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THE ECONOMIC IMPACTS OF THE US-CHINA TRADE WAR

Pablo Fajgelbaum
Amit Khandelwal

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ABSTRACT

In 2018, the US launched a trade war with China, an abrupt departure from its historical leadership in integrating global markets. By late 2019, the US had tariffed roughly $350 billion of Chinese imports, and China had retaliated on $100 billion US exports. Economists have used a diversity of data and methods to assess the impacts of the trade war on the US, China and other countries. This article reviews what we have learned to date from this work.

Pablo Fajgelbaum
Princeton University
Department of Economics
International Economics Section
Room 294 Julis Romo Rabinowitz Bldg
Princeton, NJ 08544
and NBER
pfajgelb@princeton.edu

Amit Khandelwal
Graduate School of Business
Columbia University
Uris Hall 606, 3022 Broadway
New York, NY 10027
and NBER
ak2796@columbia.edu

1 Introduction

In early 2018, the US raised tariffs on a few large import items–washing machines, solar panels, steel and aluminum. While these tariffs did not discriminate by origin, it soon became apparent that US trade policies were targeting China. The US subsequently increased tariffs on thousands of products from China between 2018-19, ultimately targeting roughly $350 billion of imports from that country. China retaliated over several tariff waves, targeting about $100 billion of US exports. The two parties signed an agreement to halt further tariff escalations in January 2020, but the existing tariffs remained in place as of 2021.

The trade war stands out as among the largest and most abrupt change in US trade policy history, particularly when juxtaposed against the leading role historically played by the US in driving tariff reductions around the globe. As the trade war unfolded, economists attempted to assess its economic impacts. This article reviews these efforts and synthesizes what we have learned.

The research has largely explored the two central questions in international economics: What are the aggregate welfare consequences of trade barriers? How is this aggregate change distributed within a country?

To assess the aggregate impacts of the trade war, standard trade models reveal that a crucial component is the pass-through of tariffs to import prices. From the previous literature, and given the presumption that the economies of the US and China are large enough to affect prices, it would have been natural to expect an incomplete pass-through of tariffs (i.e., that import prices before applying tariffs would fall with tariffs). In contrast, empirical work has found complete pass-through of tariffs to tariff-inclusive import prices (i.e., tariff-inclusive import prices rise one-for-one with the tariff changes) when looking across exporting countries or products differentially exposed to tariffs. We discuss potential conjectures for this finding.The aggregate impacts also depend on producer effects that materialize through export prices, and on changes in tariff revenue. We review approaches that have estimated these components.

The main takeaways from this research is that US consumers of imported goods have borne the brunt of the tariffs through higher prices, and that the trade war has lowered aggregate real income in both the US and China, although not by large magnitudes relative to GDP.

We also review papers that have explored the distributional consequences of the trade war through consumers and producers, employment across sectors, and spatial impacts on income and consumption across the US. We conclude with thoughts on the open questions that would be important to address in future work.

2 Background

The US-China trade war unfolded over a series of tariff waves between 2018-2019. In January 2020, the two countries signed the Phase One agreement to deescalate trade tensions in January 2020, yet the tariffs remained in place as of late 2021. We summarize the key events of the trade war, but refer readers to the summary in Bown and Kolb (2021) and the comprehensive discussion in Bown (2021) for more details.[1]

In February 2018, following a Section 201 investigation of solar panels and washing machines, the US International Trade Commission determined that imports of these products had injured domestic producers, and President Trump imposed safeguard tariffs. These first tariff waves targeted specific products from many countries. Shortly thereafter, additional tariffs on steel and aluminum were imposed based on Section 232 investigations by the Commerce Department.[2] These tariffs also targeted several countries including China, with some large economies (e.g., the European Union and Canada) initially being exempted. China and other trade partners imposed retaliatory tariffs in response.

Subsequent stages of the trade war were largely conducted between the US and China. In August 2017, the US initiated a Section 301 investigation against China's trade practices, and on March 22, 2018 the Office of the US Trade Representative accused China of unfair trade practices ranging from the forced transfer of technology to Chinese firms and intellectual property theft. On these grounds, the US ultimately implemented five tariff rounds on Chinese exports–July 2018, August 2018, September 2018, June 2019, and September 2019–with China retaliating at each stage. The US and China canceled a sixth tariff wave in December 2019 in anticipation of the Phase One agreement. Once the deal was signed in January 2020, both sides agreed to reduce the tariffs from the September 2019 wave by half, but the tariffs remain in place as of September 2021.

In terms of magnitudes, the US imposed tariffs (including other trade partners) on 17.6% of its 2017 imports. Imports as a share of 2016 GDP was about 15%, so the US raised tariffs on import transactions corresponding to about 2.6% of GDP, with average tariffs increasing from 3.7% to 25.8%. On the export side, trade partners retaliated on 8.7% of 2017 exports.[3] Exports as a share of 2016 GDP was about 12%, so trade partners imposed retaliations on exports corresponding to about 1% of US GDP, with average tariffs rising from 7.7% to 20.8%. So, the US and Chinese tariffs targeted imports and exports amounting to 3.6% of US GDP. China raised tariffs on about 11% of imports, and about 18% of their exports were targeted by the US (Chang et al. 2021). With import and export shares of 2017 GDP of 17.9% and 19.7%, respectively, the trade war affected transactions equivalent to about 5.5% of China's GDP.[4] China further hampered US access to its

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[1] We do not examine the non-tariff instruments discussed by Bown (2021) that were used during the war, such as export controls for national security purposes (e.g., semiconductors), requirements of export licenses to export to particular entities, a reclassification of all goods imported from Hong Kong as originated from China (and therefore potentially subject to Section 301 tariffs), and banned imports from Xinjiang due to concerns of forced labor. These policies have not received much systematic analysis. See Bown (2020) for details of US changes in semiconductor export control policy implemented during the trade war. We also do not review US-China tariff measures implemented prior to the trade war, such as granting China normal trading status (Pierce and Schott, 2016) or the increase in US anti-dumping duties on Chinese imports (Bown et al., 2021).

[2] Section 201 of the Trade Act of 1974 allows the President to impose safeguard tariffs in response to injury to a domestic industry. Section 232 of the Trade Expansion Act of 1962 allows the President to protectionist measures on imports posing a national security threat.

[3] These numbers are taken from Fajgelbaum et al. (2021a), which updates Fajgelbaum et al. (2020) with the 2019 tariff waves.

[4] Chinese and American importers did request tariff exclusions or rebates from their respective governments; see Bown (2021) for a detailed discussion. He estimates that exclusions and rebates affected about 4% of US imports from China (corresponding to about 9% of estimated tariff revenue collection).

market by reducing its Most Favored Nation (MFN) tariffs on about 10% of its imports.

In comparison, the 1930 Smoot-Hawley legislation raised average tariffs from 34.6% to 42.5% on dutiable imports that were equivalent to 1.4% of GDP, and several foreign trade partners retaliated (Canada, which accounted for 20% of US exports, raised duties on a third of US exports to Canada); see Irwin (1998) and Irwin (2017). Thus, by the metric of GDP targeted by tariffs, the US-China trade war appears more substantial than Smoot-Hawley tariffs.[5] Another way to gauge the magnitude of the trade war is to consider the fraction of products targeted by tariffs. Roughly two-thirds of ten-digit imported and exported products were targeted with tariff increases (Fajgelbaum et al., 2021a), while Smoot-Hawley raised tariffs on 27% of dutiable products (Irwin, 2017).

Of course, the context of the US-China trade war differs substantially from the Smoot-Hawley tariffs. Those tariffs were launched on the eve of the Great Depression, while global real growth in 2017 was 3.7% (IMF, 2018).[6] The nature of globalization today is also quite different, most notably through the volume of trade and its composition, with two-thirds of global trade now in intermediate goods (Johnson and Noguera, 2012; Antràs and Chor, 2021). A general tariff increase today may affect not only the prices that final consumers pay, but also the costs for firms that use those goods as inputs for production, a force that the papers discussed below try to account for. The US imposed tariffs on 67% of imported intermediate inputs and capital goods from China (representing 62% of the total Chinese imports targeted), and China also imposed tariffs on 67% of intermediate and capital goods from US (representing 81% of US imports targeted); see Bown (2021).

While we focus on the economic consequences, understanding the political motivations is also important. This episode stands alongside recent backlashes against globalization: it was launched two years after the 2016 UK Brexit referendum, a year after the US withdrew from the Trans Pacific Partnership, and a year before the US blocked the appointment of judges to the WTO Appellate Body.[7] These episodes materialized against a background of growing inequality related, among other forces, to China's ascent in the world economy (Autor et al., 2016, 2019; Pierce and Schott, 2016, 2020) and labor-saving or skill-biased technological change (Goldin and Katz, 2010; Acemoglu and Restrepo, 2019). In this context, trade policy can become a powerful electoral tool if deployed to benefit some groups.[8] Electoral motivations were indeed visible as part of the 2016 Trump Presidential campaign, which ran on a anti-globalization platform of tariffs on China. Fajgelbaum et al. (2020) provide suggestive evidence of electoral motivation; consistent with a median-voter view of politically motivated tariffs (Dixit and Londregan, 1995; Mayer, 1984). They find that counties with approximately balanced Republican and Democrat constituencies in the 2016 Presi-

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[5] Another notable general tariff increase by the US in the 20th century occurred in 1971 when Nixon imposed a 10% surcharge on roughly half of US imports, but these tariffs only lasted for about four months (Irwin, 2013).

[6] Moreover, because of deflation and the widespread use of specific tariffs, the effective tariff from Smoot-Hawley on dutiable imports rose to nearly 60% by 1932; Irwin (2017) argues that one-third of the tariff increase was due to legislation and two-thirds due to deflation.

[7] See Antràs (2020), Walter (2021) and Colantone et al. (2021) for a discussion of this backlash.

[8] See Helpman (1995) for a review of classic theories and Grossman and Helpman (2021) for a recent theory on how non-trade inequality shocks may trigger protectionist waves. Autor et al. (2020) and Che et al. (2020) argue that Chinese import competition affected electoral outcomes in US elections.

dential election received more import protection from the 2018 tariff waves than heavily Democratic and Republican counties.[9] However, they also find that China's retaliatory tariffs coincided with Republican-leaning counties, largely because these counties tend to be rural and the Chinese tariffs were large in agriculture. Blanchard et al. (2019) argue that the political consequences of the trade war did not pay off for the Republican party in 2018 Congressional election, as counties more exposed to the retaliatory tariffs reduced support for Republican candidates.

3 Welfare in The Standard Trade Model

We organize the discussion around a well-known formula dating to at least Dixit and Norman (1980). In neoclassical models, the aggregate equivalent variation, EV, corresponding to a change in import tariffs–the sum of money that would suffice, if properly distributed across the agents in the economy, to leave them indifferent with a tariff change–can be expressed, to a first-order approximation, as follows:

$$EV = -\underbrace{\mathbf{m}'\Delta\left(\mathbf{p}^*_{\mathbf{m}}\left(1+\tau\right)\right)}_{EV_m} + \underbrace{\mathbf{x}'\Delta\mathbf{p}^*_{\mathbf{x}}}_{EV_x} + \Delta R, \tag{1}$$

where $\mathbf{m}$ and $\mathbf{x}$ are vectors with quantities of imported and exported commodities before tariffs change, $\mathbf{p}^*_{\mathbf{m}}$ and $\mathbf{p}^*_{\mathbf{X}}$ are the import and export prices, τ are ad-valorem import tariffs, R is tariff revenue, and Δ denotes the difference between the post- and pre-trade war outcomes.[10]

The import prices $\mathbf{p}^*_{\mathbf{m}}$ are what the importing country faces when buying from the world, i.e., the price at the port. But buyers inside the country pay the tariff-inclusive price $\mathbf{p}^*_{\mathbf{m}}\left(1+\tau\right)$. So the "importer cost," EV_m encompasses all buyers of imported goods, both firms and final consumers. The export prices $\Delta\mathbf{p}^*_{\mathbf{x}}$ are the prices faced by domestic producers selling abroad, and EV_x is the change in export value that they perceive. The last term, ΔR, is the tariff revenue received by the government.

The part $\mathbf{m}'\Delta\left(\mathbf{p}^*_{\mathbf{m}}\tau\right)$ of the consumer cost EV_m is transferred to the government as tariff revenue and washes out from the previous expression, which simplifies to:

$$EV = \left(\mathbf{p}^*_{\mathbf{m}}\mathbf{m}\right)'\left(-\boldsymbol{\Delta}\ln\mathbf{p}^*_{\mathbf{m}} + \tau\boldsymbol{\Delta}\ln\mathbf{m}\right) + \left(\mathbf{p}^*_{\mathbf{x}}\mathbf{x}\right)'\Delta\ln\mathbf{p}^*_{\mathbf{x}}. \tag{2}$$

This formula holds in neoclassical environments regardless of how complex they may be. It holds for any input-output structure, or with heterogeneous consumers. Therefore, if one is content with the assumptions of neoclassical trade theory and with first-order approximations, to measure EV it suffices to use information on the trade flows and import tariffs before the trade war, and on the changes in international prices and in import quantities caused by the trade war.

The formula says that a country is made better off by terms-of-trade increases (lower import prices $\mathbf{p}^*_{\mathbf{m}}$ or higher export prices $\mathbf{p}^*_{\mathbf{x}}$) and worse off by distortions ($\tau\Delta\ln\mathbf{m} < 0$). Conveniently, and

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[9] Fetzer and Schwarz (2021) also examine the political targeting of retaliatory tariffs and conclude that the tariffs were biased towards geographic areas that voted for Trump in 2016. Brutger et al. (2021) uses survey results to argue that US voters perceived the retaliatory tariffs as a form of electoral interference.

[10] Export taxes are omitted from the formula. The US-China trade war featured export bans, but these have not been systematically analyzed by the papers reviewed in this article.

perhaps counter-intuitively, it depends on gross trade, which is readily observable, rather than on value-added trade, which would be much harder to measure.[11] The other components, the changes in international prices and import quantities *caused by the trade war,* present a challenge. The empirical and quantitative approaches reviewed below impose structure to measure how $(\mathbf{p}^*_{\mathbf{m}}, \mathbf{p}^*_{\mathbf{x}}, \mathbf{m})$ responded to the trade war tariffs.

Before discussing the estimates, it is worth reviewing how tariffs affect each term in (2). In principle every price and trade flow could respond to every tariff, but the theory guides the signs and welfare implications of some of these relationships. Consider first import prices. The mechanical effect of a tariff is to raise the tariff-inclusive price of the commodity being taxed, lowering the demand for imports of that commodity. Through market clearing, and assuming away well known "paradoxes" such as in Lerner (1936) and Metzler (1949), this reduction in demand lowers the before-tariff import price but typically not enough to fully offset the tariff increase, so that the tariff-inclusive price increases. The increase in the tariff-inclusive import price relative to the tariff increase is the *tariff pass-through rate*; the smaller it is (i.e., the larger the decline in p^*_m), the greater the gains extracted by the importer from trade partners through terms-of-trade improvements.[12] Second, the reductions in import quantities due to tariffs matter through their impact on tariff revenue. Turning to export prices, the logic we have just discussed implies that prices of exported commodities should fall with retaliatory tariffs. In addition, the flip-side of before-tariff import prices falling with tariffs is rising export prices, a manifestation of Lerner's symmetry: as tariffs reallocate resources away from export-oriented activities and demand away from imports, US producer prices increase and so do export prices.[13] Finally, import and exports prices may be indirectly affected through cost increases via input-output linkages if imported intermediates are used in production of exports.

In the next two sections, we review papers that have computed import and export prices necessary to construct the welfare consequences of the war. As noted, doing so requires measuring the full distribution of price changes triggered by the tariffs. However, in practice, identifying this distribution is challenging. Tariffs affect the prices of highly disaggregated imported transactions. Since tariff changes are not randomly assigned, identifying impacts at that level typically requires controlling for potential confounders at the product, sector, and/or country level. However, tariff changes–particularly large ones–may also affect components of prices that vary across products, sectors, or countries (for example, through wage adjustments required for market clearing at those

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[11] Readers familiar with the Hulten theorem will recognize the similarity (Hulten, 1978). In a closed economy, the Hulten theorem says that, regardless of the economy's input-output structure, aggregate real income growth equals the inner product of productivity shocks and gross sales across sectors. In an international trade context, we can think of foreign price shocks similarly to TFP shocks. Baqaee and Farhi (2021) provide a close inspection of Hulten-like results in open economy.

[12] As noted by Johnson (1953), the terms-of-trade externality arising from a trade war generally gives rise to an inefficient world equilibrium. Governments may cooperate to avoid this bad outcome, as in the theory of trade agreements developed by Bagwell and Staiger (1999). Evidence that government policy is guided by terms-of-trade manipulation is provided by Broda et al. (2008), Bagwell and Staiger (2011), Bown and Crowley (2013), Ludema and Mayda (2013), and Nicita et al. (2018).

[13] See Costinot and Werning (2019) for a general treatment of Lerner's symmetry.

levels).

The papers that we review in Section 4 typically identify the changes in US import prices from China relative to other origins within a product, or across imported products within a sector. In doing so, these empirical specifications are only able to measure relative price changes within products or within sectors, but do not estimate the full distribution of price changes. They do not identify the product-, sector-, or country-level components of the price changes potentially caused by the war. This gap between the partial distribution of price changes estimated in the regressions and the entire distribution of price changes needed for (2) can be filled in through additional assumptions in general equilibrium models, and we review those in Section 6.

4 Importers

4.1 Tariff Pass-Through

A group of papers studies the response of US import prices to US tariffs (Amiti et al., 2019; Fajgelbaum et al., 2020; Cavallo et al., 2021; Flaaen et al., 2020). This measurement allows to compute EV_m. These analyses define a commodity as a product-by-origin dyad in international trade data. The presumption is that, within a product category, countries sell differentiated varieties. The typical regression examines export prices (i.e., the prices of goods at the dock before tariffs are levied):

$$\Delta \ln p^*_{igt} = controls - \beta \Delta \ln (1 + \tau_{igt}) + \epsilon_{igt}, \tag{3}$$

where g is a product code, t is a month, i is a country exporting to the US, and the controls (that we discuss below) include fixed effects to account for trends at a broader level.[14] These fixed effects determine the source of variation that identifies pass-through and are important to interpret the results, as we discuss below. Dealing with endogeneity of tariffs is, of course, a concern in analyses of the effects of trade policy (Goldberg and Pavcnik, 2016). In the case of the trade war, this research has demonstrated that, conditional on the fixed effects that enter in the controls, the tariff changes were uncorrelated with previous price and import trends across products (e.g., Cavallo et al. 2021, Fajgelbaum et al. 2020, Amiti et al. 2020b).

The pass-through rate from tariffs to tariff-inclusive prices we have discussed in the previous section is $1 - \beta$. Incomplete pass-through means a β between zero and one. In the case of small importing countries whose demand is unlikely to impact international prices, the pass-through should be close to complete (a β of zero). The pass-through should be incomplete (a β greater than zero) and larger for importers carrying enough weight in world demand to influence prices. For example, if an importer commands a very large share of an exporter's total sales of a product, the exporter may not easily reallocate to other markets, making supply more inelastic at least over the short run. A more inelastic supply, in turn, implies lower pass-through. So, when prices

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[14] Typically, the price is measured as a unit value from product-level customs data. Tariffs are measured either from the statutory legislation or through applied tariffs. Instrumenting the applied tariff with the statutory tariff deals with potential concerns about measurement error and tariff exemptions (see Fajgelbaum et al. 2020).

Table 1: Direct Estimates of Tariff Pass-Through

Row	**Article** (1)	**Trade Policy Episode** (2)	**Importer** (3)	**Period** (4)	**β** (5)
1	Kreinin (1961)	US Reciprocal Trade Agreements Act	US	1954-1959	0.31
2	Feenstra (1989)	Trucks, Heavy cycles	US	1974-1987	1. Trucks: 0.430 2. Cycles: -0.169
3	Winkelmann and Winkelmann (1998)	New Zealand trade liberalization	New Zealand	1973-1994	0.072
4	Hummels and Skiba (2004)	none (cross-section)	US	1994	1.965
5	Mallick and Marques (2008)	India trade liberalization	India	1990-2001	0.999
6	Irwin (2014)	Sugar tariffs	US	1890-1930	0.244
7	Ludema and Yu (2016)	Uruguay Round	World	1997-1998	1.160
8	de Loecker et al. (2016)	India trade liberalization	India	1989–1997	0.849
9	Besedes et al. (2020)	CUSFTA, NAFTA	US	1989–2016	0.000

Notes: Table reports direct estimates of tariff pass-through from papers published from previous trade policy episodes. It reports the article, period and country of study, and trade policy episode. The following indicates the source of the pass-through estimate for each article (if multiple columns are reported, the estimate is an average): Row 1, Table 1 columns 1 and 3; Row 2, Table 1 column 2 and 3-4; Row 3, Table 2 column 1; Row 4, Table 2 column 2; Row 5, Table 3 column 1; Row 6, Table 2 column 4; Row 7, Table 2 column 2; Row 8, Table 8 columns 1-2; Row 9, Figure 9. The final column standardizes the estimate according to how β is defined in the text.

are expressed before tariffs as in (3), *complete pass-through* is revealed by $\beta = 0$ and *incomplete* pass-though by $\beta > 0$.

Various strands of the literature prior to the trade war provided support for incomplete pass-through; i.e., countries seem typically able to affect the terms of trade in their favor using tariffs.

First, the most closely related strand directly examined regressions similar to (3). Despite the centrality of tariff pass-through for the welfare effects of trade policy, the list of papers directly estimating tariff pass-through that were written before the trade war is small. This list includes: Kreinin (1961), Winkelmann and Winkelmann (1998), Feenstra (1989), Hummels and Skiba (2004), Mallick and Marques (2008), Irwin (2014), De Loecker et al. (2016), and Ludema and Yu (2016).[15] These papers mostly find incomplete pass-through in applications across different countries and time periods (see Table 1). For example, Feenstra (1989) estimates a β of 0.43 from US tariff increases on Japanese trucks in the 1980s and Irwin (2014) finds a β of 0.24 from US import tariffs on sugars between 1891 and 1914. Outside this range, Winkelmann and Winkelmann (1998) find complete pass-through in the context of the trade liberalization of a small importer (New Zealand in the mid-1980's).

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[15] Blonigen and Haynes (2002) (see also Blonigen and Haynes (2010)) estimate pass-through of anti-dumping duties imposed by the US on Canadian iron and steel products from 1989-1995. They point out that anti-dumping duties endogenously adjust with import prices through period reviews by the Commerce Department, and so the pass-through estimate may be less comparable with pass-through rates estimated from standard tariffs.

Second, several studies have estimated import demand and export supply elasticities that can be used to inform tariff pass-through.[16] Romalis (2007) uses NAFTA tariff cuts and finds evidence of incomplete pass-through, with an implied β of 0.79.[17] Broda and Weinstein (2006), Broda et al. (2008), Soderbery (2015), and Irwin and Soderbery (2021) do not use tariff variation, but estimate import demand and export supply elasticities following the approach from Feenstra (1994). The estimates from these papers also imply incomplete pass-through. For example, Broda et al. (2008) estimate elasticities at the product level for 15 non-WTO countries from the late 90's to early 00's. Their estimates imply a median β across all products within each country that ranges between 0.79 and 0.95 across countries. That is, their elasticities imply that every country in their sample–despite consisting of small importers except for China and Russia–has potentially strong power to manipulate international prices with tariffs. Furthermore, they find positive correlations between tariffs and inverse supply elasticities, suggesting that countries engage in some terms of trade manipulation.

Finally, a large literature has examined the related concept of exchange-rate pass-through. From the perspective of an exporter to the US, a depreciation of the exporter's currency is a positive demand shifter as much as a tariff reduction. Hence, appreciations of the exporter's currency and import tariffs should have similar effects on prices. The typical finding has been incomplete exchange-rate pass-through: a depreciation of the exporter's currency typically increases the foreign-currency prices faced by the importer. Goldberg and Knetter (1997) review earlier results that imply a pass-through rate of about $\beta = 0.4$; see also Burstein and Gopinath (2014). In Japanese auto imports, Feenstra (1989) finds support for the symmetry hypothesis.

Against these priors, it is surprising that several papers found pass-through to be virtually *complete* during this trade war (a $\beta = 0$). Moreover, the US and China account for a reasonably large fraction of each others' trade across many of the product categories affected by tariffs, so one would expect tariffs to affect bilateral prices that clear the US-China markets. Across six-digit products in 2017, China accounted for an average 23% of US imports, and the US accounted for an average 12% of Chinese imports. The pass-through evidence is robust and it was identified by several research teams independently using different data sources and at various time horizons.

Fajgelbaum et al. (2020) match the tariff changes to publicly-available US import and export data at the HS10 product level,[18] and implement the specification in (3) for both the US and China as importers at a monthly frequency. As controls, their benchmark specification includes fixed effects by product-time, exporter-time, and exporter-sector. Therefore, the identification comes from differential variation in tariff changes across exporters to the US within a product.

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[16] See next sub-section for how these elasticities map to β.

[17] Romalis (2007) estimates an inverse supply elasticity of 0.45 (Table 4, column 1) and an import demand elasticity in the range of 6.2 and 10.9 (Table 3), which implies the reported β; see next section. More recently, however, Besedes et al. (2020) analyze pass-through from the NAFTA agreement and find evidence of complete pass-through at both short and long-run horizons (up to 10 years). Their result could be different from Romalis (2007) because of differences in data aggregation or the underlying variation exploited in the analysis.

[18] For example, the US imposed tariffs of Chinese imports of "Electric Storage Water Heaters" (HS 8516100040), "Sturgeon Roe, Fresh Or Chilled" (HS 0302912000), and "Knives With Sterling Silver Handles" (HS 7219330080).

That is, they ask if China lowered prices relative to other exporters within products in response to tariffs. Fajgelbaum et al. (2020) estimate a $\beta = 0.00$ (se 0.08). Using the same data and a similar regression but 12-month differences instead of monthly changes, Amiti et al. (2019) estimate -0.012 (se 0.023). In follow-up analysis that include the September 2019 waves, Amiti et al. (2020b) and Fajgelbaum et al. (2021a) find that the pass-through remains complete over a one-year horizon.

Those studies used publicly available trade data. While the HS10 product definitions used in these analyses are narrow, they consist of aggregates of potentially many transactions across individual goods and sellers. Cavallo et al. (2021) estimate tariff pass-through using confidential micro data on the import prices that underlie the import price indices constructed by the BLS. They estimate (3) at the monthly level with a lag structure and with the bilateral exchange rate as an additional independent variable, relying on both variation across exporters to the US and across products.[19] They find a cumulative one-year value of $\beta = 0.018$ (se 0.030). In contrast to the near complete tariff pass-through, they estimate incomplete exchange-rate pass through of 25-35%, in line with previous work.[20]

The finding of complete pass-through implies that the importer cost (EV_m) from (1) can be easily calculated as the increase in the cost of the pre-trade war import basket keeping import prices constant. This cost is the product of three terms: the import share of GDP (15%), the fraction of US imports targeted by tariff increases (17.6%), and the average import price increase among targeted varieties (which equals the average tariff increase of 22.1% due to complete pass-through). This calculation implies that imports buyers lost in aggregate 0.58% of GDP. This number means that importers have been 0.58% worse off in real terms relative to the pre-trade war scenario for the entire time that the tariffs have been in place.

So far we discussed the result for the US, as this has been the focus of most research. But Chang et al. (2021) and Ma et al. (2021) implement the specifications in Fajgelbaum et al. (2020) and Amiti et al. (2019), respectively, from the perspective of China, and both find complete pass-through. The complete pass-through in China reinforces the surprising nature of the results: in standard general equilibrium, if an importer faces an elastic export supply from an exporter, then that exporter would be typically be able to manipulate the terms-of-trade using trade policy. But during the trade war, neither country seemed able to manipulate the terms of trade in its favor.[21]

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[19] Unlike the previous two studies, their analysis of exchange rate pass-through precludes country-level fixed effects. Their specification includes sector-level but not product-level fixed effects.

[20] The previous studies rely on the universe of (manufacturing) imports to identify an average pass-through rate in the economy. Fajgelbaum et al. (2020) examine potential heterogeneity along a number of characteristics, such as whether a product is an intermediate input, but find no evidence of heterogeneity. Amiti et al. (2020b) show that pass-through is complete across broad sectors, except for steel where they estimate a pass-through of about 50%.

[21] The complete pass-through result may be also surprising due to the discriminatory nature of most tariffs during the trade war. The fact that the US tariffs were aimed only at China created incentives for "tariff hopping", either by re-routing trade flows through third countries or reallocating export platforms. In these instances, by no-arbitrage, the tariff-inclusive price from China relative to other origins should not have changed with the tariffs (a zero pass-through), the opposite of what the empirical research has found. Flaaen et al. (2020) argue that, for anti-dumping duties against washing machines from Korea before the trade war, producers responded by reallocating to untaxed sources, leading to zero or negative pass-through to tariff-inclusive prices. The complete pass-through finding suggests that these reallocations were not a frequent feature during the trade war, at least among products that continued to be imported from both China and other sources after the tariffs. It is possible, however, for this force to be relevant

As we have mentioned, these pass-through calculations come with an important caveat. The estimates compare price changes across exporters within a product, or across products. So impacts of tariffs that are common across exporter or products are not reflected. For example, the results do not rule out that US tariffs lowered the overall wage level in China relative to the US, and therefore lowered the price level of all Chinese goods exported to the US. Assessing these effects require a general-equilibrium model, which we discuss in Section 6.

4.2 Conjectures for Complete Pass-Through

We speculate on possible explanations for the complete pass-through result, although we stress that more research into the mechanism is required. For this, it is worth reminding that complete pass-through reflects inelastic demand or elastic supply–in either case, the incidence of the tax falls on the importer. More explicitly, regression (3) can be thought of as the reduced-form of an import demand and foreign export supply system. Let

$$\ln m = A - \sigma \ln \left(p^* \left(1+\tau\right)\right) \tag{4}$$

be the US import demand of a variety (a commodity from an exporting country), where σ is the domestic import demand elasticity, p^* is the import price, τ is an ad-valorem tariff, and A is a demand shifter accounting for expenditures and preference shocks; and let

$$\ln p^* = Z + \omega \ln m \tag{5}$$

be the inverse foreign supply from that exporter to the importing country, where ω is the inverse foreign export supply elasticity and Z is a cost shifter accounting for wages and productivity. Combining these two equations gives (3), with a $\beta = 1/\left(1+(\omega\sigma)^{-1}\right)$. So $\beta = 0$ occurs with infinitely inelastic domestic import demand ($\sigma \to 0$) or infinitely elastic foreign export supply ($\omega \to 0$).

Therefore, in this simple framework, to understand complete pass-through one needs a story of inelastic demand or elastic supply.[22] Short of these alternatives, the explanation for the results could lie on the behavior of the demand and supply shifters, A and Z above, which may be also responding to the tariffs. We review the plausibility of these and other possible explanations next.

Inelastic Demand?

An explanation of complete pass-through based on inelastic demand can be plausibly ruled out by results in Fajgelbaum et al. (2020). They use the tariff variation as instruments to recover (σ, ω) from (4) and (5), and find $\sigma = 2.53$ (se 0.26).[23] Hence, their findings are consistent with an

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among products that were fully reallocated away from China.

[22] In this system the elasticities are constant, hence the same pass-through rate holds globally. Using local elasticities, $1-\beta$ is also the local pass-through rate from tariffs to tariff-inclusive prices of a more general system of supply and demand system (Weyl and Fabinger, 2013).

[23] The idea that both demand and supply elasticities can be estimated from just one tax was implemented by Romalis (2007) and formally developed by Zoutman et al. (2018).

infinitely elastic foreign export supply but with a finite and relatively low demand elasticity across origins.

Elastic Supply?

Another possibility is that, at the variety level, supply happens to be very elastic: this would mean that China can easily reallocate exports from the US to other destinations when demand falls. Indeed, Fajgelbaum et al. (2020) estimate $\omega = -0.002$ (se 0.05) for Chinese exporters. This hypothesis would imply that, at the product level, the value of exports to the world for the Chinese products taxed by the US should not have fallen much. Fajgelbaum et al. (2021b) estimate that, across products, US tariffs lead China to reduce exports to the US but also to increase exports to the rest of the world, and cannot reject that Chinese (product-level) exports to the world remained constant. Hence, US tariffs did not seem to impact product-level Chinese exports, suggesting seamless reallocation of Chinese exports away from US into other markets within products. Jiao et al. (2020) uses firm-level data on the universe of firms from one Chinese prefecture, and their estimates suggest no declines in firm-level sales to the world despite a decline to the US, which is again consistent with relatively easy reallocation across destinations of a product, at least for Chinese producers.

Demand Shifters?

Demand-side explanations could mask a decline in import prices before tariffs if the demand shifter A increases in products with higher tariffs. This could happen due to dynamic decisions of importers of durable goods: if current tariffs are an indication of even bigger future restrictions, buyers who can carry inventory would increase current demand in anticipation of even further tariff increases. Alessandria and Mix (2021) provide evidence of anticipatory effects in previous tariff events, but this hypothesis has not been linked to pass-through. Another possibility related to demand shifters is that the tariffs triggered simultaneous improvements in average product quality that offset (quality-unadjusted) price declines. An extensive literature documents quality-based selection, such that firms selling higher-quality and therefore more expensive products enter tougher destinations (see Hummels and Skiba (2004) and Manova and Zhang (2012), among others). Ludema and Yu (2016) note that quality-based selection matters for the how tariffs affect quality-unadjusted import prices: as tariffs increase, firms selling more expensive products survive, pushing import prices up. However, this explanation for complete pass-through seems unlikely for continuing products because Cavallo et al. (2021) and Flaaen et al. (2020) also document complete pass-through in more disaggregated price data. It is possible, however, for quality upgrading to operate on an extensive margin of product entry and exit, an hypothesis that has not yet been assessed.

Supply Shifters?

Various mechanisms related to the supply shifter Z could mask an upward sloping supply (and hence a finding of incomplete pass-through if this supply shifter was properly controlled for). First, firms' unit costs vary with imported intermediates,[24] and particularly so for Chinese exporters (e.g., Brandt et al. (2017) and Amiti et al. (2020a)). If firms import and export the same products, and taking into account that there is overlap in the product categories taxed by the US and China (64 percent of six-digit HS codes are tariffed by both countries), then a specification like (3) could yield very small or complete pass-through because the tariffs would raise the costs of Chinese exporters, pushing up exporter prices and potentially offsetting the reduction in prices due to lower demand. Relatedly, if supply chains involve two-way trade within narrow product categories, then US import tariffs may raise costs along the chain, also increasing the costs of Chinese exporters. Second, there is considerable evidence that trade liberalizations drive improvements in productivity.[25] So, it could be that decreased access to US markets reduced firm productivity, pushing costs up, but this seems unlikely at this time horizon. A third explanation concerns unobserved policies. It is possible that the Chinese and American governments provided subsidies to firms, such as farm subsidies in the US (Blanchard et al., 2019). If these subsidies were systematically chosen to offset foreign tariffs, Z and τ would be correlated in way to leave export prices constant.

Contracts with Sticky Prices?

The tariffs were imposed without much warning to firms, so the duties were levied on top of prices that had been already contracted. This could explain complete pass-through early on. However, complete pass-through persists for up to two years, hence it must have applied to new orders after tariffs were enacted. Jiao et al. (2020) surveyed 600 Chinese firms on how the tariffs affected their export prices, with 21% indicating inflexibility to adjust prices due to contractual agreements. Thus, price stickiness could explain some of the pass-through finding. Still, as documented by Fajgelbaum et al. (2020) and Amiti et al. (2019), imports did fall sharply with the tariffs, suggesting that pre-existing commitments were unlikely to be binding beyond the period in which the trade war started. This means that stories based on contract inflexibility must allow for sticky prices with lower quantities. A related idea from the exchange-rate literature is that pass-through would be complete if import prices are sticky and denominated in dollars (Gopinath et al., 2010). This idea has the extra appeal of reconciling the complete pass-through to tariffs in the trade war with incomplete exchange rate pass-through. As discussed earlier, such stickiness would need to operate at horizons beyond a year to explain the data.

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[24] See Amiti and Konings (2007), Topalova and Khandelwal (2011), and Gopinath (2016), among others.

[25] See Bernard and Jensen (1999), Pavcnik (2002), and Bustos (2011), among others.

Market Structure?

The prediction that import prices fall with tariffs is borne out of standard neoclassical assumptions of perfect competition and increasing marginal costs. However, tariffs may increase import prices if there is foreign market power, and this force may offset the declining prices due to increasing marginal costs. This could be the case under specific conditions on the curvature of the import demand faced by a foreign monopolist (Brander, 1995), or in models with import bargaining where the terms-of-trade impacts of trade policy depends on bargaining power.[26]

Level of Aggregation?

The result that $\beta = 0$ in the estimation of (3) with exporter-time fixed effects is consistent with standard general-equilibrium quantitative trade models such as the Armington model in Anderson and Van Wincoop (2003): in this model, the terms of trade move with relative wages, responding to tariffs in order to preserve market clearing. Supply is infinitely elastic to each destination, conditional on the wage.[27] So the result of complete pass-through is not surprising in the context of that model. Still, standard trade models would predict incomplete pass-through at some level of aggregation for a sufficiently large importer, or for a small importer trading differentiated products. So, even if pass-through is complete when comparing imported varieties of a product, it may not be when comparing, for example, imports of differentially exposed products. However, some of the previous papers continue to find evidence of complete pass-through across products: Fajgelbaum et al. (2020) estimate a version of (3) at the product-level (i.e., examining the change in a product-level price index instead of $\Delta \ln p^*_{gct}$), obtaining a product-level $\beta = -.09$ (se 0.20), and Cavallo et al. (2021) rely on product-level variation for their analysis in which the find β close to zero.[28]

Nevertheless, market clearing conditions *necessarily* lead to incomplete pass-through at *some* level of aggregation, such as at the sector and country level. Indeed, Cavallo et al. (2021) find that, without any controls or fixed-effects to absorb country-level trends, their regression yields some incomplete pass-through, $\beta = 0.079$ (0.026). While this result is suggestive that pass-through is present at some higher levels of aggregation, the pass-through at these higher levels is still difficult to estimate due to possible correlation with country-level trends. As discussed below, simulations of quantitative models can reveal the magnitude of these effects.

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[26] See McLaren (1997), Antràs and Staiger (2012) and Grossman and Helpman (2020) for theories of trade with import bargaining.

[27] In that model, the US import price p^*_{ig} of product g from an exporter i (such as China) is $p^*_{ig} = \frac{d_{ig}}{z_{ig}} w_i$, where w_i is the wage, d_i is the trade cost and z_{ig} is productivity of g in i. So that, across two varieties (i.e. countries of origin) i and i' within a product, relative prices across countries only change endogenously with relative wages, $w_i / w_{i'}$. Given the fixed effects in our regressions (by exporting country-time), in the context of this model we should indeed not expect a change in the relative import price $p^*_{ig} / p^*_{i'g}$ with the relative tariffs to these countries.

[28] At the product level, these results may still be consistent with a version of Anderson and Van Wincoop (2003) with multiple products. Extended with a product-level inverse labor supply elasticity ω, then, to a first-order approximation, this model would imply a product-level pass-through of US tariffs to US import prices of product g from exporting country i equal to $\frac{\omega\sigma}{1+\omega\sigma} \lambda_{ig}$, where σ here represents the elasticity of substitution across varieties of a product and λ_{ig} is the share of the US in country i's sales to the world. Among products taxed by the US, the average US share in Chinese exports to the world is 13%.

4.3 Consumer Prices

The pass-through estimations discussed above look at prices *at the port*. These are the prices faced by the country as a whole, and that therefore matter for aggregate welfare. As we discuss below, the complete pass-through result discussed above illustrated one important dimension of redistribution: there were considerable losses for imports buyers, matched almost completely by gains to producers. Of course, many buyers of imports are firms rather than final consumers.

The most direct way to assess consumer effects through higher prices is by looking at consumer prices. Flaaen et al. (2020) analyzes the retail price of one product of the trade war–washing machines–which was among the earlier products to be tariffed. As the washing-machines tax was non-discriminatory, the authors compare prices of washing machines versus other appliances. Using oven ranges as a control product, they find no evidence of incomplete tariff pass-through; if anything, their result implies more than complete pass-through with consumer washing machine prices increasing 125 percent.

However, Cavallo et al. (2021) suggest that complete pass-through to retail prices may not hold broadly. They use online prices from two large US retailers and are able to identify goods that are subject to the tariffs. In contrast to the complete pass-through at the port, they find that final consumer prices are barely affected. So, for retail goods such as a household goods and electronics, the cost of the tariffs fell on the retailers, not final consumers. However, they also document that retailers increased purchases ahead of tariff announcements, and were therefore not necessarily exposed to the tariffs. This would translate the incidence of the tariff on importers of non-retail goods (which included a large fraction of all tariffed goods), or on agents that were unable to anticipate the tariffs or stock up. It is also possible that, as the tariffs remain in place and the stocks that retailers accumulated before tariffs dwindle, the prices are eventually passed on to final consumers. In either case, an important path for future work is to assess the incidence of the tariffs across final consumers, retailers, wholesalers, and other agents within the supply chain.

5 Producers

5.1 Export Prices

The welfare formula in (2) says that the producer impact hinges on how export prices respond to tariffs. As discussed above, tariffs could affect export prices through three channels: foreign tariffs could dampen foreign demand, while domestic tariffs could increase imported input costs or reallocate expenditures to domestic goods.

Consider first the retaliatory tariff channel. US export or producer prices may fall in response to Chinese retaliation, leading to lower welfare through EV_x in (1) by lowering $\mathbf{p}_\mathbf{x}^*$. Fajgelbaum et al. (2020) and Amiti et al. (2020b) show that US variety-level export prices to China relative to other destinations did not fall in response to retaliatory tariffs, suggesting that US producers may adjust flexibly across destinations. Similarly to our previous caveat that import price responses estimated across origins within a product do not capture product-level import price changes, these regressions do not capture that US producer prices could fall in products or sectors facing higher Chinese tariffs, regardless of where these products are shipped. Indeed, using BLS micro-data on exported goods, Cavallo et al. (2021) find relative price reductions in US products targeted by China. At more aggregate levels, Fajgelbaum et al. (2020) present evidence that US sector-level export price indices fell with retaliatory tariffs in the same sector. Neither them nor Flaaen and Pierce (2019) find evidence of sector-level producer prices falling with retaliation, but capturing sectoral price impacts from retaliations may be difficult since exports are typically a small share of sectors' total sales.

Turning to the second channel, US export prices could also increase through more costly access to imported inputs. In the aggregate welfare calculation of (1), these export price increases would offset part of the greater buyer cost from EV_m, but on net the cost increases would be welfare-reducing. Benguria and Saffie (2019), Flaaen and Pierce (2019), and Handley et al. (2020) estimate this impact of US tariffs, and generally find that indeed export prices raise with US tariffs through rising cost for imported inputs. For example, Flaaen and Pierce (2019) find that an interquartile shift in exposure to rising input costs is associated with 4.5 percent relative increase in factory-gate prices.

Finally, export prices may also increase with import tariffs, leading to higher welfare through EV_x in (1). As domestic demand is reallocated away from imports into domestically produced goods, export supply is restricted and domestic goods become more scarce internationally, and therefore more expensive. Fajgelbaum et al. (2020) and Amiti et al. (2020b) find evidence suggesting that the US PPI increases with the import tariff.

5.2 Reallocations

The trade and employment reallocations from the trade war are related to changes in relative incomes and expenditures and thus also give a sense of winners and losers. The estimated trade reallocations between US and China have the expected signs: within products, US and Chinese imports and exports are reallocated away from each other into other origins and destinations, respectively. For example, Amiti et al. (2019) and Fajgelbaum et al. (2020) use specifications similar to (3) but with import quantity as dependent variable, finding that imports decline with tariffs at an elasticity of $\beta = 1.31$ (0.09) and $\beta = 1.47$ (0.24), respectively. Their event studies suggest that this response is persistent. On the export side, several studies also document sharp decreases in US exports to China relative to other destination in response to the lower Chinese demand from retaliatory tariffs (see Fajgelbaum et al. (2020), Amiti et al. (2020b), and Benguria and Saffie (2019)).

Fajgelbaum et al. (2021b) shift the focus away from US and China to study how other countries not directly exposed to trade-war tariffs reallocated trade. Their main specification considers, for each country, the change in product-level exports to the US, China, and the rest of the world as a function of the US and China tariffs on each other. They find that many countries raised exports to the rest of the world due to the trade war, rather than just reallocating into the US and China. This finding suggests downward sloping supply curves due to scale economies or other forces. Using pre-war export shares to weight the predicted export changes across products, they also find that the growth in total exports induced by the trade war was highly heterogeneous across countries, but this heterogeneity was due to country-specific elasticities, rather than by product-level specialization patterns.

The previous papers study trade reallocations across origins or products. Flaaen and Pierce (2019) instead examine employment reallocation. They match the tariffs to monthly industry-level employment from the Current Employment Statistics program of the Bureau of Labor Statistics. Their interest is in understanding both the impacts of tariffs on employment across industries and the role of the three channels we have already mentioned: import protection; rising input cost; and foreign retaliation. Their results indicate that the first channel modestly raises employment, but these gains are more than offset by the negative consequences of the other two channels. Overall, moving an industry from the 25th percentile to the 75th percentile of exposure along these three measures of tariff exposure reduces manufacturing employment by 2.3 percent. Thus, this study suggests that trade policy in a world with supply chains and the prospects of retaliation can undo positive direct impacts of tariffs on employment.[29]

Waugh (2019) examines the impact of the Chinese retaliatory tariffs on county-level employment data from the BLS Quarterly Census of Employment and Wages. His estimates suggest that total employment responds negatively to the retaliatory tariffs: a county at the upper quartile of the tariff distribution experienced 0.75 percentage point decline in employment growth relative to the lower quartile. These magnitudes are about twice as large for private-sector employment in the goods sector, which was directly affected by the trade war tariffs.

6 Aggregate and Distributional Effects

6.1 Adding up Consumer and Producer Impacts

Combining the impacts on prices and trade reallocations, we can compute the aggregate effects in (2). As we have discussed, a possible reading of the results on import tariff pass-through and export price effects is that neither import nor export prices moved much. Starting from a situation close to free trade, and assuming small changes in imports for products that did not face import tariffs, the absence of price changes readily implies that a first-order approximation to EV in (2) was approximately to zero. Under the same neoclassical assumptions, a closed-form expression for the second-order approximation is: $EV = {}^{1}\!/_{2}\,(\Delta\mathbf{m})'\,\Delta\tau$. The tariff change $\Delta\tau$ is observed, whereas $\Delta\mathbf{m}$ is estimated by Amiti et al. (2019) and Fajgelbaum et al. (2020), as we have discussed. Applying this formula and excluding 2019 tariffs, Amiti et al. (2019) finds a loss equivalent to 0.044% of GDP and Fajgelbaum et al. (2020) estimate a loss of 0.059%. Further including 2019 tariffs, Fajgelbaum

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[29] See Caliendo et al. (2015), Blanchard et al. (2016), Grossman and Helpman (2020), and Antràs et al. (2021) for recent analyses of tariffs with supply chains.

et al. (2021a) find a loss of 0.17%.

These approximations are computed assuming complete tariff pass-through. However, as discussed in the last conjecture of Section 4.2, the empirical analyses at the *variety* level do not rule out terms-of-trade effects through changes in prices at the *sector* or *country* level. Also, these back-of-envelope calculations do not consider the possible impacts of retaliatory tariffs at these higher levels of aggregation. These numbers are difficult to estimate empirically, but existing research has simulated these effects in general equilibrium models.

Fajgelbaum et al. (2020) combine the demand-side parameters estimated from a nested CES import demand system in the style of Broda et al. (2008), which accounts for substitution across products and across origins within products, with a supply side of the US economy that incorporates the three channels through which export prices respond to tariffs discussed in (5). For the supply side, they assume a static general equilibrium model where fixed factors give rise to upward sloping supply at the sector level, perfect competition, flexible prices, and an input-output structure with unitary elasticities, calibrated to match US input-output tables. Their simulations imply that US export prices $\mathbf{p}_{\mathbf{x}}^{*}$ overall rose 0.7% due to tariffs in 2018. When multiplied by a 7.4% non-service export share of GDP, this yields an increase in EV_x in (1) of 0.05% of GDP. Further including the 2019 tariffs, this component increases to 0.13%.

Including all the tariffs, further adding up a simulated tariff revenue gain of 0.34% of GDP[30] and the previous result that the consumer cost EV_m was 0.58%, the aggregate welfare loss in (1) is 0.10% of GDP (Fajgelbaum et al. (2020) estimate losses of 0.04% of GDP from only the 2018 tariffs). Chang et al. (2021) replicate their methodology on 2018-19 tariffs and find an aggregate welfare loss in China of 0.29%.

The simulations in Fajgelbaum et al. (2020) keep wages and aggregate demands in foreign countries constant. Several analyses, including Balistreri et al. (2018), Caliendo and Parro (2021), Charbonneau and Landry (2018), and Ju et al. (2020), simulate general equilibrium impacts using multi-country environments in the style of Eaton and Kortum (2002) that further account for the equilibrium of the world economy.[31] Despite the many methodological differences with Fajgelbaum et al. (2020), the aggregate effects are similar and consistently found to be small relative to GDP and negative for both the US and China. For example, Caliendo and Parro (2021) obtain that the trade war tariffs lower US and Chinese welfare by 0.01% and 0.09%,respectively.[32] This magnitude

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[30] The observed tariff revenue is not used because it includes changes in imports that took place for reasons unrelated to the trade war. The simulated tariff revenue is computed using the trade war tariffs and the model-implied changes in imports.

[31] The aggregate properties of Eaton and Kortum (2002) are similar to those in Armington models such as Anderson and Van Wincoop (2003); see Arkolakis et al. (2012). However, they have different micro-foundations, with different implications for pass-through regressions. Models like Eaton and Kortum (2002) assume a continuum of goods traded within each observable product category; due to the aggregation properties of that model, if one assumes a continuum of goods within each HS-10 product in the trade data, then the *duty-inclusive* US price distribution of each variety will be independent from the source country, implying $\beta = 1$ in regression (3); i.e., zero rather than complete pass-through.

[32] The differences include the solution method (first-order in Fajgelbaum et al. (2020) versus exact solution in Caliendo and Parro (2021)), the level of aggregation for tariffs (product versus sector-level), the demand structure, and the general equilibrium analysis (fixed wages everywhere but in the US vs full wage adjustment across the world). The somewhat smaller welfare loss for the US in Caliendo and Parro (2021) could be due to the positive terms-of-trade

and similarity is not surprising, given the observed trade to GDP ratios. As benchmark, Costinot and Rodríguez-Clare (2014) show that, in a standard parametrization of these frameworks, a 100% uniform tariff imposed by the US reduces welfare by approximately 0.3%, whereas Baqaee and Farhi (2021) compute that a 10% universal tariff shock would increase US and Chinese welfare by 0.09% and 0.16%, respectively.[33]

These welfare effects appear small relative to GDP, but this does not mean that the distortions due to tariffs are small. Finkelstein and Hendren (2020) calculate that the US-China tariffs have a marginal value of public funds (MVPF), defined as the ratio of real income costs of a policy to its revenue benefit, of (minus) 1.2-1.5. This implies that the tariffs are particularly costly relative to many other public policies.[34]

6.2 Stock Market and Uncertainty

As the trade war unfolded, the announcements of impending tariffs through social media and official government proclamations grabbed the headlines. These announcements coincided with sharp and typically negative movements in equity markets. Some analyses have relied on these movements to identify the impact of the trade war tariffs on the valuation of exposed firms, and then add up these responses through different approaches to compute the aggregate impacts of the war.[35]

Huang et al. (2020) run a three-day event study centered around March 22, 2018, when the Trump administration announced the pending imposition of 25% tariffs on the first wave of Chinese imports. Using a sample of US listed non-financial firms with sales in China or trade with that country, they find that the tariff announcements resulted in 4.3% market decline losses. They argue that about a quarter of the market losses is driven by firms' direct import and export exposure to China, while the rest is driven by changes in macro variables or indirect exposure via supply chains. Amiti et al. (2021) use 11 tariff announcements and implementations between 2018 and 2019. The market dropped a cumulative 12.9% over a three-day window around those events, and their approach attributes the vast majority of this decline to the trade war.

These numbers stand in contrast with the results based on price changes and terms of trade in static trade models, e.g. they are an order of magnitude or two larger than the approximately 0.01%

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effects for the US that they incorporate. Baqaee and Farhi (2021) show the accuracy of first-order approximations in solving quantitative trade frameworks.

[33] These models have in common that they only consider static distortions from tariffs. Reyes-Heroles et al. (2020) simulate the long-run impacts of the tariffs by making steady-state comparisons in a multi-country model with capital accumulation. They find declines in GDP in the US and China of around 1% and relatively larger benefits for emerging markets than for other advanced economies due to their factor endowments and imported inputs intensity.

[34] In Section 2 we noted that Smoot-Hawley tariff increases were somewhat smaller but comparable to the trade war tariffs. In simulations of a general equilibrium model, Irwin (1998) finds that the tariffs lowered US welfare by 0.1%-0.4%, and by up to 1.1% when allowing the (specific) tariffs to increase because of deflation. To our knowledge, tariff pass-through from the Smoot-Hawley tariffs has not been estimated. Using data from this period, Irwin and Soderbery (2021) estimate import demand and export supply elasticities across products that imply $\beta = 0.33$ for the median product.

[35] The theoretical underpinning for these endeavors dates back to Grossman and Levinsohn (1989), who first used a specific-factors model and studied the effects of international prices on sector-level excess returns.

to 0.1% decline from the models discussed in the last subsection. The reasons behind the striking difference in these numbers is an open question. As argued by Amiti et al. (2021), one possibility is that static models do not incorporate potentially important mechanisms, such dynamic losses or growing uncertainty.[36] The counter view is that very short-run stock market response at the time of tariff announcements may not reflect the actual impact of tariffs on fundamentals. For example, market participants may not have experience pricing an uncommon policy shock and may require a longer window in order to assess the potential impacts on the real economy. Methodologically, the event windows used in stock market analyses are much shorter and temporary than the before vs. after comparisons of tariff implementations used in the event studies we discussed in Section (4.1).

Efforts to reconcile the stock market responses with welfare impacts from trade models is a promising area of work.

6.3 Local Labor Markets and Distributional Consequences

Trade shocks including tariffs have different impacts across regions within countries, particularly when labor is imperfectly mobile (Topalova, 2010; Kovak, 2013; Autor et al., 2016). Fajgelbaum et al. (2020) merge the product-level US and China tariffs with (pre-war) counties' sectoral employment wage bills. and use their model to simulate real wage changes across US counties. Their results indicate large dispersion: on average, real wages in the tradeable sector decline by 1% but with a large standard deviation of 0.5% across counties. This dispersion reflects specialization patterns: the Great Lakes region of the Midwest and the industrial areas of the Northeast received higher tariff protection, while the Midwestern plains and Mountain West faced higher tariff retaliation, as about 27% of China's retaliations targeted US agricultural goods (Bown, 2021). Caliendo and Parro (2021) simulate state-level effects in a framework that additionally allows for internal trade costs, so that differences in real income also arise from differential price-index effects, with losses ranging from about 0.1% to 0.2% across states.

Lack of data availability has so far prevented an analysis of actual wage changes across regions to the trade war. Waugh (2019) creatively finds a way to study welfare effects by examining consumption patterns across counties.[37] The paper exploits data on monthly-level new automobile registration, which is available at the county level in nearly real time, as a proxy for consumer expenditures. The data captures consumption of only one (albeit important) durable good and records counts as opposed to values. Assuming that county price changes are uncorrelated with tariff exposure, differences in auto expenditures are indicative of income changes. The paper finds

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[36] A recent literature establishes an important role for trade policy in deterring trade; see Handley and Limão (2021) for a survey of this literature. Amiti et al. (2021) estimate that the tariff announcements caused the VIX, a market-based measure of volatility, to more than double, and Caldara et al. (2020) and Benguria et al. (2020) use text analysis on earnings calls and annual reports for US and Chinese firms, respectively, to document the increase in uncertainty firms faced.

[37] The equivalent variation in (1) can be also written: $EV = (pC)\,\Delta \log C$, where pC is a vector of expenditures before the trade war and $\Delta \ln C$ is a vector of log-differences in consumption across all commodities (in contrast, commodities that are not internationally traded before the tariffs change do not enter (1)).

a large impact of the (county-level) retaliatory tariffs–a one percentage point increase in China's retaliatory tariffs reduces new auto registrations by 1%. Relative to a county in the lower quartile of the retaliatory tariff distribution, a county in the upper quartile experiences a 3.8 percentage point decline in auto sales. Assuming that his difference-in-differences estimates captures the absolute impact of tariffs, he concludes that the retaliatory tariffs reduced aggregate consumption by $54 billion.

7 Open Questions

The US-China trade war is the most important trade policy shift in recent decades, and it provides researchers with an unusual opportunity to study the mechanics of global trade. Throughout this article we mentioned several questions that remain under-explored, including the various conjectures for complete pass-through that we have discussed. We conclude with a few additional questions that deserve further scrutiny.

First, a natural follow-up is to examine the longer-run aggregate effects of the trade war. This includes re-examining pass-through at different time horizons and levels of aggregation, but also examining systematically how pass-through varies along the supply chain from the dock to retail prices. Second, what are the impacts of trade barriers imposed by US and China in terms of production relocation, risk versus efficiency trade-offs, and national security implications? Third, as noted, US and Chinese firms could request exemptions from import duties, which raises natural questions: How did expectations of potential tariff rebates affect importer behavior, and what political-economy channels influenced the decisions of firms to seek exemptions and the government decisions to grant them? Fourth, what are the dynamic implications from potential reductions in investment, changes in capacity, and access to imported inputs?

Turning to the distributional consequences of the trade war, the studies to date analyze proxies for consumption, short-run employment effects, and model-based implications for wages. As time passes, what will survey and administrative data reveal about the distributional consequences through consumption and income channels? What will be the long-run implications for the spatial distribution of economic activity; e.g., will the trade war "undo" the labor market impacts of the China shock (Autor et al., 2016)? (As discussed, the evidence thus far suggests "no.")

Finally, outside the scope of this review are questions about the geopolitical implications of the US-China trade war. Answering such questions often do not lend themselves easily to clean econometric studies, but insights may be learned from theoretical frameworks and work from other fields. Such questions include: How much global "soft power" did the US gain or lose by initiating the trade war? How will the trade war affect the political relationship between US and China? And, how will the world trading system evolve in response; for example, Staiger (2021) is a recent contribution to this debate.

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