# Tariff Pass-through in the Trade War: A Firm-Heterogeneity Perspective *

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**Abstract**

Research finds complete tariff pass-through at the product level during the US-China trade war. Using firm-level customs data, we find a significant decrease in Chinese firms' ex-tariff prices in response to US tariffs, which indicates incomplete pass-through. A one-percentage-point tariff increase reduces prices by 0.173 percentage points for the highest-priced 25% of exporters while having negligible effects on firms with below-median prices. US tariffs increase Chinese exporters' probability of exiting the US market, with larger effects for lower-priced firms. The product-level complete pass-through results from two offsetting forces—price reduction by incumbents and market exits by lower-priced firms.

JEL Code: F1; Key words: trade war, tariff pass-through.

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# 1 Introduction

A key finding from research on the 2018-2019 US-China trade war is the complete tariff pass-through—ex-tariff prices of goods remained unaffected, while tariff-inclusive prices increased one for one. This finding challenges conventional trade theories, which posit that import tariffs should lead to terms-of-trade gains—lowering import prices relative to export prices. This issue has attracted broad interest (Fajgelbaum and Khandelwal, 2022; Amiti, Redding, and Weinstein, 2019), yet an explanation for the complete tariff pass-through in the trade war remains elusive.

Most studies on tariff pass-through in the US-China trade war focus on product-level analysis, specifically at the HS 8-digit level. This approach overlooks significant variations in behavior and performance among firms within narrow industries. Extensive literature, including works by Melitz (2003), Bernard et al. (2003), and Bernard et al. (2012), highlights firm heterogeneity in international trade. Notably, studies find large differences in firm markups, which could respond differentially to tariffs. Additionally, there are distinct differences in productivity and pricing among firms exiting, continuing, or entering export markets.

Firm heterogeneity is particularly relevant when analyzing exports from major exporters such as China. Data from China's General Administration of Customs show an average of 155 firms per HS 8-digit category export to the US from China. Thus, responses to US tariffs may vary substantially among Chinese firms. Analyzing firm heterogeneity is key to understanding product-level responses in the trade war.

This paper examines tariff pass-through with a focus on firm-level responses by Chinese exporters. We analyze how US tariffs affected Chinese firms' export prices and market exits and how these responses vary across firms, with the aim of relating the rich firm heterogeneity to the observed complete pass-through at the product level. Using a model of heterogeneous firms with variable markups, where more productive firms produce higher-quality goods and charge higher prices, we derive two key propositions. First, ex-tariff prices decrease with higher tariffs, with higher-priced firms reducing prices more. Second, higher tariffs raise exporters' probability of exiting the US market, with larger effects for lower-priced firms.

We use firm-level data from Chinese customs to test these predictions. First, after aggregating the data to the product level, we find that US tariffs do not significantly affect ex-tariff prices of Chinese exports, confirming the complete product-level pass-through reported in the literature. However, at the firm level, we find evidence of incomplete pass-through. The firm-level price elasticity with respect to tariffs is -0.063 (standard error = 0.025), which is notably lower than our product-level estimate of 0.056 (standard error = 0.078). This firm-level result contrasts with prior product-level analyses. Although the estimated pass-through rate of 0.937 is not far below one (i.e., complete pass-through), the statistical rejection of complete pass-through is economically crucial: perfect pass-through is inconsistent with standard trade models, whereas a large but incomplete pass-through aligns with our model.

The response of Chinese export prices to US tariffs varies across firms. While the average firm-level pass-through rate from our study is 0.937, this average masks substantial heterogeneity. Specifically, firms with higher ex-tariff prices exhibit more pronounced price reductions in response to tariff increases. A one-percentage-point tariff increase leads to a 0.079 percentage-point price reduction for firms with above-median prices and up to 0.173 percentage points for the top 25%. In contrast, tariffs have negligible effects on firms with below-median prices. Consistent with limited price adjustments, we also observe larger declines in export quantities for lower-priced firms. Our first contribution is thus to show that tariff pass-through is incomplete at the firm level and that pass-through is systematically lower for higher-priced firms.

We examine US tariffs' impact on Chinese exporters' exits from the US market. We find that a 10% tariff hike increases Chinese exporters' probability of exiting the US market by 0.32%, compared to an average net entry probability of 3%. Notably, this effect varies with firm prices, with more substantial effects for lower-priced firms. This likely stems from lower-priced firms' smaller markups limiting their ability to offset tariff effects with price adjustments. This firm-level analysis of export market exit—largely absent in existing studies of the US-China trade war—constitutes the second contribution of our paper. This analysis is particularly relevant in light of the 2025 escalation of the trade war—with US tariffs on Chinese goods rising to 145%—when exporting firms face even stronger incentives to exit the US market.

Our third and final contribution is to explain why US tariffs yield complete pass-through at the product level, despite incomplete pass-through at the firm level. Two offsetting forces are at play. First, high-priced firms respond to tariffs by cutting ex-tariff prices, which lowers the average price. Second, many low-priced firms exit the US market, which raises the average price by removing lower-priced observations. We quantify these margins using a model-free decomposition framework that separates the change in product-level prices into four components: (a) changes in incumbent firms' prices, (b) reallocation among continuing firms, (c) the price difference between entrants and incumbents, and (d) the price difference between exiting firms and incumbents. Our analysis reveals that the negative contribution from incumbent price reductions is offset by the positive contribution from market exits of lower-priced firms, resulting in a net zero price response at the product level.

While these forces lead to complete pass-through, the effects vary among US consumers. US tariffs reduce ex-tariff prices for high-priced goods, typically purchased by wealthier consumers (Bils and Klenow, 2001; Handbury, 2021), but leave lower-priced goods unaffected. Additionally, low-priced firms exit the US market, reducing product variety for lower-income consumers. As a result, these tariffs are regressive—they disproportionately harm poorer consumers. Using a simple welfare evaluation, we estimate that households at the 10th income percentile experience a welfare loss that is 0.023 percentage points greater than that of households at the 90th percentile. This disparity is sizable, particularly in light of the modest aggregate welfare losses typically associated with the 2018-2019 trade war. With the escalation of the US-China trade war in 2025—with US tariffs on Chinese goods rising to 145%—the distributional consequences are likely to be more substantial.

Our paper enriches the literature on the trade war, including Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020), Amiti, Redding, and Weinstein (2019), Cavallo, Gopinath, Neiman, and Tang (2021), Amiti, Redding, and Weinstein (2020), Ma and Meng (2023), Jiao, Liu, Tian, and Wang (2022), Fajgelbaum and Khandelwal (2022), and Jiang, Lu, Song, and Zhang (2023). These studies emphasize the effects of tariffs, particularly on prices.[1] Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020) estimate that the elasticity of ex-tariff price to tariff change is 0.00 with a standard error of 0.08. Amiti, Redding, and Weinstein (2019) report an ex-tariff price elasticity to tariff change of -0.012, with a standard error of 0.023. They also find that import tariffs reduce product varieties. Jiang, Lu, Song, and Zhang (2023) confirm no price response at the product level using monthly Chinese customs data. Cavallo, Gopinath, Neiman, and Tang (2021) estimate a US tariff pass-through coefficient of -0.057, which drops to zero after controlling for exchange rates and the producer price index.[2] Different from product-level studies, Jiao, Liu, Tian, and Wang (2022) analyze firm-level data from one Chinese city and find no impact of US tariffs on ex-tariff prices after controlling for firm-related fixed effects. Our paper differs from theirs in three ways. First, using a comprehensive sample that covers all Chinese exporting firms—rather than firms from a single city—we reject com-

[1] Studies on tariff pass-through before the trade war include Kreinin (1961), Feenstra (1989), and Irwin (2019), among others.

[2] We find incomplete pass-through even with stringent fixed effects accounting for these factors.

plete tariff pass-through.[3] Second, we show that Chinese exporters respond differently to US tariffs—high-priced firms lower their prices, while low-priced firms exit the US market. Finally, we provide a firm-level explanation for complete product-level pass-through based on firm heterogeneity.

Our paper relates to the literature on firm heterogeneity in prices, including works by Manova and Zhang (2012), Fan, Li, and Yeaple (2015), Ludema and Yu (2016), Bastos, Silva, and Verhoogen (2018), Fan, Li, Xu, and Yeaple (2020), and Brooks, Kaboski, and Li (2021). A related paper by Ludema and Yu (2016) examines the impact of tariffs on firm prices using a heterogeneous-firms model and estimates firm-level tariff pass-through during the Uruguay Round. We adopt a similar model but include the effects of tariffs on exits from the US market, helping to reconcile differences between product-level and firm-level estimates.[4] Empirically, we focus on rising US tariffs during the trade war, highlighting firm heterogeneity's role in understanding the price effects of US tariffs.

The paper is organized as follows. Section 2 presents the model and derives two testable propositions. Section 3 provides information on the data and specifications. Section 4 presents empirical results. Section 5 presents our decomposition exercise and discusses welfare implications. Section 6 concludes.

# 2 Model

We analyze the effects of a tariff increase on export prices using a model of heterogeneous firms with variable markups. We begin by characterizing consumer demand and solving for optimal firm markups as a function of product quality and productivity. We then endogenize quality choice and characterize a firm's export decision as a function of its productivity.

A key motivation for incorporating endogenous product quality is to reconcile theoretical predictions with empirical patterns. In standard trade models without quality differentiation, lower prices are typically associated with higher productivity—an implication at odds with the data. By introducing vertical differentiation, more productive firms endogenously choose to produce higher-quality goods and charge higher prices.

[3] Our comparison between full-sample estimates and single-city estimates shows significant variation in point estimates and larger standard errors for single-city samples, perhaps due to regional specialization (see Figure A2).

[4] Ludema and Yu (2016) uses a Melitz-Ottaviano utility function, while we use a discrete CES utility function. Both studies find incomplete pass-through, though they observe a positive relationship between pass-through and productivity for quality-differentiated products, while we find a negative one.

## 2.1 Tastes and Demand

Consider a world populated by $J$ countries. Country $j$ is endowed with $L_j$ labor units. The utility function of the representative consumer in country $j$ is given by

$$U_j = \left[ \sum_{\omega} \left( q\left(\omega\right) x\left(\omega\right) \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}},$$

where $x\left(\omega\right)$ and $q(\omega)$ are the quantity and quality of variety $\omega$, respectively, and $\sigma$ denotes the elasticity of substitution.

The representative consumer from country $j$ chooses $x(\omega)$ to maximize the utility, subject to a budget constraint:

$$\sum_{\omega \in \Omega} \tau(\omega) p(\omega) x(\omega) \leq w_j L_j \tag{1}$$

Here, the *tariff-inclusive* price is $\tau(\omega)p(\omega)$, where $p(\omega)$ is the *ex-tariff* price and $\tau(\omega)$ is the tariff rate. For example, $\tau(\omega) = 1.2$ indicates a 20% ad valorem tariff. Finally, $w_j L_j$ represents the consumer's income.

Utility maximization implies the following demand curve for variety $\nu$:

$$x(\nu) = \frac{q(\nu)^{\sigma-1} (\tau(\nu) p(\nu))^{-\sigma}}{\sum_{\omega} q(\omega)^{\sigma-1} (\tau(\omega) p(\omega))^{1-\sigma}} w_j L_j \tag{2}$$

## 2.2 Prices and Markups

Each variety $\nu$ is produced by a firm. Crucially, firms do not behave as infinitesimal price-takers but instead engage in a Nash-Bertrand game when setting prices.[5] A firm producing variety $\nu$ maximizes profit:

$$\Pi = \max_{p(\nu)} [p(\nu) - c(\nu)] x(\nu)$$

[5]Under Nash-Bertrand competition, firms set prices strategically, recognizing their impact on market outcomes. Unlike models with CES preferences and monopolistic competition—where firms face constant markups—this framework allows markups to vary with market share, making pricing endogenous.

where $c(\nu)$ is the marginal cost of production for variety $\nu$. This profit-maximization problem can be recast as

$$\Pi = \max_{\tilde{p}(\nu)} [\tilde{p}(\nu) - \tilde{c}(\nu)] \frac{(\tau(\nu)\tilde{p}(\nu))^{-\sigma}}{\sum_{\omega} (\tau(\omega)\tilde{p}(\omega))^{1-\sigma}} w_j L_j \tag{3}$$

where $\tilde{p}(\nu) = \frac{p(\nu)}{q(\nu)}$ is the quality-adjusted *ex-tariff* price and $\tilde{c}(\nu) = \frac{c(\nu)}{q(\nu)}$ is the quality-adjusted marginal cost. Because $\tau(\nu)$ takes the same value for all varieties to the same country, $\tilde{c}(\nu)$ is the only variable specific to variety $\nu$ in the profit maximization.

Equation 3 allows us to use the duality property to break profit maximization into two sub-problems: maximizing profit given a quality-adjusted marginal cost and minimizing the quality-adjusted marginal cost given firm-specific productivity. We first analyze profit maximization for a given quality-adjusted marginal cost, followed by a discussion on how firms endogenously choose quality to minimize this cost in Section 2.3.

From the first-order condition of Equation 3 with respect to $\tilde{p}(\nu)$, we have

$$\tilde{p}(\nu) = \frac{(\sigma - 1)(1 - s(\nu)) + 1}{(\sigma - 1)(1 - s(\nu))} \tilde{c}(\nu) \tag{4}$$

where $s(\nu) = \frac{\tau(\nu)p(\nu)x(\nu)}{\sum_{\omega} \tau(\omega)p(\omega)x(\omega)} = \frac{(\tau(\nu)\tilde{p}(\nu))^{1-\sigma}}{\sum_{\omega}(\tau(\omega)\tilde{p}(\omega))^{1-\sigma}}$ denotes the market share of variety $\nu$. Equation 4 indicates that the optimal quality-adjusted price is a markup over the quality-adjusted marginal cost. This markup depends on the market share $s(\nu)$, with higher shares leading to larger markups.

Using $R(\nu)$ and $\pi(\nu)$ to denote the sales revenue and profit from variety $\nu$, respectively, we have

$$R(\nu) = \frac{s(\nu)}{\tau(\nu)} w_j L_j \tag{5}$$

and

$$\pi(\nu) = \frac{s(\nu)}{\tau(\nu)[(\sigma - 1)(1 - s(\nu)) + 1]} w_j L_j. \tag{6}$$

## 2.3 Quality and Production

Firms are heterogeneous in productivity $\varphi$. Since $\varphi$ summarizes the choices of a firm, we will use $\varphi$ instead of $\nu$ to denote a variety. Following Feenstra and Romalis (2014), the labor requirement for one unit of output is given by:

$$l_{ij} = a + \frac{q_{ij}^{\eta}}{\varphi},$$

where $q_{ij}$ is the destination-specific quality, $\eta > 1$ denotes the scope for quality differentiation, and $a$ is a constant. The marginal cost of production is $c_{ij}(\varphi) = aw_i + \frac{w_i}{\varphi} q_{ij}^{\eta}$. Thus, the quality-adjusted marginal cost of production $\tilde{c}_{ij}(\varphi)$ becomes:

$$\tilde{c}_{ij}(\varphi) = \frac{c_{ij}(\varphi)}{q_{ij}} = \frac{aw_i + \frac{w_i}{\varphi} q_{ij}^{\eta}}{q_{ij}}. \tag{7}$$

A firm with productivity $\varphi$ chooses quality $q_{ij}(\varphi)$ to minimize $\tilde{c}_{ij}(\varphi)$. The optimal quality is given by

$$q_{ij}(\varphi) = \left( \frac{a\varphi}{\eta - 1} \right)^{\frac{1}{\eta}}. \tag{8}$$

Equation 8 indicates that more productive firms produce goods with higher quality. Additionally, optimal quality is unaffected by the tariff rate $\tau$, making $q_{ij}(\varphi)$ unchanged across all markets. Thus, a firm produces a single quality level for all destinations.

Combining Equations 7 and 8, we rewrite the marginal cost for supplying market $j$ from country $i$ as

$$c_{ij}(\varphi) = \frac{\eta a}{\eta - 1} w_i. \tag{9}$$

Accordingly, the optimal ex-tariff price is given by

$$p_{ij}(\varphi) = \frac{(\sigma - 1)(1 - s_{ij}(\varphi)) + 1}{(\sigma - 1)(1 - s_{ij}(\varphi))} \frac{\eta a w_i}{\eta - 1} \tag{10}$$

The impact of a tariff increase on the optimal ex-tariff price can be expressed as

$$\frac{\partial \ln p_{ij}(\varphi)}{\partial \ln \tau_{ij}} = \frac{1}{\sigma} \frac{p_{ij}(\varphi)}{p_{ij}(\varphi) - \frac{\eta a}{\eta - 1} w_i} - 1 \tag{11}$$

From Equation 10, we have $p_{ij}(\varphi) \geq \frac{\sigma}{\sigma-1} \frac{\eta a}{\eta-1} w_i$. Consequently, Equation 11 implies that the ex-tariff price elasticity in response to a tariff increase is negative, ranging from $\frac{1-\sigma}{\sigma}$ to 0. This negative effect is stronger for higher-priced firms. Intuitively, higher-priced firms have higher markups and can lower their prices more in response to tariffs. We summarize these results with the following proposition:

**Proposition 1** *The ex-tariff price elasticity with respect to a tariff increase is negative. The reduction in ex-tariff price for the same tariff increase is greater for firms with higher initial prices.*

The variation in price response is closely associated with quantity adjustments. As shown in Appendix A, US tariffs reduce export quantities, with a greater impact on lower-priced firms.

## 2.4 Export Market Entry

To export to a foreign market, a firm must incur a fixed cost $F \cdot \epsilon$, expressed in destination labor units. Here, $F$ is a constant, and $\epsilon > 0$ is a random variable drawn from a cumulative distribution function (CDF) $G(\epsilon)$ with mean one. We assume $G(\epsilon)$ is independent of the productivity distribution $F(\varphi)$.

A firm from country $i$ exports to country $j$ if the profit from doing so exceeds the fixed cost. Export profits are given by: $\frac{s_{ij}(\varphi)}{\tau_{ij}[(\sigma-1)(1-s_{ij}(\varphi))+1]} w_j L_j$. Formally, in order to export,

$$\frac{s_{ij}(\varphi)}{\tau_{ij}[(\sigma-1)(1-s_{ij}(\varphi))+1]} w_j L_j > w_j F \epsilon, \tag{12}$$

which can be rearranged as

$$\epsilon < \frac{s_{ij}(\varphi)}{\tau_{ij}[(\sigma-1)(1-s_{ij}(\varphi))+1]} \frac{L_j}{F}.$$

The probability of a firm $\varphi$ exporting to market $j$, $\Pr(\text{export}|\varphi)$, is given by

$$\Pr(\text{export}|\varphi) = G\Big(\frac{s_{ij}(\varphi)}{\tau_{ij}((\sigma-1)(1-s_{ij}(\varphi))+1)} \frac{L_j}{F}\Big). \tag{13}$$

To consider tariffs' impact on this probability, we derive:

$$\frac{\partial \Pr(\text{export}|\varphi)}{\partial \ln \tau_{ij}} = g(\epsilon)[(1-\sigma)(1-s_{ij}(\varphi))-1] < 0. \tag{14}$$

where $g(\epsilon) = \frac{dG(\epsilon)}{d\epsilon} > 0$ is the probability density function (PDF) for $\epsilon$. Thus, a tariff hike lowers firms' probability of exporting to that market.

We take the second-order derivative of Equation 14 with respect to productivity. For simplicity, we assume that $\epsilon$ follows a uniform distribution, thus $\frac{dg(\epsilon)}{d\epsilon} = \frac{dG^2(\epsilon)}{d(\epsilon)^2} = 0$.[6] The second-order derivative becomes:

$$\frac{\partial \Pr(\text{export}|\varphi)}{\partial \ln \tau_{ij} \partial \ln \varphi} = g(\epsilon)\frac{(\sigma-1)^2}{\eta\sigma} s_{ij}(\varphi)(1-s_{ij}(\varphi)) \left[(\sigma-1)(1-s_{ij}(\varphi))+1\right] > 0. \quad (15)$$

The following proposition summarizes Equations 14 and 15:

**Proposition 2** *A tariff increase in a market reduces firms' probability of exporting to that market. The effect is more pronounced for firms with lower prices.*

In summary, the model delivers two central predictions. First, ex-tariff prices decline in response to tariff increases, with larger reductions for higher-priced firms. Second, tariffs reduce the likelihood of market participation, especially for lower-priced firms with lower markups. These predictions guide the empirical analysis that follows.

These results stem from firm heterogeneity in productivity and quality—higher-priced firms also have higher productivity, quality, and total exports.[7] This is consistent with findings that more productive firms charge higher prices (e.g. Kugler and Verhoogen, 2009; Manova and Zhang, 2012). Our empirical analysis will examine how tariff pass-through varies with price in the baseline and its relation to product quality and total exports as robustness checks.

# 3 Background, Specification, and Data

## 3.1 Background

In 2018, the United States initiated a series of tariff increases targeting Chinese imports. The first round was announced in March 2018, with tariffs on \$34 billion of Chinese goods implemented on July 6, followed by an additional \$16 billion on August 23. A subsequent round imposed tariffs on approximately \$200 billion worth of Chinese goods,

[6]Proposition 2 continues to hold under a weaker distributional assumption that $\frac{dg(\epsilon)}{d\epsilon} = \frac{dG^2(\epsilon)}{d(\epsilon)^2}$ is not too negative.

[7]The relationship between productivity and price is given by $\frac{\partial \ln p_{ij}(\varphi)}{\partial \ln \varphi} = \frac{(\sigma-1)}{\sigma}\frac{s_{ij}(\varphi)}{\eta} > 0$ and the relationship between productivity and quality-adjusted price is given by $\frac{\partial \ln \tilde{p}_{ij}(\varphi)}{\partial \ln \varphi} = \frac{1}{\eta}[\frac{\sigma-1}{\sigma}s_{ij}(\varphi) - 1] < 0$. Similarly, the link between productivity and quality is positive, as indicated by $\frac{\partial \ln q_{ij}(\varphi)}{\partial \ln \varphi} = \frac{1}{\eta} > 0$. Additionally, a positive relationship exists between productivity and a firm's total exports to country $j$, represented $\frac{\partial \ln R_{ij}(\varphi)}{\partial \ln \varphi} = \frac{\partial \ln s_{ij}(\varphi)}{\partial \ln \varphi} = (1-\sigma)(1-s_{ij}(\varphi))\frac{\partial \ln \tilde{p}_{ij}(\varphi)}{\partial \ln \varphi} = \frac{1}{\eta}\frac{\sigma-1}{\sigma}(1-s_{ij}(\varphi))\left[(\sigma-1)(1-s_{ij}(\varphi))+1\right] > 0$.

effective September 24, 2018. Further tariffs were announced in August 2019, covering an additional $300 billion in Chinese imports, with implementation staggered between September and December 2019. By the end of 2019, most tariffs, excluding those on $160 billion in products, had been imposed. In response, China raised retaliatory tariffs on US imports. We utilize firm-level customs data to study the impact of US tariffs on Chinese firms.

## 3.2 Estimation Strategy

We compare outcomes across products subject to different US tariff levels. An observation is a firm $f$ exporting product $p$ in month $t$. Specifically, we use

$$\Delta \ln p_{fpt} = \beta \Delta \ln(1 + \text{tariff}_{pt}^{US}) + \alpha \Delta \ln(1 + \text{tariff}_{pt}^{CN}) + \gamma_{fp} + \gamma_{\text{sector},t} + \epsilon_{fpt}. \tag{16}$$

In this equation, $\Delta$ denotes the year-over-year difference at the monthly level (i.e., January 2019 relative to January 2018), while $p_{fpt}$ refers to the free-on-board price of HS 8-digit product $p$ by firm $f$ in month $t$. The term $\text{tariff}_{pt}^{US}$ denotes the import tariff by the United States on China's product $p$ in month $t$, encompassing both the baseline Most Favored Nation (MFN) tariffs and the additional trade war tariffs. Similarly, $\text{tariff}_{pt}^{CN}$ denotes the import tariff imposed by China on US goods for product $p$ in month $t$, including both baseline MFN tariffs and retaliatory tariffs.[8]

Equation 16 leverages variation in tariff changes across HS 8-digit products. A concern is that unobserved factors affecting export values and prices may be correlated with tariff changes during the trade war. To address this, we include firm-product fixed effects ($\gamma_{fp}$) to control for time-invariant firm-specific factors and sector-month fixed effects ($\gamma_{\text{sector},t}$) to account for unobserved sector-specific factors within a given month, restricting comparisons to products within the same sector.[9] Finally, Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020) find that import goods targeted by the US did not have differential time trends before the trade war. Therefore, we follow the literature (Amiti, Redding, and Weinstein, 2019; Jiao, Liu, Tian, and Wang, 2022; Jiang, Lu, Song, and Zhang, 2023) and treat tariff changes as exogenous in our analysis.

We analyze US tariffs' effect on US market exits using a modified version of Equation 16. The dependent variable, $exit_{fpt}$, equals one if a firm stops exporting product $p$ to the US compared to the same period a year earlier, and zero otherwise.

[8] Our results remain unchanged if we omit Chinese retaliatory tariffs as a control.

[9] We group HS 2-digit industries into nine sectors following Fajgelbaum et al. (2021).

### 3.3 Data

We use a comprehensive dataset from China's Customs Statistics Bureau covering 2017 to 2019. The data provide firm-product-month-level information, including firm identifiers, HS 8-digit product codes, destination countries, and export values and quantities. We standardized quantity units within each HS 8-digit code to ensure consistency in price calculations. Our baseline analysis focuses on exports from China to the United States, with robustness checks extending to exports to other trade partners.

While our dataset is the most comprehensive source of firm-level export data from China for 2017–2019, a key limitation is that it cannot be merged with other firm-level datasets. As a result, we lack information on wage bills, capital stock, or other input costs. This prevents us from directly estimating firm productivity or markups and linking them to heterogeneity in tariff pass-through.

Table 1 presents an overview of the dataset by year. Excluding processing trade,[10] our 2017 sample includes 325,256 firms with a total export value of 1.204 trillion US dollars. A total of 128,429 firms in our sample exported to the United States, accounting for 214.95 billion US dollars. According to the Chinese National Bureau of Statistics,[11] China's ordinary exports to the US and to the world in 2017 were 216.09 billion US dollars and 1.23 trillion US dollars, respectively. These figures closely match those in our dataset—minor discrepancies are due to data cleaning—which supports the quality and coverage of the data.

Table 1: Overview of the Data

| | **Exports to the US** | | **Exports to non-US Countries** | | **All Exports** | |
|---|---|---|---|---|---|---|
| Year | N firms | Value | N firms | Value | N firms | Value |
| 2017 | 128,429 | 214.95 | 313,247 | 989.76 | 325,256 | 1,204.71 |
| 2018 | 137,478 | 247.36 | 339,458 | 1,122.21 | 353,011 | 1,369.57 |
| 2019 | 141,980 | 223.23 | 368,222 | 1,188.78 | 382,171 | 1,412.01 |

Notes: This table reports annual statistics on the number of firms and the total value of Chinese ordinary exports to the United States, to other countries, and to the world. Export values are measured in billions of US dollars. Processing trade is excluded.

Figure 1 shows the distribution of export values across Chinese firms in 2017. Panel

[10] Processing trade refers to the tariff-exempt import of raw materials or components for manufacturing or assembly in China, followed by the export of the finished products. Dai, Maitra, and Yu (2016) shows that firms engaged in processing trade are systematically different from those involved in ordinary trade. Our analysis focuses on ordinary trade.

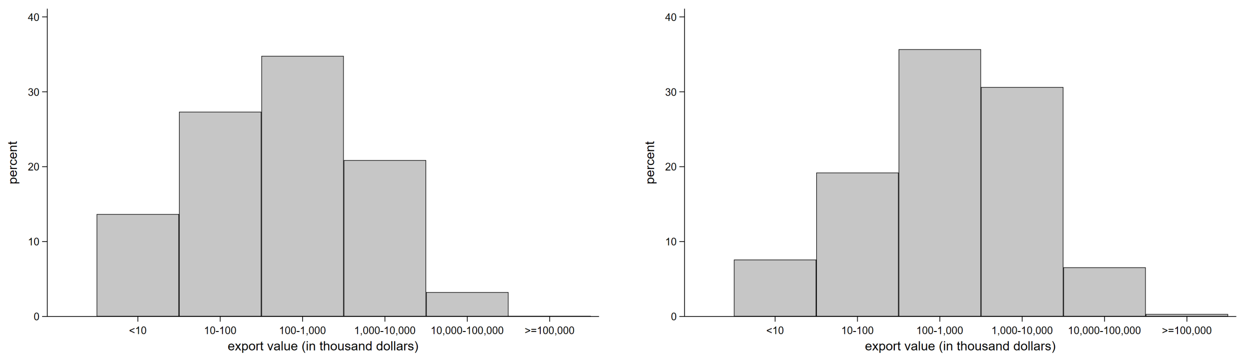
[11] https://www.stats.gov.cn/

A presents the distribution for exports to the United States, while Panel B shows the distribution for exports to the world. The data reveal substantial variation in export values. In Panel A, approximately 75.8% of firms exporting to the US had total exports below 1 million US dollars, 20.9% exported between 1 million and 10 million dollars, and 3.3% exported between 10 million and 100 million US dollars. This pronounced firm-level heterogeneity motivates our focus on firm-level responses to US tariffs.

Figure 1: Distribution of Export Values across Firms (2017 Data)

(a) Based on Firms' Export to the US

(b) Based on Firms' Export to the World




Notes: Panel A shows the distribution of 2017 export values for Chinese firms exporting to the United States. Panel B shows the distribution for exports to all countries. Processing trade is excluded.

We compiled tariff data from 2017 to 2019, including China's and the US's baseline Most Favored Nation (MFN) and trade war tariffs. US tariff data, including HS 8-digit codes, announcement and implementation dates, and ad valorem rates, were sourced from the Office of the United States Trade Representative (USTR) and the Federal Register. China's retaliatory tariff information came from its Ministry of Finance, while baseline MFN tariffs were obtained from the WITS-TRAINS database. Following Amiti, Redding, and Weinstein (2019), we assign a tariff to the current month if implemented on or before the 15th, and to the following month otherwise. All regressions use statutory tariff rates. Appendix Table A1 reports summary statistics for the variables used in the empirical analysis.

# 4 Empirical Evidence on Firm-Level Responses to Tariffs

## 4.1 Effects of Tariffs on the Prices of Continuing Exporters

We begin by analyzing US tariffs' effects on product-level export prices. The dependent variable in Column 1 of Table 2 is the year-over-year log change in product-level price, computed by dividing the total export value by quantity for each HS 8-digit product. The coefficient on $\Delta\ln(1+\text{tariff}_{pt}^{US})$ is statistically indifferent from zero. Thus, US tariffs do not significantly change product-level prices.

Table 2: Baseline Effects of US Tariffs on Chinese Export Prices

| | Product-level | | Firm-level | | |
|---|---|---|---|---|---|
| | $\Delta\ln p_{pt}$ (1) | $\Delta(\sum_f \theta_{fpt}\ln p_{fpt})$ (2) | $\Delta\ln p_{fpt}$ (3) | $\Delta\ln p_{fpt}$ (4) | $\Delta\ln p_{fpt}$ (5) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | 0.064 | 0.056 | -0.032** | -0.039** | -0.063** |
| | (0.091) | (0.078) | (0.016) | (0.017) | (0.025) |
| Chinese Tariffs | Yes | Yes | Yes | Yes | Yes |
| Product FE | Yes | Yes | Yes | No | No |
| Firm×Product FE | No | No | No | Yes | Yes |
| Sector×Month FE | Yes | Yes | Yes | Yes | No |
| HS4-digit×Month FE | No | No | No | No | Yes |
| Observations | 108,505 | 108,505 | 2,320,186 | 2,320,186 | 2,320,186 |
| R-Squared | 0.109 | 0.127 | 0.005 | 0.197 | 0.204 |

Notes: This table reports the effects of U.S. tariffs on Chinese export prices. Columns 1 and 2 present estimates from HS 8-digit product-level regressions, while Columns 3–5 report results from firm-level regressions. All regressions control for changes in Chinese tariffs. Column 2 is weighted by the initial number of exporting firms for comparability with firm-level specifications. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

A central assumption of the empirical specification is that the tariff changes are exogenous to changes in export prices. Fajgelbaum et al. (2020) show that there are no pretrends in values and prices in US imports before the tariffs. We follow Fajgelbaum et al. (2020) and check for anticipatory and delayed effects by allowing for leads and lags in product-level reduced-form regressions:

$$\Delta\ln p_{pt} = \sum_{m=-6}^{m=6} \beta_m[\ln(1+\text{tariff}_{p,t-m}^{US}) - \ln(1+\text{tariff}_{p,t-1-m}^{US})] + \gamma_p + \gamma_t + \epsilon_{pt}. \quad (17)$$

where we allow for leads and lags up to six months before and after the tariff changes.

The dependent variable $\Delta \ln p_{pt}$ denotes the one-period log difference in the export price of product $p$ exported to the US; $\gamma_p$ and $\gamma_t$ capture product and time fixed effect, respectively. Standard errors are clustered at the HS 6-digit product level.

Appendix Figure A1 reports the cumulative estimated coefficients for ex-tariff and tariff-inclusive prices. As the figure shows, there are no significant changes in ex-tariff prices (Panel A) before the tariffs, indicating no pretrend, nor after their implementation, consistent with perfect pass-through. Turning to tariff-inclusive prices (Panel B), we also find no significant changes before the tariff enactment—again indicating no pretrend—and a one-for-one increase following enactment, consistent with perfect pass-through. In sum, based on our data, we can replicate the finding in the literature that tariff changes are largely exogenous with respect to prices, and tariff pass-through is complete at the product level.

To connect the product-level analysis to the decomposition exercise in Section 5, we introduce an alternative product-level price measure in Column 2. We calculate $\widehat{P}_t = \sum_f \theta_{f,t} \ln p_{f,t}$, the weighted average of $\ln p_{ft}$ across all firms exporting the product. That is, whereas Column 1 uses the log of product-level prices, Column 2 uses the average of log firm-level prices. These two measures are highly correlated (correlation coefficient 0.961). Column 2 shows that the coefficient on $\Delta\ln(1 + \text{tariff}_{pt}^{US})$ remains unchanged and statistically insignificant. These results confirm that US tariffs do not significantly affect product-level ex-tariff prices of Chinese exports, consistent with the literature.

Column 3 of Table 2 presents the firm-level results. We include HS 8-digit and sector-month fixed effects and control for change in Chinese retaliatory tariffs. The elasticity of ex-tariff prices to tariffs is -0.032, with a standard error of 0.016. This result indicates that pass-through is incomplete at the firm level.

Column 4 replaces product fixed effects with firm-product fixed effects to address concerns about differential time trends in export price.[12] The tariff coefficient decreases slightly to -0.039 and remains statistically significant. Column 5 further replaces sector-month fixed effects with the more demanding HS4-month fixed effects. The tariff coefficient decreases to -0.063, with a standard error of 0.025, and remains statistically significant at the 5% level. In summary, US tariffs significantly decrease firm-level prices, rejecting complete pass-through at the firm level.

We compare our estimates with product-level findings from the literature. Amiti, Redding, and Weinstein (2019) estimate the elasticity of ex-tariff price to tariff change at

[12] The year-over-year specification at the firm level eliminates time-invariant price differences across firms.

-0.012 with a standard error of 0.023 (Column 1, Table 1). Similarly, Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020) find an elasticity of 0.00 with a standard error of 0.08 (Column 3, Table IV). Cavallo, Gopinath, Neiman, and Tang (2021) report a zero coefficient when controlling for exchange rates and the producer price index. In contrast, we use firm-product level data and estimate an elasticity of -0.063 while controlling for a stringent set of fixed effects. Our firm-level price elasticity of -0.063 is also much lower than our product-level estimate of 0.056 (Column 2). These differences underscore the importance of firm-level analysis in tariff pass-through. Although our estimated pass-through rate is not far below one, it is statistically distinct from complete pass-through—an economically crucial distinction: complete pass-through is inconsistent with standard trade models, while a high but incomplete pass-through aligns with our framework.

Jiao, Liu, Tian, and Wang (2022) use data from all firms in one Chinese city to estimate firm-level pass-through, finding perfect pass-through after controlling for firm-related fixed effects. As noted in the data section, our dataset is substantially larger, covering 325,256 exporting firms in 2017, compared to approximately 20,000 in Jiao, Liu, Tian, and Wang (2022). Since the city's identity in their analysis is not disclosed, we re-estimate our baseline specification using firms from one city at a time to compare results. We limit this analysis to cities with at least 10,000 firms, yielding 48 cities. Including smaller cities would increase estimate variability. Appendix Figure A2 presents the single-city point estimates and 90% confidence intervals, with the shaded band showing our full-sample baseline. The figure illustrates the substantial variation in point estimates and larger standard errors across cities, highlighting the benefit of using data from all Chinese cities in our analysis.

**Including Exports to Other Trade Partners in the Sample.** The results in Table 2 are based on Chinese exports to the US, using variations in US tariffs across products as in Jiang et al. (2023). For robustness, we extend our analysis to include exports to non-US countries, with each observation now representing a firm-product-country-month. This broader sample allows a comparison of a firm-product's exports to different countries (e.g., firm A's export to the US vs. Germany). Following Jiao et al. (2022), we use the specification:

$$\Delta \ln p_{fpct} = \beta \Delta \ln(1 + \text{tariff}^{US}_{pct}) + \alpha \Delta \ln(1 + \text{tariff}^{CN}_{pct}) + \gamma_{cfp} + \gamma_{cst} + \epsilon_{fpct}. \quad (18)$$

Here, $\gamma_{cfp}$ and $\gamma_{cst}$ represent country-firm-product and country-sector-month fixed effects, accounting for aggregate shocks like exchange rate fluctuations.

The results are presented in Appendix Table A3. As in the main analysis, we find perfect pass-through at the product level in Columns 1 and 2. Columns 3-5 show firm-level regressions with increasingly stringent fixed effects, yielding estimates similar to those in Table 2. Thus, our baseline results hold when including other trade partners.

## 4.2 Heterogeneity in Firm-Level Pass-through

Proposition 1 states that tariff pass-through decreases with firm price. We test this by interacting the tariff measure with initial prices. To standardize price across products, we divide a firm's average price for product $p$ in the base year by the average price of product $p$ to the US across all firms. We verify that the ranking of firm prices among firms within a product is stable—the correlation coefficient of log price for 2017 and 2019 is 0.813. Consequently, we use the log of standardized initial prices to analyze heterogeneity across firms.

Table 3 presents the results. Column 1 replicates the baseline results from Column 5 of Table 2, while Column 2 reports the effects by initial firm price. The coefficient on the interaction between the tariff measure and the initial price is negative and statistically significant at the 1% level, indicating that higher-priced firms lower their export prices more in response to US tariffs. The elasticity of export prices to tariffs is 0.098 for firms at the 10th price percentile, -0.039 for the median, and -0.129 for the 90th percentile.[13]

Firms' response to tariffs could vary by other characteristics. For example, firms with minor US market exposure could have higher bargaining power vis-a-vis the importing firms in the US and may be less forthcoming in cutting their prices. On the other hand, firms with significant US market presence may also be more cautious in reducing prices, which could adversely impact their overall profitability. Our estimates could be biased if firm-level prices and US market dependence are correlated. Since we do not observe domestic sales, we proxy US market dependence using the share of exports to the US in a firm's total exports. Column 3 of Table 3 includes this interaction. The coefficient on the interaction between tariffs and initial price remains robust, confirming that higher-priced firms reduce prices more in response to tariffs.

Firms' ownership types can also influence their responses to US tariffs. In Column 4, we add the interactions between the tariff and indicator variables for ownership types—state-owned enterprises (SOEs) and foreign-invested firms—while private enterprises

[13]These elasticities are calculated as $-0.105 + (-0.072) \times \ln P$, where the coefficients are taken from Column 2 of Table 2, and lnP represents the log of the initial price at the corresponding percentile, as reported in Appendix Table A1.

Table 3: Heterogeneous Effects of US Tariffs on Chinese Export Prices

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $\Delta \ln(1 + \text{tariff}^{US}_{pt})$ | -0.063** | -0.105** | -0.105** | -0.120** | -0.117** |
| | (0.025) | (0.050) | (0.052) | (0.051) | (0.052) |
| $\Delta \ln(1 + \text{tariff}^{US}_{pt})$ ×log initial price | | -0.072*** | -0.072*** | -0.074*** | -0.074*** |
| | | (0.012) | (0.012) | (0.012) | (0.012) |
| $\Delta \ln(1 + \text{tariff}^{US}_{pt})$ ×US share in export | | | 0.001 | | -0.006 |
| | | | (0.032) | | (0.032) |
| $\Delta \ln(1 + \text{tariff}^{US}_{pt})$ ×SOE | | | | -0.031 | -0.032 |
| | | | | (0.038) | (0.038) |
| $\Delta \ln(1 + \text{tariff}^{US}_{pt})$ ×foreign-invested | | | | 0.041* | 0.041* |
| | | | | (0.023) | (0.023) |
| Chinese Tariffs | Yes | Yes | Yes | Yes | Yes |
| Firm×Product FE | Yes | Yes | Yes | Yes | Yes |
| HS4-digit×Month FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 2,320,186 | 2,320,186 | 2,320,186 | 2,320,186 | 2,320,186 |
| R-Squared | 0.204 | 0.232 | 0.232 | 0.232 | 0.232 |

Notes: This table reports the effects of U.S. tariffs on export prices by initial firm price. Column 1 replicates Column 5 of Table 2. Column 2 adds the interaction between the tariff change and the logarithm of the initial price, standardized using the product-level average. Column 3 adds an interaction with the firm's initial U.S. export share. Column 4 includes interactions with ownership types—state-owned enterprises (SOEs) and foreign-invested firms—while private enterprises serve as the omitted category. Column 5 includes all interaction terms. All regressions control for changes in Chinese tariffs and include firm–product and HS4-digit–month fixed effects. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

serve as the omitted category (See Appendix Table A2 for the distribution of ownership types across firms). The coefficient on the interaction between tariff and the dummy for a foreign-invested enterprise is positive and statistically significant at the 10% level. This suggests higher tariff pass-through for foreign-invested enterprises. Yet, accounting for ownership does not alter the coefficient on the interaction between tariff change and initial price. In Column 5, we include all the above interaction terms and find the results unchanged. These results support Proposition 1.

Appendix Table A5 shows US tariffs significantly reduce export quantity, with larger effects for lower-priced firms. Using the Column 2 estimate, the elasticity of firm-level export quantity to tariffs is -0.339 for firms at the 10th percentile of price distribution, -0.239 for the median, and -0.174 for the 90th percentile. This is again consistent with lower-priced firms' limited flexibility to adjust prices.

The results in Table 3 indicate that tariff pass-through declines with firm-level prices.

In our model, these price differences reflect underlying variations in firm productivity and product quality. We further explore this heterogeneity using three firm characteristics: total exports, product quality, and market share. Appendix Table A6 examines heterogeneity by total exports, a proxy for firm size. We find that larger exporters exhibit lower pass-throughs. Appendix Table A7 explores the role of product quality, estimated following Khandelwal, Schott, and Wei (2013).[14] The results show that higher-quality firms experience lower pass-throughs, supporting the notion that quality is linked to greater pricing power. Finally, Appendix Table A8 investigates variation by market share, measured as a firm's exports to the US as a share of China's total exports to the US within the product. Firms with larger market shares also exhibit lower pass-through. The results confirm the prediction that tariff pass-through decreases with greater total exports, higher quality, and larger market shares.

Table 4: Tariff Effects on Export Prices across Initial Price Subsamples

| percentile of initial price | <25% | <50% | >=50% | >=75% |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | -0.020 | -0.034 | -0.079* | -0.173** |
| | (0.050) | (0.029) | (0.042) | (0.081) |
| Chinese Tariffs | Yes | Yes | Yes | Yes |
| Firm×Product FE | Yes | Yes | Yes | Yes |
| HS4-digit×Month FE | Yes | Yes | Yes | Yes |
| Observations | 466,382 | 1,192,812 | 1,113,823 | 454,774 |
| R-Squared | 0.289 | 0.239 | 0.224 | 0.255 |

Notes: This table reports the effects of U.S. tariffs on export prices across firm subsamples defined by initial price levels. Firms are grouped within each HS 6-digit product category based on their initial prices. Each column restricts the sample to firms in a specific price quantile (e.g., the top 25% by initial price). All regressions control for changes in Chinese tariffs and include firm–product and HS4-digit–month fixed effects. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

We further explore heterogeneous effects by analyzing sub-samples. For each HS 6-digit product, firms are grouped based on their initial price. We then select relevant firms from each product (e.g., the top 25% by initial price) and run separate regressions.

[14]Specifically, we rely on the equation $x_{fpjt} = q_{fpjt}^{\sigma-1}(p_{fpjt}\tau_{pjt})^{-\sigma}P_{jt}^{1-\sigma}Y_{jt}$, where $q_{fpjt}$ denotes quality, $P_{jt}$ is the price index, and $Y_{jt}$ stands for total demand in destination country. Following Khandelwal, Schott, and Wei (2013), we run the regression $\ln(x_{fpjt}) + \sigma[\ln(p_{fpjt}) + \ln(\tau_{pjt})] = \phi_p + \phi_{jt} + \epsilon_{fpjt}$ to calculate quality, where country-time fixed effect $\phi_{jt}$ contains price index and income of destination market and product fixed effect $\phi_p$ includes information on prices and quantities. We adopt the product-specific elasticities of substitution, $\sigma$, from Broda and Weinstein (2006).

As shown in Table 4, US tariffs have no significant effect on the export prices of firms in the lowest 25% or 50% price brackets (Columns 1 and 2). This aligns with the findings of Jiao, Liu, Tian, and Wang (2022), where managers cite low profit margins as the main reason for not reducing prices in response to US tariffs. The adverse effects of tariffs on prices are larger for firms with higher initial prices. For firms with above-median prices, a one-percentage-point tariff increase lowers prices by 0.079% (Column 3). For the top 25% of exporters, prices fall by 0.173 percentage points for each percentage-point tariff increase (Column 4). These estimates are in line with pre-trade war tariff pass-through findings (e.g., Feenstra, 1989; Irwin, 2019) and are consistent with the canonical theory of trade policy.

**Differentiated Versus Homogeneous Goods.** Tariffs may affect undifferentiated and differentiated goods differently. Cavallo et al. (2021) find a stronger ex-tariff price response to tariffs for undifferentiated goods and argue that US import prices did not decline during the trade war because these goods make up a small share of imports. In contrast, our theoretical analysis assumes that firms have price-setting power, which applies more to differentiated goods than homogeneous goods.

To investigate this issue, we estimate separate elasticities for differentiated and homogeneous goods by interacting tariffs with dummy variables for each type. We classify goods as undifferentiated or differentiated according to Rauch (1999). Appendix Table A4 shows a large, negative coefficient for undifferentiated goods, consistent with Cavallo et al. (2021). The coefficient for differentiated goods is also negative and statistically significant but smaller, similar to the baseline results in Table 2. Therefore, our findings of incomplete pass-through hold even when focusing only on differentiated goods.

## 4.3 Effects of Tariffs on Export Exits

Table 5 reports US tariffs' effects on Chinese exporters' exit decisions. The dependent variable is a firm's exit from the US market, defined as stopping exports to the US when it had exported the same month a year earlier. In Column 1, the coefficient on $\Delta\ln(1+\text{tariff}_{pt}^{US})$ is 0.032 and statistically significant at the 5% level. A 10% tariff increase raises the probability of exit by 0.32 percentage points, a notable effect compared to the 3% average net entry probability.

Column 2 adds the interactions between the tariff measure and initial price to assess the effects across firms. The coefficient is negative and statistically significant at the 1%

Table 5: Effects of US Tariffs on Firm Exit from the US Market

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | 0.032** | 0.009 | -0.008 | 0.001 | -0.019 |
| | (0.013) | (0.014) | (0.015) | (0.015) | (0.016) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$log initial price | | -0.013*** | -0.013*** | -0.014*** | -0.014*** |
| | | (0.003) | (0.003) | (0.003) | (0.003) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$US share in export | | | 0.039*** | | 0.044*** |
| | | | (0.015) | | (0.015) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$SOE | | | | 0.045*** | 0.052*** |
| | | | | (0.015) | (0.016) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$foreign-invested | | | | 0.014 | 0.013 |
| | | | | (0.010) | (0.010) |
| Net Entry Ratio | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Chinese Tariffs | Yes | Yes | Yes | Yes | Yes |
| Firm×Product FE | Yes | Yes | Yes | Yes | Yes |
| HS4-digit×Month FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 5,035,835 | 5,035,835 | 5,035,835 | 5,035,835 | 5,035,835 |
| R-Squared | 0.578 | 0.578 | 0.578 | 0.578 | 0.578 |

Notes: This table reports the effects of US tariffs on firm exit from the U.S. market. The dependent variable equals one if a firm exported product $p$ to the US in the same month of the previous year but not in the current year, and zero otherwise. Column 1 presents the average effect of tariffs on firm exit. Column 2 adds the interaction between the tariff change and the logarithm of the initial price, standardized using the product-level average. Column 3 includes an interaction with the firm's initial U.S. export share. Column 4 adds interactions with ownership types—state-owned enterprises (SOEs) and foreign-invested firms—while private enterprises serve as the omitted category. Column 5 includes all interaction terms. All regressions control for changes in Chinese tariffs and include firm–product and sector–month fixed effects. Standard errors, clustered at the HS 6-digit product level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

level, indicating that US tariffs have a milder impact on exits for high-priced firms. A 10% tariff hike raises exit probability by 0.477 percentage points for firms at the 10th price percentile but only by 0.028 points for those at the 90th percentile. Appendix Table A9 shows the impacts on exits also decrease with total exports and quality.

The above analysis defines export market exits as year-over-year monthly changes (e.g., May 2019 versus May 2018) for consistency with the price decomposition in Section 5. This definition may also capture reduced shipment frequency due to lower demand rather than permanent exits. Appendix Table A10 shows similar results using an alternative definition of exit, where a firm is considered to have exited if it exported in the previous year but not the current year.

# 5 A Decomposition of Product-level Price Changes

In Section 4, we replicated the finding of complete pass-through at the product level while showing that pass-through is incomplete at the firm level and varies systematically across firms. We also documented the effect of tariffs on firm exits, which is an important consideration given that product-level prices are calculated over a changing set of exporters.

Although firm-level prices declined on average among continuing (incumbent) exporters, the average product-level price remained unchanged. This seemingly contradictory result reflects offsetting adjustments along two margins. On the intensive margin, high-priced firms reduced their ex-tariff prices, pulling the average downward. On the extensive margin, low-priced firms disproportionately exited the US market, mechanically raising the average by removing the lowest-priced observations.

We apply the decomposition framework of Melitz and Polanec (2015) to examine how these firm-level responses aggregate into product-level outcomes quantitatively. While Section 2 presents a structural model with heterogeneous firms, endogenous markups, and quality choice, the decomposition exercise here is model-free. This approach allows us to quantify the contributions of different firm-level margins—price adjustments, market reallocation, entry, and exit—to changes in product-level outcomes in a transparent and flexible manner.

## 5.1 Decomposition Framework

We consider the change between two periods, $t$ and $t-1$. Let $\theta_{ft}$ be the revenue share of firm $f$ in product $s$ at month $t$, where we omit the subscript $s$ for readability. We define $\widehat{P}_t = \sum_f \theta_{ft} \ln p_{ft}$ as the weighted average of log prices, $\ln p_{ft}$, across all firms at time $t$. For $t-1$, we separate the time and firm subscripts with a comma for clarity (i.e., $\theta_{f,t-1}$).

Firms are categorized into three groups: incumbents (denoted by the set I) export in both periods, exiting firms (denoted by X) export in $t-1$ but not in $t$, and entrants (denoted by N) export in $t$ but not in $t-1$. We use $\bar{P}_t = \frac{1}{|I|} \sum_{f \in I} \ln p_{ft}$ to denote the unweighted average log price of incumbents. The share of each group $g$ in the total revenue at time $t$, $s_t^g$, is calculated as the sum of their respective revenue shares, $s_t^g = \sum_{f \in g} \theta_{ft}$ for $g \in \{I, N, X\}$ (e.g., $s_t^N$ denotes the combined revenue share of entrants in time $t$).

The change in product-level price $\Delta\widehat{P}_t$ can be expressed as

$$\Delta\widehat{P}_t = \underbrace{\Delta\bar{P}_t}_{\text{change in average price}} + \underbrace{\Delta cov(\theta_{ft}, \ln p_{ft})}_{\text{reallocation of market shares}} + \underbrace{s_t^N\Big(\sum_{f\in N}\frac{\theta_{ft}}{s_t^N}\ln p_{ft} - \sum_{f\in I}\frac{\theta_{ft}}{s_t^I}\ln p_{ft}\Big)}_{\text{contribution by entrants}}$$
$$+ \underbrace{s_{t-1}^X\Big(\sum_{f\in I}\frac{\theta_{f,t-1}}{s_{t-1}^I}\ln p_{f,t-1} - \sum_{f\in X}\frac{\theta_{f,t-1}}{s_{t-1}^X}\ln p_{f,t-1}\Big)}_{\text{contribution by exiting firms}}, \tag{19}$$

where $cov(\theta_{ft}, \ln p_{ft})$ denotes the covariance between $\theta_{ft}$ and $\ln p_{ft}$, with

$$cov(\theta_{ft}, \ln p_{ft}) = \sum_{f\in I}\Big(\frac{\theta_{ft}}{\sum_{f\in I}\theta_{ft}} - \frac{1}{|I|}\Big)(\ln p_{ft} - \bar{P}_t).$$

Equation 19 shows that a change in product-level price, $\Delta\widehat{P}_t$, can be decomposed into four distinct components: (a) Changes in incumbents' prices. (b) Changes associated with changing market shares of firms by different prices. (c) Changes due to price differences between entrants and incumbents. (d) Changes due to price differences between exiting firms and incumbents. The first is the change in the unweighted average price of incumbents. According to Proposition 1, higher tariffs lower ex-tariff prices for incumbent firms. Additionally, market exits affect product-level prices through composition effects. Following Proposition 2, higher tariffs increase market exits by lower-priced firms, raising average product-level prices. This corresponds to the last component of Equation 19, which compares the average prices between exiting firms and incumbents. Aggregate product-level price effects depend on the relative importance of the above two components: incumbents' price reductions and lower-priced firms' market exits.

The contributions by the other two components of Equation 19 are ambiguous. The second component involves changes in the covariance between market shares and the prices of surviving firms. This term's contribution to product-level price change is uncertain due to tariffs' complex impact on market shares.[15] The third component reflects the entrants' impact. When tariffs increase, firms' entry into the export market is limited, occurring only with a random shock $\epsilon$ in the fixed cost of exporting. Consequently, this term has a limited effect on overall price changes.

[15] The effect of tariffs on market share is given by $\frac{\partial \ln s_{ij}(\varphi)}{\partial \ln \tau_{ij}} = \frac{1-\sigma}{\sigma}\left[(\sigma-1)(1-s_{ij}(\varphi))^2 + (1-s_{ij}(\varphi))\right] < 0$. This term is maximized when $s = 1 - \frac{1}{2(\sigma-1)}$. Hence, tariffs' impact on this component is ambiguous.

## 5.2 Decomposition Results

Table 6 presents the price decomposition results. For any year-over-year change in product-level price $\widehat{P}_t$, we compute components according to Equation 19 and regress each component on the tariff measure $\Delta \ln(1 + \text{tariff}_{pt}^{US})$. Column 1 replicates the product-level regression from Table 2. The dependent variable for Column 2 is the component associated with incumbents' price changes. The coefficient on the tariff change is -0.057 and statistically significant at the 1% level. This echoes the incomplete pass-through finding in Table 2. The reallocation and entry components (Columns 3 and 4) show statistically insignificant coefficients.

Table 6: Decomposition of Product-Level Price Changes in Response to US Tariffs

| | Total Change (1) | Incumbents (2) | Reallocation (3) | Entry (4) | Exit (5) |
|---|---|---|---|---|---|
| $\Delta \ln(1 + \text{tariff}_{pt}^{US})$ | 0.056 | -0.057*** | -0.013 | 0.021 | 0.105** |
| | (0.078) | (0.018) | (0.064) | (0.044) | (0.052) |
| Chinese Tariff | Yes | Yes | Yes | Yes | Yes |
| Product FE | Yes | Yes | Yes | Yes | Yes |
| Sector×Time FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 108,505 | 108,505 | 108,505 | 108,505 | 108,505 |
| R-squared | 0.127 | 0.106 | 0.089 | 0.504 | 0.499 |

Notes: This table presents the results from a decomposition exercise based on Equation 19. For any year-over-year change in product-level price $\widehat{P}_t$, we compute the additive components according to Equation 19. We regress each of these components on $\Delta \ln(1 + \text{tariff}_{pt}^{US})$. Column 1 reproduces the product-level regression from Column 2 of Table 2. Columns 2–5 report results for the decomposition components: incumbents' price changes, reallocation among incumbents, entry, and exit. The sum of coefficients in Columns 2–5 equals the coefficient in Column 1. All regressions control for changes in Chinese tariffs and include HS 8-digit fixed effects and sector–month fixed effects. Regressions are weighted by the number of firms in the initial year. Standard errors, clustered at HS 6-digit product level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Column 5 reports the impact of US tariffs on the firm's exit component. The coefficient on the tariff change is 0.105 and statistically significant. This means that the US tariffs compelled the lower-priced firms to drop out from the US market in a given month, raising the product-level average price via a composition effect. This effect offsets the reduction in firm-level prices, leading to a complete pass-through at the product level.

Appendix Table A11 presents results from an alternative decomposition based on Khandelwal, Schott, and Wei (2013) (see Appendix B). Consistent with previous findings, US tariffs lower prices through incumbents but raise them via market exits. These opposing forces cancel each other, resulting in an insignificant price response at the product level.

## 5.3 Welfare Implications

While firm-level responses offset each other to yield complete pass-through at the product level, the distributional effects of tariffs vary across US consumers. Tariffs reduce ex-tariff prices for higher-priced goods—typically purchased by wealthier consumers (Bils and Klenow, 2001; Handbury, 2021)—but leave lower-priced goods largely unaffected. In addition, low-priced firms are more likely to exit the US market, reducing product variety for lower-income households. As a result, US tariffs are regressive: they disproportionately harm poorer consumers.

To quantify this distributional impact, we compare the welfare effects of tariffs across households at different points in the income distribution, focusing on the 10th and 90th percentiles as an illustrative example. Following Borusyak and Jaravel (2021), we evaluate welfare changes based solely on price effects and abstract from income changes (see Appendix D for methodological details). The analysis proceeds in four steps: (a) we obtain household income by percentile from US Census data; (b) we use a price-income elasticity of 0.16 from Simonovska (2015) to estimate how average prices vary with income; (c) we combine these estimates with firm-level tariff pass-through coefficients from Table 3 and an assumed 20% average tariff increase to infer the differential price effects across income groups; and (d) we compute the resulting welfare changes using the framework in Borusyak and Jaravel (2021), assuming a uniform 4% expenditure share on Chinese imports.

Appendix Table A12 presents the results. Households at the 10th income percentile experience a welfare loss that is 0.023 percentage points larger than that of households at the 90th percentile. This difference is economically significant—particularly when viewed against the relatively modest aggregate welfare impacts of recent tariffs. For example, Fajgelbaum et al. (2020) estimate that the 2018 tariff waves resulted in a total welfare loss of just 0.04% of GDP. The sharp escalation of the US-China trade war in 2025—with US tariffs on Chinese goods reaching up to 145%—is likely to amplify the regressive effects of trade policy on US consumers.

# 6 Conclusion

We study the effects of US tariffs during the 2018-2019 trade war on China's firm-level export prices. The ex-tariff price elasticity is negative and statistically significant, rejecting complete pass-through. Tariff pass-through decreases with firm prices, and lower-priced firms are more likely to exit the US market. These two opposing forces—price reductions by incumbents and exits by lower-priced firms—offset each other, yielding zero net price change at the product level.

These findings carry important welfare implications. US tariffs reduce the ex-tariff prices for higher-price varieties but not for lower-priced ones, which are more commonly purchased by lower-income consumers. Moreover, the exit of lower-priced firms reduces product variety for these consumers. In sum, the tariffs are regressive, disproportionately harming lower-income households.

These findings are especially pertinent in light of the escalating US-China trade war in 2025—marked by US tariffs on Chinese goods rising to 145% and Chinese retaliatory tariffs reaching 125%—which has significantly disrupted bilateral trade and is likely to induce varied firm-level responses in both pricing and market exits. Given the scale of these new tariffs, the distributional consequences for US households are likely to be even more pronounced, further exacerbating the burden on lower-income consumers.

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# Online Appendices (Not For Publication)

## A Proof of Propositions

For Proposition 1, we take the first-order derivative of Equation (10) with respect to tariff:

$$\begin{aligned}
\frac{\partial \ln p_{ij}(\varphi)}{\partial \ln \tau_{ij}} &= \frac{\partial \ln p_{ij}(\varphi)}{\partial \ln s_{ij}(\varphi)} \frac{\partial \ln s_{ij}(\varphi)}{\partial \ln \tau_{ij}} \\
&= \frac{s_{ij}(\varphi)}{\left(1 - s_{ij}(\varphi)\right)\left[(\sigma-1)\left(1 - s_{ij}(\varphi)\right) + 1\right]} \frac{\partial \ln s_{ij}(\varphi)}{\partial \ln \tau_{ij}} \\
&= -\frac{(\sigma-1) s_{ij}(\varphi)}{(\sigma-1)\left(1 - s_{ij}(\varphi)\right) + 1} \left(1 + \frac{\partial \ln p_{ij}(\varphi)}{\partial \ln \tau_{ij}}\right) \\
&= \frac{1}{\sigma} \frac{p_{ij}(\varphi)}{p_{ij}(\varphi) - \frac{\eta a w_i}{\eta - 1}} - 1
\end{aligned}$$

where the third equality stems from $\frac{\partial \ln s_{ij}(\varphi)}{\partial \ln \tau_{ij}} = (1-\sigma)\left(1 - s_{ij}(\varphi)\right)\left(1 + \frac{\partial \ln p_{ij}(\varphi)}{\partial \ln \tau_{ij}}\right)$ and the last equality is from the relationship between $s_{ij}$ and $p_{ij}$.

We can further derive the impact of tariffs on export quantities using Equation (2):

$$\begin{aligned}
\frac{\partial \ln x_{ij}(\varphi)}{\partial \ln \tau_{ij}} &= -\sigma \left(1 + \frac{\partial \ln p_{ij}(\varphi)}{\partial \ln \tau_{ij}}\right) - \frac{\partial \ln \left[\sum_{\omega} q(w)^{\sigma-1} [\tau(w) p(\omega)]^{1-\sigma}\right]}{\partial \ln \tau_{ij}} \\
&= -\sigma \left(1 + \frac{\partial \ln p_{ij}(\varphi)}{\partial \ln \tau_{ij}}\right) + (\sigma-1) s_{ij}(\varphi) \left(1 + \frac{\partial \ln p_{ij}(\varphi)}{\partial \ln \tau_{ij}}\right) \\
&= \left(\frac{p_{ij}(\varphi)}{p_{ij}(\varphi) - \frac{\eta a w_i}{\eta - 1}}\right) \left[\left(\frac{\sigma-1}{\sigma}\right) s_{ij}(\varphi) - 1\right]
\end{aligned}$$

The last equality arises from the effect of tariffs on prices, as indicated by Equation (11). The preceding equation implies that $\frac{\partial \ln x_{ij}(\varphi)}{\partial \ln \tau_{ij}} < 0$. Consequently, the exports of Chinese low-priced firms decline relatively more, as their prices remain unaffected while US increases tariffs on goods from China. The following proposition summarizes the results:

**Proposition A1** *The elasticity of export quantity to tariffs is negative. The decline in ex-tariff quantity for a given tariff increase is greater for firms with low initial prices.*

As for Proposition 2, we use equation (13) to study the effects of an increase in destination market tariffs on export probability:

$$\begin{aligned}
\frac{\partial \Pr(export|\varphi)}{\partial \ln \tau_{ij}} &= g(\epsilon)[\frac{\partial \ln[\frac{s_{ij}(\varphi)}{(\sigma-1)(1-s_{ij}(\varphi))+1}]}{\partial \ln s_{ij}(\varphi)}\frac{\partial \ln s_{ij}(\varphi)}{\partial \ln \tau_{ij}} - 1] \\
&= g(\epsilon)[\frac{\sigma}{(\sigma-1)(1-s_{ij}(\varphi))+1}\frac{\partial \ln s_{ij}(\varphi)}{\partial \ln \tau_{ij}} - 1] \\
&= g(\epsilon)[(1-\sigma)(1-s_{ij}(\varphi)) - 1] < 0
\end{aligned}$$

where $g(\epsilon) = \frac{dG(\epsilon)}{d\epsilon}$ is the probability density function (PDF) of $\epsilon$.

We take the second-order derivative of the previous equation with respect to firm productivity, which satisfies:

$$\begin{aligned}
\frac{\partial \Pr(export|\varphi)}{\partial \ln \tau_{ij} \partial \ln \varphi} &= g(\epsilon)(\sigma-1)\frac{\partial s_{ij}(\varphi)}{\partial \ln \varphi} + \frac{dg(\epsilon)}{d\epsilon}\frac{\partial \ln[\frac{s_{ij}(\varphi)}{(\sigma-1)(1-s_{ij}(\varphi))+1}]}{\partial \ln \varphi}[(1-\sigma)(1-s_{ij}(\varphi)) - 1] \\
&= g(\epsilon)\frac{(\sigma-1)^2}{\eta\sigma}s_{ij}(\varphi)(1-s_{ij}(\varphi))\left[(\sigma-1)(1-s_{ij}(\varphi))+1\right] \\
&+ \frac{dg(\epsilon)}{d\epsilon}\frac{(\sigma-1)(1-s_{ij}(\varphi))}{\eta}[(1-\sigma)(1-s_{ij}(\varphi)) - 1]
\end{aligned}$$

For simplicity, we assume that $\epsilon$ follows a uniform distribution, thus $\frac{dg(\epsilon)}{d\epsilon} = \frac{dG^2(\epsilon)}{d(\epsilon)^2} = 0$. The second-order derivative becomes:

$$\frac{\partial \Pr(export|\varphi)}{\partial \ln \tau_{ij} \partial \ln \varphi} = g(\epsilon)\frac{(\sigma-1)^2}{\eta\sigma}s_{ij}(\varphi)(1-s_{ij}(\varphi))\left[(\sigma-1)(1-s_{ij}(\varphi))+1\right] > 0$$

The first-order and second-order derivatives of exit probability with respect to tariffs lead to Proposition 2. In other words, an escalation in tariffs within a market diminishes firms' likelihood of exporting to that market. This effect is particularly pronounced for firms with lower prices.

# B Alternative Decomposition Formula

We conduct an alternative price decomposition following Khandelwal, Schott, and Wei (2013). Let $\bar{P} = \frac{1}{2}(\hat{P}_t + \hat{P}_{t-1})$ and $\bar{x}_f = \frac{1}{2}(x_{ft} + x_{f,t-1})$ for firm-level variable $x$. A change in product-level price can be decomposed according to

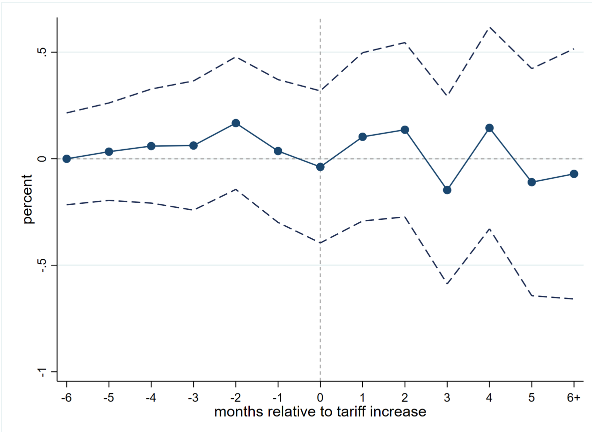
$$\begin{aligned}\Delta\hat{P}_t = {} & \Big[ \underbrace{\sum_{f\in I} \bar{\theta}_f(\log(p_{ft}) - \log(p_{f,t-1}))}_{\text{change by incumbents}} + \underbrace{\sum_{f\in I}(\theta_{ft} - \theta_{f,t-1})(\overline{\log(p)}_f - \bar{P})}_{\text{reallocation among incumbents}} \Big] \\ & + \underbrace{\sum_{f\in N} \left[\theta_{ft}(\log(p_{ft}) - \bar{P})\right]}_{\text{contribution by entrants}} - \underbrace{\sum_{f\in X} \left[\theta_{f,t-1}(\log(p_{f,t-1}) - \bar{P})\right]}_{\text{contribution by exiting firms}} .\end{aligned} \tag{20}$$

Therefore, this approach also decomposes the product-level changes into four components: change by incumbents, reallocation among incumbents, and contributions by entrants and exiting firms.

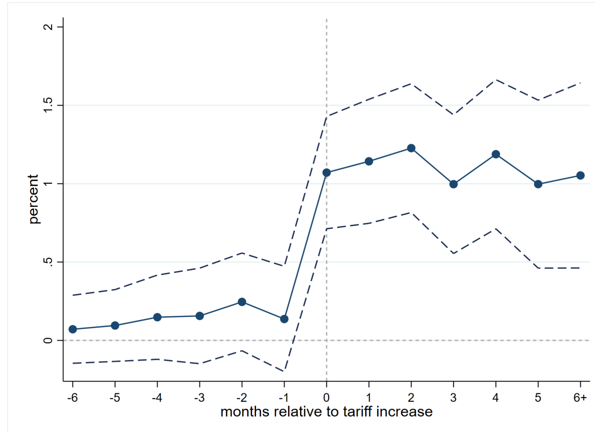
# C Appendix Figures and Tables

Appendix Figure A1: Dynamic Effects of US Tariffs on Product-Level Export Prices

(a) log ex-tariff price

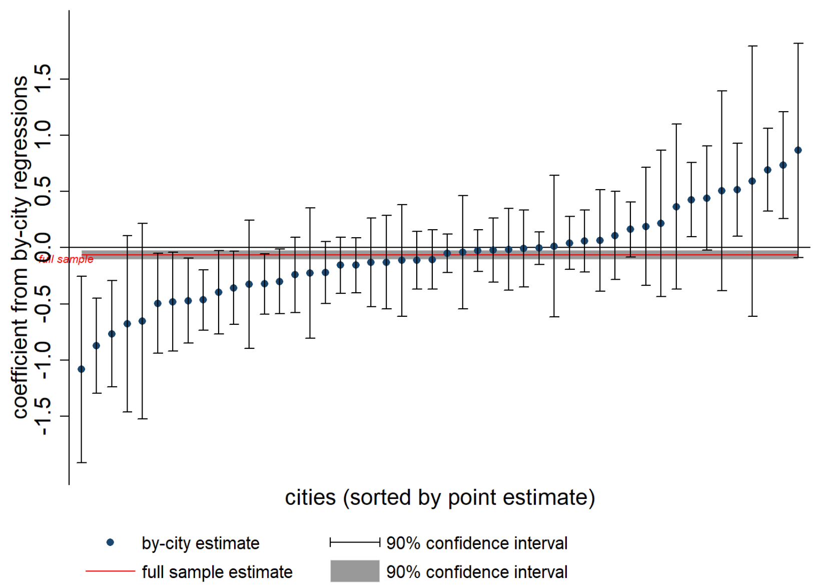



(b) log tariff-inclusive price




Notes: This figure plots cumulative coefficients from *product-level* event-study regressions with six monthly leads and lags of US tariff changes, following Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020). Panel A reports effects on ex-tariff prices, while Panel B shows effects on tariff-inclusive prices. Dashed lines indicate 90% confidence intervals. Standard errors are clustered at the HS 6-digit level.

Appendix Figure A2: City-by-City Firm-Level Estimates of Tariff Pass-Through




Notes: This figure presents city-level estimates of US tariff pass-through, using data from one city at a time. The analysis is restricted to 48 cities with at least 10,000 exporting firms to reduce sampling variability. Including smaller cities would yield more dispersed estimates. Each point represents a city-specific coefficient, with 90% confidence intervals. The shaded band indicates the baseline estimate from the full sample. Estimates vary substantially across cities and exhibit larger standard errors relative to the pooled specification.

Appendix Table A1: Summary Statistics for Key Variables

| VarName | Obs | Mean | P10 | P25 | Median | P75 | P90 |
|---|---|---|---|---|---|---|---|
| $\Delta \ln p_{fpt}$ | 2,427,751 | 0.02 | -0.58 | -0.19 | 0.01 | 0.23 | 0.64 |
| $\Delta \ln q_{fpt}$ | 2,427,751 | -0.01 | -1.85 | -0.81 | 0 | 0.79 | 1.82 |
| $\Delta \ln v_{fpt}$ | 2,427,751 | 0.01 | -1.76 | -0.78 | 0.01 | 0.8 | 1.78 |
| $\Delta\ln(1+\text{tariff}^{US}_{pt})$ | 2,427,751 | 0.06 | 0 | 0 | 0 | 0.1 | 0.21 |
| $\Delta\ln(1+\text{tariff}^{CN}_{pt})$ | 2,427,751 | 0.05 | 0 | 0 | 0.02 | 0.09 | 0.13 |
| log initial price | 2,427,751 | -1.11 | -2.82 | -1.73 | -0.91 | -0.26 | 0.34 |
| log total export | 2,427,751 | 16.03 | 13.77 | 14.8 | 15.92 | 17.15 | 18.53 |
| quality | 2,427,712 | 3.57 | -10.45 | -1.83 | 3.22 | 8.63 | 17.91 |

Notes: This table reports summary statistics for firm-month-level variables used in the empirical analysis from January 2017 to December 2019. Each observation corresponds to a firm's monthly export of a product to the United States. Tariff changes are calculated as log changes in one plus the ad valorem rate.

Appendix Table A2: Ownership Types of Firms Exporting to the US in 2017

| Ownership Type | Num of firms | Share of Total Export (%) |
|---|---|---|
| State-owned Enterprises | 3,879 | 10.7 |
| Foreign-invested Enterprises | 25,203 | 26.9 |
| Private Enterprises | 98,752 | 62.4 |

Notes: This table reports the number of exporters and their export shares to the United States in 2017, categorized by ownership type. State-owned enterprises (SOEs) include all state-owned and collective enterprises. Foreign-invested enterprises include Sino-foreign joint ventures, Sino-foreign cooperative enterprises, and wholly foreign-owned firms.

Appendix Table A3: Robustness of Tariff Effects on Chinese Export Prices:
**Including Other Trade Partners**

| | Product-level | | Firm-level | | |
|---|---|---|---|---|---|
| | $\Delta \ln p_{pct}$ (1) | $\Delta(\sum_f \theta_{fpct} \ln p_{fpct})$ (2) | $\Delta \ln p_{fpct}$ (3) | $\Delta \ln p_{fpct}$ (4) | $\Delta \ln p_{fpct}$ (5) |
| $\Delta\ln(1 + \text{tariff}_{pct})$ | 0.070 | 0.065 | -0.029* | -0.037** | -0.062** |
| | (0.091) | (0.078) | (0.016) | (0.017) | (0.025) |
| Chinese Tariff | Yes | Yes | Yes | Yes | Yes |
| Country×Product FE | Yes | Yes | Yes | No | No |
| Country×Sector×Month FE | Yes | Yes | Yes | Yes | No |
| Country×Firm×Product FE | No | No | No | Yes | Yes |
| Country×HS4×Month FE | No | No | No | No | Yes |
| Observations | 4,189,756 | 4,189,756 | 14,818,433 | 14,818,433 | 14,818,433 |
| R-squared | 0.099 | 0.094 | 0.020 | 0.205 | 0.240 |

Notes: This table replicates the baseline regressions with a broader sample that includes exports to the top 100 destination markets (accounting for more than 90% of China's total exports in 2017). Columns 1-2 report HS 8-digit product-level regressions; Columns 3-5 report firms-level regressions. All regressions control for Chinese tariffs. The regression in Column 2 is weighted by initial number of exporting firms for compatibility with firm-level regressions. Standard errors, clustered at the HS 6-digit product level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Appendix Table A4: The Effects of US Tariffs on Chinese Export Prices:
**Differentiated versus Homogeneous Products**

| | Product-level | | Firm-level | | |
|---|---|---|---|---|---|
| | $\Delta \ln p_{pt}$ | $\Delta(\sum_f \theta_{fpt} \ln p_{fpt})$ | $\Delta \ln p_{fpt}$ | $\Delta \ln p_{fpt}$ | $\Delta \ln p_{fpt}$ |
| | (1) | (2) | (3) | (4) | (5) |
| $\Delta \ln(1 + \text{tariff}_{pt}^{US}) \times$differentiated | 0.070 | 0.048 | -0.030* | -0.035* | -0.045* |
| | (0.093) | (0.087) | (0.018) | (0.019) | (0.027) |
| $\Delta \ln(1 + \text{tariff}_{pt}^{US}) \times$homogeneous | -0.076 | -0.181 | -0.364* | -0.374* | -0.293 |
| | (0.341) | (0.367) | (0.197) | (0.203) | (0.826) |
| Chinese Tariffs | Yes | Yes | Yes | Yes | Yes |
| Product FE | Yes | Yes | Yes | No | No |
| Firm×Product FE | No | No | No | Yes | Yes |
| Sector×Month FE | Yes | Yes | Yes | Yes | No |
| HS4-digit×Month FE | No | No | No | No | Yes |
| Observations | 97,773 | 97,773 | 2,095,808 | 2,095,808 | 2,095,808 |
| R-Squared | 0.111 | 0.131 | 0.005 | 0.198 | 0.205 |

Notes: This table examines differential price responses to US tariffs by product type, based on Rauch (1999) classification. Interactions with tariff changes distinguish between differentiated and homogeneous products. Columns 1-2 report HS 8-digit product-level regressions; Columns 3-5 report firms-level regressions. All regressions control for Chinese tariffs. The regression in Column 2 is weighted by initial number of exporting firms for compatibility with firm-level regressions. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Appendix Table A5: Effects of US Tariffs on Firm-Level Export Quantities

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | -0.221*** | -0.192** | 0.039 | -0.212** | 0.040 |
| | (0.069) | (0.081) | (0.086) | (0.087) | (0.091) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$log initial price | | 0.052*** | 0.049** | 0.051** | 0.049** |
| | | (0.020) | (0.019) | (0.020) | (0.020) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$US share in export | | | -0.472*** | | -0.471*** |
| | | | (0.075) | | (0.077) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$SOE | | | | 0.113 | 0.006 |
| | | | | (0.080) | (0.081) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$foreign-invested | | | | 0.029 | -0.006 |
| | | | | (0.059) | (0.059) |
| Chinese Tariffs | Yes | Yes | Yes | Yes | Yes |
| Firm$\times$Product FE | Yes | Yes | Yes | Yes | Yes |
| HS4-digit$\times$Month FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 2,320,186 | 2,320,186 | 2,320,186 | 2,320,186 | 2,320,186 |
| R-Squared | 0.198 | 0.201 | 0.204 | 0.201 | 0.204 |

Notes: This table reports the effects of U.S. tariffs on firm-level export quantities. Column 1 presents the average impact of tariffs. Column 2 adds an interaction between the tariff change and the logarithm of the initial price, standardized within each product. Column 3 adds an interaction with the firm's initial U.S. export share. Column 4 includes interactions with ownership types—state-owned enterprises (SOEs) and foreign-invested firms—where private enterprises serve as the omitted category. Column 5 includes all the aforementioned interaction terms. All regressions control for changes in Chinese tariffs and include firm-product and HS4-digit-month fixed effects. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix Table A6: Heterogeneous Effects of US Tariffs on Export Prices:
**By Total Exports**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | -0.063** | 0.335*** | 0.429*** | 0.336*** | 0.427*** |
| | (0.025) | (0.095) | (0.112) | (0.099) | (0.115) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$log total export | | -0.025*** | -0.028*** | -0.026*** | -0.029*** |
| | | (0.006) | (0.006) | (0.006) | (0.007) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$US share in export | | | -0.066* | | -0.067* |
| | | | (0.035) | | (0.036) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$SOE | | | | 0.023 | 0.018 |
| | | | | (0.042) | (0.042) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$foreign-invested | | | | 0.039 | 0.039 |
| | | | | (0.025) | (0.025) |
| Chinese Tariffs | Yes | Yes | Yes | Yes | Yes |
| Firm$\times$Product FE | Yes | Yes | Yes | Yes | Yes |
| HS4-digit$\times$Month FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 2,320,186 | 2,320,186 | 2,320,186 | 2,320,186 | 2,320,186 |
| R-Squared | 0.204 | 0.204 | 0.204 | 0.204 | 0.204 |

Notes: This table reports the effects of US tariffs on export prices by firm size, measured by total exports. Column 1 replicates Column 5 of Table 2. Column 2 adds the interaction between the tariff change and the logarithm of total firm exports across all destinations. Column 3 adds an interaction with the firm's initial US export share. Column 4 includes interactions with ownership types—state-owned enterprises (SOEs) and foreign-invested firms—while private enterprises serve as the omitted category. Column 5 includes all interaction terms. All regressions control for Chinese tariffs and include firm-product and HS4-digit-month fixed effects. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix Table A7: Heterogeneous Effects of US Tariffs on Export Prices:
**By Product Quality**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | -0.063** | -0.108*** | -0.092*** | -0.116*** | -0.096*** |
| | (0.025) | (0.024) | (0.029) | (0.025) | (0.029) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$quality | | -0.006*** | -0.006*** | -0.006*** | -0.006*** |
| | | (0.001) | (0.001) | (0.001) | (0.001) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$US share in export | | | -0.036 | | -0.046 |
| | | | (0.030) | | (0.030) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$SOE | | | | -0.042 | -0.049 |
| | | | | (0.036) | (0.036) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$foreign-invested | | | | 0.032 | 0.035 |
| | | | | (0.022) | (0.022) |
| Chinese Tariffs | Yes | Yes | Yes | Yes | Yes |
| Firm$\times$Product FE | Yes | Yes | Yes | Yes | Yes |
| HS4-digit$\times$Month FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 2,320,186 | 2,320,153 | 2,320,153 | 2,320,153 | 2,320,153 |
| R-Squared | 0.204 | 0.238 | 0.238 | 0.238 | 0.238 |

Notes: This table reports the effects of U.S. tariffs on export prices by initial product quality. Column 1 replicates Column 5 of Table 2. Column 2 adds the interaction between the tariff change and initial product quality. Column 3 adds an interaction with the firm's initial U.S. export share. Column 4 includes interactions with ownership types—state-owned enterprises (SOEs) and foreign-invested firms—while private enterprises serve as the omitted category. Column 5 includes all interaction terms. All regressions control for Chinese tariffs and include firm-product and HS4-digit-month fixed effects. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix Table A8: Heterogeneous Effects of US Tariffs on Export Prices:
**By Market Share**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | -0.063** | -0.058** | -0.053* | -0.069*** | -0.062** |
| | (0.025) | (0.025) | (0.031) | (0.027) | (0.031) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$market share | | -0.895** | -0.894** | -0.913*** | -0.907** |
| | | (0.353) | (0.354) | (0.354) | (0.355) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$US share in export | | | -0.010 | | -0.015 |
| | | | (0.033) | | (0.033) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$SOE | | | | -0.021 | -0.024 |
| | | | | (0.040) | (0.040) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$foreign-invested | | | | 0.038 | 0.037 |
| | | | | (0.025) | (0.025) |
| Chinese Tariffs | Yes | Yes | Yes | Yes | Yes |
| Firm×Product FE | Yes | Yes | Yes | Yes | Yes |
| HS4-digit×Month FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 2,320,186 | 2,320,186 | 2,320,186 | 2,320,186 | 2,320,186 |
| R-Squared | 0.204 | 0.204 | 0.204 | 0.204 | 0.204 |

Notes: This table reports the effects of US tariffs on export prices by initial market share, measured as a firm's exports to the US as a share of China's total exports to the US within the product. Column 1 replicates Column 5 of Table 2. Column 2 adds the interaction between the tariff change and initial market share. Column 3 adds an interaction withthe firm's initial US export share, defined as its exports to the US relative to its total exports. Column 4 includes interactions with ownership types—state-owned enterprises (SOEs) and foreign-invested firms—while private enterprises serve as the omitted category. Column 5 includes all interaction terms. All regressions control for Chinese tariffs and include firm-product and HS4-digit-month fixed effects. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix Table A9: Heterogeneous Effects on Firm Exit from the US Market
**By Total Export and Product Quality**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | 0.032** | 0.145*** | 0.137*** | 0.033*** | 0.006 |
| | (0.013) | (0.035) | (0.040) | (0.013) | (0.015) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$log total export | | -0.007*** | -0.008*** | | |
| | | (0.002) | (0.002) | | |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$quality | | | | -0.001*** | -0.001*** |
| | | | | (0.000) | (0.000) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$US share in export | | | 0.033** | | 0.045*** |
| | | | (0.016) | | (0.015) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$SOE | | | 0.062*** | | 0.052*** |
| | | | (0.016) | | (0.016) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$foreign-invested | | | 0.007 | | 0.012 |
| | | | (0.010) | | (0.010) |
| Net Entry Ratio | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Chinese Tariffs | Yes | Yes | Yes | Yes | Yes |
| Firm×Product FE | Yes | Yes | Yes | Yes | Yes |
| HS4-digit×Month FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 5,035,835 | 5,035,835 | 5,035,835 | 5,035,695 | 5,035,695 |
| R-Squared | 0.578 | 0.578 | 0.578 | 0.578 | 0.578 |

Notes: This table reports the effects of US tariffs on firm exits from the US market, using initial total exports and product quality as heterogeneity dimensions. Column 1 presents the average effect of tariffs on exit. Column 2 adds the interaction between the tariff change and the logarithm of total firm exports across all destinations. Column 3 includes additional interactions with the firm's initial US export share and ownership type. Column 4 replaces total exports with an interaction between the tariff change and product quality. Column 5 includes additional interactions with the US export share and ownership type. All regressions control for Chinese tariffs and include firm-product and HS4-digit–month fixed effects. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix Table A10: Robustness of Tariff Effects on Firm Exit:
**Alternative Definition of US Market Exit**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | 0.017* | -0.012 | 0.148*** | 0.062*** | 0.221*** |
| | (0.010) | (0.012) | (0.013) | (0.011) | (0.015) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$log initial price | | -0.017*** | -0.017*** | -0.011*** | -0.011*** |
| | | (0.003) | (0.003) | (0.003) | (0.003) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$US share in export | | | -0.361*** | | -0.361*** |
| | | | (0.020) | | (0.020) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$SOE | | | | -0.081*** | -0.140*** |
| | | | | (0.014) | (0.015) |
| $\Delta\ln(1+\text{tariff}_{pt}^{US})\times$foreign-invested | | | | -0.182*** | -0.170*** |
| | | | | (0.012) | (0.011) |
| Net Entry Ratio | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Chinese Tariff | Yes | Yes | Yes | Yes | Yes |
| Firm$\times$Product FE | Yes | Yes | Yes | Yes | Yes |
| HS4-digit$\times$Month FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 5,035,835 | 5,035,835 | 5,035,835 | 5,035,835 | 5,035,835 |
| R-squared | 0.841 | 0.841 | 0.842 | 0.842 | 0.842 |

Notes: This table reports robustness results using an alternative definition of firm exit. The dependent variable equals one if a firm exported product $p$ to the US in the previous year but did not export the same product in the current year, and zero otherwise. Column 1 presents the average effect of US tariffs on exit. Column 2 adds the interaction between the tariff change and the logarithm of the initial price, standardized within each HS 8-digit product. Column 3 includes an additional interaction with the firm's initial US export share. Column 4 includes interactions with ownership types—state-owned enterprises (SOEs) and foreign-invested firms—while private enterprises serve as the omitted category. Column 5 includes all interaction terms. All regressions control for Chinese tariffs and include firm-product and HS4-digit-month fixed effects. Standard errors, clustered at the HS 6-digit level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix Table A11: Alternative Decomposition of Product-level Price Changes

| | Total Change<br>(1) | Incumbents<br>(2) | Reallocation<br>(3) | Entry<br>(4) | Exit<br>(5) |
|---|---|---|---|---|---|
| $\Delta\ln(1+\text{tariff}_{pt}^{US})$ | 0.056 | -0.057*** | 0.013 | 0.035 | 0.065* |
| | (0.078) | (0.015) | (0.041) | (0.028) | (0.035) |
| Chinese Tariff | Yes | Yes | Yes | Yes | Yes |
| Product FE | Yes | Yes | Yes | Yes | Yes |
| Sector$\times$Month FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 108,505 | 108,505 | 108,505 | 108,505 | 108,505 |
| R-squared | 0.127 | 0.155 | 0.107 | 0.328 | 0.252 |

Notes: This table presents the results from the alternative decomposition exercise based on Equation 20. For any year-over-year change in product-level price $\widehat{P}_t$, we compute the additive components according to Equation 20. We regress each of these components on $\Delta\ln(1+\text{tariff}_{pt}^{US})$. Column 1 reproduces the product-level regression from Column 2 of Table 2, while the dependent variables in Columns 2-5 are the four additive components from Equation 20. Note that the coefficients on $\Delta\ln(1+\text{tariff}_{pt}^{US})$ from Columns 2-5 sum to the coefficient in Column 1. We control for the changes in Chinese tariffs in all columns. HS 8-digit fixed effects and sector-time fixed effects are included in all regressions. The regressions in all columns are weighted by the number of firms in the base year. Standard errors, clustered at HS 6-digit product level, are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

# D Welfare Effects by Household Income

For a differentiable indirect utility function $V$, the equivalent variation $EV_i$ for consumer $i$ is defined by solving:

$$\mathcal{V}\left(p^0, X_i^0 + EV_i\right) - \mathcal{V}\left(p^0, X_i^0\right) = \mathcal{V}\left(p^0 + dp, X_i^0 + dX_i\right) - \mathcal{V}\left(p^0, X_i^0\right)$$

where $p^0$ denotes the initial price vector, $X_i^0$ is the initial income of consumer $i$, and $dp$ and $dX_i$ represents small changes in prices and income, respectively.

Incorporating Roy's identity,

$$EV_i = dX_i - \sum_{\omega} q_{\omega}^i dp_{\omega},$$

where $q_{\omega}^i$ is the initial consumption of $\omega$.

Following Borusyak and Jaravel (2021), the percentage change in welfare is given by:

$$d\log \mathcal{W}i \equiv \frac{EV_i}{X_i} = d\log X_i - \sum_{\omega} s_{\omega}^i d\log p_{\omega}^i, \tag{21}$$

where $s_{\omega}^i$ is the expenditure share on good $\omega$ for consumer $i$.

As Equation 21 shows, changes in US import tariffs can influence consumer welfare through two channels: directly by altering prices ($-\sum_{\omega} s_{\omega}^i d\log p_{\omega}^i$) and indirectly via income effects ($d\log X_i$), which may arise from producer responses to tariffs. As in Dai and Wang (2022), we focus on the direct price effect and set $d\log X_i = 0$ throughout the analysis. Additionally, because we lack data on how product variety differs across income groups, our analysis abstracts from changes in variety due to firm exit—an omission that may understate welfare losses, particularly for lower-income households disproportionately affected by the disappearance of low-priced goods.

US tariffs on Chinese imports may generate differential welfare effects across income groups for two reasons: (i) differences in the expenditure share on Chinese goods ($s_{CN}^i$), and (ii) differences in the magnitude of price changes for consumed products ($d\log p_{CN}^i$). However, Borusyak and Jaravel (2021) find little variation in $s_{CN}^i$ across the income distribution. Therefore, the observed heterogeneity in welfare losses primarily stems from differences in the prices of goods consumed by households at different income levels—i.e., variation in $d\log p_{\omega}^i$ across $i$.

As an illustration, we focus on the welfare difference between households at the 10th and 90th income percentiles. The same approach can be readily applied to any other pair of percentiles. We quantify the effect in four steps:

1. Income distribution: We obtain household income by percentile from the US Census Bureau (`https://www.census.gov/`). Log income values for the 10th and 90th percentile households are reported in the first two columns of Table A12.

2. Price-income gradient: We apply a price-income elasticity of 0.16 from Simonovska (2015), which captures how the average price of tradable goods rises with income. This allows us to estimate baseline differences in consumption bundle prices between the two groups.

3. Tariff impact by income: Using the regression results in Table 3 and assuming an average tariff increase of 20%, we combine the income data and price-income gradient to infer how tariffs differentially affect Chinese import prices across the two income percentiles.

4. Welfare calculation: Using Equation (21), we compute the implied welfare loss gap between the 10th and 90th percentile households resulting from their differential exposure to price changes. Following Borusyak and Jaravel (2021), we assume a uniform 4% expenditure share on Chinese imports across all households.

Appendix Table A12: Differences in Welfare Changes by Household Income

| **Low-income Group**<br>10th percentile<br>log income | **High-income Group**<br>90th percentile<br>log income | difference in<br>log income | difference in<br>welfare loss |
|---|---|---|---|
| 9.567 | 12.094 | 2.527 | -0.023% |

Notes: This table quantifies the differential welfare impact of U.S. tariffs across income groups using the framework of Borusyak and Jaravel (2021). The estimated difference in welfare loss is based on log income differences between the 10th and 90th income percentiles, a price–income elasticity of 0.16 from Simonovska (2015), an assumed 20% average increase in U.S. tariffs on Chinese goods, and a uniform 4% expenditure share on Chinese imports across households.

Appendix Table A12 presents the estimated welfare differences. Households at the 10th income percentile suffer a welfare loss from tariffs that is 0.023 percentage points greater than households at the 90th percentile. This difference is economically substantive, especially in light of the relatively small aggregate welfare effects found in prior studies. For instance, Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020) estimate that the 2018 tariff rounds led to an overall welfare loss of just 0.04% of GDP.