Escaping the Trade War: Finance and Relational Supply Chains in the Adjustment to Trade Policy Shocks *

Felipe Benguria †   Felipe Saffie ‡

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Abstract

The impact of the 2018–2019 trade war on total US exports depends on the direct effect of foreign retaliatory tariffs as well as on the ability of US exporters to reorganize global supply chains and redirect exports to other markets, away from retaliating countries. We document that the sharp decline in US exports to retaliating countries was compensated by a gradual increase in exports to other markets. We then examine the underlying mechanisms behind the direct impact of retaliatory tariffs and the extent of the reallocation toward alternative markets. We find that financial conditions and the persistence or stickiness of trade relationships played the main role, while inventories, and the degree of product differentiation also contribute in shaping the response of trade flows. In industries with high leverage, Chinese retaliatory tariffs led to a stronger decline in US exports to China but a larger increase in exports to the rest of the world. We find a similar pattern among industries with less persistent trade relationships.

*This paper subsumes parts of an earlier working paper "Dissecting the Impact of the 2018-2019 Trade War on U.S. Exports."

†Department of Economics, University of Kentucky (fbe225@uky.edu).

‡Darden School of Business, University of Virginia (saffieF@darden.virginia.edu).

1 Introduction

Starting in 2018, the U.S. has been engaged in an unprecedented trade war involving broad rounds of tariffs imposed on its trading partners (especially China) and equally broad retaliatory tariffs on U.S. exports. An event of this magnitude is unseen in the post-war era, and constitutes a major departure from a decades-long trajectory towards free trade. This trade war constitutes an exceptional testing ground for the effects of trade policy.

In this paper, we assess the overall impact of the trade war on U.S. exports. This overall impact depends both on the direct effect of retaliatory tariffs on exports to retaliating countries and on the extent to which exports can be rerouted to alternative markets. While the literature has focused on the direct effect, our goal is to understand the full impact of the trade war on US exports. In addition, an important goal of this paper is to understand the mechanisms behind both the direct effect of tariffs and the rerouting of exports. We find that financial conditions and the persistence or stickiness of trade relationships play the main role, while inventories and elasticities of substitution also contribute to explaining the response of exports to tariffs.

We start by documenting the impact of foreign retaliatory tariffs on U.S. exports to retaliating countries. Beyond the average response documented in recent work [Amiti et al., 2019, Fajgelbaum et al., 2020], we show there is a large degree of heterogeneity in the impact of tariffs across both destinations and sectors. The effect of Chinese and Canadian tariffs on trade volumes was at least twice as large as the effect of tariffs imposed by the European Union. At the same time, retaliatory tariffs led to a decline in exports of industrial supplies and to a lesser extent consumer goods and agricultural goods, but there was little impact on exports of capital goods. Consistent with much of the literature, we find no significant adjustment in export prices in response to retaliatory tariffs.

We then extend our analysis to focus on the reallocation of exports away from retaliating countries and toward alternative markets. We find a gradual reallocation of exports away from China in product categories facing larger increases in Chinese tariffs. This reallocation led to an increase in exports primarily to East and South Asia and to Europe. To establish the total effect of the trade war on US exports, we estimate product–level regressions of foreign tariffs on US exports. We find that the sum of the large and negative direct effect and the increase in exports through the reallocation toward other markets add up to a small effect on US total exports. This effect on total exports is not statistically significant except on the very short term, given that reallocation is gradual. Nevertheless, a breakdown into sectors shows that total exports of industrial supplies do fall as a result of the trade war.

Next, we explore the mechanisms that explain both the direct effect of retaliatory tariffs and the reallocation effect. We find four elements that shape these effects: the financial conditions of US industries, the degree of persistence or stickiness in trading relationships, inventories, and elasticities of substitution. We also establish that other elements, such as the degree of diversification of US exports across markets prior to the trade war, did not make a difference.

To examine the role of financial conditions, we construct industry–level leverage ratios from COMPUSTAT during the period prior to the trade war. The literature has documented, in other contexts, that leverage shapes the response of firms to shocks. For example, Kalemli-Özcan et al. [2022] establish that European firms with higher leverage were more likely to reduce investment following the 2008 financial crisis and Giroud and Mueller [2017] document that high–leverage US firms were more likely to reduce employment in response to demand shocks during during the same crisis. Therefore, we expect that financial conditions could also shape the response to retaliatory tariffs. We find that in high–leverage industries, exports to retaliating countries face a larger decline in response to retaliaroty tariffs. At the same time, the positive reallocation effect is also larger among high–leverage industries. One interpretation of this result is that firms in high–leverage industries might not be able to smooth out tariff increases to Chinese buyers. For instance, firms in high–leverage industries might face a higher cost of providing trade credit or holding short-run inventories. Thus, when tariffs increase, they have higher incentives to redirect their exports, even if this comes at the cost of a lower profit margin. Firms in low leverage industries, in contrast, have more flexibility. For instance, they can sacrifice liquidity to provide trade credit to Chinese customers and smooth the effect of tariffs. Therefore, they face a lower direct impact on exports to retaliating countries and a lower increase in exports to other markets. Summing up, financial access allows them to weather the tariff shocks by maintaining their supply chains in China or other retaliating countries.

We find relationship stickiness is another important factor that shapes the response of exports to tariffs. For this purpose, we use a new measure by Martin et al. [2020] built using microdata on firm–to–firm trade relationships. In industries with low stickiness, the decline of exports to retaliating countries is larger and the increase in exports toward other markets is also larger. These findings can be interpreted as suggesting that in sectors with higher degrees of relationship stickiness, it is more costly to destroy existing relationships with firms in China, and it is also more costly to suddenly establish other relationships in other markets.

Inventories also played a shaping the response of exports to foreign tariffs. We find that exports to China fell only among industries with low inventory levels. Similarly, only in those industries did exports to the rest of the world increase in response to Chinese tariffs. These findings are consistent with the notion that in industries operating with high levels of inventories reorganizing supply chains might be costlier.

In addition, we observe that in industries with high elasticities of substitution, there is a larger increase in exports toward other markets away from retaliatory tariffs. This result is intuitive, as establishing new markets for less differentiated goods is probably less costly. Finally, one could conjecture that rerouting exports would be easier in sectors with more diversified markets prior to the trade war. We find, however, that this element did not shape the response of US exports in practice.

Summing up, retaliatory tariffs had a large direct effect on US exports, but reallocation toward other markets mostly compensated this negative impact. Financial conditions and the stickiness of trade relationships are the key elements behind the fast reorganization of global supply chains facing a large shock such as the 2018-2019 trade war.

Related Literature This paper complements recent work analyzing the consequences of the U.S.-China trade war on trade flows. Fajgelbaum et al. [2020] and Amiti et al. [2019] document the direct average impact of foreign retaliatory tariffs on U.S. exports to all destinations. We make two contributions relative to this work. First, we analyze the overall effect of retaliatory tariffs on US exports, which is the sum of the direct effect and the reallocation in response to these tariffs. Second, we analyze the underlying mechanisms behind these effects, establishing an important role for financial conditions, relationship stickiness and elasticities of substitution. The small effect on total exports is consistent with the small impact on US welfare (about 0.04% of GDP in 2018) computed by Fajgelbaum et al. [2020] and Amiti et al. [2019].

Other important work on the trade war includes Cavallo et al. [2021] who study tariff passthrough on to prices using data on both border prices and retail prices. They establish a full passthrough of US import tariffs on to border prices but an incomplete passthrough to retail prices. In contrast, they find a decline in US export prices in response to retaliatory tariffs, driven by nondifferentiated goods.[1] Flaaen et al. [2020] find a large impact on consumer prices of 2018 US tariffs on washing machines imposed on various trading partners and show that production relocation can dampen this passthrough. Handley et al. [2020] establish the impact of US import tariffs on US exports through input–output linkages. In addition, Benguria and Saffie [2021] show that beyond tariffs, the presence of Chinese state–owned enterprises led to a decline in US exports during the trade war. From a global perspective, Fajgelbaum et al. [2021] analyze the reallocation of third country exports in response to the trade war, finding that third countries increased exports to the US and reduced exports to China, and that the trade war did not slow down global trade. Finally, Fajgelbaum and Khandelwal [2021] provide a detailed survey of the literature analyzing the effects of the 2018–2019 trade war. From the perspective of the Chinese economy, Benguria et al. [2022] establish that trade policy uncertainty led to a decline in investment among Chinese listed firms.

Our result that industries with high financial leverage face a larger decline in exports to retaliating countries connects our work to evidence on the role of leverage in other contexts. In particular, Kalemli-Özcan et al. [2022] study the role of leverage in the context of Europe's slow recovery from the 2008 financial crisis. They establish that firms with higher degree of leverage were more likely to reduce investment. In related work, Giroud and Mueller [2017] show that firms with high leverage were more likely to reduce employment in response to demand shocks during the 2008–2009 financial crisis. To the best of our knowledge, the notion that leverage shapes the response to shocks has not been documented in the context of the reorganization of global supply chains in response to trade policy shocks. More broadly, a large literature has studied the role of finance in shaping trade flows. Much of the recent work in this literature followed the trade collapse during the 2008–2009 global financial crises, and our paper is connected in this regard to work assessing the role of finance in this event [Chor and Manova, 2012, Levchenko et al., 2010, 2011, Ahn et al., 2011, Benguria and Taylor, 2020].

Our finding that relationship stickiness shapes the response of US exports connects our work to Martin et al. [2020], who establish that this feature also determines the response of trade shocks to uncertainty shocks. It also links our paper to work on relational global value

[1] The lack of adjustment in unit values we find is consistent with other work using Census data constructed from customs records [Fajgelbaum et al., 2020, Amiti et al., 2019]. In contrast, Cavallo et al. [2021] use data from the BLS survey of international prices.

chains surveyed by Antras and Chor [2021] which studies how firm to firm relationships shape the response of firms to trade policy shocks. Finally, our result on the role of inventories connects our work to that studying inventory adjustments during the trade collapse Alessandria et al. [2010], Levchenko et al. [2010].

2 The 2018-2019 Trade War

In this section, we briefly summarize recent trade policies imposed by the U.S. and retaliatory trade policies imposed on U.S. exports by some of its main trading partners. We summarize the events up to and including August 2019, which is the last month in our dataset. For further details, see Bown and Kolb [2019] who provide an excellent and detailed timeline of the 2018-2019 trade war.

The first trade barriers imposed by the U.S. were global safeguard tariffs on imports of washing machines and solar panels in October and November 2017, under the argument of a material injury to these industries based on Section 201 of the 1974 Trade Act. This led to WTO disputes being filed by South Korea and China. The U.S. later imposed tariffs on imports of steel (at a 25% rate) and aluminum (at a 10% rate) in March 2018 based on a national security threat argument under Section 232 of the 1962 Trade Expansion Act. While these tariffs were originally going to be applied to all trading partners, several were temporarily exempt, including Canada, Mexico and the European Union. China retaliated immediately targeting about $2.4 billion in U.S. exports. After the exemption on Canada, Mexico and the European Union ended in June 2018, these countries imposed retaliatory tariffs covering $17.8, $4.5 and $8.2 billion of U.S. exports respectively.

Starting in mid 2018, new trade barriers imposed by the U.S. focused exclusively on China. Following an investigation on China's treatment of U.S. intellectual property rights and based on Section 301 of the 1974 Trade Act, the U.S. imposed a first round of tariffs covering $50 billion. This tariff round was announced in April 2018 and was imposed in two waves, in July ($34 billion) and August ($16 billion) 2018. China immediately retaliated with tariffs targeting an equivalent amount in U.S. goods with a 25% rate. This $50 billion round targeted mostly food and agricultural products (40% in terms of value), followed by industrial supplies (31%) and consumer goods (24%).

In September 2018 the U.S. applied a broader set of tariffs at a 10% rate covering $200 billion in imports from China. The announcement included a further increase of the rate to 25% to be implemented in January 2019 and later postponed until May 2019. China retaliated with a $52 billion round applying 5% and 10% rates.[2] These Chinese tariffs targeted primarily industrial supplies (46% in terms of value) and capital goods (42%).

Further tariff increases were postponed amid negotiations to halt the trade war. However, in May 2019 the US raised retaliatory tariffs on China on the same list of products included in the $200 billion September 2018 round. China retaliated in June 2019 also increasing tariffs on part of the products included in its previous $52 billion round. Later, in September 2019 the US once again imposed tariffs on a $112 billion list, which was the first part of a broader $300 billion list. China retaliated immediately, raising tariffs on a first segment of a $57 billion list. The second part of these tariff lists were not enacted as a result of the Phase One agreement reached by between both countries by the end of that year.

3 Data Sources

To assess the impact of the trade war on U.S. exports, we assemble a monthly panel of U.S. exports by product and destination spanning the period from January 2015 to August 2019. We combine these data with MFN tariffs faced by U.S. exports in each destination and additional retaliatory tariff increases during the ongoing trade war imposed by China, Canada, Mexico, the European Union, Turkey, Russia and India. Finally, we build data on several product–level characteristics used to assess the mechanisms shaping the response of US exports to retaliatory tariffs. We describe each of these datasets below.

3.1 Monthly U.S. Exports

U.S. exports detailed by product and destination at a monthly frequency are available from the U.S. Census Bureau "U.S. Exports of Merchandise" publication. In this publication, products are detailed at the 10-digit level of the U.S. version of the harmonized system (HS).[3] Export

[2] This Chinese tariff round was initially labeled as a $60 billion round given the approximate amount of trade targeted.

[3] At this level of disaggregation products are very specific. The following is a useful example: HS 4-digit code 6109 is "T-shirts, singlets, tank tops and similar garments, knitted or crocheted". HS 6-digit code 6109.10 restricts this product to "Of cotton:". HS 10-digit code 6109.10.0004 restricts it further to "Men's or boys': T-shirts, all

values and quantities are aggregated to the level of product-destination-month cells for the analysis. We compute unit values ("prices") as the ratio of export values and quantities. We restrict the analysis to domestic exports.[4]

3.2 Retaliatory Tariffs

The tariffs faced by U.S. exports in each destination are computed as the sum of MFN tariffs and the additional retaliatory tariff rates imposed by China, the European Union, Canada, Mexico, Turkey, Russia and India. Our main source of data is Fajgelbaum et al. [2020], which we extend as follows. We use data from Bown et al. [2019] to include several reductions in retaliatory tariffs and changes in MFN tariffs by China. In addition, we extend the sample in time, obtaining data on the 2019 retaliatory tariffs from official sources.

Most U.S. trading partners imposing retaliatory tariffs (including China, the European Union, Canada, and Mexico) report these at the 8-digit level of their national versions of the Harmonized System (HS).[5] HS codes are identical for all countries up to the 6-digit level of disaggregation. Following Fajgelbaum et al. [2020] we work with tariffs at the 6-digit level to make them comparable across destinations. It is also worth noting that most of the retaliatory tariff rounds during the trade war have a single ad–valorem rate, and the variation across products within each round depends on whether they are targeted or not, rather than on the rate.[6]

3.3 Product Characteristics

End–use classification We distinguish between four different product categories based on the U.S. Census Bureau's End-Use classification. This classification divides products into food and agricultural goods, industrial supplies, capital goods, and consumer goods.[7] The largest categories in exports to China are industrial supplies (each accounting for 37% of total exports

white, short hemmed sleeves, hemmed bottom, crew or round neckline, or V-neck, with a mitered seam at the center of the V, without pockets, trim or embroidery".

[4]Domestic exports exclude exports manufactured in other countries and temporarily stored without further processing in the U.S. to be re-exported.

[5]India's tariffs are reported at the HS 6-digit level and Russian tariffs at the HS 10-digit level.

[6]An exception is China's $52 billion round which assigns a 10% rate to 69% of products and a 5% rate to the remaining ones.

[7]The original end use classification has automobiles as a separate category. We assign passenger cars (end use code 300) to consumer goods; trucks, buses and special purpose vehicles (301) to capital goods; and parts, engines, bodies, and chassis (302) to industrial supplies.

in 2017) followed by capital goods (34%), food and agricultural products (15%), and consumer goods (13%). Exports to the rest of the world, in turn, have a similar composition, with a smaller share of food and agricultural products and a larger share of industrial supplies and consumer goods.

Elasticities of substitution Elasticities of substitution are obtained from Soderbery [2018], who calculates these by country pair for each industry at the HS 4–digit level with data over 1991–2007.

Leverage and trade credit We use COMPUSTAT to compute leverage ratios in each industry. Following Giroud and Mueller [2017], we define a leverage ratio equal to the sum of debt in current liabilities and long-term debt to total assets. We use annual data over 2010–2017. Following Levchenko et al. [2011], we first compute the median for each firm across time. We then compute the median across firms within each NAICS 4–digit industry. We match these measures to HS10 codes in the trade data using a concordance provided by the US Census Bureau.

We measure trade credit in each industry also from COMPUSTAT. Net trade credit is defined as the difference between accounts receivable and accounts payable, divided by income. We follow the same procedure as with leverage ratios, computing the median within firms over time, and then the median across firms within NAICS 4–digit industries.

Inventories We measure the inventory intensity of each industry using COMPUSTAT. We first compute the inventory to revenue ratio of each firm, then compute averages within firms over time between 2010 and 2017, and finally compute averages across firms within NAICS 4–digit industries, which are then matched to HS 10–digit codes.

Relationship stickiness We use measures of relationship stickiness provided by Martin et al. [2020]. They construct this measure based on the duration of firm to firm trade relationships computed using French customs data for trade with European countries over 2002–2006. These data are provided at the HS 6–digit level.

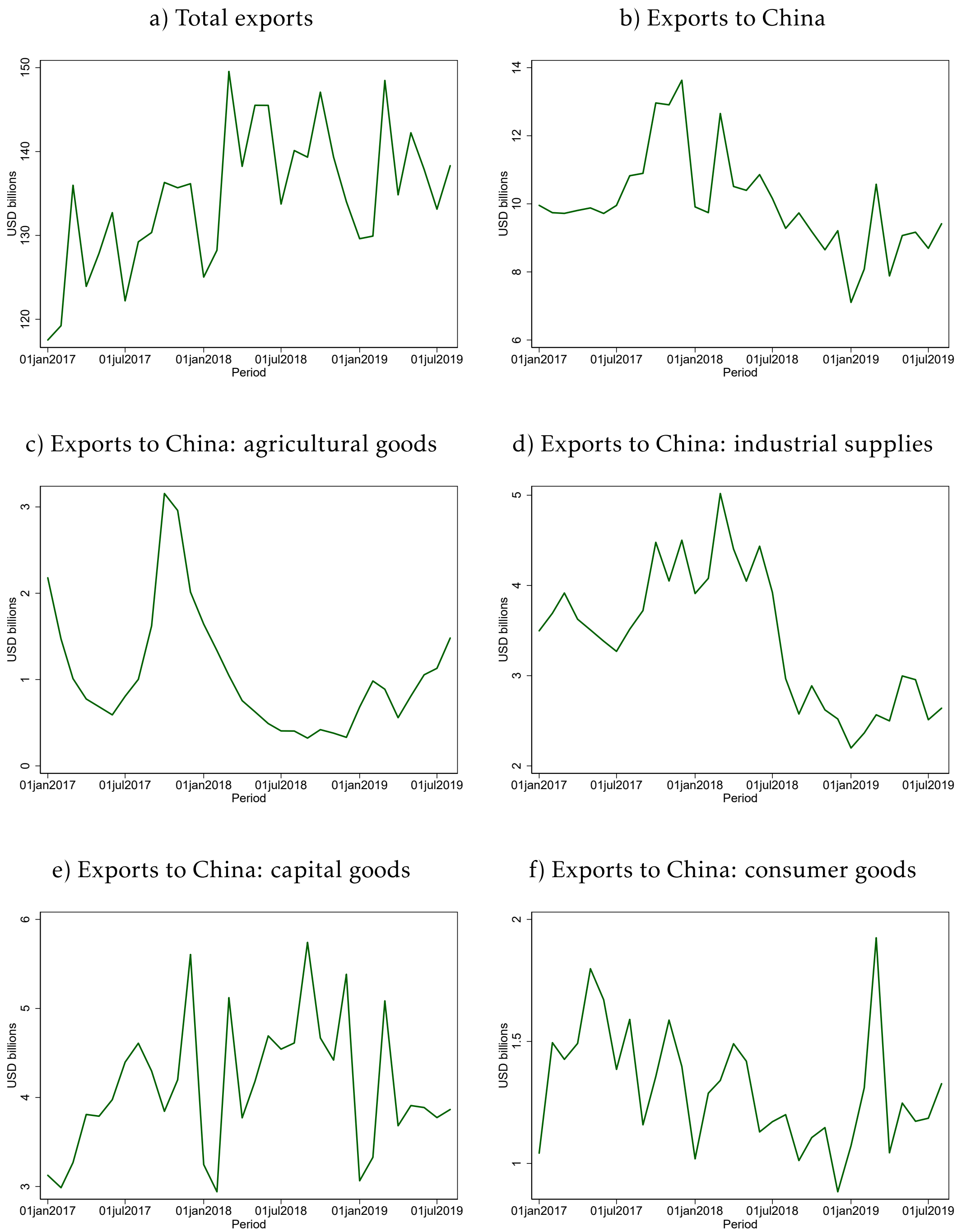
Market diversification We measure the degree of market diversification of US exports for each HS10 product in 2017, before the start of the trade war. For each product, we compute the share of value exported to each market over total exports. We then define a Herfindahl–Hirschmann index of concentration as the sum of squared shares. This index ranges from zero to one, where higher values indicate more concentration (i.e. lower diversification).

3.4 Trends in U.S. exports

Figure 1 plots trends in US exports to the world and to China, which was the main retaliating trading partner. U.S. exports to the world increased in nominal terms by 6% from 2017 to 2019, while US exports to China fell 19% during the same period.[8] The same figure also plots exports to China by end–use product categories. The largest decline corresponds to agricultural goods and industrial supplies, with exports falling 38% and 31% respectively between 2017 to 2019. For capital and consumer goods, exports to China fell much less (by 4% and 11%) respectively between the same years.

[8]These magnitudes are computed normalizing 2019 exports given that our data does not extend to the end of 2019.

Figure 1: Trends in US Exports



Notes: Panels a) and b) plot the value of US exports to all destinations and to China at a monthly frequency. Panels c) through d) split exports to China based on end–use product categories.

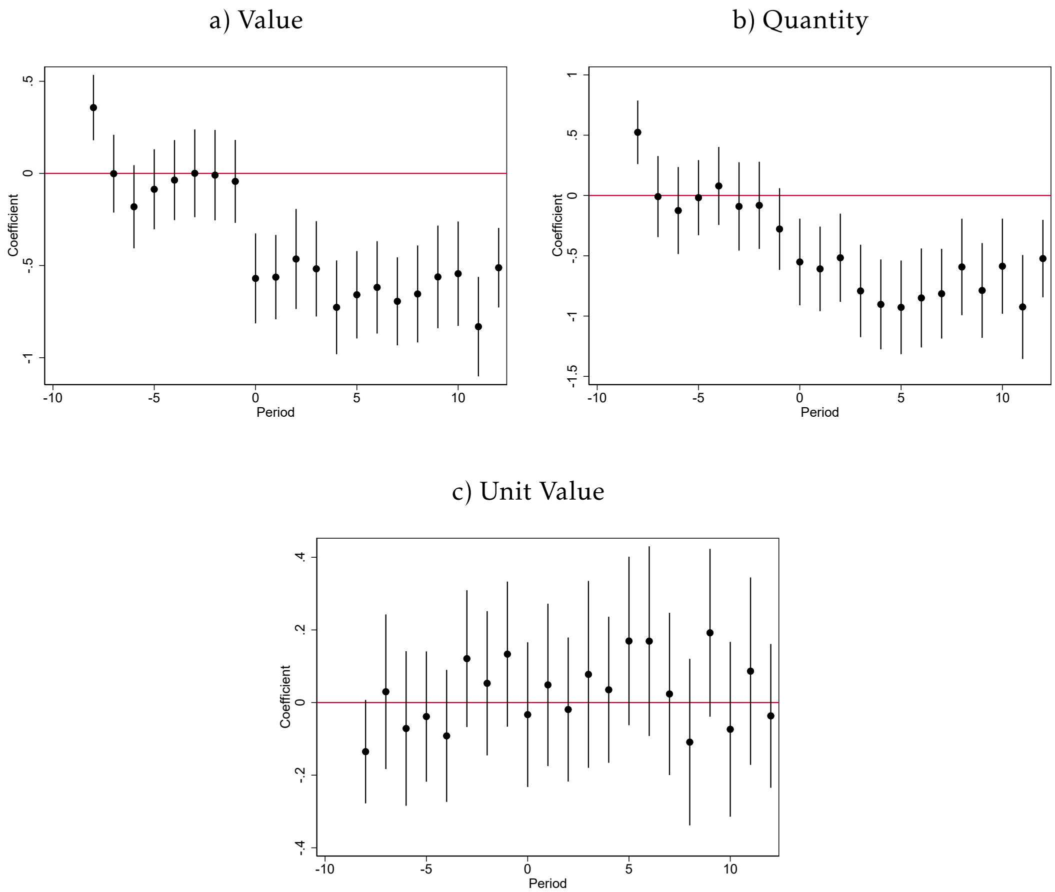
4 The Direct and Indirect Effects of Retaliatory Tariffs on U.S. Exports

We first analyze the impact of retaliatory tariffs on US exports to retaliating countries. We use a dynamic specification which follows the literature [Amiti et al., 2020]. The sample consists of US exports by HS10 product, destination country and month. The dependent variable Y_{cpt} is the exported value, quantity or (fob) unit value of product p to country c at time t.

$$\log \mathrm{Y}_{cpt} = \sum_{k=--\underline{T}}^{\overline{T}} \beta_k \left(I_{cpk} \times \ln \left(\frac{1+\tau_{cpk}}{1+\tau_{cp0}} \right) \right) + \eta_{cp} + \delta_{cst} + \epsilon_{cpt} \,. \quad (1)$$

On the right side, $\sum_{k=--\underline{T}}^{\overline{T}} \beta_k \left(I_{cpk} \times \ln \left(\frac{1+\tau_{cpk}}{1+\tau_{cp0}} \right) \right)$ measures the dynamic effect of retaliatory tariffs in each destination. The term I_{cpk} represents a treatment month indicator variable equal to one in the first month a tariff is raised and zero otherwise. The size of the tariff increase is represented by the term $\ln \left(\frac{1+\tau_{cpk}}{1+\tau_{cp0}} \right)$. Given the length of our sample, we allow for 8 leads and 12 lags ($\underline{T} = 8$ and $\overline{T} = 12$). We include country × product and country × sector (HS2) × time (year–month) fixed effects. We estimate this equation by OLS, with standard errors clustered by product at the HS6 level. Figure 2a shows the result for export values. There are no apparent pre–trends, and there is a large decline in exports immediately following the imposition of retaliatory tariffs. The magnitude is such that a ten percent increase in retaliatory tariffs is associated to a 5 percent decline in US exports at a six month horizon. The effect is stable and persistent over time. Figures 2b and 2c plot the results for quantities and prices (unit values). In line with other work using the same type of data [Amiti et al., 2019, Fajgelbaum et al., 2020] we do not find signs of adjustment in (fob) prices; the full adjustment corresponds to quantities.

Figure 2: Retaliatory Tariffs and US Exports

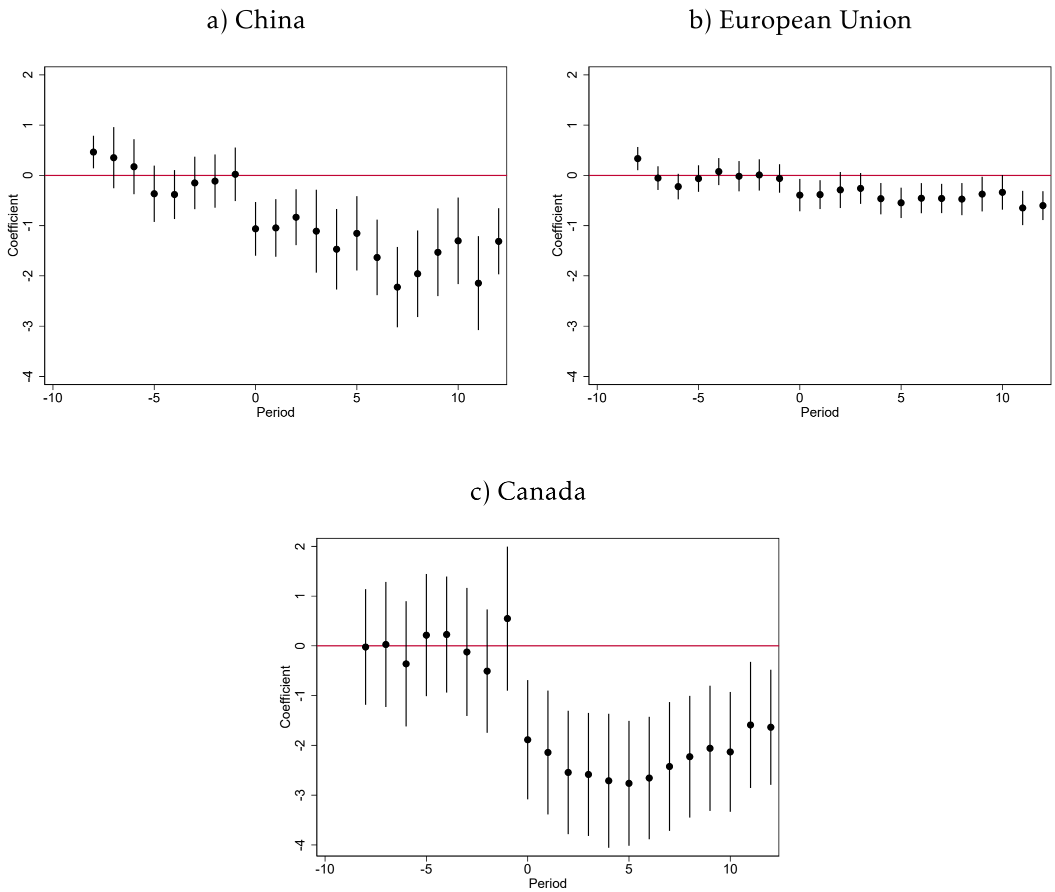


Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

Next, we document a substantial degree of heterogeneity in this effect of retaliatory tariffs both across destinations and sectors. Figure 3 shows the result of estimating equation (1) separately for the main retaliating countries or regions. We find that the coefficients based on Chinese retaliatory tariffs are roughly twice as large as those found using the worldwide sample.[9] The effect of Canadian tariffs is equally large. In contrast, tariffs imposed by the European Union result in a substantially milder impact.

[9]Appendix Figure 14 plots the response of quantities and unit values to Chinese retaliatory tariffs.

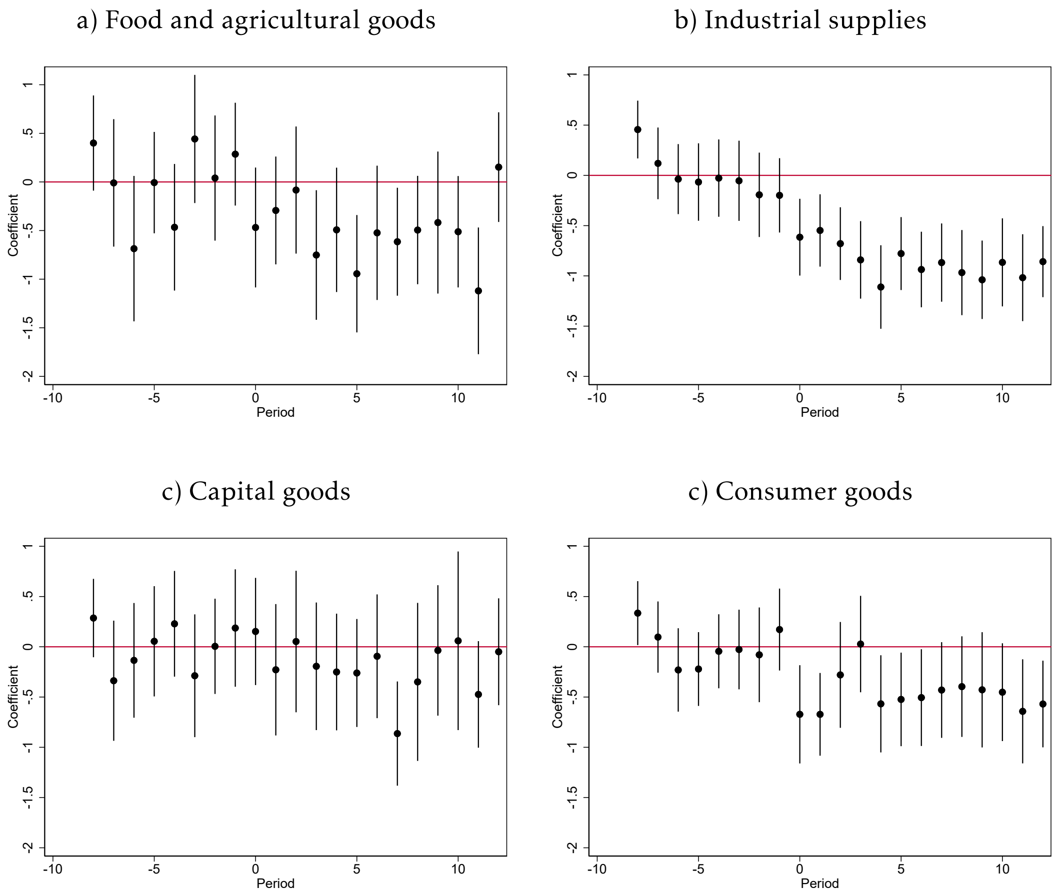
Figure 3: Retaliatory Tariffs and US Exports to Main Retaliating Countries



Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

Figure 4 splits the sample by sectors, considering worldwide exports. In this case, tariffs on intermediate inputs have the largest negative impact on US exports. The magnitude for this sector is such that a ten percent increase in retaliatory tariffs leads to about an 8 percent decline in US exports at a six month horizon. Among consumer goods and agricultural products, tariffs also have a negative impact on trade flows, but the magnitude is about half than that found for industrial supplies. In contrast, we do not find an economically or statistically significant effect of tariffs on capital goods. One potential explanation for this result is that the US exports machinery that is difficult to replace with products from other source countries. In Appendix Figure 15, we show similar patterns of heterogeneity across sectors focusing only on US exports to China.

Figure 4: Retaliatory Tariffs and US Exports by Sector



Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

4.1 Indirect Effect: Export Reallocation

As we argued in the introduction, the overall impact of the trade war on US exports depends not only on the direct effect of retaliatory tariffs but crucially also on the ability of US exporters to redirect trade to other markets. From a policy standpoint, it is important not only to quantify the extent to which this rerouting occured, but also which determinants influenced it.

We use a similar dynamic specification to that discussed earlier. Because China imposed the largest retaliatory tariff rounds by far, we focus on the extent to which US exports can be redirected away from Chinese tariffs. Thus, the sample considers US exports to all destinations in the rest of the world, excluding China. The dependent variable Y_{cpt} represents the exported value (or alternatively quantity or unit value) of product p to country c at time t.

$$\log \mathrm{Y}_{cpt} = \sum_{k=--\underline{T}}^{\overline{T}} \beta_k \left(I_{cpk} \times \ln\left(\frac{1+\tau_{cpk}}{1+\tau_{cp0}}\right)\right) + \sum_{k=--\underline{T}}^{\overline{T}} \gamma_k \left(I_{pk}^{CHN} \times \ln\left(\frac{1+\tau_{pk}^{CHN}}{1+\tau_{p0}^{CHN}}\right) \times \mathrm{S}_{p0}^{CHN}\right)$$
$$+ \eta_{cp} + \delta_{cst} + \epsilon_{cpt} \,. \qquad (2)$$

The independent variables capture both the effect of tariffs on each destination market and the effect of Chinese tariffs imposed on each product. The term $\sum_{k=--\underline{T}}^{\overline{T}} \beta_k \left(I_{cpk} \times \ln\left(\frac{1+\tau_{cpk}}{1+\tau_{cp0}}\right)\right)$ measures the dynamic effect of retaliatory tariffs in each destination. In this expression, I_{cpk} is a treatment month indicator variable which is one in the first month a tariff is raised and zero otherwise. The size of the tariff increase is represented by the term $\ln\left(\frac{1+\tau_{cpk}}{1+\tau_{cp0}}\right)$ which is equal to the ratio between the higher tariff and its original value. The term $\sum_{k=--\underline{T}}^{\overline{T}} \gamma_k \left(I_{pk}^{CHN} \times \ln\left(\frac{1+\tau_{pk}^{CHN}}{1+\tau_{p0}^{CHN}}\right) \times \mathrm{S}_{p0}^{CHN}\right)$ measures the impact of Chinese retaliatory tariffs corresponding to each product p on exports to the rest of the world. In this case, I_{pk}^{CHN} is a treatment month indicator. and the size of the tariff increase is represented by $\ln\left(\frac{1+\tau_{pk}^{CHN}}{1+\tau_{p0}^{CHN}}\right)$. Naturally, the effect of Chinese tariffs on US exports to other destinations should be a function of the importance of China as a market for each product. For example, if China represents a negligible market for a given product prior to the trade war, there would be little trade to reallocate. For this reason, we include the market share of China in US exports for each product, S_{p0}^{CHN}, which we compute in 2017.

Figure 5*a* illustrates the impact of retaliatory tariffs in each rest–of–the–world market on US export value, which is captured by the coefficients β_k. Retaliatory tariffs have an immediate and persistent negative impact on US exports, consistent with the discussion in the previous section.

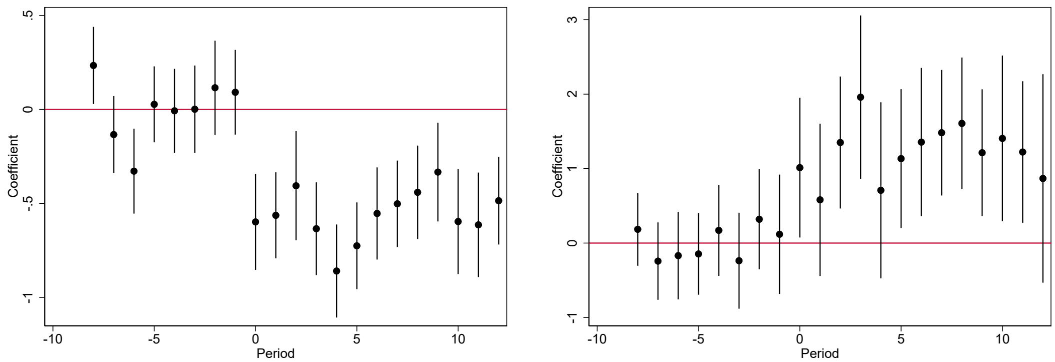
The main coefficients of interest in this section (γ_k) are shown in Figure 5b. There is a clear increase in exports to the rest of the world in response to Chinese tariffs. This increase takes place gradually over time. To get a sense of the magnitude of this reallocation, at a six month horizon, a ten percent increase in Chinese tariffs leads to a 0.8 percent increase in US exports.[10]

[10] To compute this elasticity, we multiply 10% × 0.06 ×1.35, where 1.35 is the estimated γ coefficient on the 6th lag, and 0.06 is the mean of S_{p0}^{CHN}.

Figure 5: China's Retaliatory Tariffs and US Exports to ROW

a) ROW Tariffs and US Exports to ROW

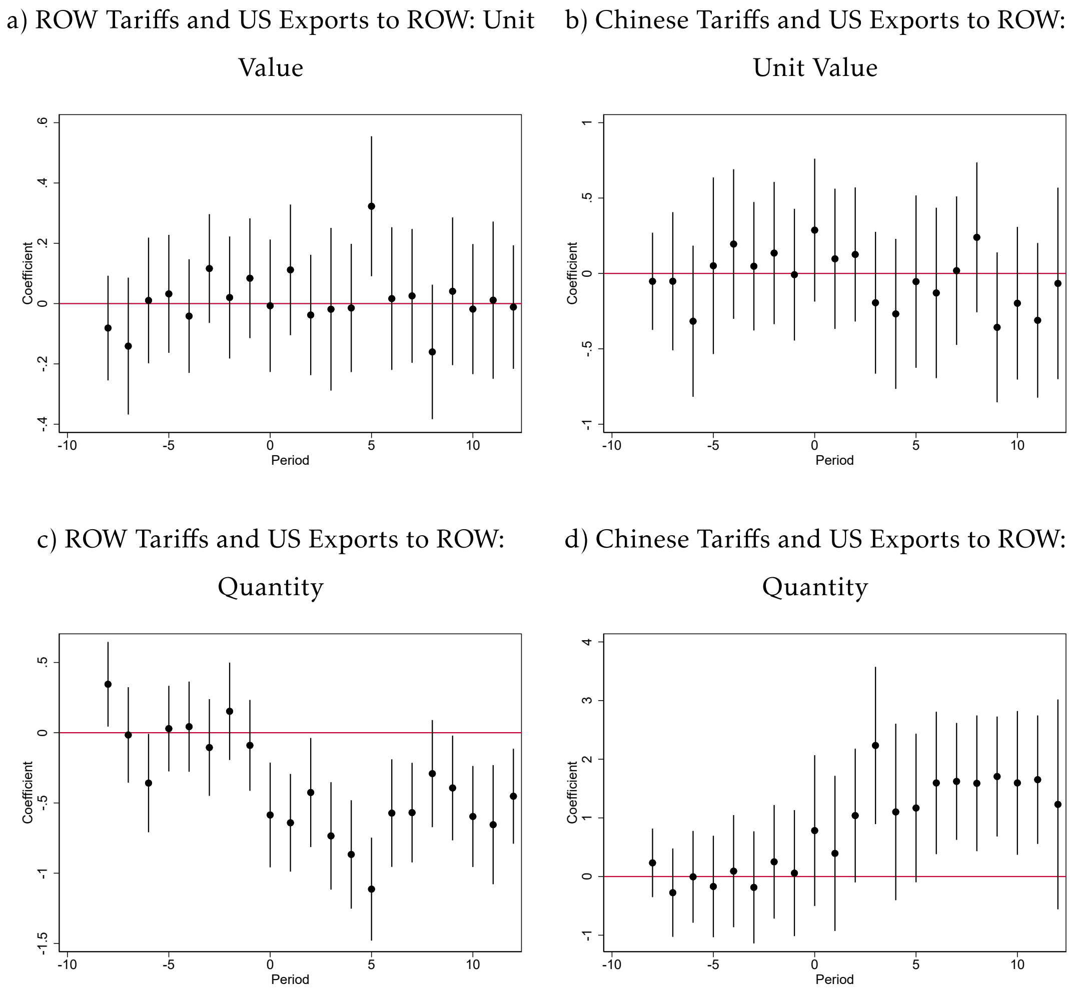
b) Chinese Tariffs and US Exports to ROW



Notes: This figure plots the coefficients obtained from the estimation of equation (2). Vertical bars represent 90% confidence intervals.

In Figure 6 we extend these results to look at the behavior of prices (unit values) and quantities. Perhaps surprisingly, there are no signs of a change in unit values charged to the rest of the world in response to Chinese tariffs (Figure 6b). This means all the adjustment is due to changes in quantities (Figure 6d).

Figure 6: China's Retaliatory Tariffs US and Exports to ROW: Unit Values and Quantities



Notes: This figure plots the coefficients obtained from the estimation of equation (2). Vertical bars represent 90% confidence intervals.

Finally, we examine the patterns of reallocation by geographic regions. Appendix Figure 20 indicates that the overall increase in US exports to rest of the world destinations is driven by exports to East and South Asia and by exports to Europe. In contrast, we do not see statistically or economically significant changes in exports to other regions including North America, South and Central America, or the Middle East and Africa. One potential explanation for this result is that the US can redirect exports to destinations where the composition of exports is similar. Another potential explanation is that the type of products exported to Asia and Europe are more easily reallocated than products exported to other regions.

4.2 Total Impact of Retaliatory Tariffs on US Exports

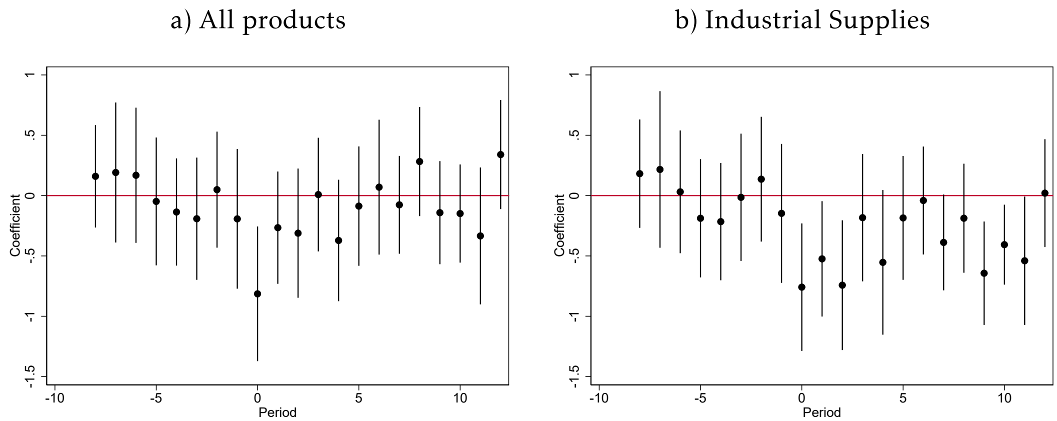
We have documented a decline in US exports to retaliating countries and an increase in exports to other markets in product categories targeted by retaliatory tariffs. To assess the overall impact of retaliatory tariffs on US exports, we estimate the following product–level regression. In this regression, exports are aggregated across all destination markets.

$$\log Y_{pt} = \sum_{k=--\underline{T}}^{\overline{T}} \beta_k \left(I_{pk} \times \ln \left(\frac{1+\tau_{pk}}{1+\tau_{p0}} \right) \right) + \eta_p + \delta_{st} + \epsilon_{pt} \,. \tag{3}$$

The dependent variable Y_{pt} represents the exported value, quantity or unit value of product p at time t. The term $\sum_{k=--\underline{T}}^{\overline{T}} \beta_k \left(I_{pk} \times \ln \left(\frac{1+\tau_{pk}}{1+\tau_{p0}} \right) \right)$ captures the dynamic effect of retaliatory tariffs in each product. Product–level tariffs τ_{pk} are weighted averages of country–by–product tariffs, with weights equal to exports in 2017. As before, I_{cpk} is a treatment month indicator variable which is one in the first month a tariff is raised and zero otherwise and the magnitude of the tariff increase is captured by the ratio between the higher tariff and its original value ($\ln \left(\frac{1+\tau_{cpk}}{1+\tau_{cp0}} \right)$). We include product and sector (HS2) × time (year–month) fixed effects.

The results are shown in Figure 7*a*, and indicate that the overall impact of retaliatory tariffs on US exports is not statistically significant and close to zero. This implies that US exporters successfully reallocate the exports lost in retaliating countries. The exception is the first month in which a tariff is raised, in which we do find a negative and statistically significant coefffi-cient. This is consistent with the fact that the direct effect of retaliatory tariffs documented earlier is immediate, while the reallocation effect is more gradual. Looking at specific sectors by end use, we do find a significant decline in total exports in the industrial supplies category (see Figure 7*b*). This is the sector which was facing the largest decline in exports directly to retaliating countries, as discussed earlier.

Figure 7: Retaliatory Tariffs and US Exports: Product–level regression



Notes: This figure plots the coefficients obtained from the estimation of equation (3). Vertical bars represent 90% confidence intervals.

5 Mechanisms

Next, we explore the determinants of the ability of US exporters to reallocate exports facing retaliation away from China and toward other markets. We assess the role of four determinants: i) financial conditions, ii) the degree of stickiness in trading relationships, iii) inventories, iv) the original extent of diversification across markets of US exports, and v) the elasticity of substitution. Our approach to assess the role of each of these factos consists of constructing industry–level measures capturing each of these elements and comparing the response of trade flows across different industries.

5.1 Financial Conditions

We first document that financial conditions shaped the response of US exports to retaliatory tariffs. We hypothesize that the response of direct exports to retaliating countries as well as the capacity of US exporters to reallocate exports to other markets might depend on leverage levels, in the same way that leverage has been shown to affect the response of firms to other shocks in contexts such as financial crises [Kalemli-Özcan et al., 2022, Giroud and Mueller, 2017]. In our context, as foreign tariffs reduce foreign demand for US exports, exporting firms might seek to provide trade credit to foreign buyers to smooth out the shock.[11] The literature suggests that this might be easier for firms in low–leverage industries, given that firms in high–leverage industries might face tighter credit conditions [Kalemli-Özcan et al., 2022, Giroud and Mueller, 2017]. In other words, when facing the foreign demand shock caused by retaliatory tariffs, US exporters can either provide better terms to buyers in retaliating countries, or redirect their exports to other markets.[12] For firms in low–leverage industries, providing better terms to buyers might be easier.

To assess this hypothesis, we construct to leverage ratios defined as the sum of debt in current liabilities and long–term debt to total assets. They are constructed for NAICS 4–digit industries with data prior to the trade war and matched to the trade flows data as described in Section 3.3. We examine first the direct effect of retaliatory tariffs on US exports to China, estimating equation (1) splitting the sample between industries with above– and below–median leverage. The results (shown in Figure 8) are striking and show no significant impact of retaliatory tariffs on exports to China among low–leverage industries. This contrasts with the impact on the high–leverage sample, in which there is a clear decline in exports with a magnitude such that a ten percent increase in retaliatory tariffs is associated to an approximately ten percent decline in US exports at a six month horizon. Financial conditions also play a role in the redirection of exports toward alternative markets. To this end, we estimate equation (2), again splitting the sample between high– and low–leverage industries. Figure 9 shows that there is a substantial increase in exports to rest of the world destinations as a result of Chinese tariffs among high–leverage industries. In contrast, there is no statistically significant reallocation effect in the low–leverage sample.

To provide further evidence in terms of the mechanism discussed earlier, we also examine the response of trade flows in industries with high or low levels of trade credit. Following the literature, we define net trade credit as the difference between accounts receivable minus accounts payable normalized by income. This implies that higher levels of this ratio indicate more trade credit extended by the industry. Like with leverage ratios, we again compute a

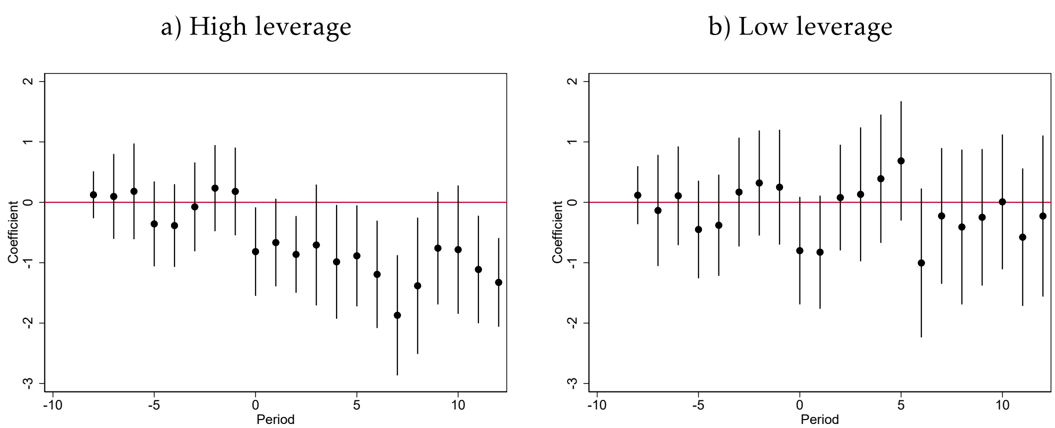
[11] Alternatively, or in addition, US exporters might seek to reduce export prices, but we do not find evidence in favor of this adjustment margin. While Amiti et al. [2019] and Fajgelbaum et al. [2020] also do not see and adjustment in fob export prices, Cavallo et al. [2021] find a decline in export prices (of nondifferentiated goods) using different data from the BLS international price survey.

[12] Redirecting exports can entail several costs, such as the fixed cost of finding buyers in new markets, or the cost of destroying valuable relationships with buyers in retaliating countries.

long–term average for each industry prior to the trade war as described in Section 3.3. The results are plotted in Appendix Figure 16. We find that there is a substantial decline in exports to China in response to Chinese tariffs in industries which operate with low levels of trade credit prior to the trade war. In contrast, we do not see a significant response among industries with high trade credit levels. This finding supports the previous discussion, in the sense that industries with low net trade credit would not be able to smooth out the shock for Chinese importers, thus leading to a decline in exports.[13]

Overall, our findings suggest that firms in high–leverage industries might be less able to smooth out tariff increases to Chinese buyers, leading to a larger decline in exports to China and a larger degree of reallocation to other markets. For example, high–leverage exporters could face a higher cost of providing trade credit or holding short-run inventories. While low–leverage firms might be willing to maintain valuable trading relationships, high–leverage firms might have more incentives to redirect exports, even if this implies a lower profit margin.

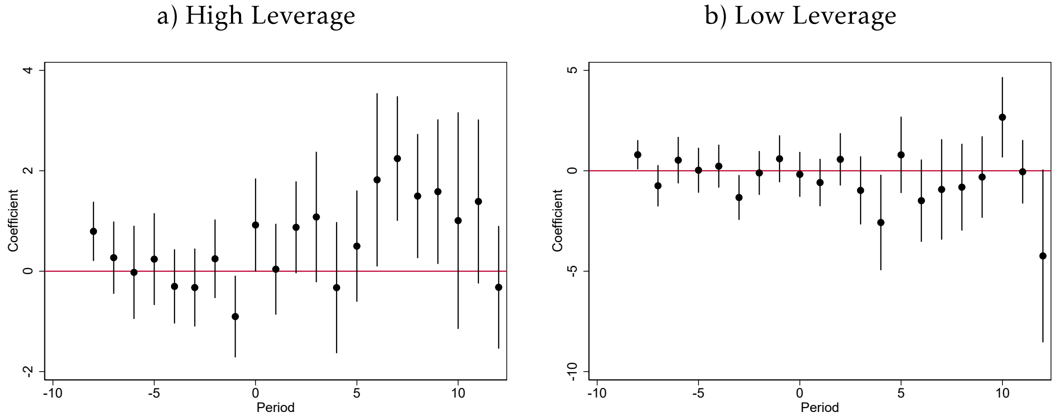
Figure 8: China's Retaliatory Tariffs and US Exports to China: High vs. Low Leverage



Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

[13]Note that there is a very small correlation in our data between the leverage and net trade credit ratios but in Section 5.6 we show that both results still hold when including all interactions jointly.

Figure 9: China's Retaliatory Tariffs and US Exports to ROW: High vs. Low Leverage



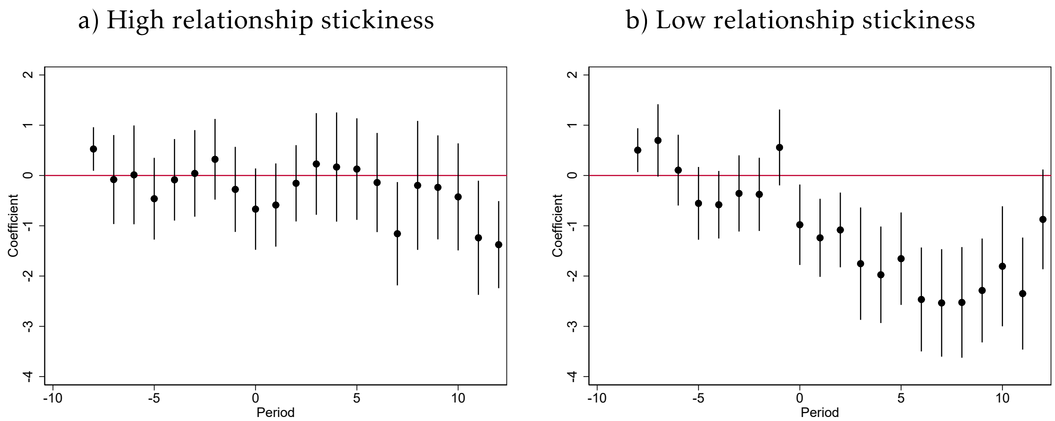
Notes: This figure plots the coefficients obtained from the estimation of equation (2). Vertical bars represent 90% confidence intervals.

5.2 Stickiness of Trade Relationships

The type of trade relationships held by exporting and importing firms is also an important factor shaping the response of US exports. Facing an increase in tariffs, US exporters had to assess whether to terminate relationships with Chinese importers. This leads to a trade–off between the short–term benefits of reallocating exports to other markets and the long–term cost of losing valuable relationships.[14] In addition, one can conjecture that establishing new relationships in alternative markets is less costly in industries in which relationships are short–lived. To assess this, we use a novel measure of relationship stickiness constructed by Martin et al. [2020] based on the duration of relationships observed in firm–to–firm trade data. We divide the sample into products with above– or below–median relationship stickiness. Figure 10 shows that exports to China fell more in response to Chinese tariffs in industries with low relationship stickiness. At the same time, Figure 11 shows that exports to the rest of the world increased more in response to Chinese tariffs in the same set of industries.

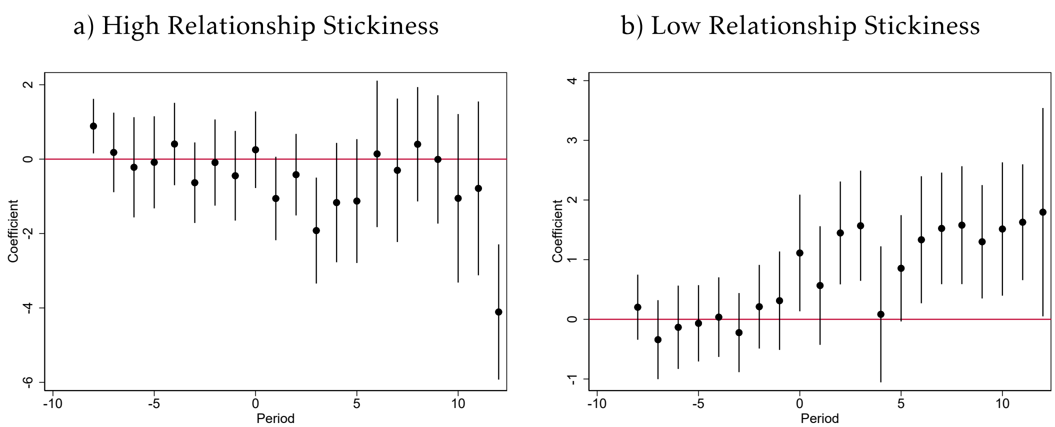
[14]Recent work emphasizing the value of exporter–importer relationships includes Heise [2019] and Monarch and Schmidt-Eisenlohr [2017]. The recent survey by Antras and Chor [2021] conjectures that the US–China trade war could have different impact on relational vs spot relationships.

Figure 10: China's Retaliatory Tariffs and US Exports to China: High vs. Low Relationship Stickiness



Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

Figure 11: China's Retaliatory Tariffs and US Exports to ROW: High vs. Low Relationship Stickiness



Notes: This figure plots the coefficients obtained from the estimation of equation (2). Vertical bars represent 90% confidence intervals.

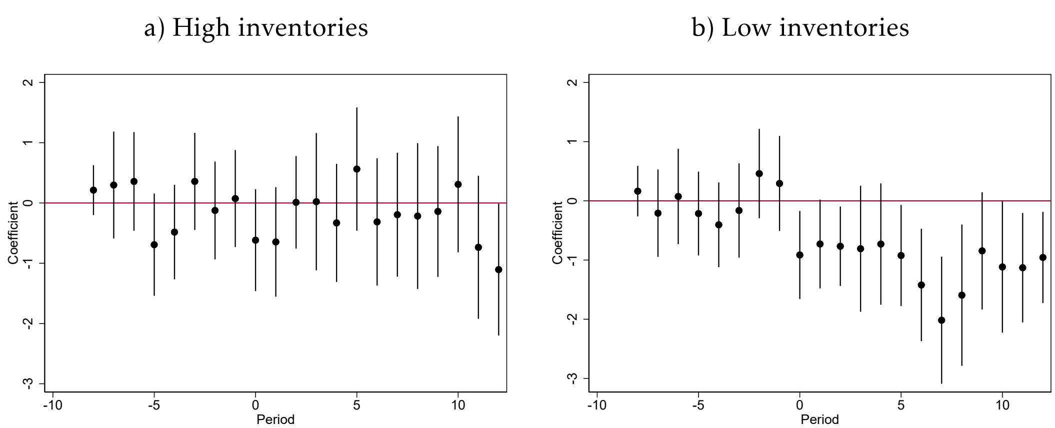
5.3 Inventories

The literature has also emphasized the role of inventories in shaping the response of trade flows to policy changes or crises [Alessandria et al., 2010, Levchenko et al., 2010, Alessandria et al., 2019]. In particular, in industries which operate at high inventory levels it can be more costly to reorganize supply chains. In those industries holding high inventories, in addition, the cost of waiting for the gradual reallocation of exports is costly.

In Figure 12 we split the sample between industries with high and low inventory levels prior to the trade war, and find a clear decline in exports to China in response to Chinese retaliatory tariffs in low inventory industries. In contrast, there is no statistically or economically significant impact on high inventory industries. This goes in line with the idea that it is costly to reorganize supply chains in high inventory industries, which need to keep shipping to China given their high expense in storage.

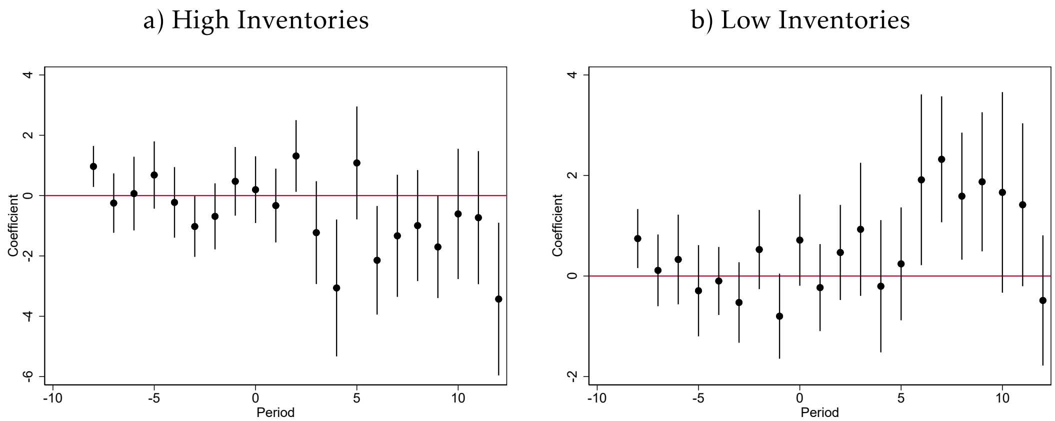
Figure 13 analyzes the evolution of exports to the rest of the world in response to Chinese tariffs. We see a clear increase in exports to the rest of the world in low inventory industries, which goes hand in hand with the decline in exports to China in the previous figure. In contrast, we find no increase in exports to the rest of the world in the sample of high inventory industries.

Figure 12: China's Retaliatory Tariffs and US Exports to China: High vs. Low Inventories



Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

Figure 13: China's Retaliatory Tariffs and US Exports to ROW: High vs. Low Inventories



Notes: This figure plots the coefficients obtained from the estimation of equation (2). Vertical bars represent 90% confidence intervals.

5.4 Elasticities of Substitution

Another element that affects the response of trade flows to tariffs is the elasticity of substitution. In Appendix Figure 17, we split exports to China into categories with above– and below–median elasticities of substitution. We see a similar impact of Chinese tariffs on both samples, albeit with more precise estimates among less differentiated goods. However, a large difference appears in terms of the reallocation of exports. Appendix Figure 18 reports the results for the estimation of equation (2) (measuring the reallocation effect) split again into products high and low elasticity of substitution. As can be seen, the magnitude of the reallocation effect is nearly twice as large among less differentiated goods.

5.5 Market Diversification

One could also conjecture that the diversification of US exports prior to the trade war could ease the reallocation of exports facing retaliatory tariffs. The reason is that it might be easier to increase exports to markets in which an exporting firm is already present, rather than to establish new markets. To assess this possibility we use a measure of market diversification constructed with data for 2017. Specifically, for each HS10 product we construct an Hirschmannn–Herfindahl index equal to the sum of squared shares of exports to each market. In Appendix Figure 19, we estimate equation (2) splitting the sample between products with high and low market diversification. We find a statistically significant increase in exports to the rest of the world in response to Chinese retaliatory tariffs in both samples. However, we do not find a meaningful difference in this response between both samples. Thus, we conclude that market diversification did not have a role in easing the reallocation of US exports.

5.6 Comparing the mechanisms

Finally, we quantify the relative importance of all the mechanisms discussed earlier which could shape the response of US exports to trade war tariffs. To this end, we focus on exports to China and the effect of Chinese retaliatory tariffs. In order to allow for the various elements to simultaneously mediate the effect of tariffs, we simplify our empirical approach and estimate a regression of changes in product–level exports to China between 2017 and 2019 as a function of changes in Chinese tariffs during the same period. We interact the change in tariffs with all the industry–level measures described throughout this section, including leverage ratios, relationship stickiness, inventories, elasticities of substitution, and market diversification. Because our sample ends in August 2019, we compute differences between January to August of 2017 and January to August of 2019. Specifically, for each HS10 product, we aggregate total exports for each of these periods, and define the dependent variable as the log difference. Similarly, we compute the average tariff for each product within each of these periods and also compute the log difference.

$$\Delta log(V)_p = \beta_1 \cdot \Delta\tau_p + \beta_2 \cdot \Delta\tau_p \cdot X_p + \epsilon_p \tag{4}$$

In this regression, the term X_p includes each of the industry characteristics described earlier. The results are reported in Table 1, with all variables standardized to have mean zero and standard deviation one such that coefficients are comparable. They indicate that leverage ratios and relationship stickiness are clearly the strongest mechanism explaining the decline in exports to China in response to Chinase tariffs, with a magnitude that is twice as large as that of the other elements.

6 Conclusions

We have established the total effect of the 2018–2019 trade war on US exports and shed light on the underlying mechanisms. This total effect results from the combination of the direct effect

Table 1: China's Retaliatory Tariffs and US Exports to China: Comparing the Mechanisms

	(1)	(2)
$\Delta\tau_p$	0.054	0.060
	(0.058)	(0.059)
$\Delta\tau_p$ × Leverage ratio	-0.062**	-0.066**
	(0.026)	(0.026)
$\Delta\tau_p$ × Net Trade Credit Ratio		-0.023
		(0.017)
$\Delta\tau_p$ × Inventories ratio	0.031	0.036
	(0.026)	(0.026)
$\Delta\tau_p$ × Rel. Stickiness	-0.071	-0.070
	(0.050)	(0.050)
$\Delta\tau_p$ × Elast. of Subs.	-0.024	-0.024
	(0.016)	(0.016)
Observations	4111	4111

Notes: This table reports the estimation of equation (4). ***, **, and * indicate statistical significance at the 1%, 5% and 10% level. All coefficients are standardized to have mean zero and standard deviation one.

of retaliatory tariffs to retaliating countries and the reallocation away from retaliating countries toward alternative markets. We show that this reallocation was gradual but important in magnitude, nearly compensating the decline in exports due to the direct effect of retaliatory tariffs.

We have documented four determinants that shape the impact of retaliatory tariffs on US exports. First, financial conditions matter. In high–leverage industries, there is a larger decline in US exports to retaliating countries, and at the same time a larger increase in exports to alternative markets. Second, we have found a larger decline in exports and a larger reallocation effect in industries with low degrees of relationship persistence or stickiness. Third, we see a larger decline in exports to China and higher degrees of reallocation in low inventory industries. Finally, the response of exports is shaped by elasticities of substitution, such that less differentiated goods are reallocated to a larger extent away from retaliatory tariffs. In contrast, the market diversification of US exports did not appear to play a role in the extent of reallocation away from retaliating countries.

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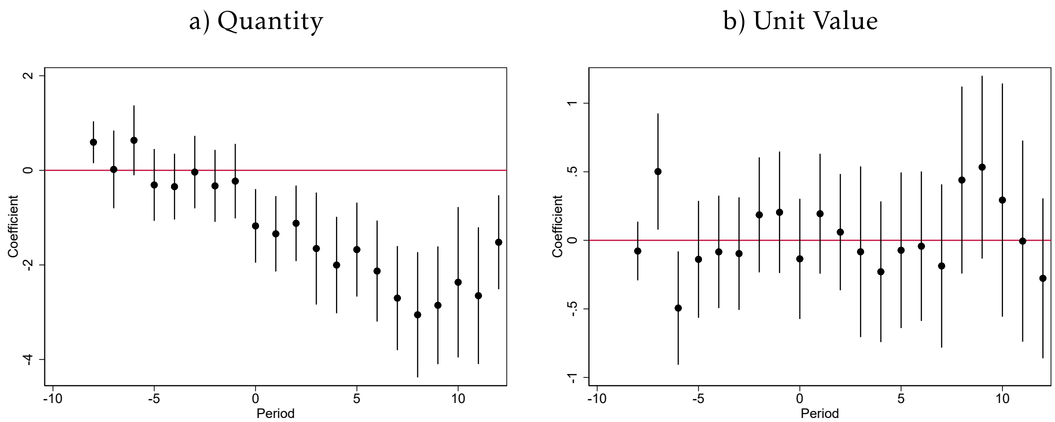
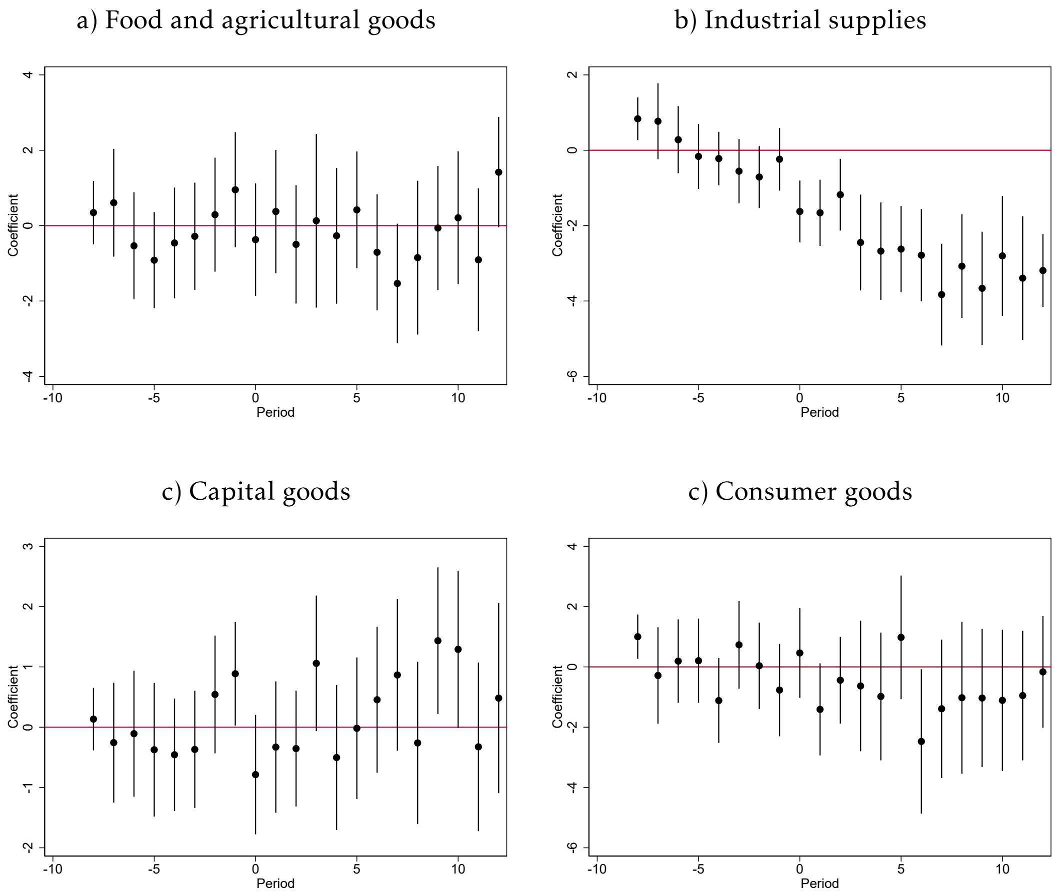
A Appendix

Figure 14: Chinese Retaliatory Tariffs and US Exports to China: Quantities and Unit Values



Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

Figure 15: China's Retaliatory Tariffs and US Exports by Sector

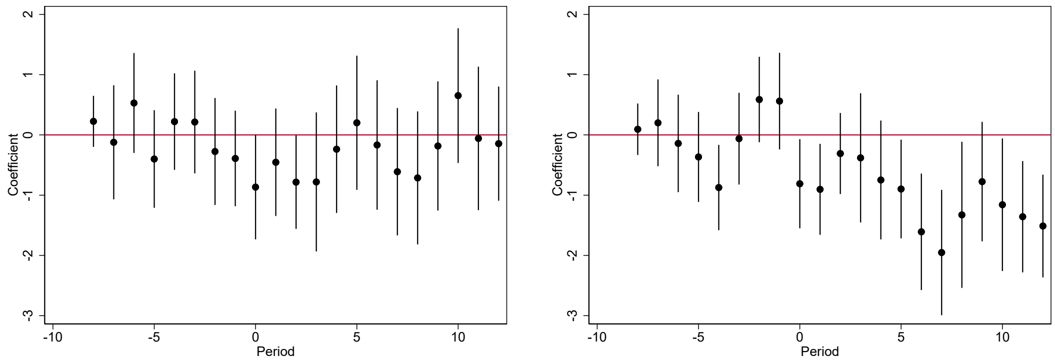


Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

Figure 16: China's Retaliatory Tariffs and US Exports to China: High vs. Low Net Trade Credit

a) High trade credit

b) Low trade credit

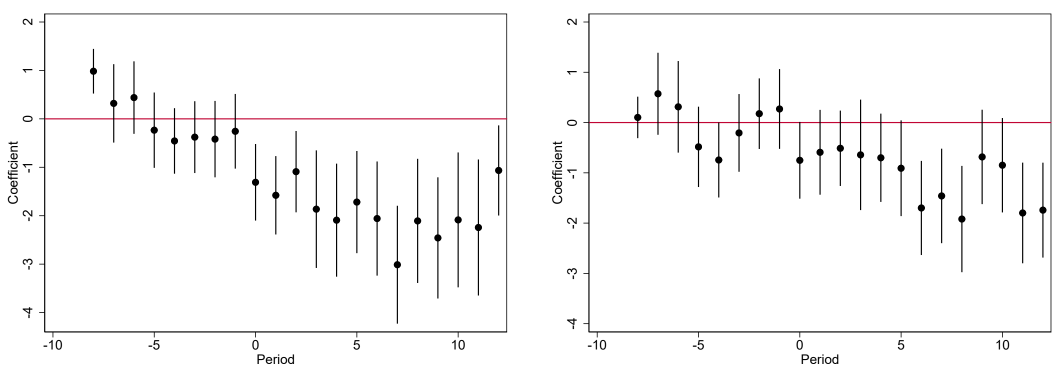


Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

Figure 17: China's Retaliatory Tariffs and US Exports to China: High vs. Low Elasticities of Substitution

a) High elasticity of substitution (lower differentiation)

b) Low elasticity of substitution (higher differentiation)

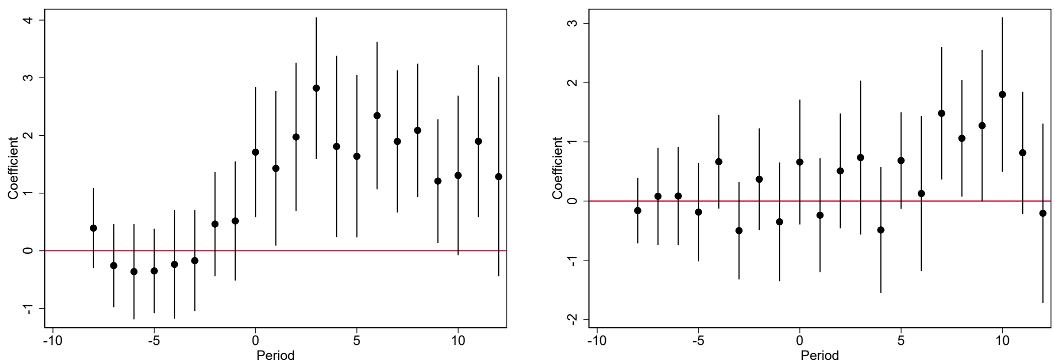


Notes: This figure plots the coefficients obtained from the estimation of equation (1). Vertical bars represent 90% confidence intervals.

Figure 18: China's Retaliatory Tariffs and US Exports to ROW: High vs. Low Elasticity of Substitution

a) High elasticity of substitution (lower differentiation)

b) Low elasticity of substitution (higher differentiation

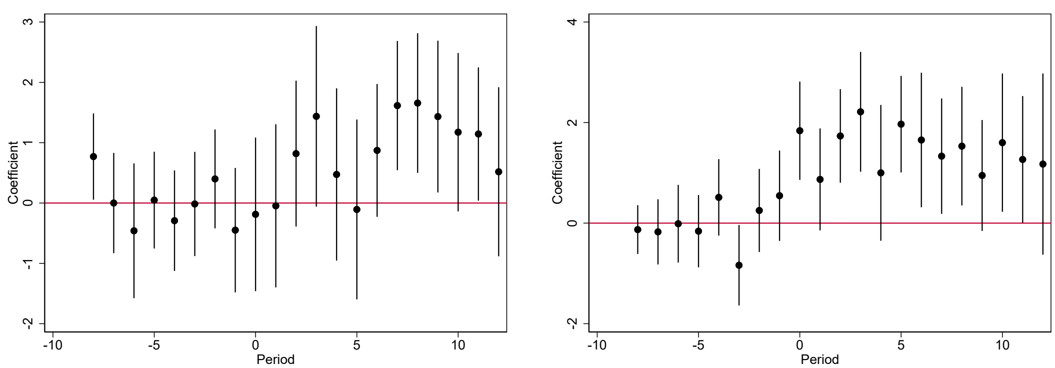


Notes: This figure plots the coefficients obtained from the estimation of equation (2). Vertical bars represent 90% confidence intervals.

Figure 19: China's Retaliatory Tariffs and US Exports to ROW: High vs. Low Market Diversification

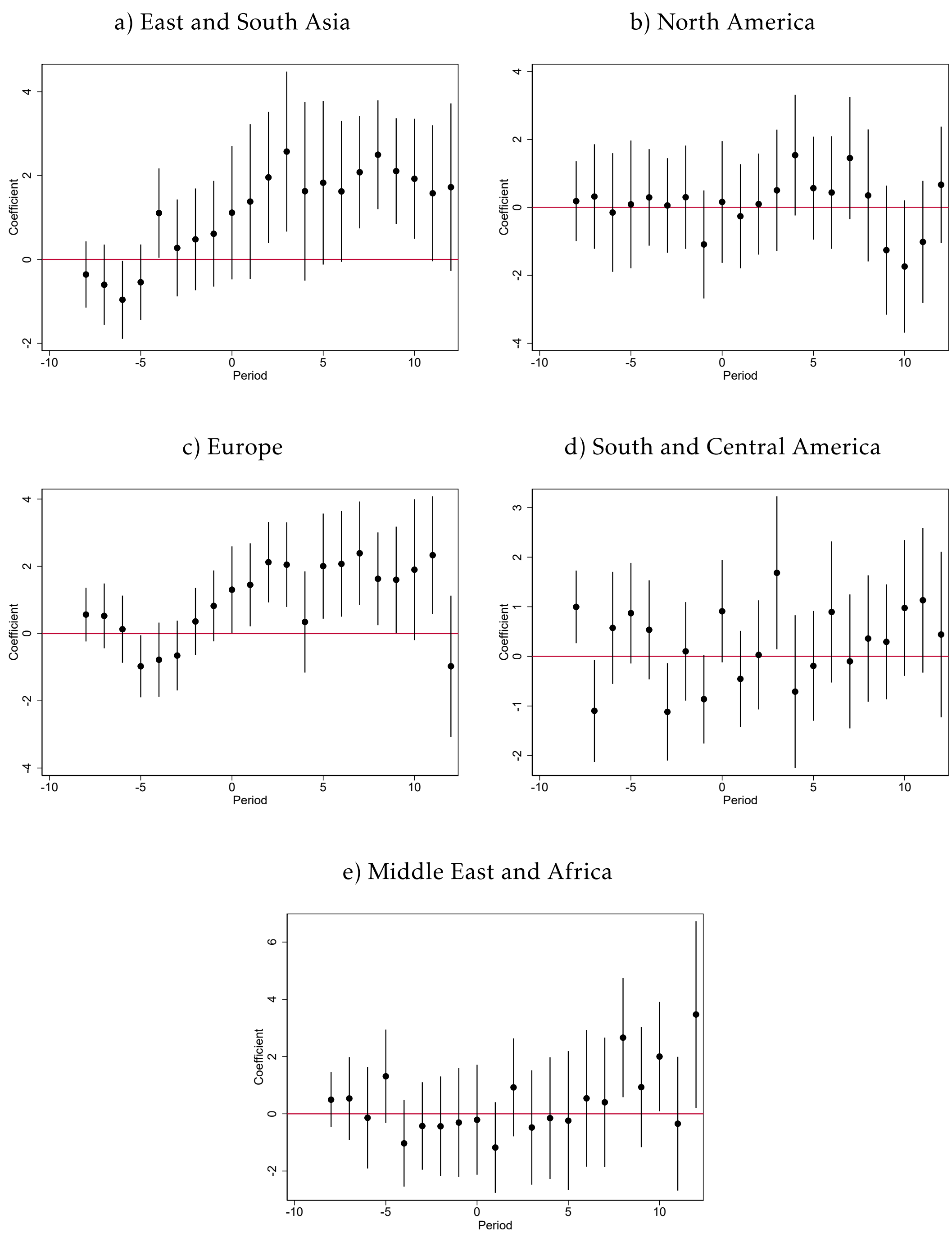
a) High HHI (low diversification)

b) Low HHI (high diversification)



Notes: This figure plots the coefficients obtained from the estimation of equation (2). Vertical bars represent 90% confidence intervals.

Figure 20: China's Retaliatory Tariffs and US Exports to ROW: Breakdown by Regions



Notes: This figure plots the coefficients obtained from the estimation of equation (2). Vertical bars represent 90% confidence intervals.