Heterogeneous impacts of the Section 301 tariffs: Evidence from the revision of product lists

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Abstract. In each of the three waves of the Section 301 tariffs on Chinese imports, the US government exempted some products on the originally proposed list from additional duties. Using these exempted products as the counterfactual, we identify modest but heterogeneous impacts of the tariffs on the value of US imports from China. We find a complete pass-through for the first and second waves of tariffs. However, unlike in previous studies, we estimate a very limited tariff pass-through of the third wave of tariffs. Finally, we find little import diversion for the US and significant export diversion for China.

Résumé. Répercussions hétérogènes des tarifs douaniers en vertu de l'article 301 : données probantes tirées de la révision des listes de produits. Dans chacune des trois vagues de tarifs douaniers en vertu de l'article 301 sur les importations chinoises, le gouvernement américain a exempté de tarifs douaniers supplémentaires certains produits de la liste initialement proposée. En utilisant ces produits exemptés comme hypothèse, nous déterminons des répercussions modestes mais hétérogènes sur les tarifs douaniers sur la valeur des importations américaines de la Chine. Nous constatons une répercussion complète pour les première et deuxième vagues de tarifs douaniers. Toutefois, contrairement aux études antérieures, nous estimons une répercussion très limitée des tarifs douaniers pour la troisième vague de tarifs. Enfin, nous observons une faible diversion des importations pour les États-Unis et une importante diversion des exportations pour la Chine.

JEL classification: F13, F14

1. Introduction

The unprecedented protectionist measures implemented by the Trump administration between 2018 and 2019 have two prominent features. First, although the tariff actions involve many countries, the primary target was China. The United States imposed punitive tariffs on approximately $400 billion of imports, 90% of which were on Chinese goods (figure 1, panel A). Meanwhile, the average tariff rate on Chinese goods rose to 16.6%, in sharp contrast to the 2.3% running rate on products from other countries (figure 1, panel B). Second, the new duties on Chinese imports, also known as the Section 301 tariffs, were rolled out in waves between 2018 and 2019. They first targeted a narrow range of

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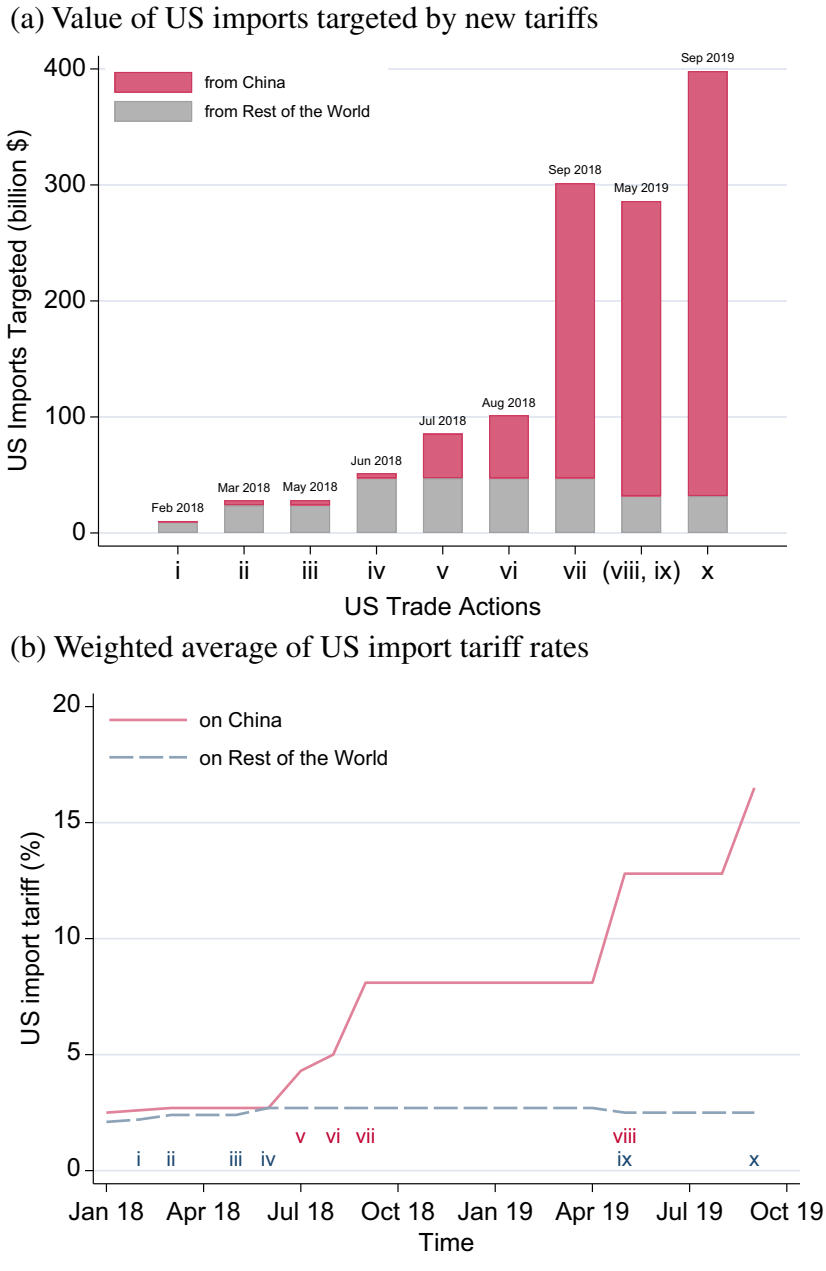

FIGURE 1 The US trade wars against China and the rest of the world

NOTES: Roman numerals indicate US trade actions: (i) "201" on washers and solar panels; (ii) "232" on steel and aluminum; (iii) "232" adds Korea; (iv) "232" adds EU, Canada and Mexico; (v) "301" on China – Tranche 1; (vi) "301" on China – Tranche 2; (vii) "301" on China – Tranche 3; (viii) "301" on China – Tranche 3 tariff increased to 25%; (ix) "232" excludes Canada and Mexico; (x) "301" on China – Tranche 4; (xi) proposed additional tariff increase from 25% to 30% on $250 billion Chinese imports on October 15, 2019, suspended after the October meeting between China and US negotiation delegation; (xii) proposed 15% additional tariffs on $160 billion Chinese imports on December 15, 2019. (xi) and (xii) are not shown in the above figure 1.

DATA SOURCES: Foreign trade data are from the US Census Bureau. Tariff data are from the World Integrated Trade Solution and United States Trade Representative at the HS-8 level, weighted by US import values in 2017. [Colour figure can be viewed at `wileyonlinelibrary.com`.]

industrial inputs and equipment, later broadened to cover more intermediate goods and many consumer goods.[1]

This paper takes these two features into account and provides a systematic investigation of the impact of Section 301 tariffs on imports from China.[2] First, we focus on imports from China, which have been shown to have important social and economic consequences for the US. On the one hand, increased imports from China lowered US prices of consumer goods and inputs (Bai and Stumpner 2019, Amiti et al. 2017), but on the other hand, it also reduced manufacturing employment (Autor et al. 2013, Pierce and Schott 2016). Given China's large market share in total US imports, it is critical to understand how sudden tariff hikes, most of which still remains in effect, would affect the value and price of imported Chinese goods.[3] Empirical work so far has found complete pass-through of the newly imposed US tariffs, which is surprising given the presumption that the US market is large enough to affect prices (Fajgelbaum and Khandelwal 2022).

Second, the phased roll-out of the Section 301 tariffs reflects altered policy priorities of the United States as the trade tension escalated. Policy documents from the Office of the United States Trade Representative (USTR) clearly show that the first two tranches of tariffs ($50 billion), effective from July and August 2018, respectively, focused on specific inputs and capital equipment that (a) may have benefited from China's industrial policies, (b) may not disrupt the US economy and (c) have minimal impacts on US consumers.[4] Given the carefully designed criteria for selection, it would be interesting to know the actual effects of these tariffs. By contrast, the third tranche, implemented in September 2018 as a countermeasure to China's retaliation duties, covered a much broader set of goods ($200 billion), ranging from industrial inputs such as electricity transformers to everyday groceries such as meats.[5] The third tranche of tariffs may have different impacts from the first two.

Existing research has compared tariff-affected products with those unaffected by tariffs from China and the rest of the world to analyze the impacts of these tariffs on values and prices (for example, Amiti et al. 2019 and Amiti et al. 2020). The resulting findings of complete pass-through of tariffs—the US bears the entirety of these tariffs—have received widespread attention. In this paper, we adopt a different empirical research design and find evidence that the estimates of tariff-passthrough are more complicated than previously thought and depend on the targeted products. Specifically, our research design accounts for the fact that the various tranches of tariffs were chosen with specific purposes and leverages the fact that some products were excluded from the initially proposed lists, thereby providing a natural control group. The control group picked by previous work is concerning because it contains untargeted Chinese products that show differential pre-trends and foreign alternatives of targeted Chinese products that are susceptible to trade diversion effects. Moreover, none of the previous studies account for potential front-loading effects that could confound the estimates.

1 We describe the timeline and coverage of the different tranches of tariffs in more detail in section 2. Key information of the three tranches of tariffs is summarized in online appendix table A1. See Bown and Kolb (2021) for an excellent description of the details of the tariff lists.

2 In fact, all of the tariffs studied in this paper are still effective.

3 China has been the largest import source of the United States since 2007. See online appendix figure A1, panel A, for the historical bilateral trade volume between the two countries.

4 See the notice from the USTR office (docket number USTR-2018-0005).

5 The third tranche covers 79 out of all 98 two-digit HS product categories, while the first and the second tranche cover only 9 and 13 categories, respectively.

Our choice of the control group takes advantage of the unique way the tariffs were implemented. Unlike other tariffs, each wave of the Section 301 tariffs was initially announced, subsequently revised and finally imposed with months of time lags. Taking the first tranche, for instance, the USTR announced a proposed list of 1,333 eight-digit HS products on April 3, 2018, which was revised on June 15, with 515 products exempted. Tariffs on the remaining 818 products were finally imposed on July 6. These exempted products exhibit very similar time trends to those remaining on the list. Thus, we rely on the growth path of the exempted products as a credible counterfactual for what would have happened to the dutiable products in the absence of additional tariffs.

Moreover, our difference-in-differences (DD) specification explicitly accounts for any anticipation effect of upcoming tariffs, also known as front-loading. The new tariffs were announced ahead of implementation, so importers could shift forward the purchase of goods that were scheduled to be tariffed. To identify relative front-loading between the treated and exempted products, we specify an interim period between the announcement and implementation dates, allowing for the difference in trends for the treated and control products during the intervening period. Furthermore, this specification prevents the potential front-loading effect from confounding our estimation of the true effects of the tariffs.

Based on the most disaggregated product-level (i.e., 10-digit HS) import data, our analysis reveals moderate but heterogeneous effects of US tariffs on the total value of imports from China. For the first tranche of tariffs (25%), imposed on July 6, 2018, the estimated elasticity for import value is 0.53. For the second tranche of tariffs (25%), effective from August 23, 2018, the analogous elasticity is around one. For the third tranche of tariffs (10% with a threatened increase to 25%), imposed on September 24, 2018, our estimated elasticity for import value is 0.21. In addition, we find evidence of anticipatory effects of tariff announcements and threats.

Unlike earlier research, we discover that tariff incidence varies dramatically between products. We find a complete pass-through of the first and second waves of tariffs to tariff-inclusive prices.[6] However, we find a very limited pass-through of the third wave of tariffs. Our results suggest that the findings of complete pass-through in previous studies, such as Amiti et al. (2019) and Amiti et al. (2020), may have masked substantial heterogeneity in the incidence of US tariffs. Further, we show that the high fraction of homogeneous products on the third list partly drives the limited pass-through of the third tranche of tariffs.

The Section 301 tariffs resulted in trade diversion effects that favour third countries. When tariffs are levied on products from a certain origin, importers turn to other sources. For example, the 2016 anti-dumping duty on washing machines produced in China had only minor effects because production was later shifted to Vietnam and Thailand (Flaaen et al. 2019). Meanwhile, facing higher barriers to the US market, Chinese exporters could also sell to alternative destinations. So far, little is known about the overall and country-specific trade diversion effects of the Section 301 tariffs on both imports and exports. Our paper provides evidence of such effects including asymmetric trade diversion for the US and China. We find that the US could hardly make up the loss in imports from China by buying more from alternative sources.[7] By contrast, our estimates based on China's export data suggest

6 We first compute the unit value by dividing the total value by quantity for each 10-digit HS product. Based on the publicized tariff rate, we then calculate the tariff-inclusive unit value, which we use to proxy for tariff-inclusive price.

7 This result is consistent with Handley et al. (2020), who find that US firms were unable, at least in the short-term, to reorient sourcing strategies.

that Chinese producers responded to higher US tariffs by selling more to other countries. The asymmetry in trade diversion implies possible relocation of supply chains from the US to Canada, Mexico and Europe. Some results also indicate an increase in indirect exports via Vietnam and Taiwan.

Our work complements the recent empirical assessments of Trump's global trade wars in 2018. Amiti et al. (2019) and Amiti et al. (2020) found that the US tariffs reduced the trade flows to the US and were fully passed on to US buyers. Fajgelbaum et al. (2020) used tariffs as an instrument and identified the elasticities of the US import demand and foreign export supply. They found that the additional tariffs substantially reduced the US imports and were completely passed through into US domestic prices. Moreover, they embedded the estimated parameters in a quantitative general equilibrium model and revealed that the short-run US welfare loss from the trade wars amounted to 0.04% of annual GDP. With microdata on "at-the-dock" and retail prices, Cavallo et al. (2021) found an almost complete pass-through of tariffs onto the US importers, but a limited pass-through onto the US consumers.

Our analysis contributes to this ongoing research agenda in the following aspects. First, we explore the dynamic effects of different tranches of US tariffs on China with a novel empirical strategy. Second, our results reveal substantial heterogeneity in the import elasticities of Chinese goods with respect to different rounds of the Section 301 tariffs. Our estimates are smaller than the global average elasticities estimated by Amiti et al. (2019) and Fajgelbaum et al. (2020). Third, it is striking that the previous studies found complete tariff pass-through, because it implies a large welfare loss and no terms-of-trade gains.[8] Our results indicate that this is not always the case. Our findings reveal substantial heterogeneity in the pass-through rates of tariffs. Ironically, the tariffs on the goods in the first two lists, which the USTR carefully selected to avoid higher domestic prices in the US, turned out to be borne mostly by US importers. Meanwhile, the tariffs on the goods in the third list, which was less well targeted, fell mostly on the Chinese exporters. This irony suggests that, albeit with clear policy objectives, the US policymakers did not seem to have a good a priori knowledge of the product-specific tariff pass-through rates before selecting the dutiable products to achieve their goals. Fourth, we provide evidence of anticipatory responses of US importers, thereby confirming the anecdotal accounts of such behaviour in the media.[9] Last but not least, we are among the first to systematically examine the trade diversion effects of changes in bilateral tariffs.

2. Section 301 Tariffs on China

Tranche 1: On April 3, 2018, the USTR released an initial list of 1,333 US tariff lines of Chinese products for an additional 25% tariff ("list 1") based on its Section 301 investigation findings. The proposed list particularly targets the products regarded as "strategically important to and benefit from" China's distortive industrial policies, including the "Made in China 2025" program.[10] On June 15, the USTR released a finalized list that reflects the

8 Amiti et al. (2020) estimate a complete pass-through of the tariffs for most products. The only exception is steel inputs, for which they find a 50% pass-through one year after the imposition of tariffs.

9 Cavallo et al. (2021) showed that two US retailers started to build up inventories of Chinese goods as soon as new tariffs were announced.

10 See the Section 301 Fact Sheet, available at www.ustr.gov/about-us/policy-offices/press-office/fact-sheets/2018/june/section-301-investigation-fact-sheet.

removal of 515 product lines from the original target list. This first set of Chinese products, which took effect on July 6, 2018, contains 818 tariff lines worth approximately $34 billion.

Tranche 2: On June 15, 2018, the USTR issued another list comprising 284 product lines ("list 2") that were identified to benefit from China's industrial policies. On August 7, 2018, the USTR modified this list by removing five product lines. The remaining 279 tariff lines were worth approximately $16 billion. An additional duty of 25% on this set of products was implemented on August 23, 2018.

Tranche 3: On June 16, 2018, the Chinese government issued a notice concerning additional tariffs on $50 billion of imported US goods. On July 10, the USTR responded to China's retaliation and announced further actions by proposing an additional 10% tariff on 6,031 tariff lines of Chinese products worth approximately $200 billion ("list 3"). On September 17, the USTR finalized list 3 by removing 286 tariff lines. The additional tariffs took effect on September 24, 2018. The tariff rate was initially set at 10% and scheduled to escalate to 25% on January 1, 2019. This deadline was extended after President Trump and President Xi agreed to a ceasefire when they met at the G20 summit in Buenos Aires on December 1, 2018. Since then, the tariffs remained fixed at 10%. Because the change in tariff rates complicates the evaluation period significantly, for this study, we limit our sample period to be before May 2019 when studying the third tranche of tariffs.

Further escalation: The truce turned out to be short-lived. On May 6, 2019, the US President reactivated his tariff threats ahead of another round of US–China trade talks. On the next day, the USTR confirmed that the US would move forward with the President's threat to increase the tariffs for list 3 to 25%, effective May 10, 2019.[11] The tension further escalated on August 1, 2019, when the bilateral negotiations broke down again, and the US president announced a plan imposing an additional 10% tariff on the remaining Chinese products worth approximately $300 billion ("list 4") from September 1, 2019. On August 13, 2019, the USTR announced two finalized lists, namely, list 4A (effective September 1, 2019) and list 4B (effective December 15, 2019), with additional tariffs initially set at 10%. However, the tariff was increased to 15% on August 30 after China announced its new retaliatory tariffs.[12] Our sample period covers January 2016 to July 2019. When analyzing the third tranche of tariffs, we focus on the period before May 2019, when the tariff rates remained at 10%.

Tariff exclusions: For each tranche of tariffs, the USTR also set out procedures for interested parties to request product exclusion. The USTR accepted some and rejected others, with accepted exclusions applied retroactively. However, it remains opaque what exactly determined the acceptance or rejection (Hufbauer and Lu 2019).[13] Bown (2021) provides a detailed analysis of the exclusion program. He estimates that the USTR excluded around 4% of the value of all US imports subject to Section 301 tariffs at some point between 2018 and 2020.

11 Products on list 3 that were shipped before May 10, 2019 and arrived in the US before June 15, 2019 will still be subject to a 10% tariff.

12 On January 15, 2020, the US and China signed the long-awaited "phase one" trade deal, which was perceived as the first sign of de-escalation in the US–China trade dispute.

13 See "China Section 301-Tariff Actions and Exclusion Process," available at https://ustr.gov/issue-areas/enforcement/section-301-investigations/tariff-actions, for the detailed list.

3. Empirical approach

Finding a credible control group is the main econometric challenge to estimate the effects of tariff hikes on the US imports from China. The typical practice in the recent literature thus far has been to rely on product-country observations. For example, Amiti et al. (2019) and Amiti et al. (2020) use all US imports from different source countries at the HS-10 level. Their control group includes the Chinese products that are not on the tariff lists, products that are on the lists but are from other countries and products that are not on the lists and are from other countries.

First, the Chinese products not on the tariff lists (also known as "list 4") might not constitute a valid control group because the USTR targets the products on the first three, especially the first two, lists for specific reasons.[14] For example, according to the USTR (2018), the first announced list targets the products regarded as "strategically important to and benefit from" China's distortive industrial policies, including the "Made in China 2025" program. Empirically, we show that these products cannot be used as a credible control group given that they exhibit significantly different pre-existing trends compared with those affected by new duties. The left column of online appendix figure A2 (panels A, C and E) contains plots for the normalized monthly mean log import value for the treated products (in red), the products on list 4 (in blue) and the control products of our choice (in grey). Unlike our control group, the products on list 4 fail to closely track the time series of the treated products in the pre-period, thus cannot serve as a valid control group in a DD setting. Formal event-study analysis in the figure's right column (B, D and F) further supports this point. Confirming the visual evidence in the left column, the event-study coefficients using products on list 4 as the control group (in light blue) indeed show pre-trends that differ significantly from those of the treated products. Therefore, a naive comparison of the imports of the affected products with the entire set of untargeted ones is likely to yield biased estimates. In contrast, the analogous event-study estimates using our control products (in dark blue) show no differential trends before the tariffs.

Second, the products on the list but from countries other than China cannot serve as a good control group. Because these tariff-free products are direct substitutes of the dutiable Chinese items, their value and price are likely affected by the tariffs due to trade diversion. Indeed, Amiti et al. (2019) are aware of the possibility that "tariffs also raised prices for untreated goods in response to the higher tariffs imposed on their competitors" (page 195).

Finally, the products not on the list and from other countries are unlikely a suitable control group because they are widely different from the targeted Chinese products.

In this study, we use the set of Chinese products initially included but eventually removed from the provisional tariff list as a control group. The USTR decided to exempt these items after an official review, public comment and public hearing. For example, the Tranche 1 tariff list underwent a three-day public hearing in May 2018. After the review, the USTR removed 515 product lines from the initial proposed list. A report in *The Washington Post* suggests that US Trade Representative Robert E. Lighthizer decided to drop these items after hearing objections from business groups.[15] We argue that, compared with the Chinese products on list 4 and products from other countries, these exempted products are relatively similar

14 Online appendix figure A1, panel B displays the year-on-year percentage change of monthly US imports for each set of Chinese products in Section 301 tariff lists.

15 David J. Lynch and Emily Rauhala, "With tariffs, Trump starts unraveling a quarter-century of U.S.–China economic ties," *The Washington Post*, June 15, 2018.

to the treated products. Although this assumption cannot be tested directly, we examine whether the parallel trends assumption holds before the new tariffs were implemented. We fail to reject that the trends are equal (see details in subsections 4.1 and 4.2).[16]

The chosen control groups vary across the three tariff lists. For the first tranche of tariffs, the original list consists of 1,333 tariff items. Among such items, 515 are subsequently removed from the list, and these items were assigned as the control group. Thus, a total of 818 dutiable products remain. For the second tranche of tariffs, only five items were removed from the original list containing a total of 279 items. We could have used these five items to establish the counterfactual, but the small size of this candidate control group could result in noise and therefore less meaningful estimates. To increase power, we use the 515 products that were removed from list 1 to construct a control group for the dutiable products in the second tranche of tariffs. Following the USTR's notices, list 2, which is similar to list 1, targets the advanced technology sectors supported by China's distortive industrial policies.[17] From an empirical perspective, the 515 untreated codes from Tranche 1 display similar pre-trends as the treated items for the 279 treated codes from Tranche 2, which supports the parallel trends assumption for our DD analysis. The original list for the third tranche of tariffs covers 6,031 tariff lines. Among these tariff lines, 286 were excluded prior to the implementation of new tariffs. A total of 5,745 dutiable products remain, while the 286 exempted products are used as the control group.[18] Finally, we want to point out that the HS codes in each of the three tranches are mutually exclusive; therefore, the untreated HS codes are never treated. In particular, none of the 515 codes from Tranche 1 were subject to tariffs in Tranche 2.

Another challenge is derived from the choice of event time. When a significant time gap is observed between announcement and actual implementation of a policy, the forward-looking economic agents should have the incentive to act in anticipation of the future treatment. In our case, the US importers can start hoarding Chinese goods scheduled to be tariffed when new tariffs are disclosed but not yet imposed. If we disregard this possibility and treat the entire pre-implementation period as the pre-period, our analysis is likely plagued by differential pre-trends that bias the estimates of the actual effects of tariffs. To account for potential anticipatory responses, we explicitly define an interim period, which lies between the pre-announcement and post-intervention periods.[19] Thus, we allow for the different

16 Yagan (2015), as an example in the public finance setting, explicitly stated that the identifying assumption underlying his DD design is *not* the random assignment of the treatment status. Instead, the assumption is that treatment and control outcomes would have trended similarly in the absence of the policy.

17 The 515 untreated codes from Tranche 1 and the 279 treated codes from Tranche 2 are similar because the USTR chose them according to the same criteria. More specifically, they: 1. May have benefited from China's industrial policies. 2. May not disrupt the US economy. 3. Have minimal impacts on US consumers (please refer to the notice from the USTR office "USTR-2018-0005" for details).

18 A few HS-8 products were only partially subject to additional tariffs. We removed these product lines from the treated group, and our results are hardly affected by this sample restriction. Refer to annex B of the following file for the detailed list: www.ustr.gov/about-us/policy-offices/press-office/press-releases/2018/september/ustr-finalizes-tariffs-200.

19 Conceptually, one could divide the interim period into two subperiods: one after the initial announcement but before the revision, the other after the revision but before the tariffs. The transition from the list revision and tariff implementation usually took place in a relatively

changes in outcomes of the treatment and control products during the interim period. Note here that our empirical framework measures only the *relative* anticipatory effects between the eventually treated items and the removed ones.[20]

In the empirical setting for the first and the third tranches of tariffs, the interim stage starts from the announcement time when people started to expect that both the control and treated units will be subject to tariffs. As previously mentioned, the tariff lines dropped from the same lists for these two tranches are used as the control groups. If beliefs about the certainty of future tariffs for both groups are the same, then the US importers would ramp up their purchase of Chinese goods from the control and treatment groups. Therefore, no difference in trends between the two will be observed.[21] Before new duties were collected, the products used as controls were formally removed from the tariff list. From then on, importers will no longer have the incentive to hoard these exempted products but will still have the incentive to hoard the commodities that are subject to higher tariffs. Thus, from the date of revision, from when exempted products were formally removed until the date of implementation, any positive difference between the trends of the dutiable goods and the exempted goods reflects front-loading.

In the empirical setting for the second tranche of tariffs, the interim period begins with the announcement time of the products that were eventually exempted from list 1, which is earlier than the announcement time of list 2. In mid-June 2018, the exempted products on list 1 were taken off and the dutiable products on list 2 were publicized. Until this point, we could observe that the imports under the control products grow faster than that of the treated ones due to front-loading. By contrast, after this date until the implementation of the second tranche of tariffs, the imports of the treated units could grow faster than that of the control for the same reason. For the analysis of the second tranche, the post period begins when the new tariffs become effective for the dutiable products on list 2.

Given that trade flows are observed monthly, we assign the event time to be the nearest full month to the actual event. This selection of event windows is reflected in our two econometric specifications detailed below.

First, we assess the temporal dynamics of the US trade actions on imports from China in an event-study framework similar to the one used in Amiti et al. (2020):

$$\ln y_{it} = \sum_{k=-A}^{B} \beta^k \left(\mathsf{Dutiable}_j \times \ln\left(\frac{1+\tau_{jk}}{1+\tau_{j0}}\right)\right) + \gamma_j + \delta_t + \epsilon_{it}, \tag{1}$$

short time window (e.g., for Tranche 3, the revision took place on September 17 while the tariffs became effective on September 24). For this reason, we decide to combine the two subperiods into one single period (the interim period). If the treated and control units start to trend differently during the second subperiod, our dynamic setup can still pick it up in the interim period.

20 On the one hand, importers would continue to increase the purchase of the treated items, i.e., front-loading. On the other hand, there could also be "back-loading" for the exempted ones as firms cut imports to adjust to optimal inventory holdings after the exemption. Therefore, our empirical framework measures the *relative* anticipatory effect, i.e., the front-loading effect for the treated items relative to the exempted ones. For this reason, we cannot quantify the *absolute* anticipatory effect with our current approach precisely.

21 However, if certain importers have information about which products are likely to be removed, the imports of dutiable products will grow faster than those of the eventually exempted ones.

where i indicates an HS-10 level product category, j indicates an HS-8 level product category and t indicates the month. k indicates the event time, such that $k = 0$ in the last month before tariff announcement and $k = 1$ in the first month of tariff announcement. HS-8 product is the level at which new tariffs are implemented. The outcome variable y_{it} is either the total value or the tariff-inclusive price (unit value) of US imports from China at HS-10, the most disaggregated level of products.[22] $\mathsf{Dutiable}_j$ is an indicator variable that equals 1 if the HS-8 product is subject to the new tariffs and 0 if it is eventually exempted from the new tariffs. $\ln[(1+\tau_{jk})/(1+\tau_{j0})]$ is the log change in tariffs between month k and the last untreated month. We let τ_{jk} be the announced tariff rate during the interim period, so β^k can measure any difference in the treated and the control induced by the pre-announced tariffs in this period. γ_j and δ_t are HS-8 and year–month fixed effects, respectively. Because both the dependent variable and the right-hand side tariff variable are measured in logarithms, the coefficients β^k are elasticities estimated over different periods. For inference, we cluster standard errors by the HS-8 level, at which the punitive tariffs are implemented.

The event-study framework allows us to explore the dynamics of the causal effect of new tariffs. Owing to dynamic considerations, US importers are likely to stockpile Chinese goods before the implementation of new tariffs. During this interim stage, we allow for the growth paths of the products to be retained on the list and those removed from the list to differ. In practice, the interim period spans three months for the first and third tranches of tariffs and five months for the second. The dynamic specification also enables us to investigate for the presence of pre-trends by examining whether the leading terms $\widehat{\beta}^k = 0$ for $-A \leq k < 0$. For this dynamic specification, observations for all $k < -A$ are used as the omitted period. We allow for 12 months of leading terms in the regressions, so $A = 12$. The number of months after the treatment varies by tranche. We have 15 months (so $B = 15$) for the first two tranches after the treatment. For the third tranche, $B = 9$ because the tariffs came much later, and we limit the sample to months before May 2019, when the trade tension escalated. Because we have closely followed equation (1) in Amiti et al. (2020) to specify our regression model, any significant difference in results between theirs and ours should stem from the difference in control samples.

To quantify the aggregate effects during the interim and post-treatment periods and to increase the precision of estimates, we subsequently adopt a "static" DD specification:

$$\begin{aligned}\ln y_{it} = {} & \beta_1 \mathsf{Dutiable}_j \times \mathsf{Interim}_t \times \Delta \ln(1+\tau_{jt}) + \beta_2 \mathsf{Dutiable}_j \times \mathsf{Post}_t \\ & \times \Delta \ln(1+\tau_{jt}) + \gamma_j + \delta_t + \epsilon_{it}. \end{aligned} \tag{2}$$

We interact the treatment dummy, $\mathsf{Dutiable}_j$, with time indicators that mark different development stages of the US trade actions and the log change in tariffs. In this three-period DD, t is collapsed by *pre*, *interim* and *post* periods. $\mathsf{Interim}_t$ is an indicator that turns on when the proposed list is unveiled but not implemented yet. Post_t is a dummy indicating whether the new tariffs are imposed. $\Delta \ln(1+\tau_{jt})$ is the *announced* log change in tariffs in the *interim* period and the *actual* log change in tariffs in the *post* period. This term is zero in the *pre* period; therefore, $\mathsf{Dutiable}_j \times \mathsf{Pre}_t \times \Delta \ln(1+\tau_{jt})$ does not appear in the equation. β_2, which measures the elasticity of punitive tariffs on imports from China, is our primary parameter of interest. Analogously, β_1 measures the elasticity of pre-announced tariffs, which reflects the relative anticipatory effects between the treated and removed products.

22 Following Amiti et al. (2019), we use the inverse hyperbolic sine transformation for zero values of imports.

TABLE 1
Summary statistics

Panel A: Summary statistic for samples of analysis			
	List 1	List 2	List 3
Value (million USD)	1.31	2.43	1.81
	(6.72)	(10.90)	(20.42)
Unit value (thousand USD)	11.17	3.97	0.66
	(129.92)	(103.17)	(37.06)
Panel B: Product characteristics by tariff list			
	List 1	List 2	List 3
Consumer good	0.008	0.012	0.196
	(0.088)	(0.109)	(0.396)
Differentiated good	0.924	0.610	0.470
	(0.266)	(0.488)	(0.499)

NOTES: Panel A shows the mean and standard deviation (in parenthesis) the samples constructed based on US Census Bureaus monthly trade data between January 2016 and July 2019. Each sample contains observations for the dutiable and exempted products. Panel B shows the mean and standard deviation (in parenthesis) of characteristics of dutiable products in the three product lists.

We fit the models on the monthly import data from the US Census Bureau, which provides information on the values and quantities of trade flow at the 10-digit Harmonized System (HS-10) level. Unit value is calculated as total value over quantity and will be missing if the total value is zero or the quantity is not reported. Finally, we obtain a balanced panel for the total values of imports and an unbalanced panel for the unit values of imports. Our data cover the period from January 2016 to July 2019. Each regression further restricts the sample to 24 months before tariff implementation. For a clear interpretation of the results, we do not analyze the sample on or after May 2019 for Tranche 3, when the trade disputes escalated. We are unable to extend our analysis beyond July 2019, because the previously exempted products were also subject to new tariffs after this date. We further restrict the sample to account for tariff exclusions, which often occurred at the sub-HS10-level. The USTR proposed most of these exclusions after our sample period. A few of the exclusions for the first tranche took place in our study period and were announced at different dates, so we drop all the related HS-10 products from our sample. The exclusions for the second and third tranche of tariffs will unlikely affect our analysis because they both occurred after our study period. The summary statistics of our sample on the US imports from China are presented in table 1. Panel A provides descriptive statistics for the value and unit value of imports.[23] Panel B tabulates the fraction of various types of products for each of the three lists. A consumer good is defined based on the BEC classification, while a differentiated good is defined according to Rauch (1999).

4. Effects on US imports from China

4.1. Graphing the raw data

Figure 2 plots the raw data of US imports from China for all three tranches of tariff hikes since January 2016. Each row represents products in a particular tariff list. The left column contains plots for the log import value, and the right column contains plots for the log tariff-inclusive unit value of import. To ease the comparison of trends, we normalize the

23 None of the import values and less than 7% of the quantities are missing in our sample.

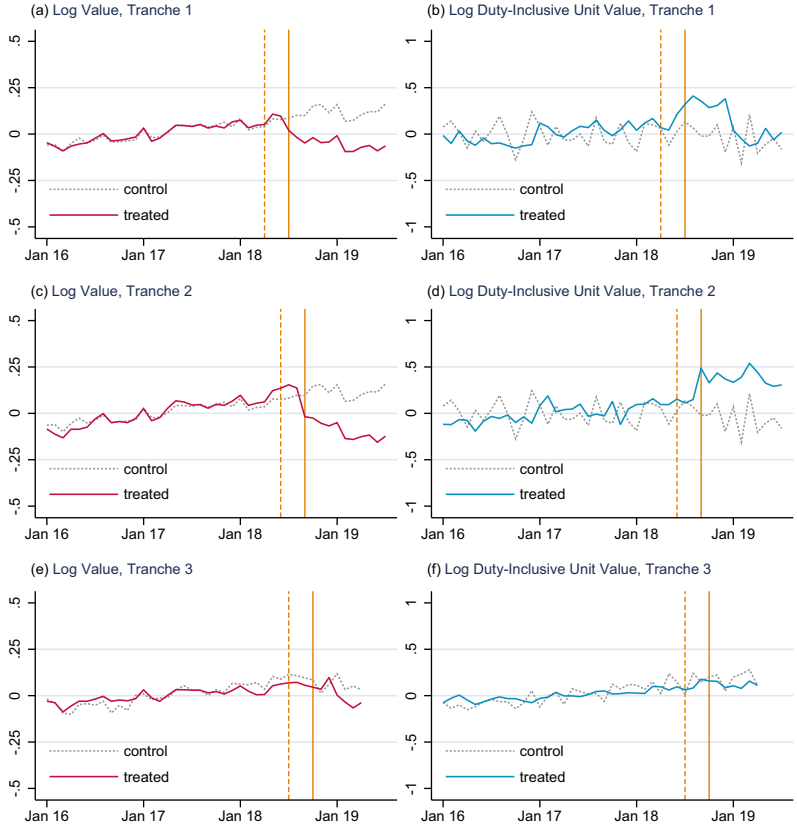

FIGURE 2 Effects of tariff hikes on the US imports from China – Dutiable versus exempted products from the provisional tariff lists

NOTES: The figure plots the monthly mean outcomes for the dutiable and exempted products based on US Census Bureau's monthly trade data between January 2016 and July 2019. For Tranche 3, the graphs (panels E and F) drop the sample on or after May 2019. In all panels, the x-axis denotes calendar time. We normalize the outcomes of the control group and treatment group by subtracting their pre-announcement means. The dashed vertical lines mark the month in which the new tariff was initially proposed. The solid vertical lines mark the month in which the new tariff came into force. [Colour figure can be viewed at `wileyonlinelibrary.com`.]

outcomes of the control and treatment groups by subtracting their pre-announcement means. We have three important observations.

First, the plots support our parallel trends assumption that is indispensable for a typical DD analysis. In each of the six panels, the outcomes of the exempted and dutiable products closely trace each other until the announcement of new tariffs (indicated by dashed vertical lines).

Second, the three plots for log import values (left column) suggest that higher tariffs reduce the US imports from China for all three tariff lists. Most visible in panels A and C, the two series diverge noticeably following the tariff hikes, with the import of the products removed from the proposed list continuing to grow, relative to those of the products subject to new tariffs. The pattern in panel E indicates that the imports of the exempted products outgrow those of the dutiable ones a few months after the new duties came into force. We discuss these results in more detail when we obtain the event-study estimates in the following subsection.

Third, the plots for tariff-inclusive unit values (right column) exhibit a certain degree of heterogeneity across tariff lists. For the first and second tranches (panels B and D), the tariff-inclusive unit value of imports for the dutiable product seems to significantly outgrow that of the exempted ones after the new duties came into force. For the third tranche (panel F), the two series hardly diverge after implementing new tariffs. We likewise postpone the discussion of the results to the following subsection when we look at the event-study estimates.

4.2. Event-study estimates

Figure 3 presents the main event-study figures, which depicts the dynamic monthly responses in the value and tariff-inclusive unit value of imports from China to the rising tariffs. Specifically, the figure plots the regression coefficients from estimating specification (1) in section 3 using import data between January 2016 and July 2019. For Tranche 3, the regressions exclude the sample on or after May 2019. To test for pre-existing trends, we

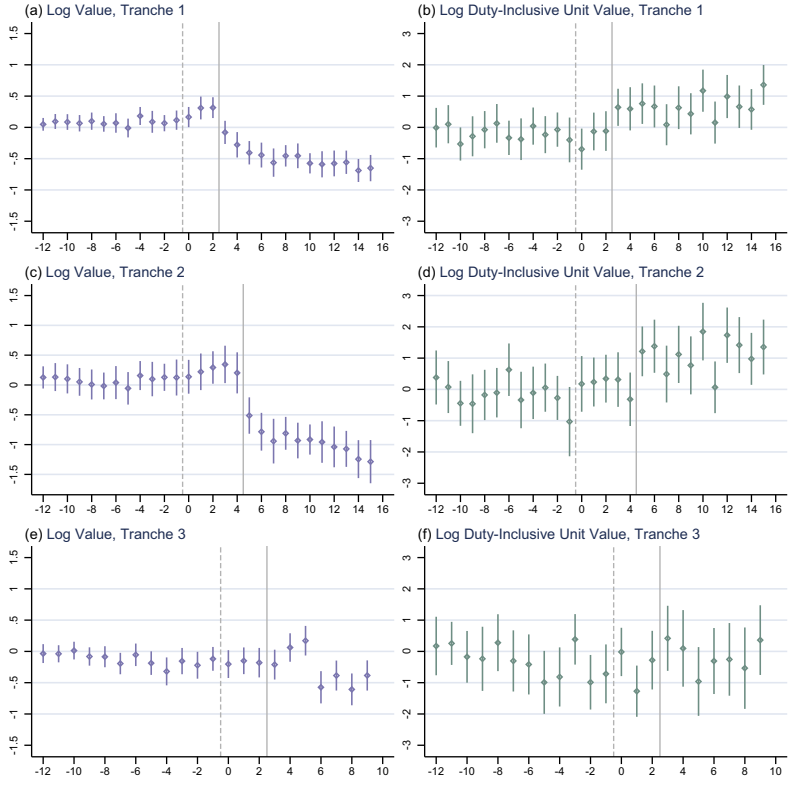

FIGURE 3 Event-study estimates of the elasticities of value and price of US imports from China

NOTES: The figure plots regression coefficients from estimating specification (1) in section 2 using US Census Bureau's monthly trade data between January 2016 and July 2019. For Tranche 3, the graphs (panels E and F) drop the sample on or after May 2019. Each regression further restricts the sample to 24 months before tariff implementation. For Tranche 3, the regressions (panels E and F) drop the sample on or after May 2019. The horizontal axis denotes the month relative to the announcement of new tariffs (the event time). Exempted products on the originally proposed tariff lists are used to establish the counterfactual. The analysis controls for fixed effects by eight-digit product category and month. The 95% confidence intervals shown are based on standard errors clustered by eight-digit product category. The dashed vertical lines mark the month in which the new tariff was initially proposed. The solid vertical lines mark the month in which the new tariff came into force. [Colour figure can be viewed at `wileyonlinelibrary.com`.]

include 12 months of leading terms ($A = 12$) in the regressions. Whiskers indicate the 95% confidence intervals based on standard errors clustered by the eight-digit product category.

The event-study estimates of pre-announcement terms confirm the scant evidence of pre-existing differential trends in the total value of imports between the treatment and control groups (left column of figure 3). The estimates for the pre-intervention period are slightly noisy for the unit value of imports (right column of figure 3), but they do not exhibit any consistent pattern of differential pre-trends. More formally, for every of the six event-study regressions in figure 3, we fail to reject the joint test that all the pre-period coefficients ($\widehat{\beta}^k = 0$ for $-A \leq k < 0$) are equal to 0.

The event-study analysis suggests that the first tranche of tariff on Chinese goods has led to a significant decrease in the value of imports from China and a substantial increase in the tariff-inclusive unit value. Panel A of figure 3, which shows the estimates for log value of imports, also suggest a relative anticipatory effect during the period when the new duties were announced but not yet implemented. The list was updated during this period, with a group of products dropped and therefore exempted from new duties. The revision was publicized in the last month before implementation, but we cannot rule out the possibility of information leakage before formal announcement. The estimated coefficients during this transition period (event time = 0, 1 and 2) are positive and increasing in time. Specifically, the estimates for event time 1 and 2 are significant at the 5% level. We interpret these effects as evidence of front-loading by US importers. After knowing the revised lists, however, the importers will no longer have incentives to do so for the products exempted from new tariffs, relative to those remaining on the tariff list. They could even reduce the purchase of newly exempted products to re-optimize their inventories. By the time the new tariffs are levied, the log value of imports begins to fall, reflecting a negative effect of higher tariffs. The elasticities largely stabilize after five months (event time = 7), hovering around −0.5 thereafter. Panel B contains the tariff-inclusive unit value's estimated response to tariff changes (the pass-through elasticities). If the pass-through elasticity is less than one, the foreign exporters absorb part of the tariff by lowering their selling price, thus an incomplete pass-through. After the tariffs are applied, we observe an immediate increase of the elasticity estimates, which fluctuates around one after that, indicating a complete pass-through of the tariffs into domestic prices.

The estimated dynamic impacts of the second tranche of tariffs reveal somewhat similar patterns. As shown in panel C of figure 3, a few of the elasticities of import value with respect to pre-announced tariffs are positive and significant during the interim period, suggesting the possibility of front-loading. The estimated elasticities of import value begin to turn negative after new tariffs become effective. They increase in magnitude over time throughout the study period. As for the terms-of-trade effect, panel D indicates a complete tariff pass-through into domestic prices immediately after the tariffs are effective. In a few months, the tariff pass-through even rise above one, although typically not significantly so.

With the same strategy, we find interesting patterns for the goods on list 3 facing new tariffs and concurrent tariff threats.[24] As displayed in panel E of figure 3, the estimated responses in import value to the tariff hikes during the interim period are largely zero. However, the estimated elasticities start to increase after the implementation of new tariffs, although none of the estimates is significant. This pattern is consistent with a combined effect of new tariffs (10%) and the threat of even higher tariffs (25%). Anticipating higher

24 President Trump announced on September 17, 2018, that the 10% tariffs on the imports on list 3 would be raised to 25% on January 1, 2019, if no agreement was reached.

tariffs, the US importers would ramp up their purchase of Chinese goods before the higher tariffs set in. The overall positive effect during this period suggests that the front-loading effect not only offsets but also dominates the discouraging effect of the already effective higher tariffs. Starting from the fourth month (event time = 6), however, the elasticities become negative and remain relatively stable around −0.5 for the next four months. This pattern suggests a waning front-loading effect. The event time = 6 corresponds to December 2018, when President Trump and President Xi announced a deal to suspend the escalation of tariffs that were expected in January 2019. As the trade tensions eased, the importers seemed to have formed a new belief that the punitive tariff rate of the third tranche will stay at 10%. As for the terms-of-trade effect, we estimate a very limited pass-through of the new tariffs for list 3. As shown in panel F of figure 3, the estimates are not statistically different from zero in the first seven months after the tariff.

Our estimates of the elasticities for import values are smaller than those in Amiti et al. (2020). Although the elasticities we have estimated vary across different tranches of tariffs and over time, most of them are below one, ranging between 0 and 1. In contrast, most of the estimated elasticities in Amiti et al. (2020) are consistently above one, ranging between 1 and 4 within a similar study period.

More importantly, the limited pass-through for the third tranche we have found stands in stark contrast to a complete tariff pass-through found in the previous studies. Amiti et al. (2020) show a nearly complete tariff pass-through for capital goods, consumer goods and non-steel inputs. It implies that the prices charged by Chinese exporters for goods exported to the US have not fallen, except for the steel products. In contrast, we separately estimate the elasticities for three waves of tariffs with a similar specification as in Amiti et al. (2020). The estimated tariff pass-through is nearly complete for the first tranche of tariffs and is approximately complete for the second. However, the pass-through for the third tranche is very limited, implying that the tariff increase falls mainly on the Chinese exporters.

4.3. Static DD estimates

The main regression results from estimating equation (2), the static specification, are reported in table 2. Column (1) presents the results for the log value of imports for products on list 1. According to these estimates, the elasticity of imports from China with respect to newly announced tariffs is 0.22 during the interim period. We interpret the positive elasticity with respect to pre-announced tariffs as the relative front-loading effect: firms stockpile products anticipating incoming trade restrictions. The estimated elasticity of imports with respect to actual tariffs is −0.53 during the post period. Column (2) examines the response in the tariff-inclusive unit value of products at the 10-digit HS level belonging to the same tariff list. We estimate a negative effect during the interim period, although the estimate is insignificant. For the post period, we estimate a statistically significant elasticity of 0.74. We cannot reject the null hypothesis that this elasticity is equal one, which implies an approximately complete pass-through for the first tranche of tariffs.

In the following two columns, we present results for the products on list 2. For import value, the estimated elasticity with respect to actual tariffs is −1.0 (column (3)) during the post-intervention period. Similar to list 1, the elasticity with respect to pre-announced tariffs is positive during the interim period, pointing to the possibility of front-loading. As for the unit value, we estimate a statistically significant elasticity of 1.2 for the post-tariff period, and this estimated elasticity is statistically indistinguishable from one. Thus, similar to the first tranche, there is also a complete pass-through for the second tranche of tariffs.

The effects of the third tranche of tariffs are pretty different from the previous two tranches, as shown in the last four columns of table 2. First, column (5) reports a regression

TABLE 2

Impact of tariff hikes on US imports from China

	Tranche 1		Tranche 2		Tranche 3			
	(1) ln value	(2) ln unit value (Duty-inclusive)	(3) ln value	(4) ln unit value (Duty-inclusive)	(5) ln value	(6) ln unit value (Duty-inclusive)	(7) ln value	(8) ln unit value (Duty-inclusive)
Dutiable × Interim × Δ ln (1 + tariff)	0.218***	−0.230	0.193**	0.253	−0.107	−0.151	−0.107	−0.151
	(0.053)	(0.199)	(0.092)	(0.217)	(0.071)	(0.115)	(0.071)	(0.115)
Dutiable × Post × Δ ln (1 + tariff)	−0.532***	0.738***	−1.001***	1.223***	−0.205**	0.003		
	(0.068)	(0.168)	(0.120)	(0.231)	(0.084)	(0.134)		
Dutiable × Post 1 × Δ ln (1 + tariff)							0.078	0.013
							(0.087)	(0.146)
Dutiable × Post 2 × Δ ln (1 + tariff)							−0.417***	−0.004
							(0.092)	(0.157)
Product (HS-8) FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.633	0.891	0.687	0.887	0.720	0.875	0.721	0.875
Observations	86,025	34,349	30,660	15,316	264,244	134,566	264,244	134,566

NOTES: The regressions are based on the monthly foreign trade data at the 10-digit product category level over the period from January 2016 to July 2019 from the US Census Bureau. Each regression further restricts the sample to 24 months before tariff implementation. For Tranche 3, the regressions (columns (5) to (8)) drop the sample on or after May 2019. "Dutiable" is an indicator variable that equals 1 if the eight-digit product category was subject to new tariffs and 0 if it was eventually exempted from the new tariffs. "Interim" is an indicator that turns on when the proposed list is unveiled by not yet implemented. "Post" is dummy indicating whether the new tariffs are put into effect. "Post 1" is a dummy variable indicating the period when the third tranche of tariffs (10%) were in place with a threat of 25% tariffs in the future. "Post 2" is a dummy variable indicating the period when the third tranche of tariffs (10%) were in place without any threat of higher tariffs in the future. "Δ ln (1 + tariff)" is the log change in tariffs between the current month and the last untreated month. Standard errors, shown in parentheses, are clustered at the HS-8 product level. * denotes statistical significance at the 10% level, ** at the 5% level, *** at the 1% level. FE = fixed effect.

similar to columns (1) and (3). The estimated elasticity of imports with respect to actual tariffs is −0.21 during the post period. The results reported in column (6) suggest that the tariff-inclusive unit value of the targeted products hardly responded to the new tariffs. The estimated pass-through for the third tranche of tariffs is close to and statistically insignificant from zero.

The third tranche of tariffs differs from the previous two tranches in the back-and-forth negotiations during its implementation and its uncertainty. As discussed in section 2, after formally imposing the 10% additional tariffs on September 24, 2018, the US government threatened to increase the rates to 25%. It then postponed the escalation after the meeting of President Trump and President Xi at the G20 summit in Buenos Aires on December 1, 2018. The 10% additional tariffs were maintained until early May when the bilateral trade negotiation broke and the USTR announced to increase the punitive tariffs to 25%. Given this complicated timeline for the implementation of the third tranche of tariffs, we estimate an alternative specification that breaks the *Post* period into two subperiods, *Post 1* and *Post 2*. "Post 1" is a dummy variable indicating the period when the third tranche of tariffs (10%) was in place with a threat of 25% tariffs in the future, i.e., from September to December 2018. "Post 2" is a dummy variable indicating the period when the third tranche of tariffs (10%) was in place without any threat of higher tariffs in the future, i.e., after the Trump-Xi meeting. Thus, the coefficient on "Post 2" captures the pure effect of the 10% tariff. As the estimates in column (7) suggest, the elasticity of import value is zero for the "Post 1" period, probably due to worries of higher tariffs and consequential front-loading. In the absence of the threat to increase the tariffs further, the estimated elasticity with respect to the effective tariff is −0.42, as indicated by the coefficient of the "Post 2" interaction. The results in the last column indicate that there are limited tariff pass-throughs in both subperiods. Unlike Amiti et al. (2019) who estimated a full pass-through of US tariffs in general, our results for the third tranche suggest a very limited pass-through.

For Tranche 3, our results show a substantial negative impact of tariffs on import values, while the tariff-inclusive prices remain largely intact. These results, taken together, seem to suggest that the demand for Chinese products is close to perfectly elastic. Perfectly elastic demand for the Chinese products on list 3 is consistent with its higher fraction of homogenous products, for which it is easier to source from other countries. With a perfectly elastic (and horizontal) demand curve for Chinese imports, the imposition of a tariff would shift China's export supply curve to the left, leading to a lower quantity of Chinese goods, an unaffected post-tariff price and a lower pre-tariff price. Therefore, the total value of import, which equals pre-tariff price times quantity, would also fall.

Why are our estimates different from those of the related prior studies, such as Amiti et al. (2019)? Is the difference driven mainly by our choice of the control group or the different way we account for the timing of tariffs (announcement vs. implementation)? To see which issue is more important, we estimate a specification that does not account for potential anticipatory effects (in terms of timing of pre vs. post) but uses the same control group. The new specification is similar to the one in equation (2) but without the first term, $\beta_1 \mathsf{Dutiable}_j \times \mathsf{Interim}_t \times \Delta \ln(1+\tau_{jt})$, on the right side of the equation. The results from estimating this new model, reported in online appendix table A2, suggest the estimated elasticities of tariffs (β_2 in equation (2)) are very similar to our baseline estimates reported in table 2. The similarity of the results suggests that the difference between our findings and the existing studies comes mainly from the use of different control groups.

We perform a set of robustness checks of our static DD results. In online appendix table A3, we show that the standard errors of our main estimates (table 2) do not change much when we cluster at alternative levels, i.e., the HS-4 level or the year level. In online appendix tables A4 and A5, we estimate alternative specifications with 10-digit product category fixed

effects or product (capital good, intermediate or consumption good) type-specific time fixed effects, the results of which are very similar to our main results.

4.4. Product heterogeneity

Why are the responses to tariffs so different across different waves? Specifically, why were tariffs fully passed on to prices of products on the first two lists, but not to prices of those on the third?

A first possibility is that the tariffs rate was set at 10% for the third list, and firms did not adjust for this lower rate for salience reasons. A second possibility is that the composition of products was different across tariff lists. The third list is notably different from the preceding ones, because it has consumer products on it. According to the USTR, the first two tranches of tariffs deliberately targeted products from industrial sectors that contribute to or benefit from China's industrial policies.[25] They focused almost exclusively on non-consumer goods, including machinery, electronic components and chemicals. The third tranche of tariffs, however, was largely a hasty response to China's retaliatory tariffs on US exports.[26] Although the USTR's approach to the Section 301 tariffs had been to avoid imposing duties on consumer goods, it soon ran out of Chinese non-consumer products to fill in an ever-growing list as the tension continued to escalate. List 3, therefore, covered a much broader range of products, from metals and industrial inputs, to consumer goods such as frozen food, television and furniture. Indeed, consumer goods accounted for 20% of the tariff lines on list 3, while lists 1 and 2 had almost no consumer goods (table 1, panel B).

Although we cannot evaluate the first possibility directly, we can test the second by investigating the heterogeneous response to tariffs on consumer and non-consumer goods by exploiting the variation in product categories within list 3. For this purpose, we interact a complete set of product-category dummies, C_k, with the three-way interaction terms in the static DD specification (equation (2)) and estimate:

$$\begin{aligned}\ln y_{it} = &\sum_k \theta_1^k \left(\mathsf{Dutiable}_j \times \mathsf{Interim}_t \times \Delta \ln(1+\tau_{jt}) \times C_k\right) \\ &+ \sum_k \theta_2^k \left(\mathsf{Dutiable}_j \times \mathsf{Post}_t \times \Delta \ln(1+\tau_{jt}) \times C_k\right) \\ &+ \gamma_j + \delta_t + \sum_k \delta_t C_k + \epsilon_{it}. \end{aligned} \tag{3}$$

As before, we include product fixed effects to control for time-invariant product characteristics and time-varying shocks that are common to all products. We also include product-category × time dummies to absorb any trends of the category. This specification allows us to estimate the response to tariffs for each product category separately.

25 One oft-cited example is the "Made in China 2025" program, which provides support to industrial sectors such as aerospace, information and communications technology, robotics, industrial machinery, new materials and automobiles.

26 Immediately after the USTR issued the finalized tariff lists (list 1 and list 2) on approximately $50 billion worth of Chinese imports on June 15, 2018, the Chinese government published its retaliation lists on US goods, which aroused President Trump to respond by further escalating the trade tension. See the response statement from President Trump at https://trumpwhitehouse.gov/briefings-statements/statement-president-regarding-trade-china-2/.

TABLE 3

Impact of the third tranche of tariff hike on different types of products

	(1) ln value	(2) ln unit value (duty-inclusive)	(3) ln value	(4) ln unit value (duty-inclusive)
Dutiable × Interim × Δ ln (1 + tariff) × Intermediate good	−0.121 (0.078)	−0.139 (0.130)		
Dutiable × Interim × Δ ln (1 + tariff) × Consumer good	0.008 (0.150)	−0.173 (0.199)		
Dutiable × Post × Δ ln (1 + tariff) × Intermediate good	−0.168* (0.094)	0.059 (0.147)		
Dutiable × Post × Δ ln (1 + tariff) × Consumer good	−0.393** (0.162)	−0.228 (0.324)		
Dutiable × Interim × Δ ln (1 + tariff) × Differentiated good			0.130 (0.150)	0.160 (0.238)
Dutiable × Interim × Δ ln (1 + tariff) × Homogenous good			−0.223*** (0.079)	−0.216 (0.135)
Dutiable × Post × Δ ln (1 + tariff) × Differentiated good			−0.088 (0.205)	0.493** (0.230)
Dutiable × Post × Δ ln (1 + tariff) × Homogenous good			−0.258*** (0.090)	−0.053 (0.159)
Product (HS-8) FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
R-squared	0.721	0.875	0.721	0.875
Observations	264,244	134,566	264,244	134,566

NOTES: The regressions are based on the monthly foreign trade data at the 10-digit product category level over the period from January 2016 to April 2019 from the US Census Bureau. "Dutiable" is an indicator variable that equals 1 if the eight-digit product category was subject to new tariffs and 0 if it was eventually exempted from the new tariffs. "Interim" is an indicator that turns on when the proposed list is unveiled by not yet implemented. "Post" is dummy indicating whether the new tariffs are put into effect. Standard errors, shown in parentheses, are clustered at the HS-8 product level. * denotes statistical significance at the 10% level, ** at the 5% level, *** at the 1% level. FE = fixed effect.

We find somewhat different tariff responses for consumer and intermediate goods. As the first column of table 3 shows, the estimated elasticity of import value is larger and more significant for consumer goods than for non-consumer goods. Our results on the difference in pass-throughs between consumer and intermediate goods are less conclusive. As column (2) shows, we estimate a very limited pass-through for intermediate goods and a negative pass-through for consumer goods, although neither estimate is statistically significant at conventional levels.

List 3 also has a higher fraction of homogeneous products. As shown in table 1 (panel B), differentiated goods accounted for about 92.4% and 61% of all products included in list 1 and list 2, respectively. By contrast, only 47% of products in list 3 are differentiated goods. Intuitively, homogeneous products tend to be more substitutable in global markets than more sophisticated products for which quality is important in shaping consumer demand. Therefore, identical tariffs can have smaller tariff pass-through rates for homogeneous goods than for differentiated goods.

We find different tariff responses for differentiated and homogeneous goods with a similar model specified in equation (3). The elasticity of imports with respect to tariffs is significantly larger for homogeneous goods than for differentiated goods (column (3)). Meanwhile, we estimate a positive but incomplete tariff pass-through for differentiated goods and very limited pass-through for homogeneous goods in the post period (column (4)). The results in these two columns suggest that producers of homogeneous goods in China needed to cut their prices to stay competitive in the US market. Nevertheless, US importers may still look for

substitutes from third countries and reduce imports from China if Chinese producers fail to absorb the entire tariff shock. By contrast, the producers of differentiated goods in China did not have to follow suit because their products had a lower substitution degree. Therefore the limited tariff pass-through for list 3 is driven partly by its higher fraction of homogeneous products. More work is needed to explore the heterogeneity in tariff pass-through across different products.

4.5. Total impacts

To quantify the direct effect of Section 301 tariffs on US imports from China, we first run a parsimonious model separately for the three tariff lists to estimate the effects of tariffs on US imports from China:

$$\ln y_{it} = \rho_1 \left(\mathsf{Dutiable}_j \times \mathsf{Interim}_t\right) + \rho_2 \left(\mathsf{Dutiable}_j \times \mathsf{Post}_t\right) + \gamma_j + \delta_t + \epsilon_{it}. \tag{4}$$

The variables are defined similarly as in equation (2). The regressions are weighted by the 2017 import value for each HS-10 product category. The results suggest that the three tranches of tariffs reduced imports from China by 16.2%, 24.4% and 7.7%, respectively. The detailed results are reported in online appendix table A6.

We then multiply the estimated effects of tariffs by the base import values, which are obtained by aggregating the monthly values of the three sets of targeted imports in 2017. They are \$31.2 billion, \$13.7 billion and \$189.3 billion, respectively.

Finally, we aggregate these estimated losses in imports resulting from the three tranches of tariffs. That is,

$$\Delta\mathsf{Import}^{\mathsf{China}} = \sum_{l=1}^{3} \widehat{\rho_{2,l}} \times \mathsf{Import}^{\mathsf{China}}_{2017,l},$$

where $l = 1, 2, 3$ refers to the three tariff lists and $\widehat{\rho_{2,l}}$ are obtained from estimating equation (4). This calculation shows a loss of \$22.9 billion relative to the baseline US imports from China in 2017, roughly 9.8% reduction in the annual US imports from China in the targeted product categories, or about 4.5% reduction in the total US imports from China.

We can also compare the implied decrease in imports from China, as calculated with the above formula, with the actual decrease in imports. Because the tariff increase was initially implemented in July 2018, we can calculate the actual import values of the targeted products for the pre-Section 301 period (July 2017 to June 2018) and the post-Section 301 period (July 2018 to June 2019). We can then calculate the *actual* reduction in imports for the targeted products as 10%.[27] Thus our estimation can account for almost all (98%) of the decrease in trade volume from China in the targeted product categories.

5. Trade diversion effects

We have shown in section 4 that the Section 301 tariffs have reduced US imports from China in targeted product categories. To measure the welfare loss caused by the bilateral tariff hikes, however, it is important to realize that US buyers may turn to alternative sources for replacement. Therefore, in this section, we investigate whether the rising import duties imposed by the US government induced trade diversion. We distinguish

27 The United States imported \$224.8 billion of products in the three lists for the one year after July 2018 and \$249.4 billion for the one year before. So the reduction rate is $(249.4 - 224.8)/249.4 = 10\%$.

between two types of trade diversion. We first examine the "import diversion," referring to US buyers shifting purchases of targeted products from countries other than China. We then examine the "export diversion," i.e., the rerouting of Chinese products to destinations other than the US using product-level export data reported by the China Customs.

It has been widely reported that US importers diverted imports from mainland China to other countries such as Mexico or Vietnam.[28] Indeed, a comparison of the actual import value during post-Section 301 period (July 2018 to June 2019) to that of the pre-Section 301 period (July 2017 to June 2018) suggests that the US imports of Chinese goods on list 1 dropped by about $8.4 billion, while imports of the same product categories from Mexico increased by $12 billion. Imports of the same product from Vietnam also rose, albeit by a smaller percentage.[29] But, how much of these dynamics reflects US imports diverted away from China?

To correctly identify the diversion of US imports, we apply the same empirical strategy to the data of US imports from countries other than China. That is, we estimate the model specified in equation (4) with the HS-10 products belonging to the same set of HS-8 products on the proposed Section 301 tariff list. Now, the variable $\mathsf{Dutiable}_j$ equals one if the same HS-8 product j is on the tariff lists. The event time indicators are defined according to the US trade actions against China. The dependent variable is the log of total value of imports for that HS-10 product category. A positive ρ_2 provides evidence of trade diversion effects from US tariffs on Chinese goods.

The first column in table 4 reports the estimated import diversion effects of three tranches of tariffs on US imports to the rest of the world (ROW). All of the estimated coefficients of the two-way interactions are small and imprecise, suggesting no significant overall diversion of US imports to third countries following the tariffs.[30]

The lack of response of imports from the rest of the world masks heterogeneity across different products. Using a specification based on equation (4) but allowing the effect to vary by product type, we estimate different trade diversion effects for differentiated and homogenous goods. As the first column in table 5 shows, the tariffs on Chinese goods led to an over 23% increase in the US imports of homogenous goods on list 1 from countries other than China. We find no similar effects on differentiated goods for the same tranche of tariffs. We also find a 10% increase in imports of homogenous goods on list 3 from third countries, while the effect on imports of differentiated good on the same list is small and insignificant. These effects are consistent with the overall insignificant diversion results reported in column (1) of table 4, because most of the Chinese goods subject to the tariffs are differentiated goods. In addition, the immediate and sharp import diversion of homogenous goods is also consistent with the findings of decreasing values and prices of homogenous goods imports from China (table 3, columns (3) and (4)). Both sets of results seem to

28 For example, Bloomberg reports that Mexico has seen a significant increase in exports to the US in categories where Chinese goods were hit with tariffs, see www.bloomberg.com/news/articles/2019-03-27/who-is-winning-trump-s-trade-war-with-china-so-far-it-s-mexico.

29 Similarly, during the same period, US imports of Chinese products on list 2 and list 3 dropped by about $3.3 and $12.9 billion, respectively, which were largely offset by a rise in imports of the same products from Mexico by $2.8 and $10.7 billion.

30 There seems to be a *decrease* in imports from ROW for the products on list 3 after tariffs (column (1), panel C), although the estimate is only marginally significant.

TABLE 4

Impact of tariff hikes on US imports from economies other than China (HS10 level analysis)

	(1) ROW	(2) Canada	(3) Mexico	(4) EU	(5) Japan	(6) South Korea	(7) Taiwan	(8) Vietnam
Panel A: Tranche 1								
Dutiable × Interim	0.007	−0.012	0.019	−0.028	0.029	0.036***	0.004	0.003
	(0.056)	(0.029)	(0.019)	(0.043)	(0.022)	(0.012)	(0.009)	(0.014)
Dutiable × Post	0.071	0.056*	0.026	0.025	0.025	0.036***	0.010	−0.005
	(0.058)	(0.031)	(0.022)	(0.044)	(0.025)	(0.013)	(0.011)	(0.016)
R-squared	0.632	0.536	0.685	0.586	0.524	0.485	0.563	0.623
Observations	97,650	98,427	81,571	105,049	92,880	79,851	78,776	38,829
Panel B: Tranche 2								
Dutiable × Interim	−0.018	−0.023	0.045	−0.074	−0.002	0.050***	0.019	0.026
	(0.097)	(0.052)	(0.034)	(0.072)	(0.038)	(0.018)	(0.012)	(0.021)
Dutiable × Post	−0.012	−0.013	0.029	−0.092	−0.019	0.045**	0.036**	0.078**
	(0.099)	(0.054)	(0.035)	(0.077)	(0.040)	(0.021)	(0.017)	(0.031)
R-squared	0.659	0.623	0.707	0.643	0.614	0.543	0.483	0.452
Observations	36,792	35,518	29,670	38,614	33,067	29,885	30,272	17,673
Panel C: Tranche 3								
Dutiable × Interim	−0.012	−0.007	−0.006	−0.000	0.001	0.004	−0.002	−0.017
	(0.015)	(0.010)	(0.013)	(0.011)	(0.009)	(0.012)	(0.008)	(0.018)
Dutiable × Post	−0.032*	−0.002	−0.007	−0.013	−0.006	−0.002	−0.006	−0.013
	(0.018)	(0.013)	(0.019)	(0.015)	(0.010)	(0.012)	(0.010)	(0.016)
R-squared	0.751	0.684	0.706	0.689	0.664	0.620	0.655	0.599
Observations	358,008	291,884	237,618	365,328	264,063	218,225	209,582	136,310
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product (HS-8) FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

NOTES: The regressions are based on the monthly foreign trade data at the 10-digit product category level over the period from January 2016 to July 2019 from the US Census Bureau. Standard errors, shown in parentheses, are clustered at the product (HS8) level. * denotes statistical significance at the 10% level, ** at the 5% level, *** at the 1% level. FE = fixed effect.

suggest that homogenous goods are more replaceable in the international market compared with differentiated goods.

The absence of overall diversion effects on US imports also masks heterogeneity across different exporters. In columns (2) to (7) on table 4, we estimate import diversion to other major exporters to the US market, including Canada, Mexico, the European Union, Japan, South Korea, Taiwan and Vietnam. These economies and China combined account for 80% of total US imports. We estimate very limited diversion effects of US imports to North America (columns (2) and (3)), Europe (column (4)) and Japan (column (5)). In particular, the estimated null diversion effect to Mexico suggest that one should not interpret the observed surge in US imports from Mexico as evidence of one-for-one trade diversion. Although there was a significant rise in imports from Mexico in the dutiable products, imports from Mexico in the exempted (from Section 301) products rose significantly in the meantime. Therefore, the concurrent increase in Mexican exports to the US is not a direct replacement for the dutiable imports from China. Further analysis, however, reveals the diversion of certain products from a few Asian economies (columns (6) to (8)). For products on list 1, we estimate a 3.6% increase in imports from South Korea but no significant increase from Taiwan and Vietnam. For those on list 2, we estimate a 4.5% increase in imports from South Korea, a 3.6% increase from Taiwan and a 7.8% increase from Vietnam. No significant diversion effects are estimated for products on list 3 from the same set of exporters.

TABLE 5
Impact of tariff hikes on US imports from economies other than China (HS10 level analysis)

	Tranche 1 (1)	Tranche 2 (2)	Tranche 3 (3)
Dutiable × Interim × Differentiated good	0.041	−0.049	−0.063
	(0.119)	(0.130)	(0.069)
Dutiable × Interim × Homogenous good	0.172*	0.024	0.122***
	(0.095)	(0.119)	(0.037)
Dutiable × Post × Differentiated good	0.065	−0.033	−0.086
	(0.119)	(0.131)	(0.068)
Dutiable × Post × Homogenous good	0.231**	0.017	0.103***
	(0.100)	(0.120)	(0.039)
Product (HS-8) FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
R-squared	0.504	0.512	0.583
Observations	97,650	36,792	358,008

NOTES: The regressions are based on the monthly foreign trade data at the 10-digit product category level over the period from January 2016 to July 2019 from the US Census Bureau. "Dutiable" is an indicator variable that equals 1 if the eight-digit product category was subject to new tariffs and 0 if it was eventually exempted from the new tariffs. "Interim" is an indicator that turns on when the proposed list is unveiled by not yet implemented. "Post" is dummy indicating whether the new tariffs are put into effect. Standard errors, shown in parentheses, are clustered at the HS-8 product level. * denotes statistical significance at the 10% level, ** at the 5% level, *** at the 1% level. FE = fixed effect.

We have found diversion effects on US imports to only a few countries for a subset of the products subject to tariffs. For Tranche 1, we find that the trade diversion for the US is limited, probably because the imports from China account for only a tiny share of the total US imports. For Tranche 2, we have evidence for trade diversion to a few Asian economies (see columns (6) to (8) for South Korea, Taiwan and Vietnam). For Tranche 3, our results suggest limited trade diversion. Due to the limited pass-through of tariffs, Chinese exporters seem to have borne most of the tariff burden. We find that the reduction of imports for Tranche 3 is moderate, consistent with a limited tariff pass-through.

Did Chinese exporters, on the other hand, succeed in finding alternative markets for exports in response to rising US tariffs? To answer this question, we estimate equation (4) using Chinese export data. Because the Harmonized System requires consistency of product code at six-digit HS level across different countries, we conduct the analysis on Chinese exports at six-digit HS level. Here, $\mathsf{Dutiable}_j$ is defined at the HS-6 level. It equals one if any of its HS-8 subheadings are dutiable to US tariffs and zero if none of its HS-8 subheadings are. Accordingly, we control for HS-6 specific fixed-effects (γ_j).

We find significant export diversion for China following US tariffs. These effects are heterogeneous across destination countries and across product lists, though. These countries, together with the US, account for 67% of China's exports. The estimation results are shown in table 6.

The first column on table 6 shows the estimated export diversion effects of three tranches of tariffs on US imports from the rest of the world. For the third tranche of tariffs that cover $200 billion worth of Chinese products, we estimate a 13.6% surge in China's exports to countries other than US when the tariffs were pre-announced and 14.9% when they were implemented (column (1)). This result is in line with the fact that the third tranche covered homogeneous goods, for which alternative purchasers are easier to come by. No such effects are estimated for the first and second tranche of tariffs. Interestingly, we estimate a decline in Chinese exports to third countries when the first tranche of tariffs was pre-announced.

TABLE 6

Impact of tariff hikes on Chinese exports to economies other than US (HS6 level analysis)

	(1) ROW	(2) Canada	(3) Mexico	(4) EU	(5) Japan	(6) South Korea	(7) Taiwan	(8) Vietnam
Panel A: Tranche 1								
Dutiable × Interim	−0.093***	−0.033**	0.024	0.015	−0.012	−0.009	0.024*	−0.083***
	(0.032)	(0.013)	(0.017)	(0.024)	(0.016)	(0.019)	(0.012)	(0.028)
Dutiable × Post	−0.038	−0.004	0.041***	0.067***	−0.000	0.002	0.054***	0.014
	(0.025)	(0.011)	(0.015)	(0.020)	(0.015)	(0.018)	(0.013)	(0.022)
R-squared	0.944	0.844	0.869	0.930	0.945	0.913	0.907	0.851
Observations	31,980	30,724	30,682	31,952	31,364	31,508	30,973	31,669
Panel B: Tranche 2								
Dutiable × Interim	−0.049	−0.012	0.047**	0.039	0.019	0.018	0.055***	−0.014
	(0.034)	(0.015)	(0.021)	(0.030)	(0.024)	(0.024)	(0.015)	(0.035)
Dutiable × Post	−0.055	0.032**	0.085***	0.087***	−0.010	0.024	0.074***	0.092***
	(0.034)	(0.016)	(0.026)	(0.029)	(0.024)	(0.023)	(0.016)	(0.035)
R-squared	0.955	0.866	0.890	0.945	0.955	0.937	0.943	0.883
Observations	20,432	19,176	19,134	20,404	19,816	19,960	19,425	20,121
Panel C: Tranche 3								
Dutiable × Interim	0.136*	0.105**	0.018	0.222**	0.070	0.024	0.015	0.049
	(0.072)	(0.045)	(0.069)	(0.097)	(0.053)	(0.069)	(0.048)	(0.075)
Dutiable × Post	0.149*	0.128**	0.092**	0.188*	0.055	0.150*	0.001	0.181**
	(0.086)	(0.063)	(0.044)	(0.099)	(0.078)	(0.085)	(0.056)	(0.083)
R-squared	0.960	0.920	0.914	0.956	0.950	0.915	0.895	0.890
Observations	113,190	112,142	111,640	113,013	112,952	112,890	112,628	112,314
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product (HS-6) FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

NOTES: The regressions are based on the monthly foreign trade data at the six-digit product category level over the period from January 2016 to July 2019 from the Chinese Customs Office. Standard errors, shown in parentheses, are clustered at the product (HS6) level. * denotes statistical significance at the 10% level, ** at the 5% level, *** at the 1% level. FE = fixed effect.

This is consistent with our previous findings of the front-loading activities in response to the first tranche of tariffs (table 2, column (1)).

We estimate strong diversion effects on China's exports to North America except for products on list 1 to Canada (table 6, columns (2) and (3)). We find even stronger diversion effects of China's exports to the European Union (column (4)). For the products on all three lists, our results suggest that China ramped up its exports to Europe, and at higher growth rates compared with Canada and Mexico.

The diversion of China's export to North America and Europe makes an interesting comparison with little diversion of US imports to the same areas. The observed asymmetry of trade diversion here suggests that not all trade diversion caused by the bilateral tariffs is a simple rerouting of goods from China to US via other countries. Because most of the products are intermediate good, this asymmetry points to the possibility of supply chains shifted from US to Canada, Mexico and Europe. More specifically, China can send materials and parts to these other countries, where they are made into finished products and then shipped to other places including the US. Due to data limitation, we do not have further empirical evidence to confirm this conjecture.

We find diversion effects of China's exports to several parts of Asia, with noticeable heterogeneity across countries or regions and across different sets of products. For the products on list 1, we estimate a 5.4% rise in mainland China's exports to Taiwan (table 6, column

(7)) and no similar effects for exports to Korea and Vietnam (table 6, columns (6) and (8)). For the products on list 3, we find sizeable export diversion to Korea and Vietnam and very limited diversion to Taiwan. These results, combined with the null import diversion of US from these exporters, suggest that these increased imports from China are not simply reexported to US.

For the products on list 2, we estimate an increase in mainland China's exports to Taiwan and Vietnam (table 6, panel B, columns (7) and (8)). This finding, combined with the concurrent increase in US imports of products on list 2 from Taiwan and Vietnam (table 4, panel B, columns (7) and (8)), suggests potential production relocation, that is, Chinese producers moving their production from Mainland China to Vietnam or Taiwan. Another possibility is "roundabout exports" from China to the US via third countries or regions that may involve faking the origin of products. More specifically, the Chinese producers could have been shipping their products to these places and repacking them there to disguise their place of origin.

Are "roundabout exports" from China to US via third countries or regions feasible under Rules of Origin (ROOs)? ROOs are commonly used to determine if products are eligible for duty-free or reduced duties under the MFN/FTA rules. To our knowledge, however, it is still possible for "tariff hopping," either by rerouting trade flows through third countries or reallocating export platforms (Fajgelbaum and Khandelwal 2022). Both empirical and anecdotal evidence shows the possibility for Chinese exporters to transship their product through third countries. Reports in the *New York Times*, the *Barron's* and *The Wall Street Journal* described how Chinese products got transshipped through Malaysia, Vietnam, or other countries.[31] Moreover, rigorous academic studies also provide empirical evidence for such activities. For example, Rotunno et al. (2013) show evidence that ethnic-Chinese firms may use Africa as a quota-hopping export platform to export apparel products to the US. They estimate that direct transshipment may account for around 22% of Africa's apparel exports from 2001 to 2008. Flaaen et al. (2019) has also shown that discriminatory tariffs may induce the relocation of producers.

6. Conclusion

Using monthly import data at the 10-digit product level, we evaluate the impacts of the recent US Section 301 tariffs on imports from China. Our empirical strategy exploits the fact that some products initially proposed on the tariff list were later dropped and therefore were not dutiable by new tariffs. Using these exempted products to establish the counterfactual, our analysis finds heterogeneous elasticity of imports with respect to tariffs, ranging from 0.4 to 1.0 for the three tranches of tariffs. In addition, US importers were found to purchase forward in anticipation of higher upcoming tariffs. A back-of-the-envelope calculation indicates a loss of $22.9 billion worth of US imports from China in 2017, or a 4.5% reduction in the total US imports from China.

Not all the Section 301 tariffs were passed on to US producers and consumers. For the first two tranches of tariffs, our estimates suggest a full pass-through. However, our estimates for the third tranche indicate that some Chinese exporters absorbed most of the tariff burden

31 K. Bradsher, "Tariff Dodgers Stand to Profit Off U.S.–China Trade Dispute," *New York Times*, April 22, 2018; Dow Jones Newswire, "Companies Dodge U.S. Tariffs on China by Rerouting Goods," *Barron's*, June 26, 2019; C-W. Yap, "American Tariffs on China Are Being Blunted by Trade Cheats," *Wall Street Journal*, June 26, 2019.

by cutting pre-tariff prices. The reduction in average price for products on list 3 is partly driven by reduced prices of homogenous goods.

We find that the tariffs led to asymmetric trade diversion effects for US and China. The US could barely make up the loss in imported Chinese goods by purchasing more from alternative origins. In contrast, an analysis of the Chinese export data shows that China responded to the tariffs by selling more to other destinations. The asymmetry in trade diversion is consistent with the relocation of supply chains from the US to Europe and other parts of North America. Some of our findings also indicate the possibility of "roundabout exports" from China to US via Vietnam and Taiwan.

Our analysis is confined to the direct and immediate effects of US punitive tariffs. It does not capture the resulting uncertainty of trade (Handley and Limão 2017), the disruption of the global supply chain (Fontagné and Bellora 2019) and other long-term general equilibrium effects, all of which deserve further research.

Supporting information

Supplementary material accompanies this article. The data and code that support the findings of this study are available in the Canadian Journal of Economics Dataverse at https://doi.org/10.5683/SP3/RUDEH2.

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