Quantifying the impact of the US-China trade war on exports *

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February 14, 2020

Abstract

This paper studies the response of US and Chinese exports to the 2018/19 tariff war. Using bilateral product-level trade data, we find very similar average trade elasticities for the two countries. Perhaps surprisingly, there was no reallocation of exports to other destinations. This resulted in a sizable fall of aggregate exports for both countries, estimated to be -0.8ppt for the US and -2.0ppt for China.

Keywords: Import tariffs, trade elasticities.

JEL Classification: F14, xxx.

*The opinions expressed are the authors own and do not necessarily reflect the views of the Banque de France or the Eurosystem.

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1 Introduction.

Starting in the first half of 2018, the US has progressively raised tariffs on Chinese imports. While initial US tariffs on solar panels and washers as well as steel and aluminum targeted almost all countries exporting to the US, subsequent tariff increases exclusively targeted China. The US have implemented four waves of tariffs by December 2019, and China retaliatated against each of these waves, resulting in an escalating tariff war.

In many trade models, a fall in import demand by one trade partner can be partially compensated for by exporting more to other destinations (trade deflection). The fall in aggregate exports is then smaller than the fall in bilateral exports to the first partner. The main question of this paper is to what extent countries can insure against idiosyncratic trade partner demand shocks through trade deflection.

We analyze the export response to the tariff war for both the US and China and, perhaps surprisingly, find no reallocation of exports. We also do not find any change in unit values to other destinations, suggesting that exporters did not adjust their markups in order to attract new customers. This suggests that insurance to foreign demand shocks through trade deflection is very limited, as trade relationships do not adjust quickly in the near term. This has potentially important consequences at the aggregate level. Using a back-of-the-envelope calculation, we find that the decline of aggregate exports was at the order of 2.0ppt for China, and of 0.8ppt for the US.

We start with a descriptive analysis of tariff increases to try to understand how the two administrations chose the products in the tariff lists. Controling for several product-level characteristics, we show that the bilateral import share emerges as the dominant factor in the choice of tariff lines and tariff levels, for both the US and China. The choice of protection by tariff line follows an inverted u-pattern with respect to the bilateral import share: Tariff lines with a low, but positive bilateral import share saw the largest increase in protection, while the average tariff increase was substantially lower for categories with high bilateral import dependence. This suggests that countries were well aware of the economic costs of tariffs for importers and tried to spread the burden of the tariffs more evenly across industries. In contrast to the bilateral import share, we find no significant role for the partner's bilateral export share, import growth, or the partner's export growth in determining tariffs.

Estimating the effect of tariffs on bilateral trade flows delivers very similar average elasticities for the US and China. We find elasticities at the order of -1.1 for China (starting from zero tariffs initially, a 10pp tariff increase leads to a 11pp drop in the growth of exports) and -1.2 for the US. The elasticities for US-China bilateral trade flows have been estimated before (in Fajgelbaum et al. (2019) and Amiti et al. (2019) for US imports and in Amiti et al. (2019) for US exports), and this section confirms these results, but using new data. We also find no change in Chinese export prices, consistent with full pass-through into US import prices. As a new result, we also show that tariffs led to more exit and less entry of exported products, thus the extensive margin contributed to the decline in exports.

We then show that the tariffs did not lead to any substantial reallocation of exports to other destinations. These results hold for both US and Chinese exports, and also when zooming in on destination markets more similar to the US and China, such as the EU and other Asian countries. We also see no substantial change in unit values to other destination markets.

Finally, we use a back-of-the-envelope calculation to estimate the effect on aggregate exports. This is based on the assumption that products with no tariff changes were unaffected by the tariff war. This exercise therefore ignores any potential macro-effects of the tariff war, for instance through exchange rates, that our difference-in-difference design cannot address. Using the estimated elasticities, and aggregating across categories, we find effects of -2.0pp for China and -0.8pp for the US over the entire time period of the tariff war (until August 2019). This difference in aggregate effects is the result of the different scale at which the US and China applied tariffs, and is not due to different trade elasticities with respect to tariff increases.

This paper fits into a recent literature investigating the consequences of the US-China trade war. Existing literature so far has focused on consequences for the US. Fajgelbaum et al. (2019), Amiti et al. (2019), Cavallo et al. (2019), and Amiti et al. (2020) have all shown that US import tariffs have been passed on almost entirely into US import prices.[1] We confirm this result using unit values for Chinese exports. Other studies for the US have looked at the consumption response (Waugh (2019)), the effect on manufacturing

[1] In a related paper, Flaaen et al. (2019) report a large price response for Washing Machines to the 2018 tariffs, driven by both direct and indirect effects (markup increases of domestic firms).

employment (Flaaen and Pierce (2019)) and the role of input tariffs for US exports (Handley et al. (2020)). The effect of the tariff war on stock returns has been studied in Huang et al. (2018) and Egger and Zhu (2019). Fontagné and Bellora (2019) provide results from a computable general equilibrium model featuring global value chains.

Some recent literature has also investigated the choice of taxed products, focusing particularly on political targeting. Fajgelbaum et al. (2019) report that US tariffs were targeted to protect politically competitive counties from foreign competition. There is also some evidence that retaliatory tariffs by other countries were set to hurt particularly Republican counties.[2] We add to this literature by showing that the choice of tariff lines also followed an economic rationale, namely to spread the burden of tariffs more evenly across importing industries.

Compared to previous work, our main contribution is to show for both the US and China that tariffs did not lead to any reallocation of exports to other destinations, and to quantify the effect on aggregate exports. In addition, this paper also makes several smaller contributions. First, we are the first to analyze the consequences of the trade war using detailed Chinese customs data. Second, we show that, despite differences in the types of products being taxed, average trade elasticities for the US and China are remarkably similar. Third, we demonstrate the importance of the bilateral import share in determining which industries were granted protection. Fourth, we show that tariffs also led to less trade through the extensive margin, that is through less entry and more exit of products.

2 Data and Descriptive Statistics

We use monthly bilateral export data for the US and China, collected from the websites of the respective customs authorities, for January 2017 to August 2019. For both countries, we restrict attention to 33 partner countries, and a ROW aggregate.[3] The 33 individual

[2]See Fajgelbaum et al. (2019) and Fetzer and Schwarz (2019), although Fajgelbaum et al. (2019) report that this relationship is not robust to controling for agricultural employment shares. Recent evidence from Blanchard et al. (2019) also indicated that the retaliatory tariffs have been effective in hurting the Republican party, as their House candidates have lost support in the 2018 congressional election, particularly in counties targeted by retaliatory tariffs.

[3]The 33 countries are: The US/China, Canada, Mexico, Brazil, Chile, Germany, France, UK, Italy, Spain, Netherlands, Belgium, Switzerland, Poland, South Africa, Turkey, Saudi Arabia, Iran, Russia,

partner countries account for 86% (for China) and 87% (for the US) of total exports in 2017. The data are at the HS8 level for China (8,046 products) and at the HS10 level for the US (9,351 products).

We match the data with the US tariff lists published on the USTR website, and with information on Chinese retaliatory tariffs from Bown et al. (2019).[4]

Figure 1 shows the evolution of the simple average tariff rate that the US applies to China and vice versa. Initially, the trade relationship was governed by WTO MFN tariffs, which are on average lower for the US (3%) than China (8%). The US started applying severe protectionist measures against almost all its trading partners in early 2018, first with tariffs on Solar Panels and Washing Machines, then on Steel and Aluminum (section 232). After complaints about forced technology transfer and market access, the US started a section 301 process against China. After two initial tariff waves in July ($34 bn) and August 2018 ($16 bn), which were matched in scope by China's retaliation, the tariff war significantly escalated in September 2018, when the US increased tariffs by 10ppt on 200 bn worth of goods from China (wave 3). After a temporary 90-day trade truce was reached between Presidents Trump and Xi during the G20 summit in December 2018, which included a reduction of Chinese retaliatory tariffs on autos and auto parts, the tariff war further escalated in May 2019. After failed negotiations, the US raised the applied tariff rate for wave 3 by another 15 ppt. Tariff increases by wave are shown in figure 2. Our data cover the period until Aug 2019, so does not include the introduction of wave 4(a) by the US in September 2019, and the corresponding retaliation by China.[5]

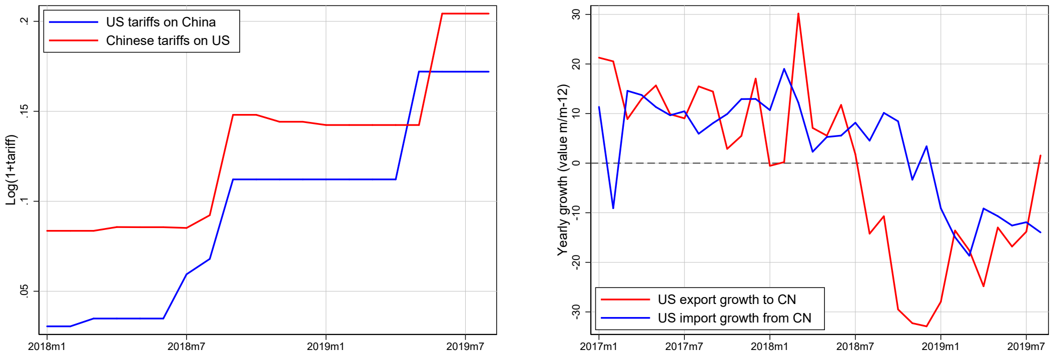
We start by analyzing for which products tariffs were raised. The left panel of figure 3 shows the distribution of US imports from China across major broad economic categories (BECs). Compared to aggregate US imports, US imports from China are more concentrated in capital and consumption goods, and less in intermediate goods. However, the US chose to target particularly intermediate goods for tariff increases. Intermediate goods account for over 50% of the US tariff increases on China, even though they only make up roughly 30% of US imports from China. This relationship is similar for Chinese tariffs, as intermediate goods account for almost 80% of Chinese tariffs on the US, even

Australia, India, Japan, Korea, Hongkong, Taiwan, Singapur, Vietnam, Thailand, Bangladesh, Malaysia, Indonesia, Philippines, and United Arab Emirates.

[4] This early version of the draft does not yet include retaliatory tariffs from other countries such as the EU.

[5] A more detailed description of events during the tariff war can be found in Bown and Kolb (2020).

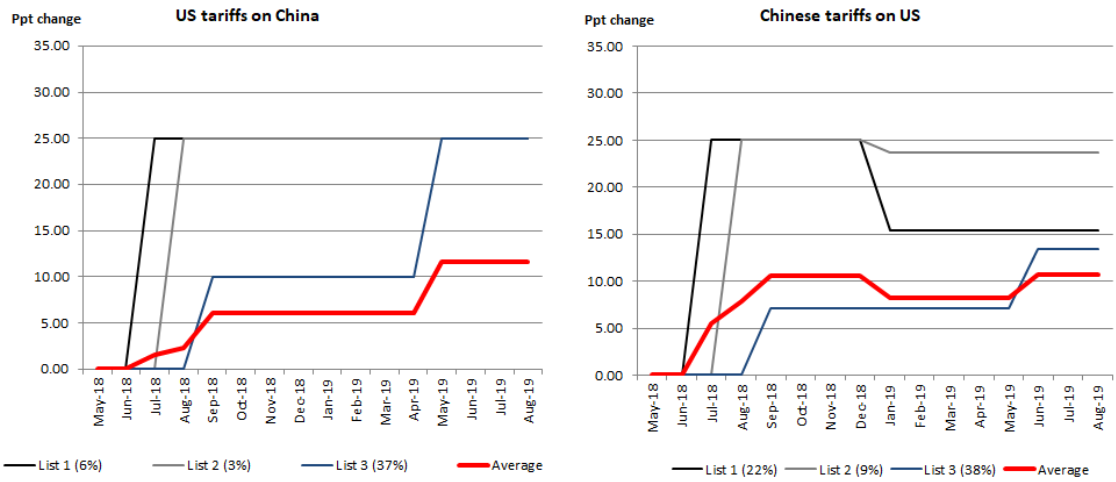
Figure 1: Trade war: China versus US



Average tariff Yearly trade growth

Note : Tariffs are the average of the log of 1+tariff, considering all goods categories. Trade data for this graph are from the census Bureau and were downloaded via FRED (St Louis FED).

Figure 2: Trade war: US/China tariff waves



Note : Tariff increases that exclusively apply to China/US. Percentages in brackets refer to shares in total bilateral imports. US imports from China in 2017: 505bn USD. Chinese imports from US in 2017: 153bn USD.

though their share in Chinese imports from the US is only slightly above 60%.

Next, we do a more systematic descriptive analysis to better understand how the US and Chinese administrations chose the products to be taxed. For each country, we regress the cumulative ppt increase in the tariff rate (until Aug 2019) on decile dummies for import growth (D_{1s}), bilateral import share (D_{2s}), partner's bilateral export share (D_{3s}), and partner's export growth (D_{4s}), leaving out the dummies for the lowest decile for each variable.[6] We also add BEC dummies.[7]

$$Pptchange_k = \alpha + \sum_{j=1}^{4}\sum_{s=2}^{10} \beta_{js} D_{jsk} + \sum_{s=2}^{4} \gamma_s BEC_{sk} + \epsilon_k \tag{1}$$

In all estimations, partner export growth and export share as well as own import growth do not have noticable effects on the tariff choice and are therefore omitted from the graphs.

For both countries, we find a strong and quite similar dependence of granted protection on the bilateral import share. This is shown in figure 4. For both countries, the average tariff increase exhibits an inverse u-shape with respect to the bilateral import share. While categories with zero bilateral imports, unsurprisingly, were essentially not taxed, tariff increases were highest at low-medium levels of the bilateral import share (around 5-10%). Both countries chose to tax those products substantially less which had a very high bilateral import dependence. These differences are substantial. Compared to the groups with highest tariff increases, tariffs at the top of the bilateral import share distribution increased on average by 7pp (US) - 15pp (CHN) less. This suggests that both countries wanted to spare industries with particularly high bilateral import dependence from tariff increases and instead spread the burden of the tariff war more widely across the economy.

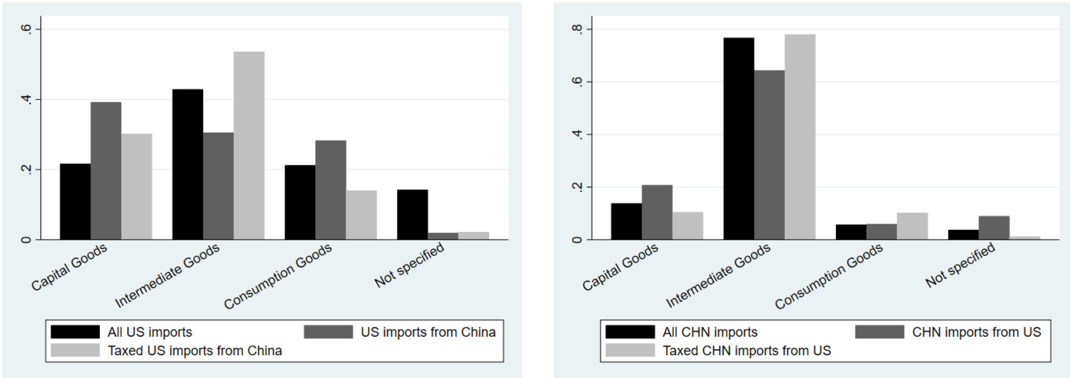
By Aug 2019, all categories in which the US exclusively taxed China were taxed at a uniform 25%. Differences in average tariff rates along the bilateral import share distribution are therefore only due to differences in the shares of products that got taxed.

China, in contrast, applied very different rates across products. We can therefore split up the average tariff increase into the probability of a tax increase times the ppt incrase given a tariff change. Doing so shows that categories with high bilateral import shares had lower average tariff rates not so much because they had a lower probability of taxation, but because their applied rates were smaller (figure 5).

[6] Export and import shares are zero for sizable share of categories. For these variables, we group all categories with zero shares into the lowest bin, and divide all remaining categories into nine equally sized bins.

[7] In the case of China, we also add the US tariff increase in the same category, to test whether China simply retaliated on the same categories that the US chose.

Figure 3: Determinants of US and CN tariffs



(a) US Imports (b) CN imports

Note: Panel (a) shows the distribution across broad economic categories (BEC) for all US imports in 2017 (in black). The dark grey bars show the same distribution for US imports from China. The light grey bars show the distribution for taxed US imports from China. This is calculated using the product-level cumulative tariff increase times the product weight in 2017 imports from China. Panel (b) shows the corresponding graph for China.

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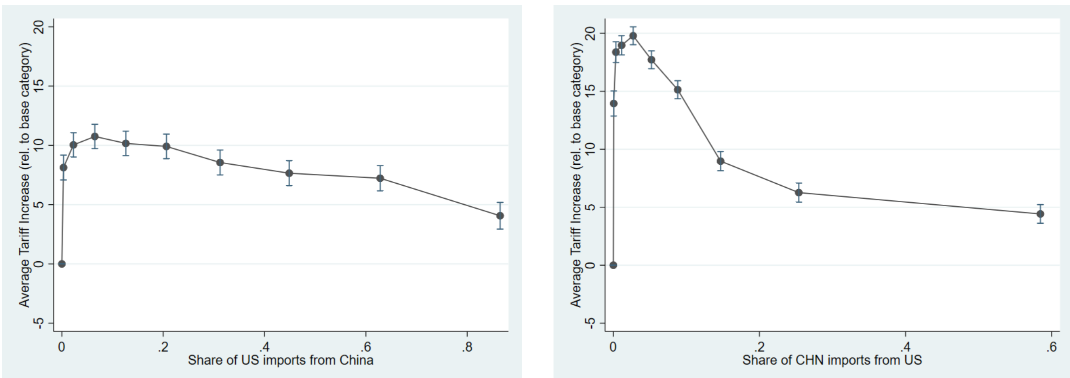
Figure 4: Bilateral Import Share as a determinant of US and CN tariffs



(a) US tariffs on CN (b) CN tariffs on US

Note: Panel (a) shows the estimated coefficients (and standard errors) from a regression of the cumulative increase in the US tariff rate on decile dummies of the US import share from China (controls are detailed in equation 1). Panel (b) shows the corresponding graph for Chinese tariffs.

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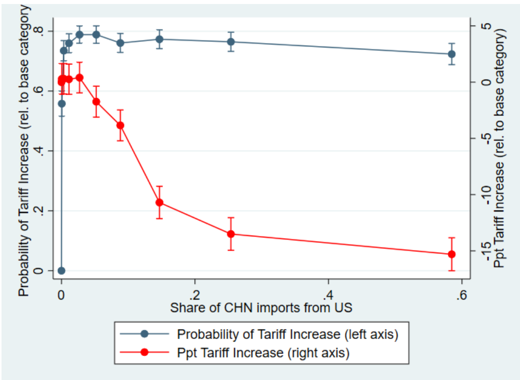
Figure 5: CN tariff increase by import share



Note: This graph shows the estimated coefficients (and standard errors) from a regression of a dummy for a tariff increase (the ppt increase, given a tariff increase) on decile dummies of the Chinese import share from the US (controls are detailed in equation 1).

3 Results: Intensive margin adjustment

3.1 Direct impact of tariffs on exports

3.1.1 Event study

We start the analysis at the intensive margin by showing the results of an event study based on the response of Chinese exports to US tariffs changes (events). We date the start of the event at the date where the tariff increase started for each product. Formally, we estimate Equation 2, where the dependent variable $\Delta \log(X_{kt})$ is the yearly log variation of exports in product k and date (month) t. The main explanatory variable is the interaction between a dummy variable identifying products with a tariff change (T_k) and a dummy identifying the s month away from the tariff change (D_s). We are interested in the value of coefficients β_s for each period s before / after the event. In this empirical specification, α_k and α_t are product and time fixed effects. The United States is the only destination that we keep in this specification for Chinese exports. We estimate this empirical equation using an OLS specification.

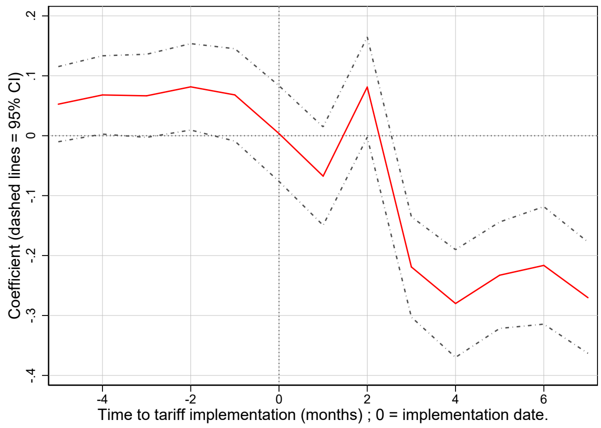
$$\Delta \log(X_{kt}) = \alpha_k + \alpha_t + \sum_{s=-5}^{7} \beta_s * D_s * T_k + \epsilon_{kt} \tag{2}$$

The estimation results reported in Figure 6 clearly show that Chinese exports to the US started to decline – in targeted product categories – shortly after new tariffs were implemented. The average adjustment for targeted product is statistically and economically significant (between -0.2 and -0.3 log points), meaning that bilateral exports for the average product targeted declined by about 20%. We provide evidence below that this adjustment was strongly linked to tariff changes at the product-level over this period of time.

3.1.2 Effects of tariffs: Descriptive evidence

We evaluate here the effects of the bilateral rise in import tariffs between the United States and China on product-level bilateral export growth in targeted products. We start the analysis by providing some descriptive evidence of the relation between tariff

Figure 6: Impact of tariff changes on the value of Chinese exports to the US: event graph



Note: Graphs based on coefficients from event study regressions for Chinese and US bilateral export growth. Dashed lines represent 95% confidence intervals. 0 is the date of the tariff implementation.

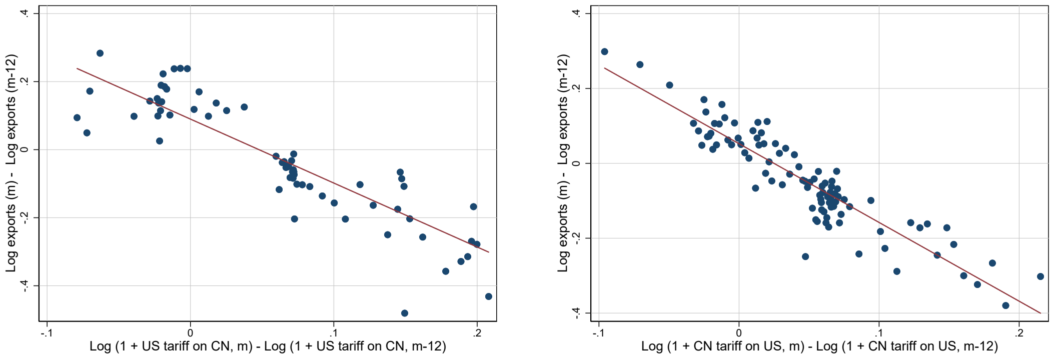
changes over the period of the trade war covered by our data and the adjustment of bilateral product-level exports by China and the United States.

We report in Figure 7 a simple correlation between the yearly growth of bilateral exports between the two countries and tariff changes during the same period in each product category. Each graph (A: Chinese exports to the US; B: US exports to China) was obtained using the Binscatter command under Stata, controlling for product-level fixed effects. These two graphs report that over the period considered, the relation between the log variation of exports and the log change in tariffs is clearly negative and fairly log-linear.

3.1.3 Effects of tariffs: Econometric analysis

We complete the analysis by estimating an econometric model described below. The empirical strategy is similar to the one described in Amiti et al. (2019) and Fajgelbaum et al. (2019). In Equation 3, the log variation of bilateral exports between the two countries, over a 12 month period, is explained by product-level fixed effects (α_k), time dummies (α_t) and our main variable of interest, the log variation of the tariff over the same period of time ($\Delta \log(1 + \tau_{kt})$). The strategy is then a simple difference-in-difference based on an OLS estimator, which consists in comparing taxed with not-taxed products,

Figure 7: Impact of tariffs on China and US bilateral exports.



A: CN exports to US   B: US exports to CN

Note : Tariffs are the average of the log of 1+tariff, considering all goods categories. This graph was obtained using the Stata Binscatter command, controlling for product fixed effects.

before and after the tariff change.

$$\Delta \log(X_{kt}) = \alpha_k + \alpha_t + \beta \Delta \log(1 + \tau_{kt}) + \epsilon_{kt} \tag{3}$$

In an alternative approach (Equation 4), we also estimate a similar equation but this time we consider all possible destinations in Chinese and US exports. Adding more destination countries allows to control for product-specific global demand and supply shocks, and have a cleaner identification of our main coefficient of interest (β) on the tariff change variable.

$$\Delta \log(X_{jkt}) = \alpha_{jk} + \alpha_{jt} + \alpha_{kt} + \beta \Delta \log(1 + \tau_{jkt}) + \epsilon_{jkt} \tag{4}$$

In this specification, α_{jk} corresponds to product-destination fixed effects and allows for different trends of Chinese or US exports by partner and product. α_{jt} corresponds to destination-country by month fixed effects and controls for importer demand shocks that are common across products. α_{kt} corresponds to product by month fixed effects and controls for product demand shocks that are common across markets. This estimator compares the double difference for Chinese exports to the US (or US exports to China) with the double difference in other markets.

Table 1: Direct Effect of Tariffs on Exports

Dep. var. (Δ ln)	Value	Quantity	Unit Value	Value	Quantity	Unit Value
Exporter	A: China					
Destination	USA			All destinations		
$\Delta \log(1+\tau)$	-1.162***	-1.052***	-0.110	-1.117***	-1.127***	0.010
	(0.119)	(0.136)	(0.085)	(0.117)	(0.134)	(0.083)
Number of obs	91,898	91,898	91,898	2,193,399	2,193,399	2,193,399
Adj. R2	0.12	0.11	0.08	0.11	0.12	0.12
Exporter	B: United States					
Destination	China			All destinations		
$\Delta \log(1+\tau)$	-1.533***	-1.700***	0.167	-1.229***	-1.423***	0.195
	(0.255)	(0.288)	(0.137)	(0.288)	(0.302)	(0.154)
Number of obs	59,033	59,033	59,033	1,245,981	1,245,981	1,245,981
Adj. R2	0.11	0.09	0.05	0.20	0.07	0.19
FE	CP+CT	CP+CT	CP+CT	CP+CT+PT	CP+CT+PT	CP+CT+PT

Note: Significance levels: $***$ p<0.01, $**$ p<0.05, $*$ p<0.1. Standard errors clustered by HS 6-digit product.

Estimation results of the direct impact of US tariff on Chinese exports or Chinese tariffs on US exports are reported respectively in Panels A and B of Table 1. The estimation coefficients on the tariff variable are always negative when the dependent variable is the value of bilateral exports, and the magnitudes are similar in the case of Chinese exports to the US or US exports to China. Results are also consistent when we consider only bilateral exports between China and the US, or exports to all possible destinations in a double difference-in-difference approach. This confirms that Bilateral tariffs in this trade war had a strong detrimental impact on the value of bilateral trade. In quantitative terms, a 10 pp. increase in the tariff rate (as in US list 3) reduces export growth by about 11 to 12 pp. (Chinese exports to the US) or by about 12 to 15 pp. (US exports to China).

An important result, confirming previous ones by Amiti et al. (2019) and Fajgelbaum et al. (2019), is that the effect is entirely driven by lower quantities exported in both directions, while the F.O.B. unit values remain unaffected.

We test for the robustness of these results by weighting the observations used for these estimations by the value of bilateral export flows at product level. This strategy allows

Table 2: Direct Effect of Tariffs on Exports : weighted estimations

Dep. var. ($\Delta \ln$)	Value	Quantity	Unit Value	Value	Quantity	Unit Value
Exporter	A: China					
Destination	USA			All destinations		
$\Delta \log(1+\tau)$	-0.967***	-1.012***	0.045	-1.077***	-1.016***	-0.062
	(0.188)	(0.178)	(0.095)	(0.268)	(0.211)	(0.129)
Number of obs	91,811	91,811	91,811	2,190,551	2,190,551	2,190,551
Adj. R2	0.29	0.27	0.21	0.35	0.38	0.43
Exporter	B: United States					
Destination	China			All destinations		
$\Delta \log(1+\tau)$	-3.203***	-2.853***	-0.350**	-3.517***	-3.078***	-0.440
	(1.111)	(1.053)	(0.156)	(0.970)	(0.960)	(0.310)
Number of obs	58,995	58,995	58,995	1,244,455	1,244,455	1,244,455
Adj. R2	0.25	0.25	0.06	0.36	0.34	0.31
FE	CP+CT	CP+CT	CP+CT	CP+CT+PT	CP+CT+PT	CP+CT+PT

Note: Significance levels: $***$ p<0.01, $**$ p<0.05, $*$ p<0.1. Standard errors clustered by HS 6-digit product. In this weighted estimation, the weights correspond to the value of bilateral export flows at product-level.

to get a better sense of the macroeconomic impact of the trade wars, and also corrects for outliers due product categories with only small amounts traded.

The estimation results reported in Table 2 are qualitatively similar to the ones obtained in un-weighted estimations. The most significant change is that now the tariff elasticity of US exports vis-à-vis Chinese tariffs is now larger than in the un-weighted case (about three times as large). This result is partly driven by a product composition effect, as Chinese tariffs targeted mostly US agriculture in product categories associated with larger price elasticities of imports. Other results remain unchanged: tariff waves implemented by the two countries reduced significantly bilateral exports in value terms. This effect is entirely driven by a drop in the quantities exported in targeted product categories, while the F.O.B. unit values of exports remained unaffected in both directions.

There are two interesting findings here that are useful to discuss.

Firstly, the tariff elasticities that are obtained, especially in un-weighted estimations, are close to -1 and therefore remain quantitatively low in absolute terms compared with the price elasticity of imports that is estimated based on similar product-level or firm-level trade data (Imbs and Mejean, 2015; Fontagné et al., 2018), or with the tariff elasticity that has been estimated in previous work based on firm-level trade data Berthou and Fontagné (2016); Fitzgerald and Haller (2018) in "normal" times and mostly from cross-sectional variation of tariffs. The weakness of the elasticity obtained during the trade war period may result from the fact that we as estimating a short or medium-run elasticity whereas previous works have been focusing more on the long-term impact. For instance, it may take time for US importers to switch their imports from an alternative non-taxed supplier. Testing for this intuition will require a longer time span of data.

Secondly, the absence of adjustment of trade unit values contrasts with standard trade models with a large country, where targeting foreign countries with new tariffs is expected to improve the terms of trade, meaning that there can exist an optimal taxation in the absence of retaliation by foreign trade partners (Costinot and Rodríguez-Clare, 2014; Ossa, 2014). This result, which is obtained in both directions of the US-China trade, implies that tariffs were fully passed through into importer prices, reinforcing the negative welfare impact of the trade war.

3.2 Impact on exports to third destinations: Trade Deflection effect.

In a second step, we test if the rise in bilateral tariffs between the United States and China caused exports in targeted product categories to be re-oriented towards third countries, i.e. a "Deflection Effect". Such a deflection effect can be expected in different case where the drop in foreign demand in targeted goods categories cause a decline in export prices towards all destinations. This may be the case for instance if the marginal cost is increasing with quantities exported (decreasing returns to scale) or if the drop in foreign demand leads exporters to reduce their markups.

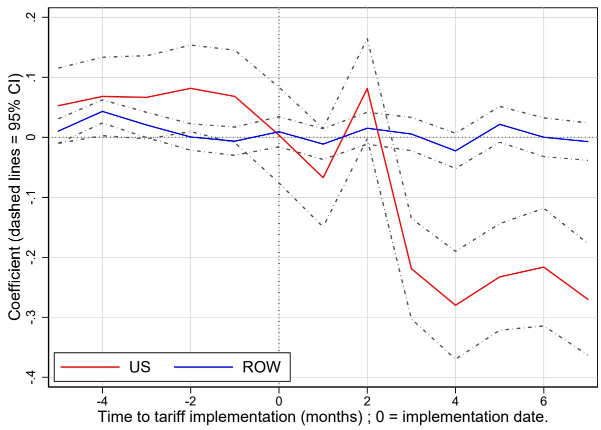
3.2.1 Event study

We start the analysis by reporting the results of an event study, where the main variable of interest is now the growth of exports towards third destinations in product categories targeted by the foreign tariffs. We make this analysis in the case of Chinese exports towards third markets (Rest of the World, ROW). The empirical approach is similar to the one described in the previous section: we estimation Equation 5 where the dependent variable is now the detailed yearly log variation of product-level exports towards all extra-US destinations in our sample. α_{kt} are product-time fixed effects, and α_{jt} are destination-time fixed effects. We also report also for comparison the impact of tariff events on export growth by China to the United States in targeted product categories.

$$\Delta \log(X_{j \neq US,kt}) = \alpha_{kt} + \alpha_{jt} + \sum_{s=-5}^{7} \beta_s * D_s * T_k + \epsilon_{jkt} \tag{5}$$

The results from this estimation (the β_s coefficients are reported in Figure 8. While there is a clear decline in the Chinese exports growth to the United States in targeted product categories following the start of the trade war, we find no quantitative impact on exports towards third destinations.

Figure 8: Impact of tariff changes on the value of Chinese exports to the rest of the World: event graph



Note: Graphs based on coefficients from event study regressions for Chinese export growth. Dashed lines represent 95% confidence intervals. 0 is the date of the tariff implementation.

3.2.2 Effects of tariffs: Econometric analysis

We complete the analysis by estimating the impact of bilateral tariff changes on exports towards third destination. We estimate Equation 6. In the case of Chinese exports, destinations exclude the United Sates and tariffs are US tariffs applied to targeted goods categories. In the case of US exports, destinations exclude the China and tariffs are Chinese tariffs applied to targeted goods categories. We proceed with two types of estimations, by considering firstly the Rest of the World as an aggregate, and then detailed ROW destinations in a second approach.

$$\Delta \log(X_{j\in ROW,kt}) = \alpha_{jk} + \alpha_{jt} + \alpha_{kt} + \beta\Delta \log(1 + \tau_{jkt}) + \epsilon_{jkt} \tag{6}$$

Estimation results are reported in Table 3. Results indicate that in value terms, no trade deflection effect can be identified in the case of Chinese or US exports to ROW destinations. This result remains valid when we consider the rest of the world as an aggregate, or when we consider individual destinations. In the case of China, we find that export quantities increased towards third destinations when we consider them individually, but this was compensated by lower trade unit values. This result is not significant however when we aggregate the rest of the world into a single region, so this result should be interpreted with caution and may result from trade adjustment with small countries. In the case of the United States, we rather find a negative impact of Chinese tariffs on export quantities towards third countries.

Table 3: Trade Deflection: Effect of tariffs on exports to third destinations.

Dep. var. (Δ ln)	Value	Quantity	Unit Value	Value	Quantity	Unit Value
Exporter	A: China					
Destination	Aggregate extra-US			Detailed extra-US		
$\Delta \log(1 + \tau_{us})$	0.096	0.104	-0.008	0.024	0.115***	-0.091***
	(0.088)	(0.092)	(0.063)	(0.036)	(0.037)	(0.024)
Number of obs	132,214	132,214	132,214	2,060,808	2,060,808	2,060,808
Adj. R2	0.12	0.16	0.18	0.08	0.09	0.10
Exporter	B: United States					
Destination	Aggregate extra-CN			Detailed extra-CN		
$\Delta \log(1 + \tau_{chn})$	-0.149	-0.199**	0.050	-0.089	-0.181***	0.092
	(0.093)	(0.088)	(0.073)	(0.073)	(0.069)	(0.059)
Number of obs	145,373	145,373	145,373	1,203,778	1,203,778	1,203,778
Adj. R2	0.07	0.09	0.06	0.04	0.06	0.03
FE	CP+CT	CP+CT	CP+CT	CP+CT+PT	CP+CT+PT	CP+CT+PT

Note: Significance levels: $***$ p<0.01, $**$ p<0.05, $*$ p<0.1. Standard errors clustered by HS 6-digit product.

Weighted estimations are reported in Table 4. The results confirm previous un-weighted results: in the case of Chinese exports to the rest of the world, or in the case of US exports to the rest of the world, no reallocation / deflection effect can be identified when observations are weighted using export values at weights. These results are based on data covering the trade war up to August 2019, and may be updated based on more recent data.

Table 4: Trade Deflection: Effect of tariffs on exports to third destinations: weighted estimations.

Dep. var. (Δ ln)	Value	Quantity	Unit Value	Value	Quantity	Unit Value
Exporter	A: China					
Destination	Aggregate extra-US			Detailed extra-US		
$\Delta\log(1+\tau_{us})$	0.020	-0.116	0.136*	0.102	-0.007	0.109
	(0.109)	(0.104)	(0.075)	(0.130)	(0.094)	(0.076)
Number of obs	132,091	132,091	132,091	2,058,177	2,058,177	2,058,177
Adj. R2	0.23	0.46	0.50	0.17	0.27	0.33
Exporter	B: United States					
Destination	Aggregate extra-CN			Detailed extra-CN		
$\Delta\log(1+\tau_{chn})$	-0.138	-0.127	-0.011	-0.094	-0.107	0.013
	(0.142)	(0.163)	(0.132)	(0.142)	(0.160)	(0.117)
Number of obs	145,331	145,331	145,331	1,202,281	1,202,281	1,202,281
Adj. R2	0.16	0.18	0.11	0.11	0.15	0.05
FE	CP+CT	CP+CT	CP+CT	CP+CT+PT	CP+CT+PT	CP+CT+PT

Note: Significance levels: $***$ p<0.01, $**$ p<0.05, $*$ p<0.1. Standard errors clustered by HS 6-digit product.

4 Extensive margin adjustment

4.1 Descriptive evidence

This section evaluates the effects of the bilateral rise of import tariffs between the United States and China on the probability to export targeted products (the extensive margin adjustment). This channel comes on top of the adjustment at the adjustment at the intensive margin and could reinforce the quantification of the aggregate impact.

In data terms, the analysis at the extensive margin requires to generate an export dummy variable in our dataset. We identify with a “one” the products that are exported from a country of origin to a country of destination, and with a “zero” the products that are not exported. In practical terms, we “fill in” our trade matrix with zeros whenever the product is listed in the product nomenclature (8,046 products HS 8 products in Chinese export data; 9,351 HS 10 products in US export data) and is not exported, and with ones otherwise. The overall probability to export can be computed as the share of exported products to a destination.

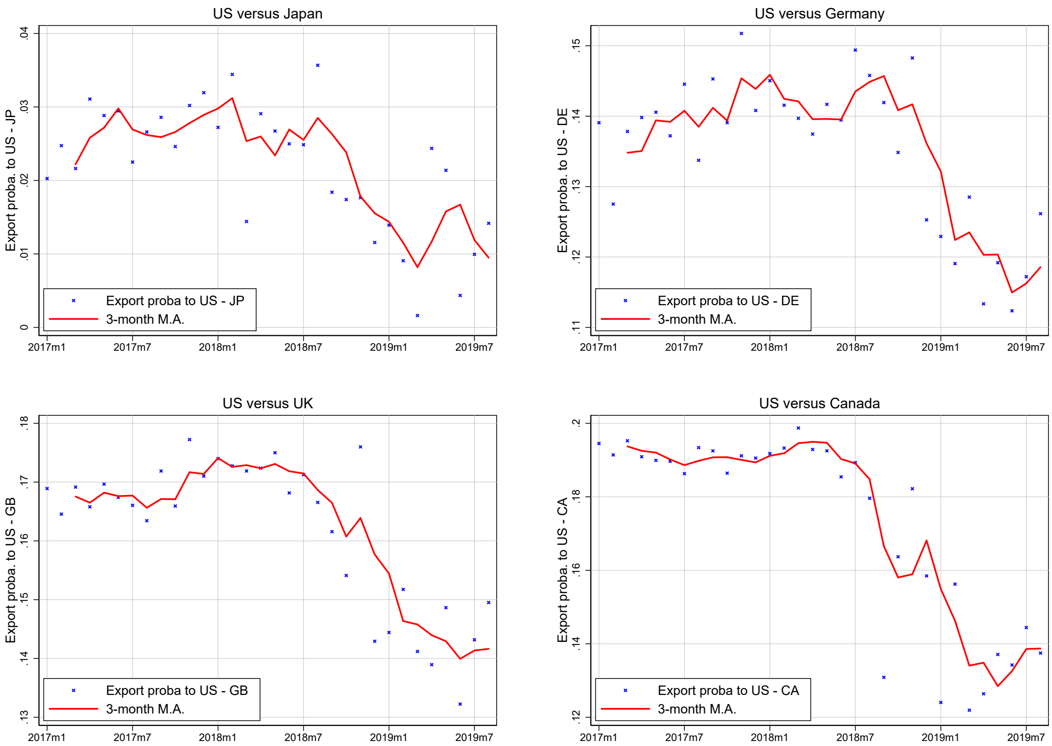
We start the analysis by providing some descriptive evidence of the effects of tariffs on (1) the probability of China to export goods categories to the United states relative to a reference destination; and, (2) the probability of the United States to export goods categories to China relative to other destinations. Our main variable of interest in this exercise is the share of product categories exported to the United States (or China) minus the share of products exported to a reference destination (Japan, Germany, the United Kingdom or Canada). Using reference destinations allows controlling for macroeconomic patterns that could impact global trade flows and therefore the export probability of China and the United States to all destinations, and allows focusing on the shocks that are specific to the US-China trade relation. While this exercise does not represent a formal test of the quantitative impacts of tariffs, it provides a useful representation that they had an impact within the US-China trade relation compared with the trade relation with the group of reference destinations.

We present in Figure 9 the evolution of the export probability of China to the United States relative to other reference destinations. The graphs present both the relative export probability in each month and a 3-month moving average. It is clear from these graphs that relative to Japan, Germany, UK and Canada, the export probability of China to the United States has been declining. The striking pattern is that this decline starts precisely when the trade war started in early 2018, and accelerates in the second semester.

In quantitative terms, the export probability of China to the United States was about 19 pp. higher than the export probability to Canada before the trade war. In the summer of 2019 (i.e. 18 months after the start of the trade war), the export probability to the United States was only 14 pp. higher. So, everything else equals, the trade war may have reduced the export probability of China to the US relative to Canada by about 4 pp. in this period of time. The loss in terms of export probability is of about 2 to 3 pp. relative to Japan, Germany or the united Kingdom over the same period of time.

In Figure 10, we show that similar pattern emerges for the export probability of the United States to China relative to other destinations: the probability to export declines by about 2 pp. relative to Japan, Germany, the United kingdom and Canada, between January 2018 and the summer of 2019.

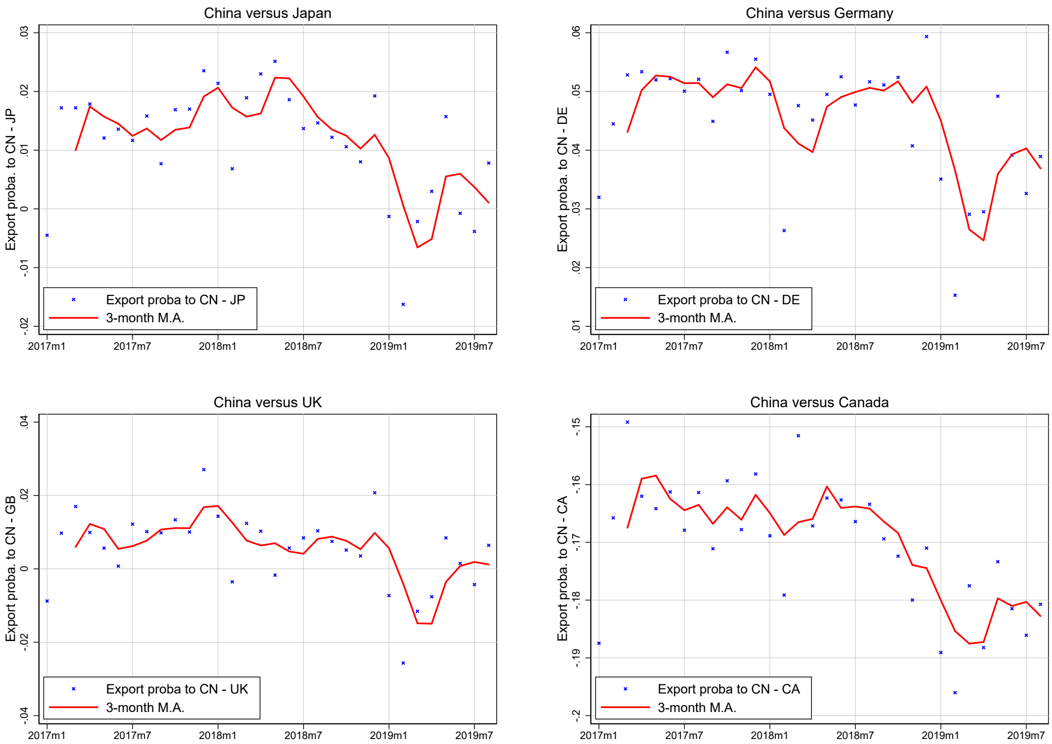
Figure 9: China: Probability of exports to the United States relative to reference destinations



Note : Export probability to the US minus export probability to the reference destination (Japan, Germany, United Kingdom or Canada) .

Figures 11 and 12 present a correlation between the relative export probabilities of China and the United States and foreign import tariffs applied by the two countries. The relative export probabilities are computed as in the previous graphs with the same set of reference destinations. The graphs were obtained by using the Stata Binscatter command, controlling for HS 6-digit product fixed effects. In the cases of US and Chinese exports, we obtain a negative relation between the log of $1 + tariff$ and the relative export probability. While this evidence does not represent a complete test of the effects of

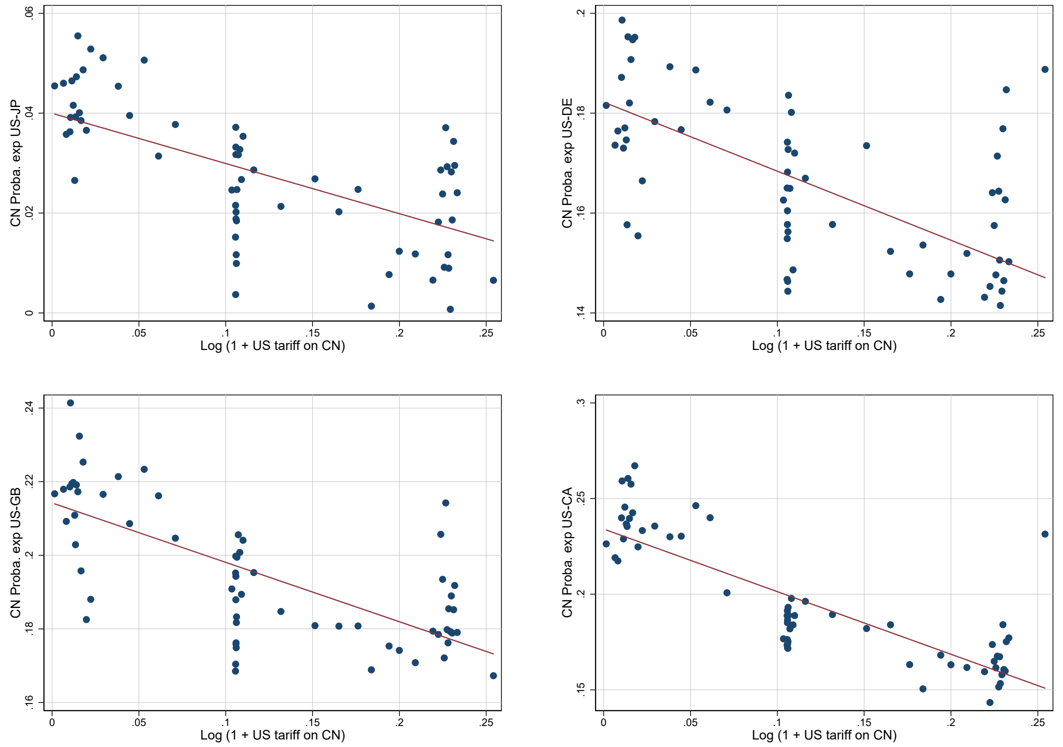
Figure 10: US: Probability of exports to China relative to reference destinations



Note : Export probability to China minus export probability to the reference destination (Japan, Germany, United Kingdom or Canada).

foreign import tariffs on US and Chinese exports, they indicate that higher tariffs levels are indeed associated with a lower probability to export a given product.

Figure 11: China Impact of US import tariffs on the probability of exports to the United States relative to reference destinations

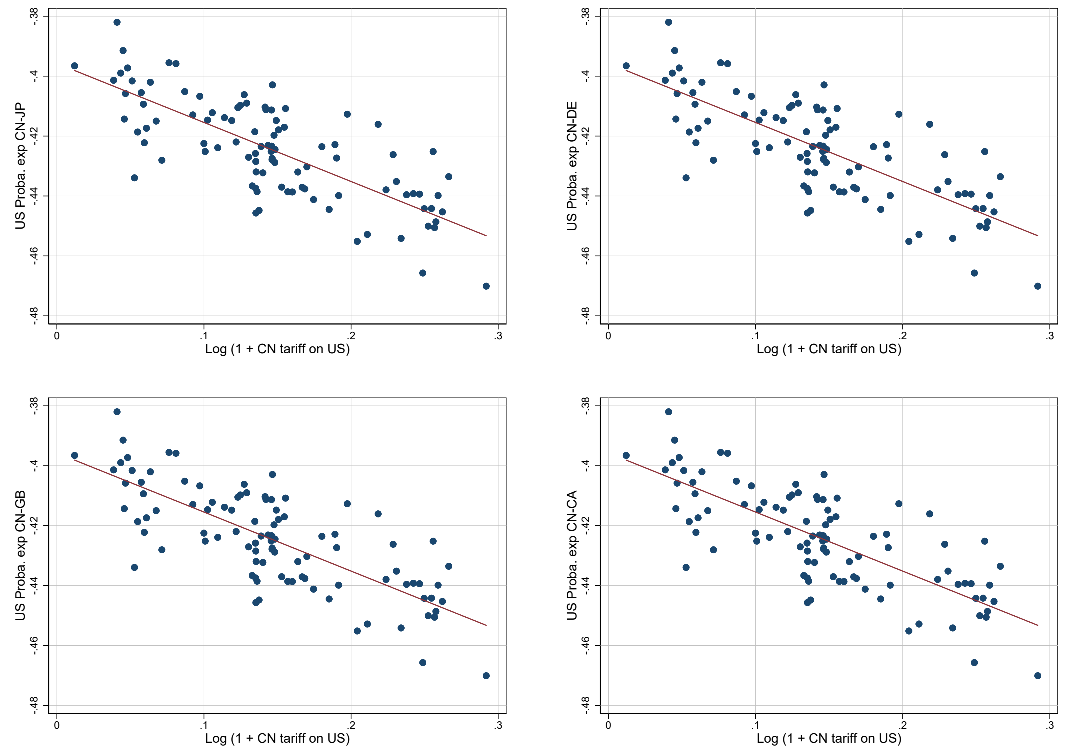


Note : Export probability to the US minus export probability to the reference destination (Japan, Germany, United Kingdom or Canada) in the same product.

4.2 Event study

To explore more precisely the impact of the bilateral trade war on exports, we proceed with an event study framework. To do so, we identify in Chinese or US exports those product categories that were subject to a bilateral increase of tariffs between the two countries and the timing of these tariff increases. Formally, we estimate Equation 7, where the dependent variable $\mathbb{1}_{Ejkt}$ is the probability of export to destination country j in product k and date (month) t. The main explanatory variable is the interaction between a dummy variable identifying products with a tariff change (T_k) and a dummy

Figure 12: Impact of Chinese import tariffs on the probability of exports to China relative to reference destinations



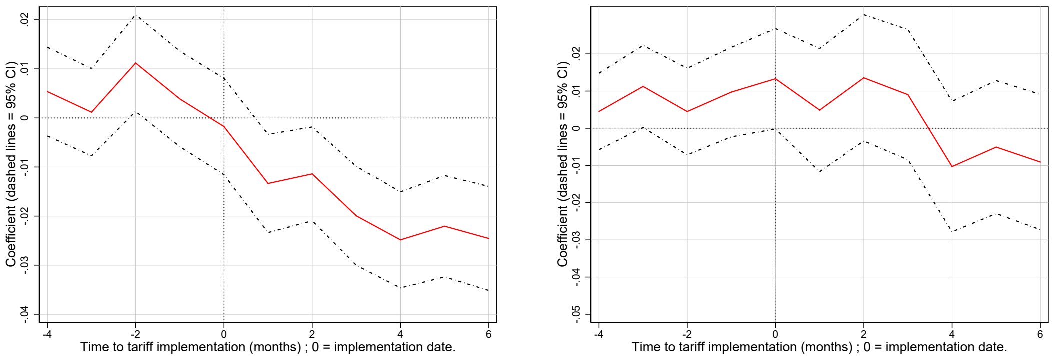
Note : Export probability to China minus export probability to the reference destination (Japan, Germany, United Kingdom or Canada) in the same product.

identifying the s month away from the tariff change (D_s). We are interested in the value of coefficients β_s for each period s before / after the event. In this empirical specification, α_{jk}, α_{kt} and α_{jt} are destination-product, product-time and destination-time fixed effects, which absorb in particular global (product-specific) shocks or country shocks. We estimate this empirical equation using a linear probability model with OLS.

$$\mathbb{1}_{Ejkt} = \alpha_{jk} + \alpha_{kt} + \alpha_{jt} + \sum_{s=-4}^{6} \beta_s * D_s * T_k + \epsilon_{jkt} \quad (7)$$

The estimation results for Chinese and US exports are represented respectively in the two graphs of Figure 13. Both graphs confirm the decline in the probability to export for exposed products, though the event study shows more significant impact in the case of Chinese exports to the United States. The insignificant effect estimated in the case of US exports to China may be explained by the greater variety of events in this direction, which introduces some noise in the estimation of the β_s coefficients.

Figure 13: Event study: impact of US import tariffs on Chinese export probability



Chinese exports to US

US exports to CN

Note : Graphs based on coefficients from event study regressions for Chinese and US export probability (linear probability models). Dashed lines represent 95% confidence intervals. 0 is the date of the tariff implementation.

4.3 Impact of US tariffs on the probability to export

In this section, we present the estimation results based on the estimation of the linear probability model. We start by estimating the cross-section impact of the tariff level on the probability to export ($\mathbb{1}_{Ejkt}$). The estimation strategy is presented in Equation 8. Our main variable is the level of the bilateral tariff ($\log(1+\tau_{jkt})$) and the estimation controls for destination-product (α_{jk}), destination-time (α_{jt}) and product-time (α_{kt}) fixed effects.

$$\mathbb{1}_{Ejkt} = \mathbb{1}[X_{jkt} \neq 0] = \alpha_{jk} + \alpha_{jt} + \alpha_{kt} + \gamma \log(1+\tau_{jkt}) + \epsilon_{jkt} \tag{8}$$

We also evaluate the dynamic impact of the tariff changes on the probability of product entry (counterfactual is non-entry) and exit (counterfactual is remain exported). The estimated specifications are presented in Equations 9 and 10.

$$\mathbb{1}_{Njkt} = \mathbb{1}[X_{jkt} = 1 \cap X_{jkt-1} = 0] = \alpha_{jk} + \alpha_{jt} + \alpha_{kt} + \theta \Delta \log(1+\tau_{jkt}) + \epsilon_{jkt} \tag{9}$$

$$\mathbb{1}_{Ejkt} = \mathbb{1}[X_{jkt} = 0 \cap X_{jkt-1} = 1] = \alpha_{jk} + \alpha_{jt} + \alpha_{kt} + \eta \Delta \log(1+\tau_{jkt}) + \epsilon_{jkt} \tag{10}$$

The empirical results from these estimations are presented in Table 5, panels A (China) and B(United States). These results mostly confirm the descriptive analysis presented earlier in this section. Higher foreign import tariffs reduce the probability of exports. In the case of Chinese exports, with an elasticity of about -0.10, an increase in US tariffs by 10pp. (25pp.) reduces the export probability of Chinese products in the US by about 1.0% (2.5%). In the case of US exports, with an elasticity of about -0.18, an increase in Chinese tariffs by 10pp. (25pp.) reduces the export probability of US products in China by about 1.9% (4.7%).

Similar dynamic patterns appear in the cases of the two countries' exports: the increase in foreign tariffs faced by exporters reduced the probability to enter the foreign market, and increased the probability to exit. These results remain valid empirically when we change our set of fixed effects to control for product-time effects on top of country-product and country time in our baseline specification. In the last section of the paper, we evaluate the aggregate contribution of these changes at the extensive margin to the dynamics of aggregate exports since January 2018.

Table 5: Impact of tariffs on the probability to export

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Export dummy		Entry dummy		Exit dummy	
Exporter			A: China			
ln(1+tariff)	-0.101***	-0.107***				
	(0.019)	(0.018)				
Δ ln(1+tariff)			-0.109**	-0.095**	0.084***	0.067***
			(0.045)	(0.043)	(0.016)	(0.015)
Number of obs	8,707,680	8,707,680	2,883,477	2,878,363	2,544,773	2,540,321
Adj. R2	0.61	0.61	0.30	0.32	0.36	0.37
Exporter			B: United States			
ln(1 + tariff)	-0.168***	-0.186***				
	(0.030)	(0.030)				
Δ ln(1 + tariff)			-0.076**	-0.083**	0.142***	0.145***
			(0.036)	(0.034)	(0.035)	(0.035)
Number of obs	10124288	10124288	4,281,646	4,280,834	2,026,333	2,021,819
Adj. R2	0.58	0.58	0.27	0.28	0.38	0.39
FE	CP+CT	CP+CT+PT	CP+CT	CP+CT+PT	CP+CT	CP+CT+PT

Note: Significance levels: ∗ ∗ ∗ p<0.01, ∗∗ p<0.05, ∗ p<0.1. Standard errors clustered by HS 6-digit product.

4.4 Extensive margin : exports probability to ROW

We examine here the impact of US or China tariffs on to probability to export targeted products to third destinations. These estimations are similar in nature to those presented above when we consider all possible destinations and products. This time, however, only third destinations are considered: we exclude from the sample of destinations either the United States in the case of Chinese exports, or the China in the case of US exports. In all estimations, the main variable of interest is the tariff change in the US or China. We can therefore investigate the effects of US tariff changes on Chinese exports to third destinations, and the effects of Chinese tariff changes targeting US goods on US exports to third destinations.

The main estimation results are reported in Table 6 for Chinese export probability to third destinations (panel A) or the US export probability to third destinations (panel B). All results indicate that the export probability of China to third destinations was not impacted by US tariffs. This result holds when the US and the European Union countries are both excluded from the sample of destinations (we have a negative coefficient on exit for China in column 6, but it is only weakly significant).Similar result appears in the case of the United States. In this case, excluding as well the European Union is important as the EU also engaged into a (more limited) trade war with the US. If anything, Chinese tariffs increased (moderately) the probability to exit from third destinations in the rest of the world.

Table 6: Impact of tariffs changes on the probability of entry to ROW

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Export dummy		Entry		Exit	
Exporter			A: China			
Excluded destinations	US	US + EU	US	US + EU	US	US + EU
ln(1 + US tariff)	-0.007	-0.005				
	(0.009)	(0.009)				
Δ ln(1 + US tariff)			0.021	0.034	-0.012	-0.023*
			(0.025)	(0.024)	(0.013)	(0.014)
Number of obs	5,125,923	3,883,275	898,907	654,892	1,039,518	813,844
Adj. R2	0.57	0.57	0.30	0.30	0.36	0.36
Exporter			B: United States			
Excluded destinations	China	China + EU	China	China + EU	China	China + EU
ln(1 + CN tariff)	-0.002	-0.000				
	(0.007)	(0.007)				
Δ ln(1 + CN tariff)			-0.001	-0.014	0.029*	0.038**
			(0.011)	(0.011)	(0.015)	(0.016)
Number of obs	7,713,849	5,843,825	1,791,314	1,366,329	1,088,070	815,390
Adj. R2	0.56	0.58	0.27	0.27	0.38	0.38
FE	CP+CT	CP+CT+PT	CP+CT	CP+CT+PT	CP+CT	CP+CT+PT

Note: Significance levels: $***$ p<0.01, $**$ p<0.05, $*$ p<0.1. Standard errors clustered by HS 6-digit product.

5 Aggregation exercise

Finally, we use a simple calculation to gauge the effect of the tariff war on aggregate exports. This comes with two caveats. First, we only estimate the effect of output tariffs, and not the potentially negative effect of input tariffs on exports (see for instance Handley et al. (2020)). Second, we do not capture any general equilibrium effects that are soaked up by our difference-in-difference design.

We begin by writing export growth to destination j as the weighted average of the growth of different products k:

$$\begin{aligned}\Delta\log(X_{jt}) = \Delta\log\left(\sum_k X_{jkt}\right) &\cong \frac{\sum_k \Delta X_{jkt}}{X_{jt-1}} \\ &\cong \sum_{k\in S}\frac{X_{jkt-1}}{X_{jt-1}}\Delta\log(X_{jkt}) + \sum_{k\in N}\frac{X_{jkt}}{X_{jt-1}}\mathbb{1}_{Njkt} - \sum_{k\in X}\frac{X_{jkt-1}}{X_{jt-1}}\mathbb{1}_{Xjkt}\end{aligned}$$

where S, N and X denote the sets of staying, entering, and exiting products, and $\mathbb{1}_N$ and $\mathbb{1}_X$ are indicator functions for entry and exit.

The predicted change in aggregate exports is

$$\Delta\widehat{\log(X_t)} = \sum_j \frac{X_{jt-1}}{X_{t-1}}\Delta\widehat{\log(X_{jt})}$$

and the predicted change in bilateral exports

$$\Delta\widehat{\log(X_{jt})} = \sum_{k\in S}\frac{X_{jkt-1}}{X_{jt-1}}\Delta\widehat{\log(X_{jkt})} + \sum_{k\in N}\frac{X_{jkt}}{X_{jt-1}}\widehat{\mathbb{1}_{Njkt}} - \sum_{k\in X}\frac{X_{jkt-1}}{X_{jt-1}}\widehat{\mathbb{1}_{Xjkt}}$$

For the predicted values, we then plug in the contribution of output tariffs from the estimations. This uses the assumption that a category with no change in tariff was unaffected by the trade war. Given that our estimates use yearly growth rates, we use the period from Aug 2017 - Aug 2019 to span the entire tariff war. Using this procedure, we find aggregate effects of -2.0 ppt for Chinese exports, and -0.8 ppt for US exports.

6 Conclusion

In this paper, we estimate the effect of the US-China trade war on bilateral and aggregate exports, using detailed product-level customs data from the US and China. We start with a descriptive analysis of tariff increases. For both the US and China, we find that the administrations chose to tax heavily those products with a small, but positive bilateral import share, and to tax by much less those products with high bilateral import dependence. This suggests that the administrations were well aware of the negative consequences of tariffs for the domestic economy, and wanted to spread the burden of tariffs more widely across industries.

Turning to causal effects of the tariffs, we find very similar average trade elasticities for the US and China, and a sharp fall in bilateral trade. For both countries, we estimate an elasticity of values with respect to tariffs of about 1.1-1.2, that is a 10% tariff increase leads to a 11-12ppt decline in the growth of exports. While this is estimated for continuously exported varieties, we also observe that tariffs led to less entry and more exit of products. Consistent with previous evidence, we find no change in export prices following the introduction of tariffs.

Suprisingly, we find no evidence for a reallocation of exports to other destinations, for both the US and China. We also find no support for the idea that Chinese and US exporters lowered their prices to other destinations in order to gain market share. The lack of export reallocation exacerbates the effect of tariffs on aggregate exports, which we estimate to be -0.8ppt for the US and -2.0ppt for China.

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