1+\hat{\omega}\hat{\sigma}^*} \Delta \ln \left(1+\tau^*_{ig}\right) \cdot \left(p^X_{ig} x_{ig}\right) / \sum_{ig} \left(p^X_{ig} x_{ig}\right) \equiv -\hat{\sigma}^* \frac{1+\hat{\omega}}{1+\hat{\omega}\hat{\sigma}^*} \overline{\Delta \ln \left(1+\tau^*_{ig}\right)}^{wa}$ for exports, where the response ratio $-\hat{\sigma}^* \frac{1+\hat{\omega}}{1+\hat{\omega}\hat{\sigma}^*}$ is implied by the demand and supply equations (30) and (31). The calculations use the elasticity estimates reported in Tables 3 and 6, the pre-war duty-exclusive trade value of 2017 (as weights), and the latest revised tariff change for each variety observed during the period 2018:1–2019:12 (as the shock).