

Behavioral Pricing Constrains Tariff Pass-through

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Abstract

How do firms transmit macroeconomic shocks to consumers through retail prices? We show that pricing frictions induced by behavioral biases play a central role in shaping how cost shocks pass-through to consumers. We document that import tariffs are transmitted primarily through prices that do not end in nine, while nine-ending prices exhibit substantially lower pass-through. After the tariffs, annual inflation is meaningfully larger for non-nine-ending priced products, even products that are not tariffed. These findings identify channels through which consumer biases constrain firms' responses to macroeconomics shocks.

1 Introduction

How do firms transmit macroeconomic shocks to consumers through retail prices? Pass-through of taxes, tariffs, and exchange-rate movements is central to economics, and has taken on renewed importance with the increased use of tariffs over the last decade. Yet, estimates of pass-through from recent rounds of tariffs to consumer prices are low ([Cav-allo et al., 2021,0](#); [Bai et al., 2025](#); [Amiti et al., 2026](#)). While standard models emphasize nominal rigidities, market structure, and local costs as the key drivers of pass-through, the role of consumers' psychological responses to prices remains underexplored. For example, many retail prices are set at psychologically salient thresholds such as ending in digit 9 ([Ginzberg, 1936](#)). A leading explanation is consumers' left-digit bias: consumers perceive a price just below a round-number threshold as substantially lower than a nearby price just above it ([Thomas and Morwitz, 2005](#); [Strulov-Shlain, 2023](#); [List et al.,](#)

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2023; Strulov-Shlain, 2025). Although such price points are a known source of price rigidities (Knotek, 2011; Knotek II, 2024; Levy et al., 2011), to our knowledge, there are no estimates of their effect on the pass-through of cost shocks into retail prices.

We show that left-digit behavioral pricing substantially affects the transmission of macroeconomic shocks from firms to consumers. We develop a simple framework in which consumers’ left-digit bias creates salient price thresholds that alter firms’ pricing incentives. Crossing a threshold, such as moving from \$29 to \$30, produces a discrete increase in perceived price and a corresponding loss in demand. As a result, firms are more reluctant to raise prices in response to cost shocks when their initial prices lie at such thresholds. The model therefore predicts lower pass-through into prices that end in nine just before a cost shock and a reallocation of price adjustment toward products whose prices are not constrained by salient thresholds.

We test this prediction in the context of the recent U.S.–China trade war in 2018–2019. Using two million retail prices collected by Cavallo et al. (2021) from two large U.S. multi-product retailers, we estimate cumulative one-year tariff pass-through. Three features of this dataset enable the analysis of the *aggregate* implications of behavioral pricing. Firstly, this data contains retail prices of a wide range of products that represent most existing product categories. Secondly, for these retailers, tariffs represented a large cost shock, because 40% of their product assortment consisted of the affected product categories imported from China. Finally, this data reveals the striking prevalence and persistence of left-digit prices, in line with retailers’ optimal response to consumers’ left-digit bias. Around 60% of products had nine-ending prices prior to the trade war. Conditional on a price change, they were more likely to keep left-digit prices and to change discretely (by a whole number)¹, than products with initially non-nine-ending prices.

Using pre-trade-war price endings to classify products, we demonstrate a striking heterogeneity in tariff pass-through into retail prices across nine- and non-nine-ending prices hidden behind the aggregate estimates. We find that, after one year, a 10 pp increase in the U.S. import tariffs on China translates into 0.75% increase in retail prices of products with initially non-nine-ending prices. In contrast, for products with initially nine-ending prices in the same COICOP category, the pass-through is 0.16% and statistically insignificant. Given the prevalence of nine-ending prices in U.S. retail markets, this can explain surprisingly low aggregate tariff pass-through estimates (Cavallo et al., 2021; Bai et al., 2025; Amiti et al., 2026).

Our theoretical framework suggests that this differential pass-through can be ex-

¹Conlon and Rao (2020) also document discreteness of price changes. We find that it is more likely to be a feature of nine-ending rather than non-nine-ending prices.

plained by lower likelihood for a retailer to raise prices of nine- rather than non-nine-ending prices of tariffed products. To test this mechanism, we compare prices in the month prior to the tariffs going into effect to 1 year prior and 1 year after. Products with nine-ending prices in the month prior to the tariffs are less likely to increase in prices, but especially after the tariffs go into effect. Additionally, the post-period negative interaction is larger in the subsamples that saw the highest pass-through difference.

Finally, we consider whether firms offset the costs of the tariffs by increasing prices on non-tariffed products and how nine-ending prices affect that price inflation. Similar to our passthrough exercise, the prediction of our framework is that firms should be more likely to raise prices on non-nine-ending products. We examine annual inflation of nine-ending products in response to the tariffs in a difference-in-differences design. We show that Chinese products with nine-endings have annual inflation that is 2.85 pp less than non-nine-ending products. We observe a smaller but similar effect of .86 pp in the full sample of products. These results show that firms offset the cost increases of the tariffs by raising prices on non-tariffed products, but target the products that have non-nine-ending prices.

This paper contributes to several strands of the literature. First, we contribute to the literature on behavioral pricing and left-digit bias ([Thomas and Morwitz, 2005](#); [Strulov-Shlain, 2023](#); [List et al., 2023](#); [Strulov-Shlain, 2025](#)). Existing work demonstrates that consumers perceive prices ending in 9 as substantially lower than nearby round prices and that firms often fail to fully exploit this bias in their pricing decisions. While this literature focuses primarily on the level of prices and firms' static pricing incentives, we show that behavioral pricing also affects firms' responses to macroeconomic shocks. Products with initially nine-ending prices exhibit substantially lower pass-through of tariffs and exchange-rate movements than otherwise similar products with initially non-nine-ending prices. This implies that behavioral pricing shapes not only the level but also the *dynamics* of retail prices' adjustment to shocks. Our paper is closely related to [Conlon and Rao \(2020\)](#), who show that firms' tendencies to raise prices in discrete amounts in the alcohol market, often from nine-ending to nine-ending prices, complicates the estimation of tax pass-through.

Second, we contribute to the literature on pass-through and incidence of cost shocks. This literature attributes incomplete transmission of cost shocks into prices to market power, local distribution costs, nominal rigidities, and other pricing frictions ([Gopinath et al., 2010](#); [Nakamura and Zerom, 2010](#); [Amiti et al., 2014](#); [Marion and Muehlegger, 2011](#); [Conlon and Rao, 2020](#)). Recent studies have examined the pass-through of U.S. import and retaliatory tariffs ([Cavallo et al., 2021](#); [Alviarez et al., 2023](#); [Cavallo et al., 2025](#);

Bai et al., 2025; Ma et al., 2025; Ganapati and Hottman, 2026; Gopinath and Neiman, 2026; Cavallo et al., 2026). We identify behavioral pricing as a quantitatively important determinant of tariff pass-through into retail prices. Since firms are reluctant to move prices across left-digit thresholds, tariffs are absorbed to a greater extent in markups. This makes the incidence of trade policy state-dependent: consumers bear less of the burden when goods have nine-ending prices, while firms absorb a larger share of the shock. Firms offset this by raising prices on non-tariffed goods with non-nine-ending prices.

Finally, we contribute to a growing literature linking micro-level pricing heuristics to aggregate outcomes (Rotemberg, 2005,0; Knotek, 2011; Hahn and Marenčák, 2020; Knotek II, 2024). Previous work argues that psychological price points contribute to nominal rigidity and influence inflation dynamics. We extend this insight to the transmission of real cost shocks. By affecting how firms adjust prices in response to tariffs and exchange-rate movements, behavioral pricing shapes the aggregate pass-through of macroeconomic shocks and the incidence of trade policy. More broadly, our findings demonstrate that consumer behavioral biases can have quantitatively important implications for aggregate economic outcomes.

2 Theoretical Framework

We model retail pricing of imported goods in a standard monopolistic competition environment with CES demand, augmented to capture behavioral pricing frictions. The key departure from the canonical framework is that consumers exhibit a left-digit bias: prices just below an integer are perceived as meaningfully cheaper than prices just above it. This generates a kink in the demand curve at salient (focal) price thresholds, even in the absence of any nominal adjustment costs.

Consumers with left-digit bias. In the domestic market, consumers derive utility from a CES aggregate of differentiated product varieties indexes with φ . Demand for product φ depends on its *perceived* price rather than its posted price:

$$Q(P(\varphi)) = A \left(\frac{\tilde{P}(P(\varphi))}{P^*} \right)^{-\sigma}, \quad (1)$$

where $P(\varphi)$ denotes the posted retail price of product φ in the domestic market, P^* is the CES price index, A is a market-specific demand shifter, and $\sigma > 1$ is the elasticity of substitution across product varieties.

Consumers exhibit left-digit bias and therefore do not perceive posted prices perfectly. Let the perceived price, $\tilde{P}(\varphi)$ be determined as follows:

$$\tilde{P}(P(\varphi)) = P(\varphi) - \eta S(P(\varphi)), \quad (2)$$

where $\eta > 0$ captures the strength of consumer bias and $S(P)$ is a salience function that attains its maximum at focal price points located immediately below salient psychological thresholds, such as 9 or 19. Thus, consumers perceive prices near these focal points as lower than their nominal value.

For differentiation purposes, we assume that function $S(P)$ is smooth and decreasing as prices move away from a focal point.² In the absence of left-digit bias, $\eta = 0$, implying

$$\tilde{P}(P(\varphi)) = P(\varphi), \quad (3)$$

and the model collapses to the standard CES demand system.

The key implication of left-digit bias is that a small increase in a posted price located near a focal threshold substantially reduces the perceived discount associated with that price. Differentiating perceived prices with respect to posted prices yields

$$\frac{\partial \tilde{P}(P(\varphi))}{\partial P(\varphi)} = 1 - \eta S'(P(\varphi)). \quad (4)$$

Because the salience function declines as prices move away from focal thresholds, $S'(P(\varphi)) < 0$ in the neighborhood above a left-digit price point. Consequently,

$$\frac{\partial \tilde{P}(P(\varphi))}{\partial P(\varphi)} > 1, \quad (5)$$

implying that a one-unit increase in the posted price generates a more than one-unit increase in the perceived price.

Therefore, the effective demand elasticity faced by retailers is

$$\varepsilon(P(\varphi)) = -\frac{\partial \log Q(P(\varphi))}{\partial \log P(\varphi)} = \sigma \frac{\partial \log \tilde{P}(P(\varphi))}{\partial \log P(\varphi)}. \quad (6)$$

Away from focal thresholds, $S'(P(\varphi)) \approx 0$ and the retailer faces the standard CES elasticity $\varepsilon(P(\varphi)) \approx \sigma$. Near a salient left-digit threshold, however, the perceived-price elasticity exceeds one, which implies $\varepsilon(P(\varphi)) > \sigma$. Thus, left-digit bias generates a local increase

²This function can be viewed as a continuous approximation to a discontinuous kink in demand.

in the effective elasticity of demand around focal price points, making price increases particularly costly for retailers operating near these thresholds.

Retailers. Domestic retailers purchase goods from foreign suppliers and combine these goods with local retail services before selling to consumers. Let $P^F(\varphi)$ denote the foreign supplier's price in producer currency. The domestic-currency procurement cost of product φ is $E(1 + \tau)P^F(\varphi)$, where E is the exchange rate between producer currency and domestic currency, and τ is an ad-valorem tariff. Retailers also incur local non-traded costs, denoted by ℓ , such as labor, rent, warehousing, distribution, etc. Therefore, retailer's marginal cost of selling variety φ can be expressed as

$$MC(\varphi) = E(1 + \tau)P^F(\varphi) + \ell. \quad (7)$$

To maximize profits, retailers set prices as a markup over their marginal costs:

$$P(\varphi) = \frac{\varepsilon(P(\varphi))}{\varepsilon(P(\varphi)) - 1} MC(\varphi), \quad (8)$$

where mark-up (the first term) is inversely related to the effective demand elasticity faced by the retailer, $\varepsilon(P(\varphi))$.

Pass-through of cost shocks. Denote the pass-through of retailer's marginal costs into consumer prices as

$$\theta(P(\varphi)) = \frac{\partial \log P(\varphi)}{\partial \log MC(\varphi)} \quad (9)$$

Differentiating the optimal pricing rule in (8) yields

$$\theta(P(\varphi)) = \frac{1}{1 + \Gamma(P(\varphi))}, \quad (10)$$

where $\Gamma(P(\varphi))$ is the elasticity of optimal markups with respect to price changes, which depends on the local curvature of demand. Because left-digit bias causes the effective elasticity of demand to increase rapidly near salient thresholds, markups become more responsive to marginal-cost shocks in these regions. As a result, $\Gamma^9 > \Gamma^n$, which further implies $\theta^9 < \theta^n$, where superscripts 9 and n denote initially nine- and non-nine-ending prices, respectively.

We illustrate this mechanism of differential passthrough into initially nine-ending and non-nine-ending prices in Figure 1. When faced with higher marginal costs, the

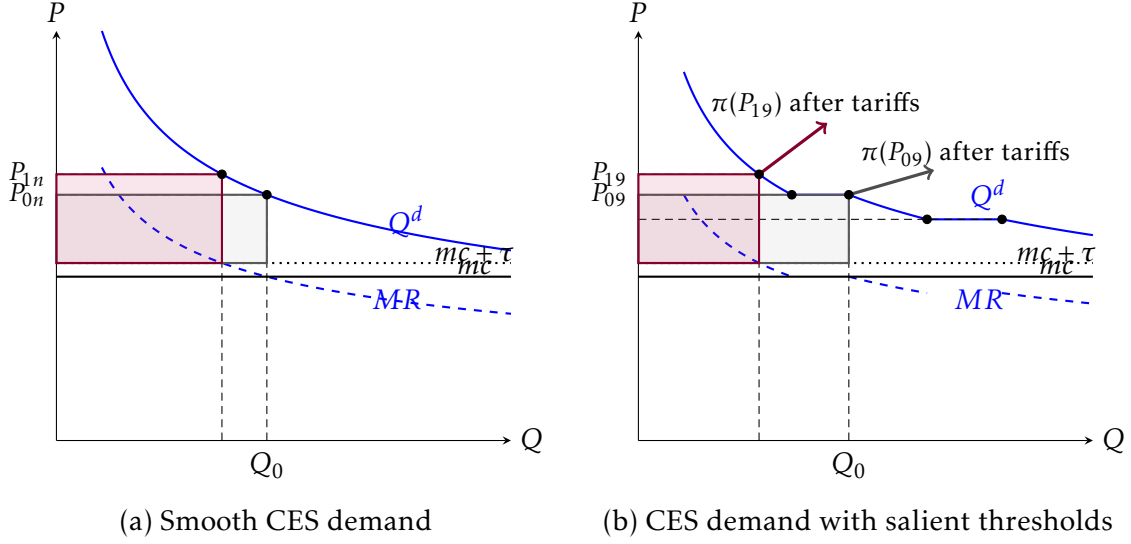


Figure 1. Smooth and threshold-dependent CES demand under tariffs.

Notes: The figure illustrates retailers' price responses to an increase in marginal costs induced by a tariff. In both panels, demand is isoelastic within each pricing regime, with inverse demand $P(Q) = A^{1/\sigma} Q^{-1/\sigma}$ and marginal revenue $MR(Q) = (1 - 1/\sigma)P(Q)$. Panel (a) assumes smooth demand. In panel (b), crossing the salient price threshold P_{09} causes a discrete inward shift in demand. The purple area represents profits from increasing the price to $P_{1i} > P_{0i}$ after the tariff, whereas the gray area represents profits from retaining the initial price P_{0i} , where $i \in \{n, 9\}$.

retailer decides whether to keep the same quantities by fully absorbing the cost increase in its mark-ups or to pass-through some of the cost increase into consumer prices at the expense of lower quantities. When demand is smooth, as in Figure 1a, quantity reduction is gradual and results in higher profits shown by the purple area relative to the gray area depicting profits under no price adjustment. In contrast, when demand is kinked, as in Figure 1b, quantity reduction is disproportionate to the price change. This makes profits under price adjustment shown by the purple area fall below profits under no price change shown by the gray area.

Importantly, this mechanism applies symmetrically for pass-through of both tariffs and exchange rates. Tariff (or exchange rate) pass-through can be derived as

$$\rho_\tau = \rho_E \equiv \frac{\partial \log P(\varphi)}{\partial \log MC(\varphi)} \frac{\partial \log MC(\varphi)}{\partial \log \tau} = \frac{\partial \log P(\varphi)}{\partial \log MC(\varphi)} \frac{\partial \log MC(\varphi)}{\partial \log E} = \frac{1}{1 + \Gamma(P(\varphi))} \frac{E(1 + \tau)P^F(\varphi)}{MC(\varphi)} \quad (11)$$

where the last term is the share of imported price in domestic currency (inclusive of tariffs) in the retailer's marginal costs. Since $\Gamma^9 > \Gamma^n$, both pass-through are predicted to be lower for initially 9- than non-nine-ending prices, conditional on the same share of imported price in retailer's costs. In the following analysis, we test this prediction.

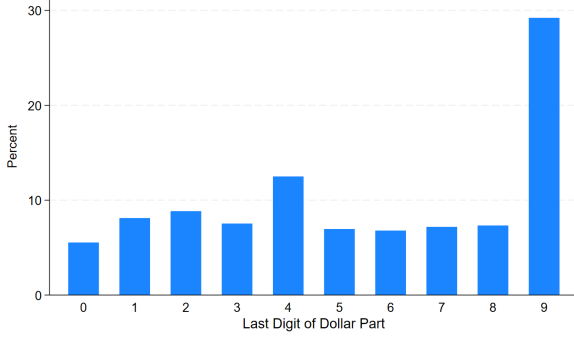
3 Data

Data source. We observe retail prices of a wide range of products at high frequency in two datasets collected by the Billion Prices Project (Cavallo et al., 2014,0). Our main dataset comes from Cavallo et al. (2021) and contains more than two million retail prices from two large multi-product retailers in the U.S. during the recent U.S.-China Trade War in 2018-2019.

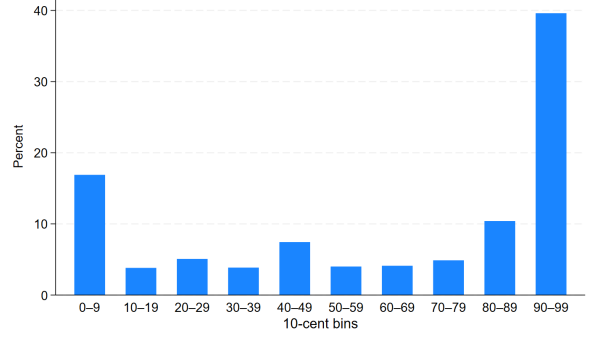
Summary statistics. The two large U.S. retailers in the main dataset sell a wide range of products from fruits and vegetables to motor cycles. They represent around three-quarters of tradable consumer-goods COICOP classes. Among all products, imported products represent 64% in the pre-trade-war period, 70% of which are imports from China. 37.5% of their products were directly affected by the U.S. tariffs on China imposed in 2018. More than 80% of products initially sold by these retailers could be indirectly affected as products from affected HS6 categories but not imported from China. The average retail price in this data is 155 US\$, while median price is 25 US\$ and standard deviation is 897 US\$.

Behavioral pricing of U.S. multi-product retailers. We document that, across a wide range of products, U.S. multi-product retailers set prices at numbers to take advantage of consumers' left-digit bias. Figures 2a and 2b show that around 30% of their prices end in the digit 9 in the dollar part and almost 40% of prices end in 9 or above 90 in the cent part. Prices cluster in the 9-th cent bin across nearly all dollar digits, reflecting the widespread use of the left-digit pricing (see Figure A3). The use of left-digit pricing is not specific to any product category, but is a common feature of most products sold by these retailers (see Figure A1). In general, left-digit prices are more common among more expensive product categories, as shown in Figure A2.

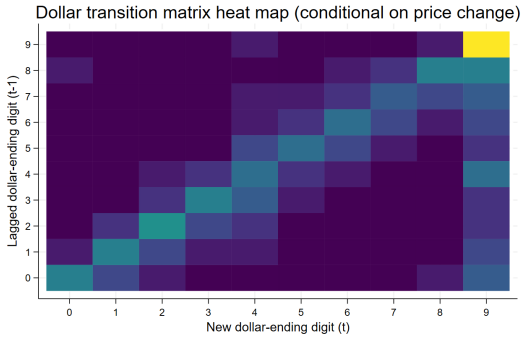
Left-digit prices exhibit a much higher degree of persistence than any other prices observed in the data. To show this, we plot a heat map of transition probabilities of the last digits in the dollar part of prices and cent bins, conditional on a price change. Figure 2c shows that, although last-dollar digits are persistent for all digits, digit 9 in the dollar part is especially persistent. Conditional on a price change, prices ending in 9 in their dollar part change to the nine-ending dollar price with probability around 53%. Among the cent bins, as Figure 2d illustrates, only 0-9, 80-90 and 90-99 cent bins exhibit persistence, conditional on a price change. Prices with 90-99 cents ending transition to different prices but with the same cents bin with 50% probability. Figure A4 in the Online



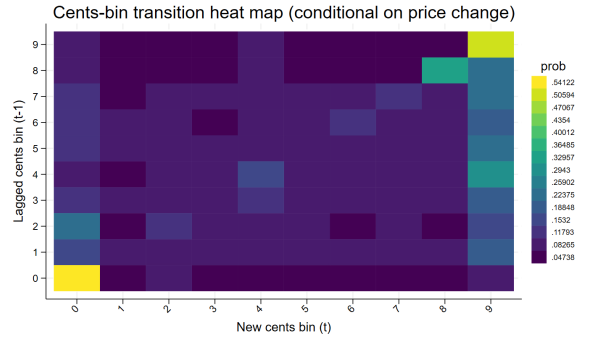
(a) Distribution of dollar-ending digits



(b) Distribution of cent-ending digits



(c) Transition matrix: dollar-ending digits



(d) Transition matrix: cent-ending digits

Figure 2. Price-ending distributions and transition matrices for U.S. multi-product retailers.

Notes: Panels (a) and (b) show the distribution of dollar-ending and cent-ending digits, respectively. Panels (c) and (d) report transition matrices between price endings across consecutive price observations.

Appendix additionally illustrates that the left-digit prices are more persistent because they change more discretely than non-left-digit prices.

Prevalence and persistence of nine-ending prices are not specific to the retailers in our sample but a common previously documented feature of retail markets (Levy et al., 2011; Knotek II, 2024; Strulov-Shlain, 2023). In the next section, we demonstrate its quantitative importance for the transmission of macroeconomic shocks to consumers.

4 Identification

4.1 Distributed lags model

Following the literature (Nakamura and Zerom, 2010; Cavallo et al., 2021), we estimate the short-run pass-through of cost shocks into retail prices using a distributed lags model.

The model relates monthly price changes to contemporaneous and lagged cost shocks, allowing retail prices to adjust gradually over time. Importantly, unlike the existing studies, we allow the response of retail prices to differ depending on whether a product in a given product category was priced at a left-digit price point (LDP) before the trade war.

Specification. We estimate the following specification of a distributed lag model:

$$\Delta \log p_{i,r,t} = \sum_{\ell=0}^L \beta_{\ell}^{\tau} \Delta \tau_{i,t-\ell} + \sum_{\ell=0}^L \gamma_{\ell}^{\tau} \left(\Delta \tau_{i,t-\ell} \times Price9_i \right) + \alpha^{\tau} Price9_i + \eta_{s(i)} + u_{i,r,t}, \quad (12)$$

where $\Delta \log p_{i,r,t}$ is the log change in the retail price of product i sold by retailer r in month t , and $\Delta \tau_{i,t}$ is the change in the tariff rate; $\eta_{s(i)}$ denote sector fixed effects (COICOP), and $u_{i,r,t}$ is an error term.

The left-digit pricing indicator, $Price9_i$, is defined using the last observed price of a product before the onset of the US-China trade war. For products without observed prices in the pre-trade-war period, it is based on the first observed price. $Price9_i = 1$ if the last pre-trade-war price or, in its absence, the first observed price ends in 9 in the dollar part or 9 or 9X in the cents part, and zero, otherwise. For products with observed pre-trade-war prices, this ensures that the left-digit indicator is not mechanically affected by the contemporaneous shock. We consider alternative definitions of left-digit pricing for robustness (see Appendix 5.4).

Interpretation. The coefficients in equation (12) trace out the dynamic response of retail prices to tariff shocks. The coefficients β_{ℓ}^{τ} capture the response of prices that do not follow left-digit pricing conventions, while the coefficients γ_{ℓ}^{τ} measure how this response differs for products priced at left-digit price points.

To summarize the overall effect of tariff shocks, we compute cumulative H -month pass-through rates for the two groups of prices:

$$PT_{\tau}^{\text{non-9}}(H) = \sum_{\ell=0}^{H-1} \beta_{\ell}^{\tau} \equiv \rho_{\tau}^{\text{non-9}}, \quad (13)$$

$$PT_{\tau}^9(H) = \sum_{\ell=0}^{H-1} (\beta_{\ell}^{\tau} + \gamma_{\ell}^{\tau}) \equiv \rho_{\tau}^9. \quad (14)$$

These cumulative coefficients over 12 periods measure the total pass-through of tariff shocks into retail prices over a one-year horizon for products without left-digit pricing

and for products priced at left-digit price points, respectively. The simple model in Section 2 predicts that $\rho_{\tau}^{\text{non-9}} > \rho_{\tau}^9$.

4.2 Difference-in-Differences

We use difference-in-difference identification strategy, to test two additional implications of our theoretical framework. First, we examine whether initially nine-ending prices are less likely to increase in response to tariffs, relative to non-nine-ending prices. For tariffed Chinese products, we consider price increases as changes relative to prices in the month before the tariffs go into effect. We use the month one year prior to the tariffs going into effect to establish the baseline rate of price increases, and then compare that rate to one year after the tariffs go into effect. Specifically, we estimate

$$\text{PriceIncrease}_{it} = \beta_1 \text{Price9}_i + \beta_2 \text{Post}_t + \beta_3 (\text{Price9}_i \times \text{Post}_t) + \lambda_{c(i)} + \varepsilon_i \quad (15)$$

Here, $\text{PriceIncrease}_{it}$ is a dummy variable equal to one when product i has a price that is lower than the price at $t - 1$ a year before the tariffs or higher than the price at $t - 1$ a year after the tariffs. Post_t is equal to one for prices observed one year after the tariffs hike, and zero for prices observed one year before the tariffs' hike. $\lambda_{c(i)}$ are COICOP fixed effects. The model predicts that initially nine-ending prices are less likely to increase in the post-trade-war period than non-nine-ending prices ($\beta_3 < 0$).

Secondly, we investigate how firms manage the increased costs of tariffs across their full portfolio of products. We treat the tariffs as a cost shock to the firm and examines how that cost shock impacts prices for products – both tariffed and non-tariffed – depending on the product's pre-tariff price ending. As suggested by our theoretical framework, we should expect to see greater price increases for non-nine-ending products in response to the tariff cost shock.

To measure this, we consider the effect of the tariffs on annual inflation at the product level. Our outcome variable of interest is

$$Y_{it} = 100 * \left(\frac{p_{it}}{p_{it-12}} - 1 \right)$$

This measure is interpretable as the percent change in the price from the previous year (Sangani, 2026). We winsorize this measure at the 1% level to reduce the impact of outliers.

Using the month before the first round of 2018 tariffs as the hold out month, we estimate the following regression specifications. The first examines products that were not

tariffed. This specification captures spillovers in firm pricing after the tariff cost shock.

$$Y_{it} = \beta_1 (\text{Price9}_i \times \text{Post}_t) + \alpha_i + \gamma_t + \varepsilon_{it} \quad (16)$$

where Y_{it} is the annualized inflation measure described above, i indexes products, and t indexes year-month. Price9_i is an indicator equal to one if the product had a nine-ending price in the month prior to the tariffs, and Post_t is an indicator equal to one in periods following the imposition of tariffs. α_i and γ_t are product and year-month fixed effects, respectively. The coefficient of interest, β_1 , captures the differential change in annualized inflation for nine-ending-priced products relative to other products after the tariff announcement. We cluster our standard errors at the COICOP level.

To examine whether the impact of treatment is stronger for tariffed products, we estimate

$$Y_{it} = \beta_1 (\text{Price9}_i \times \text{Post}_t) + \beta_2 (\text{Tariffed}_i \times \text{Post}_t) + \beta_3 (\text{Price9}_i \times \text{Tariffed}_i \times \text{Post}_t) + \alpha_i + \gamma_t + \varepsilon_{it} \quad (17)$$

which is similar to the above specification except that it is a triple difference specification that includes tariffed goods and Tariffed_i , an indicator equal to one if the product was from China and in an HS6 category affected by the tariffs.

For both specifications, we also estimate event studies which trace out the dynamic response of annualized inflation in each period relative to the tariff announcement. The event-study specification is

$$Y_{it} = \sum_{\substack{k=-K \\ k \neq -1}}^K \beta_k (\mathbb{1}[t - t_0 = k] \times \text{Price9}_i) + \alpha_i + \gamma_t + \varepsilon_{it} \quad (18)$$

where t_0 denotes the month of the first round of 2018 tariffs and k indexes time relative to t_0 in months. The indicator $\mathbb{1}[t - t_0 = k]$ equals one in the month that is k periods from the tariff announcement. We omit $k = -1$, the month immediately preceding the tariffs, as the reference period, so all coefficients β_k are interpreted as the differential change in annualized inflation for nine-ending products relative to other products, k months from treatment, relative to the omitted month prior to treatment. As before, α_i and γ_t are product and year-month fixed effects, and standard errors are clustered at the HS6 level.

The event-study specification for the triple difference that allows inflation to differ by tariff exposure is:

$$\begin{aligned}
Y_{it} = & \sum_{\substack{k=-K \\ k \neq -1}}^K \beta_k (\mathbb{1}[t - t_0 = k] \times \text{Price9}_i) + \sum_{\substack{k=-K \\ k \neq -1}}^K \gamma_k (\mathbb{1}[t - t_0 = k] \times \text{Tariffed}_i) \\
& + \sum_{\substack{k=-K \\ k \neq -1}}^K \delta_k (\mathbb{1}[t - t_0 = k] \times \text{Price9}_i \times \text{Tariffed}_i) + \alpha_i + \gamma_t + \varepsilon_{it}
\end{aligned} \tag{19}$$

where, as above, Tariffed_i indicates whether product i was sourced from China and fell within an HS6 category directly targeted by the tariffs. The coefficients of interest are δ_k , which trace out the differential evolution of the nine-ending price effect specifically among tariffed products, relative to the omitted month $k = -1$. We again cluster standard errors at the HS6 level.

The tariffs were implemented in waves, with the first three waves in consecutive months from July to September of 2018. In May of 2019, the tariffs implemented in September of 2018 were increased from 10 to 25%. To avoid possible contamination by the later tariff increase, we limit our post period to ending before the May 2019 increase.

5 Results

5.1 Heterogeneous pass-through of import tariffs into retail prices

We begin by replicating the benchmark analysis of [Cavallo et al. \(2021\)](#), who estimate the pass-through of the 2018–19 U.S. tariffs on Chinese imports into retail prices. In Table 1, column (1) shows that, after one year, a 10 pp tariff increase raises retail prices by approximately 0.35% within a COICOP category. However, we show that this low average pass-through masks substantial heterogeneity by initial price ending. Column (2) shows that, within a COICOP category, a 10 pp tariff increase raises non-nine-ending prices by approximately 0.75% but nine-ending prices by only 0.16%. The latter estimate is economically small and statistically indistinguishable from zero. The difference of approximately 0.56 percentage points is marginally significant.

Importantly, we further show that both the average pass-through and pass-through heterogeneity by initial price ending vary across the two retailers. Column (3) reports that, after one year, retailer 1, increases its prices by 1% in response to a 10 pp tariff increase in a COICOP category. This is three time larger than the aggregate passthrough estimated in the pooled sample. Moreover, Retailer 1 increases prices of products with

Table 1. Tariff Pass-Through and Nine-Ending Prices

	Pooled		Retailer 1		Retailer 2		Retailer 2 (direct)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1-Y PT (all prices)	0.035*		0.107***		0.007		0.158*	
	(0.021)		(0.029)		(0.027)		(0.091)	
1-Y PT (non-9)		0.075**		0.195***		0.034		0.368*
		(0.031)		(0.039)		(0.040)		(0.203)
1-Y PT (9)		0.016		0.074**		-0.006		0.086
		(0.023)		(0.034)		(0.030)		(0.095)
Δ (9 – non-9)		-0.059*		-0.121***		-0.040		-0.282
		(0.033)		(0.046)		(0.042)		(0.218)
COICOP FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Direct imports only	No	No	No	No	No	No	Yes	Yes
Observations	1,118,870	1,118,870	422,490	422,490	696,380	696,380	72,762	72,762
R^2	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.005

Notes: Table 1 reports the estimates of one year cumulative tariff pass-through within COICOP product categories. For each group, the first column reports pass-through pooling all prices; the second column allows pass-through to differ by whether the product's last pre-trade-war price was nine-ending. Columns (7)–(8) restrict Retailer 2 to direct imports. Heteroskedasticity-robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

initially non-nine-ending prices by 1.95%, while prices of products initially prices at nine-endings increase by only 0.74%. The difference of 0.12 pp is both economically and statistically significant. In Table A1, we show that these findings remain when more granular HS6-Country fixed effects and initial price level controls are used to account for characteristics of products with nine- and non-ending prices.

In contrast, Retailer 2 exhibits little pass-through in the full sample uniformly across initial price endings. Columns (3) and (4) report aggregate and price-ending-specific pass-through rates close to zero. One possible explanation is that Retailer 2 sources a large share of its products indirectly through intermediaries, attenuating its direct exposure to the tariff increases.³ Consistent with this interpretation, pass-through is substantially higher among Retailer 2's products identified as direct imports. Column (7) implies that a 10 pp tariff increase raises their prices by 1.6%. The direct-import pass-through estimates also display the same price-ending heterogeneity as Retailer 1. Column (8) reports pass-through of 3.7% into non-nine-ending prices, compared with 0.9% into nine-ending prices. The differences of 2.8 pp is economically large but imprecisely estimated, reflecting the much smaller direct-import sample.

³This interpretation is in line with evidence that wholesale and distribution margins shape the transmission of tariffs along supply chains (Flaen et al., 2025) and with models in which direct and indirect importing entail different costs and pricing incentives (Raff and Schmitt, 2012; Ganapati, 2025).

5.2 Price Increases

Here, we investigate whether lower tariff pass-through into initially nine-ending prices can be explained by their lower likelihood of a price increase. Table 2 presents the results of estimating equation 15 in the overall sample and each relevant subsample from Table 1. Consistent with our findings above, 9-ending prices are less likely to be increased than non-9-ending prices. In the pooled specification, 9-ending prices are about .29 pp less likely to increase 1 year after the tariffs. This comes from a pre-period gap in the likelihood of increase that widens in the post period. However, there is substantial heterogeneity by retailer consistent with our pass-through results above. For Retailer 1 and direct imports for Retailer 2, which show the largest pass-through gap above, 9-ending prices are substantially less likely to increase in the post period. Prices are 7.7 pp and 6.1 pp less likely to have increased. Retailer 2 in the full sample also is less likely to increase 9-ending prices by .007 pp, though this is mostly coming from a pre-period tendency to increase 9-ending prices less.

Table 2. Price increase likelihood 1 year prior to and after the tariffs

	Pooled	Retailer 1	Retailer 2	Retailer 2 (direct)
9-ending (pre-period gap)	−0.013** (0.005)	0.019** (0.008)	−0.031*** (0.007)	−0.007 (0.017)
Post period	0.109*** (0.006)	0.174*** (0.010)	0.075*** (0.007)	0.145*** (0.019)
9-ending × Post	−0.016* (0.009)	−0.096*** (0.014)	0.024** (0.011)	−0.054** (0.025)
Observations	37 019	13 378	23 641	4976

Notes: Table 2 shows the likelihood a product increases in price relative to the month prior to the tariffs comparing one year prior to one year after the tariffs go into effect. Column one shows the pooled sample, column two shows the results for retailer one, column three shows the results for retailer two, and column four shows the results for retailer 2's direct imports. Robust Standard errors are shown in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Products are substantially more likely to increase in price after the tariffs go into effect. However, consistent with our theoretical framework, firms are less likely to increase nine-ending prices after the tariffs go into effect. These results provide suggestive evidence that firms are constrained from imposing price increases on tariffed goods by their nine-ending pricing strategies.

5.3 Spillovers to non-tariffed products

The previous section shows that, for tariffed products, firms pass through more of the tariff to the prices of non-nine-ending goods than nine-ending goods. We next consider whether nine endings have an effect on inflation of prices for both tariffed and non-tariffed goods. One possible way for firms to offset the costs associated with tariffs is to pass through those costs to goods that are not tariffed. Our previous evidence suggests this will be more likely for goods that do not have nine-ending prices.

Descriptively, inflation increases following the tariffs with inflation rising from $-.21\%$ to $.83\%$ in annual terms among Chinese products. Table 3 shows our simple difference-in-differences specification. Among Chinese products, we estimate that non-tariffed products with nine-ending prices before the tariffs went into effect have an annual inflation rate that is 2.58 pp lower than non-nine-ending products. Expanding the data to compare tariffed and non-tariffed products, we show there is no significant difference in annual inflation between tariffed and non-tariffed products. We replicate these findings including products from all countries with nine-ending products having .855 pp lower annual inflation, and again observe no significant difference between tariffed and non-tariffed products. Appendix Figure A5 shows event study specifications. The parallel trends assumption for the difference in difference specification appears defensible, and the effects are immediately and persistently negative after the tariffs are introduced. Consistent with Table 3, the event studies for the triple difference are more mixed.

Table 3. Difference in differences analysis of the impact of the tariffs on nine-ending vs. non-nine-ending price annual inflation.

	(1) China DiD	(2) China DDD	(3) All DiD	(4) All DDD
Post $\times$ 9-ending	-2.580*** (0.871)	-2.584*** (0.867)	-0.856* (0.503)	-0.855* (0.505)
Post $\times$ Tariffed		-0.933* (0.549)		0.325 (0.226)
Post $\times$ 9-ending $\times$ Tariffed		0.906 (0.766)		-0.823** (0.332)
Observations	46 812	308 952	429 731	691 871

Notes: Table 3 shows the percentage point change in inflation over a preceding year: $(p_t/p_{t-12} - 1) \times 100$. Column one shows the our simple difference in difference estimates for only Chinese products that were not tariffed, column two shows our triple difference estimates for only Chinese products, column three shows the simple difference in difference estimates for products from all countries that were not tariffed, and column four shows the triple difference estimates for products from all countries. All models include product and month fixed effects. Nine-ending status is fixed at last pre-tariff observation. Standard errors clustered by COICOP are shown in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Our results suggest that firms pass through the costs of the tariffs into prices for non-tariffed goods. However, consistent with our theoretical framework, they do so significantly more for products whose pre-tariff prices are not nine-ending. As a result, inflation is over percentage point higher for non-nine-ending products. Firms can pass on the cost shocks of tariffs into both tariffed and non-tariffed goods, but are constrained by the elasticities around nine-ending prices.

5.4 Robustness and External validity

Now we discuss the robustness of our findings to alternative definitions of left-digit pricing, alternative definitions of the pre-period price used to classify products, and alternative sources of cost shocks.

Alternative definitions of left-digit pricing. Our baseline specification classifies a product as left-digit priced if its last pre-trade-war price either ends in the digit 9 in the dollar position or has a cents component ending in 9 (including prices with cents values above 90). While this definition captures the broad set of psychologically salient price endings in retail markets, different forms of left-digit pricing may have different economic effects.

Table A2 separately considers products whose dollar digit ends in 9 and products whose cents component ends in 9 or lies above 90 cents. Columns (1)–(2) classify products solely according to whether the dollar digit ends in 9. Under the preferred specification with HS6-country fixed effects, a 10 pp tariff increase raises non-9 prices by 1.67% but dollar-9 prices by only 0.42% after one year, implying a statistically significant difference of 1.25 pp. Columns (3)–(4) instead classify products according to whether the cents component ends in 9 or exceeds 90 cents. Under this definition, pass-through estimates for nine-ending and non-nine-ending prices are very similar, and the difference is not statistically significant.

A natural explanation is that many prices with left-digit cent endings also have a dollar digit ending in 9. To isolate the independent role of cent endings, columns (5)–(6) restrict the sample to products whose dollar digit does not end in 9. Within this subsample, products with cents endings of 9 or above 90 cents exhibit substantially lower pass-through than comparable products without such endings. Under the HS6-country specification, a 10 pp tariff increase raises non-nine prices by 2.35% but prices with salient cent endings by only 1.16%, implying a statistically significant difference of 1.18 pp.

Alternative identification strategy. Our baseline analysis defines left-digit pricing using the last observed price before the trade-war period. This has the advantage of fixing product status before the tariff shock, but it treats left-digit status as time-invariant throughout the distributed-lag window. As an additional robustness check, we allow left-digit status to vary over time while ensuring that it remains predetermined with respect to each tariff change entering the regression. For that, we include interactions of tariff change at time $t - \ell$, with the left-digit price status at time $t - \ell - 1$, in the distributed lags model in (12), as described in Online Appendix A.5.

Table A3 reports the results. Columns (1)–(4) replicates benchmark pass-through estimates without interactions. Columns (5)–(8) introduce interactions between tariff changes and the lagged left-digit pricing indicator. Across all specifications, pass-through remains lower for products whose prices were located at a left-digit threshold immediately prior to the tariff shock. Under the preferred specification with HS6-country fixed effects, a 10 pp tariff increase raises non-9 prices by approximately 1.8% after one year, compared with only 0.7% for nine-ending prices, implying a statistically significant difference of 1.1 pp (column (7)). The corresponding estimate in the specification with additional price-decade controls is 1.0 pp (column (8)).

Relative to the baseline results, the estimated pass-through differences are somewhat smaller but remain economically large and statistically significant. This suggests that the

lower pass-through of tariffs into left-digit prices is not driven by the particular choice of the last pre-trade-war price used to classify products. Instead, the results continue to hold when left-digit status is defined dynamically using the predetermined price observed immediately before each tariff change.

External validity. To assess whether our findings generalize beyond U.S. tariff shocks and U.S. retailers, we examine exchange rate pass-through into IKEA’s global retail prices observed in [Cavallo et al. \(2014\)](#). A key advantage of this setting is that we observe the same product (identified by a barcode) across multiple countries, allowing us to control for detailed product characteristics and isolate within-product price variation.

We assume that most of IKEA’s input costs are denominated in U.S. dollars, so that movements in the local currency-to-USD exchange rate constitute a relevant cost shock. This assumption is consistent with U.S. dollar as a dominant invoicing currency ([Gopinath et al., 2020,0](#); [Gopinath and Itskhoki, 2022](#)). As a result, exchange rate fluctuations against the U.S. dollar are likely to affect input costs independently of local demand conditions, providing a source of exogenous variation for the empirical analysis.

Table [A4](#) reports 1-year cumulative exchange-rate pass-through (ERPT) estimates from a distributed lag model similar to [\(12\)](#), as discussed in Online Appendix [A.6](#). In columns (1) – (3), we progressively add fixed effects, starting with only country and month-year fixed effects, then adding item fixed effects, and finally using country-item fixed effects. Across these specifications, we find substantial pass-through for non-nine-ending prices, with estimates ranging from 0.22 to 0.26. In contrast, pass-through for products with initially nine-ending prices is systematically lower. The difference between pass-through into initially 9- and non-nine-ending prices in columns (1) - (3) range from -0.05 to -0.10 . This differences is statistically and economically significant, and holds across alternative definitions of left-digit prices, as shown in columns (4) - (6).

These results closely mirror our findings for tariff pass-through: prices that are not constrained by left-digit pricing adjust more strongly to cost shocks, while nine-ending prices exhibit attenuated responses. This suggests that the role of left-digit pricing in shaping pass-through is not specific to U.S. trade policy or a particular retailer but reflects a more general feature of firm’s price adjustment behavior.

6 Conclusions

Behavioral pricing conventions shape the pass-through of global cost shocks into retail prices. Using micro-level data from the U.S.–China trade war, we find that tariffs

are transmitted primarily through products without nine-ending prices, while products priced at salient left-digit thresholds exhibit substantially lower pass-through. These differences arise mainly because nine-ending prices are less likely to increase following cost shocks. Nine-ending products show less annual inflation, even among those categories that are not tariffed.

Our results imply that psychological pricing is not only a marketing strategy, but also an important determinant of policy incidence and inflation dynamics. Behavioral pricing frictions dampen and delay the transmission of tariffs into consumer prices. This shifts part of the burden of cost shocks onto firms. More broadly, firms may use fewer 9-ending prices to provide greater flexibility in changing prices over time ([Strulov-Shlain, 2023](#)).

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A Online Appendix

A.1 Left-digit pricing across broad product categories

Figure A1 shows that left-digit pricing is a common feature of most product categories. It plots shares of left-digit prices and shares of observations across 25 COICOP product categories observed in U.S. retail price data from Cavallo et al. (2021). Such prices are less often used in pricing of food products, drinks, and vegetables ($\approx 15\%$) that have been the focus of the behavioral literature, and are more often used in pricing of clothes, electronics and furniture (30-40%).

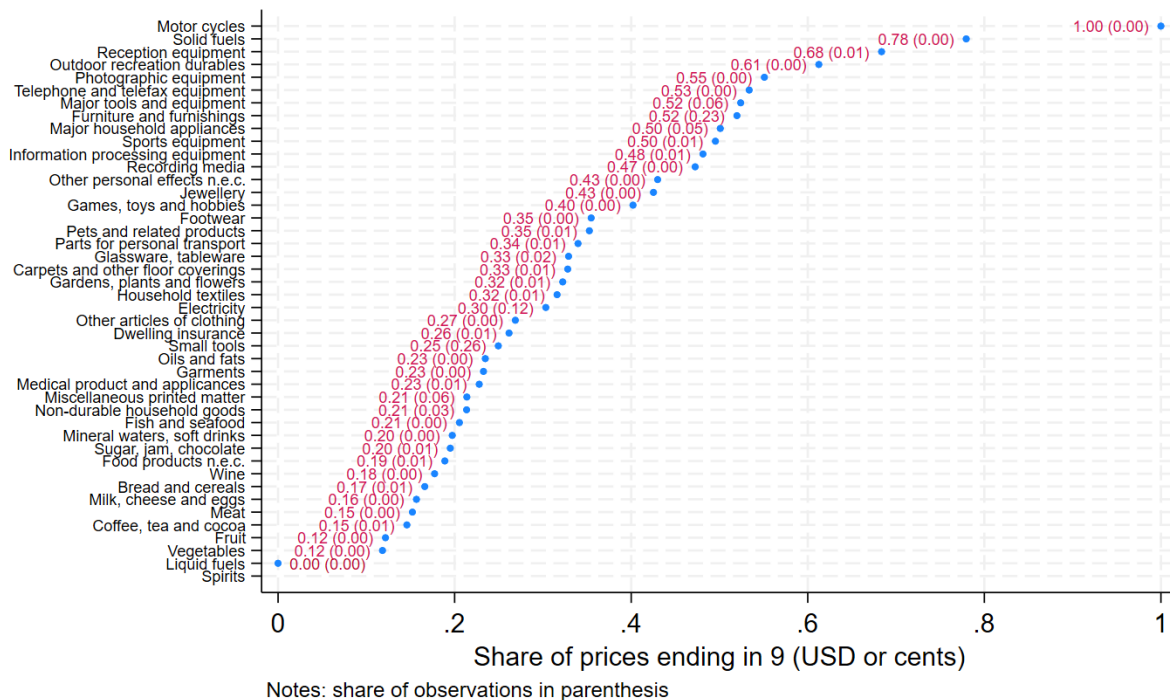


Figure A1. Heterogeneity in left-digit pricing across product categories

Notes: The figure reports the share of products classified as left-digit priced across COICOP product categories. A left-digit price is a price ending in 9 either in the dollar digit or in the cent digits (9X or X9). Blue markers indicate the share of left-digit prices within each category. Numbers in parentheses report the category's share of observations in the sample.

Figure A2 further illustrates differences in characteristics of products with nine-ending prices relative to non-nine-ending prices in the pre-trade-war period. Within broad COICOP product categories, left-digit priced products are much more expensive and adjust more frequently. Comparing prices by price ending within progressively more dis-

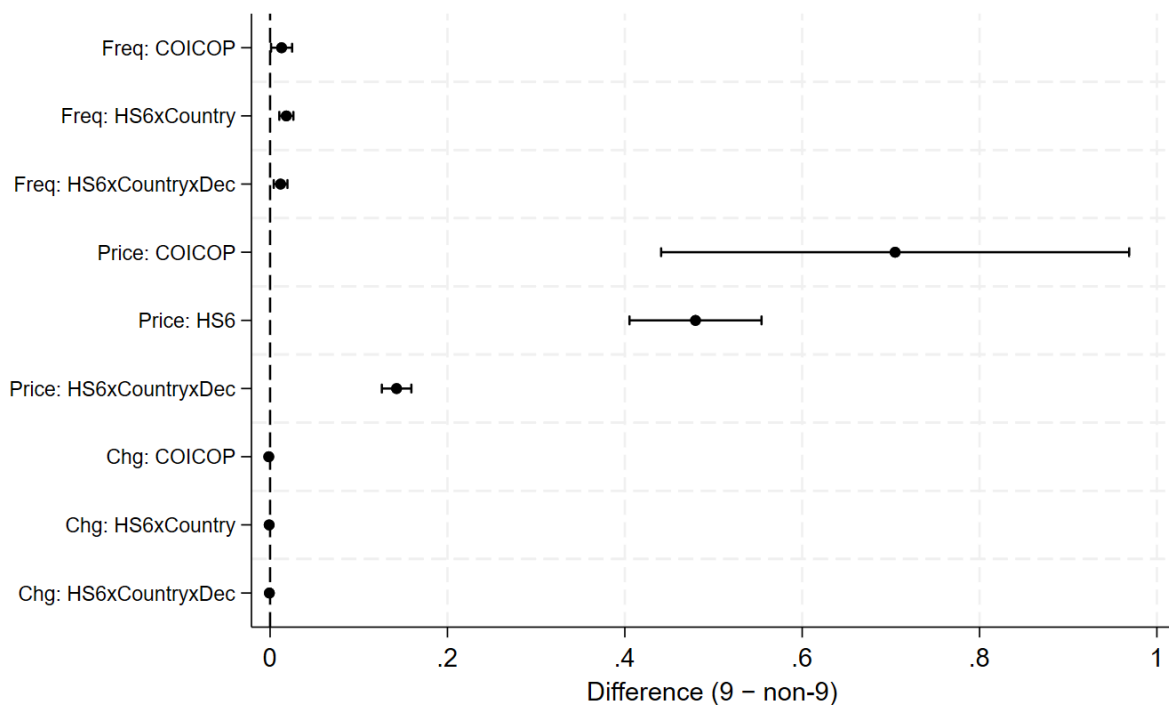


Figure A2. Pre-trade-war differences in characteristics of products with nine-ending and non-nine-ending prices.

Notes: This figure reports differences in pre-period characteristics between products with nine-ending and non-nine-ending prices. Each point corresponds to a regression coefficient from specifications that compare products within narrowly defined categories. The horizontal axis shows the estimated difference, with bars indicating 95% confidence intervals.

aggregated HS6, HS6-Country, and HS6-Country-Price-decades makes price differences between them much smaller.

A.2 Prevalence and persistence of left-digit prices

Figure A3 illustrates the joint distribution of the last dollar digit and the cent-ending bin for prices observed in the retail scanner data. The heatmap displays the probability of observing a given last-dollar digit conditional on the cent-ending bin. Several patterns emerge. First, prices ending in the 90–99 cent range are substantially more likely to have a last-dollar digit of 9 than any other cent bin. The highest concentration in the distribution occurs at the combination of a nine-ending dollar digit and a 90–99 cent ending, corresponding to prices such as \$9.99, \$19.99, and \$29.99. Second, for most cent bins, observations are distributed across a wider range of last-dollar digits. These patterns suggest that dollar-ending and cent-ending left-digit prices are closely related

but not identical pricing strategies, motivating the robustness checks that distinguish between these alternative definitions.

Figure A4 shows that although in line with [Conlon and Rao \(2020\)](#) all price changes are often discrete, they are more discrete for initially nine-ending rather than non-nine-ending prices. It plots the distributions of price changes, in US\$, from initially 9- and non-nine-ending prices. The distribution for the initially nine-ending prices exhibits visual spikes at 10 US\$ increments, while the initially non-nine-ending prices exhibit a much smoother distribution of price changes.

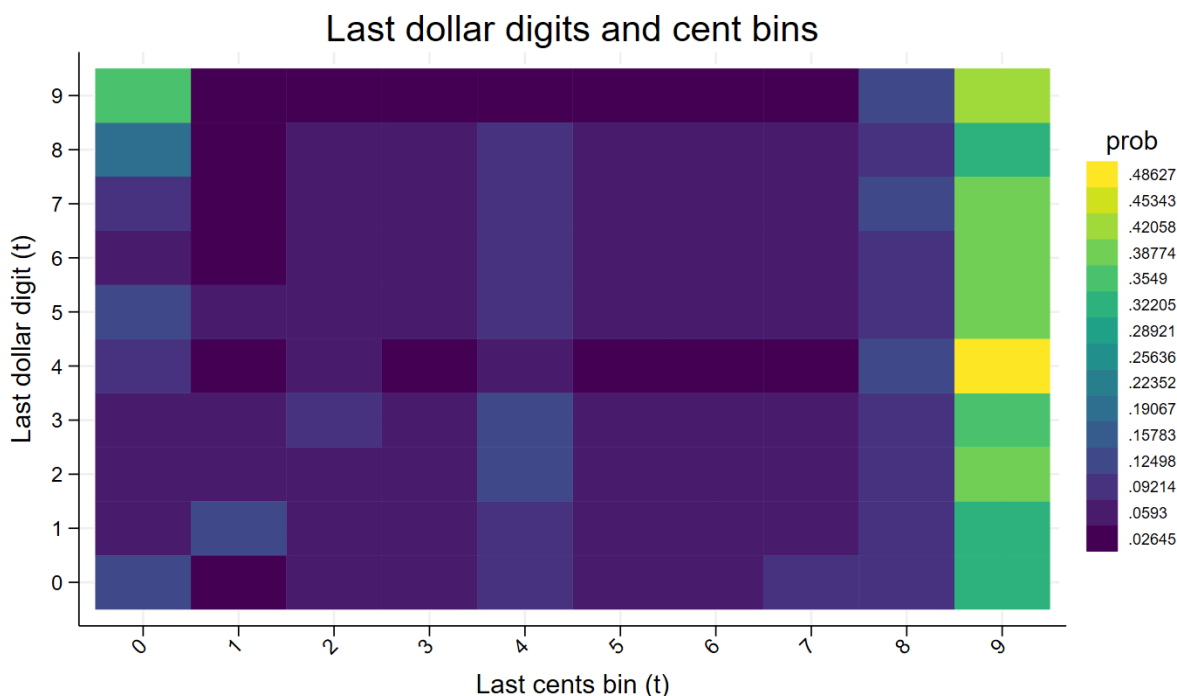


Figure A3. Bunching of prices at nine-ending dollar digits and 9X-ending cents digits

Notes: The figure reports the joint distribution of price endings in the pre-trade-war sample. Rows correspond to the last digit of the dollar component of the price, while columns correspond to cent-ending bins. Cell colors indicate the share of observations associated with each combination. Darker cells represent more common price endings. The concentration of observations in the upper-right corner reflects the prevalence of prices ending in both a dollar digit of 9 and cents between 90 and 99.

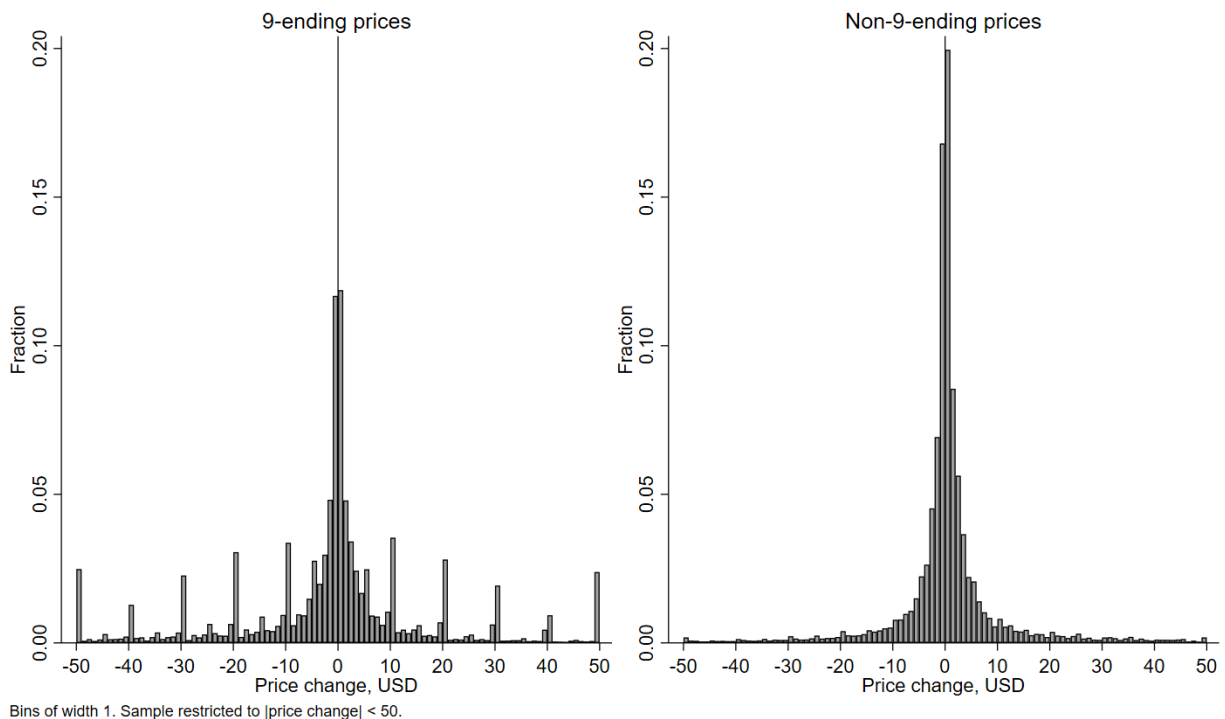


Figure A4. Price changes are more discrete for initially 9- than non-nine-ending prices

Notes: The figure plots the distribution of price changes conditional on a price adjustment. The left panel shows products whose initial price was nine-ending, while the right panel shows products whose initial price was not nine-ending. Price changes are measured in U.S. dollars and restricted to changes smaller than \$50 in absolute value. The pronounced spikes at round-number increments for initially nine-ending prices indicate greater discreteness of price adjustment among left-digit prices.

A.3 Alternative fixed effects

We show that the results presented in Table 1 are robust to using more granular fixed effects to absorb differences in products with initially nine- and non-nine ending prices. We use a subsample of products sold by Retailer 1. Unlike Retailer 2, Retailer 1 also reports more disaggregated (than COICOP categories) 6-digit Harmonized systems (HS6) classification codes and countries of origin for all its products.

Table A1 presents the estimates of one-year cumulative tariff pass-through under progressively more granular fixed effects available for Retailer 1. Column (1) shows that, within HS6 product categories, a 10 pp tariff increase raises retail prices by 1.05% after one year. This is close to the COICOP-FE estimate for Retailer 1 reported in column (3) of Table 1 (1.07%). Columns (3) and (5) show the same is true when further narrowing fixed effects to HS6-country cells and controlling for the last pre-trade-ward price decade of a

product. The benchmark estimate is stable at around 1% across all specifications.

Importantly, the heterogeneity of pass-through by initial price ending also survives this tightening of fixed effects essentially unchanged. Under HS6 fixed effects (column 2), a 10 pp tariff increase raises non-nine-ending prices by 2.06%, compared with 0.64% for nine-ending prices — a statistically significant difference of 1.42 pp. Moving to HS6-country fixed effects (column 4) leaves the gap slightly larger, at 1.66 pp (2.20% versus 0.54%). This estimate is essentially unaffected by the further inclusion of initial price-decade fixed effects in column (6). Across all specifications, pass-through into non-nine-ending prices remains three to four times as large as pass-through into nine-ending prices.

These results indicate that the muted pass-through of nine-ending prices documented in Table 1 is not an artifact of unobserved heterogeneity absorbed by coarser COICOP categories: the same pattern, of similar magnitude, emerges when comparing products within much narrower HS6-country cells and after controlling for the initial price level of the product.

Table A1. Tariff Pass-Through and Nine-Ending Prices: Retailer 1, Alternative Fixed Effects

	Benchmark	By price ending	Benchmark	By price ending	Benchmark	By price ending
	(1)	(2)	(3)	(4)	(5)	(6)
1-Y PT (all prices)	0.105*** (0.031)		0.102*** (0.032)		0.102*** (0.032)	
1-Y PT (non-9)		0.206*** (0.041)		0.220*** (0.042)		0.220*** (0.042)
1-Y PT (9)		0.064* (0.036)		0.054 (0.037)		0.055 (0.038)
Δ (9 – non-9)		-0.142*** (0.047)		-0.166*** (0.048)		-0.165*** (0.049)
HS6 FE	Yes	Yes	No	No	No	No
HS6–Country FE	No	No	Yes	Yes	Yes	Yes
Price-decade FE	No	No	No	No	Yes	Yes
Observations	422,474	422,474	401,002	401,002	400,986	400,986
R^2	0.005	0.005	0.007	0.007	0.007	0.007

Notes: The dependent variable is the monthly change in log price. Cumulative (1-year) tariff pass-through is the sum of the contemporaneous tariff coefficient and its eleven monthly lags. Sample restricted to Retailer 1. For each specification, the first column reports pass-through pooling all prices; the second column allows pass-through to differ by whether the product's last pre-trade-war price was nine-ending. Columns (5)–(6) additionally include fixed effects for the decade of the last pre-trade-war price. Heteroskedasticity-robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A.4 Alternative definitions of left-digit pricing

Table A2 examines the robustness of the tariff pass-through results to alternative definitions of left-digit pricing. We separately estimate specification (12) under three alternative definitions: (i) prices with a dollar component ending in 9 (Dollar-9), (ii) prices with a cent component ending with 9 or in the 90–99 cent range (Cents-9X), and (iii) prices in (ii) excluding those with a dollar component ending in 9 (Cents-9X, Dollar-9=0).

The results indicate that the lower pass-through of left-digit prices is not driven by the particular definition used, although the strength of the effect varies across definitions. Under the Dollar-9 definition, the estimated one-year pass-through is 16.7% for non-9 prices and 4.2% for Dollar-9 prices in the HS6-country specification (column 2), implying a statistically significant difference of 12.5 percentage points. A similarly large differential emerges when focusing on cent-based thresholds while excluding Dollar-9 observations. As shown in column 6 of Table A2, pass-through falls from 23.5% for non-left-digit prices to 11.6% for Cents-9X prices, corresponding to a statistically significant difference of 11.8 percentage points. By contrast, the broad Cents-9X definition produces little evidence of differential pass-through. In the HS6-country specification reported in column 4 of Table A2, pass-through equals 10.8% for non-9 prices and 9.7% for Cents-9X prices, yielding a small and statistically insignificant difference of only 1.1 percentage points.

Overall, the results in Table A2 suggest that the strongest evidence of reduced pass-through is associated with prices featuring a salient dollar-ending digit. At the same time, the significant estimates obtained for the Cents-9X definition after excluding Dollar-9 observations indicate that cent-based thresholds can also contribute to pricing rigidity. These findings support the broader conclusion that psychologically salient price endings reduce the transmission of tariff-induced cost shocks into retail prices.

	Dollar-9		Cents-9X		Cents-9X, Dollar-9=0	
	(1)	(2)	(3)	(4)	(5)	(6)
1-year PT (non-9)	0.046** (0.023)	0.167*** (0.036)	0.051* (0.027)	0.108*** (0.038)	0.076** (0.032)	0.235*** (0.044)
1-year PT (9)	0.017. (0.031)	0.042. (0.045)	0.019. (0.025)	0.097** (0.044)	0.021. (0.031)	0.116** (0.056)
Δ (9 – non-9)	-0.029. (0.034)	-0.125** (0.049)	-0.033. (0.032)	-0.011. (0.050)	-0.054. (0.038)	-0.118* (0.063)
COICOP FE	Yes	No	Yes	No	Yes	No
HS6-Country FE	No	Yes	No	Yes	No	Yes
Pre-trade-war prices	No	Yes	No	Yes	No	Yes
Observations	1,118,870	401,002	1,118,870	401,002	792,327	252,865
R-squared	0.001	0.007	0.001	0.007	0.001	0.010

Robust standard errors in parentheses.

Table A2. Robustness of tariff pass-through to alternative left-digit pricing definitions

Notes: The table reports one-year tariff pass-through estimates from the distributed-lag model in (12). Pass-through is allowed to differ according to alternative definitions of left-digit pricing status. In columns (1)–(2), a price is classified as nine-ending if either the dollar digit equals 9 or the cent digits end in 9X or X9. In columns (3)–(4), a price is classified as nine-ending only if the cent digits end in 9X or X9. In columns (5)–(6), the same cent-digit definition is used, but observations with a dollar digit equal to 9 are excluded. “1-Y PT” denotes the cumulative pass-through of a tariff change after one year. “ Δ (9 – non-9)” reports the difference in pass-through between nine-ending and non-nine-ending prices. Columns (2), (4), and (6) are estimated on the sample of products with observed pre-trade-war prices, and price-ending status is determined using the last observed pre-trade-war price. Robust standard errors are reported in parentheses. Stars (*, **, ***) indicate significance at the 10%, 5%, and 1% levels.

A.5 Alternative identification strategy

Here, we show that our findings are robust to an alternative identification strategy. Instead of using a time-invariant pre-determined left-digit price status, we use a time-varying left-digit price status lagged relative to each tariff change. Specifically, instead of equation (12), we estimate the following distributed lags model:

$$\Delta \log p_{i,r,t} = \sum_{\ell=0}^L \beta_{\ell}^{\tau} \Delta \tau_{i,t-\ell} + \sum_{\ell=0}^L \alpha_{\ell}^{\tau} Price9_{i,t-\ell-1} + \sum_{\ell=0}^L \gamma_{\ell}^{\tau} \left(\Delta \tau_{i,t-\ell} \times Price9_{i,t-\ell-1} \right) + \eta_s + u_{i,r,t}, \quad (20)$$

where $\Delta \log p_{i,r,t}$ is the log change in the retail price of product i sold by retailer r in month t , and $\Delta \tau_{i,t}$ denotes the log change in the tariff rate applied on this product. The term $\eta_{s(i)}$ denotes sector fixed effects (COICOP), and $u_{i,r,t}$ is an error term. Using estimates of β_ℓ^τ and γ_ℓ^τ , we compute 1-year import tariff pass-through into 9- and non-nine-ending prices, as shown in expressions (13)-(14).

Table A3 presents the results of estimating 1-year passthrough into 9- and non-nine-ending prices within a product category, using this alternative identification strategy. The benchmark pass-through estimates reported in columns (1)–(4) are similar to those obtained in the main specification. One-year tariff pass-through ranges from 3.7% in the broad COICOP specification to 11.5% in the specification with HS6-country and lagged price-decade fixed effects.

Columns (5)–(8) interact tariff changes with the dynamically defined left-digit pricing indicator. Across all specifications, tariff pass-through is lower for products that were priced at a left-digit threshold immediately before the tariff change. In the specification with HS6-country fixed effects (column 7), the estimated one-year pass-through equals 18.8% for non-left-digit prices but only 7.8% for left-digit prices, implying a statistically significant difference of 11.1 percentage points. The result remains virtually unchanged after controlling for lagged price-decade fixed effects (column 8), where the corresponding differential is 10.7 percentage points.

The estimates are also economically meaningful in the broader COICOP specifications. In column (5), pass-through for non-left-digit prices is 8.3%, while pass-through for left-digit prices is statistically indistinguishable from zero, producing a differential of 8.5 percentage points. Although the difference becomes smaller and statistically insignificant when restricting attention to the common pre-trade-war sample (column 6), the point estimate remains negative.

Overall, the results in Table A3 closely mirror those obtained using the baseline pre-trade-war classification of left-digit prices.

	Benchmark				Dynamic Price9 interaction			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1-Y PT (all prices)	0.037* (0.021)	0.057*** (0.021)	0.111*** (0.032)	0.115*** (0.033)				
1-Y PT (non-9)					0.083*** (0.030)	0.076** (0.031)	0.188*** (0.042)	0.190*** (0.042)
1-Y PT (nine-ending)					-0.002. (0.024)	0.034. (0.024)	0.078** (0.039)	0.083** (0.039)
Δ (9 – non-9)					-0.085** (0.034)	-0.041. (0.035)	-0.111** (0.049)	-0.107** (0.050)
COICOP FE	Yes	Yes	No	No	Yes	Yes	No	No
Common pre-war sample	No	Yes	Yes	Yes	No	Yes	Yes	Yes
HS6×Country FE	No	No	Yes	Yes	No	No	Yes	Yes
Lagged price decade FE	No	No	No	Yes	No	No	No	Yes
Observations	1,082,302	1,037,863	389,964	388,310	1,082,302	1,037,863	389,964	388,310
R-squared	0.001	0.001	0.007	0.007	0.002	0.001	0.008	0.009

Robust standard errors in parentheses.

Columns (2)–(4) and (6)–(8) are estimated on the common sample of products with observed pre-trade-war prices.

Stars (*, **, ***) indicate significance at the 10%, 5%, and 1% levels.

Table A3. Tariff pass-through with dynamically defined left-digit pricing indicator

Notes: The table reports one-year tariff pass-through estimates from the distributed-lag model in (20). Columns (1)–(4) report benchmark pass-through estimates pooling all prices. Columns (5)–(8) allow pass-through to differ according to a dynamically defined left-digit pricing (Price9) indicator. A price is classified as a nine-ending price if, immediately prior to a tariff change, its last observed price ended in 9 or 9/9X in either the dollar or cent digit. “1-Y PT” denotes the cumulative pass-through of a tariff change after one year. “ Δ (9 – non-9)” reports the difference in pass-through between nine-ending and non-nine-ending prices. Columns (2)–(4) and (6)–(8) are estimated on the sample of products with observed pre-trade-war prices. Robust standard errors are reported in parentheses. Stars (*, **, ***) indicate significance at the 10%, 5%, and 1% levels.

A.6 Exchange rate passthrough into IKEA’s retail prices

To show that our results hold more generally, we estimate exchange-rate pass-through into IKEA’s global retail prices collected by (Cavallo et al., 2014). We assume that as a large multinational retailer, IKEA uses US Dollar as the currency of payments for its inputs, in line with the dominant currency paradigm (Gopinath et al., 2020; Gopinath and Itskhoki, 2022). Then we treat an appreciation of the destination currency relative to US dollar as a retailer’s cost shock and study its propagation to retail prices.

We use a distributed lags model similar to (12) as our baseline exchange-rate pass-

through (ERPT) specification:

$$\Delta \log p_{i,c,t} = \sum_{\ell=0}^L \beta_{\ell} \Delta \log E_{c,t-\ell} + \alpha Price9_{i,c} + \sum_{\ell=0}^L \gamma_{\ell} \left(\Delta \log E_{c,t-1} \times Price9_{i,c} \right) + FE + \varepsilon_{i,c,t}, \quad (21)$$

where $\Delta \log E_{c,t}$ denote the monthly log change in the destination currency per USD exchange rate, and FE is a set of fixed effects. Since in this dataset we observe the same retailer selling identical products with the same barcode to different countries, we can experiment with various fixed effects: for country of destination, month of the year, and even bar-code and bar-code-country. The LDP status, $Price9_{i,c}$ is based on the first observed price for each barcode-country.

The coefficient β_{ℓ} captures the response for non-nine-ending prices; $\beta_{\ell} + \gamma_{\ell}$ captures the response for nine-ending prices. The cumulative H -month exchange rate pass-through (e.g., $H = 12$ months) is the sum of distributed-lag coefficients:

$$ERPT^{\text{non-9}}(H) = \sum_{\ell=0}^{H-1} \beta_{\ell} \equiv \rho_E^{\text{non-9}}, \quad (22)$$

$$ERPT^9(H) = \sum_{\ell=0}^{H-1} (\beta_{\ell} + \gamma_{\ell}) \equiv \rho_E^{\text{non-9}}. \quad (23)$$

Similarly to the cumulative tariff pass-through in (13)-(14), we expect $\rho_E^{\text{non-9}} > \rho_E^9$.

Table A4 presents the results of estimating 1-year exchange-rate passthrough (ERPT) into IKEA's retail prices. They reveal substantial heterogeneity across initially 9- and non-nine-ending prices even within the same bar-code. Across specifications, the one-year exchange-rate pass-through (ERPT) for non-left-digit prices ranges between 16.5% and 30.8%, depending on the fixed effects structure and the definition of left-digit pricing. By contrast, pass-through into left-digit prices is consistently lower, ranging between 11.6% and 26.3%.

Columns (1)–(3) report results using the baseline definition of left-digit pricing, where a price is classified as left-digit if either the dollar component ends in 9 or the cent component falls in the 90–99 cent range. Across all three specifications, exchange-rate pass-through is significantly lower for left-digit prices. In the most demanding specification with country-item fixed effects (column 3), the one-year pass-through equals 26.3% for non-left-digit prices but only 16.8% for left-digit prices, implying a statistically significant difference of 9.6 percentage points.

Columns (4)–(6) explore alternative definitions of left-digit pricing. Using only the Dollar-9 definition (column 4), exchange-rate pass-through falls from 16.5% for non-left-

digit prices to 11.6% for Dollar-9 prices, corresponding to a statistically significant difference of 4.8 percentage points. A similar differential is obtained using the Cents-9X definition (column 5), where pass-through is 20.6% for non-left-digit prices and 14.9% for left-digit prices. Finally, restricting attention to Cents-9X prices while excluding Dollar-9 observations (column 6) yields a somewhat smaller but still economically meaningful differential of 4.5 percentage points.

Taken together, this evidence closely parallels the tariff results reported in the main text. Despite examining a different source of cost variation, a different retailer, and a multinational sample of products sold across countries, prices ending at psychologically salient thresholds exhibit systematically lower pass-through of cost shocks. This finding suggests that the relationship between left-digit pricing and pass-through is not specific to U.S. import tariffs or U.S. retailers, but instead reflects a broader feature of retail price-setting behavior.

	Dollar-9/Cents-9X			Dollar-9	Cents-9X	Cents-9X Dollar-9 = 0
	(1)	(2)	(3)	(4)	(5)	(6)
1-Y ERPT (non-9)	0.224*** (0.029)	0.213*** (0.028)	0.263*** (0.031)	0.165*** (0.014)	0.206*** (0.026)	0.308*** (0.033)
1-Y ERPT (9)	0.174*** (0.013)	0.148*** (0.012)	0.168*** (0.014)	0.116*** (0.012)	0.149*** (0.012)	0.263*** (0.020)
Δ (9 – non-9)	-0.050* (0.027)	-0.065** (0.027)	-0.096*** (0.029)	-0.048*** (0.011)	-0.057** (0.024)	-0.045. (0.029)
Country FE	Yes	Yes	No	Yes	Yes	Yes
Month-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Item FE	No	Yes	No	Yes	Yes	Yes
Country FE×Item FE	No	No	Yes	No	No	No
Observations	1,625,045	1,623,947	1,617,523	1,623,947	1,623,947	889,157
R-squared	0.017	0.044	0.058	0.045	0.044	0.062

Robust standard errors in parentheses.

Stars (*, **, ***) indicate significance at the 10%, 5%, and 1% levels.

Table A4. One-year exchange rate pass-through by price-ending status, IKEA

Notes: The table reports one-year exchange-rate pass-through estimates from the distributed-lag model in (21). Exchange rates are defined as destination country’s currency per U.S. dollar. So positive coefficients indicate higher destination-currency prices following an appreciation of the U.S. dollar. Columns (1)–(3) define nine-ending prices as those ending in 9 either in the dollar digit or in the cent digits (9X or X9). Column (4) classifies prices as nine-ending only if the dollar digit equals 9. Column (5) classifies prices as nine-ending only if the cent digits end in 9X or X9. Column (6) uses the same cent-digit definition but excludes prices that also end in 9 in the dollar digit. “1-Y ERPT” denotes the cumulative exchange-rate pass-through after one year. “ Δ (9 – non-9)” reports the difference in pass-through between nine-ending and non-nine-ending prices. Robust standard errors are reported in parentheses. Stars (*, **, ***) indicate significance at the 10%, 5%, and 1% levels.

A.7 Robustness to Pre-trade-war product characteristics

A potential concern is that products priced at left-digit thresholds may differ systematically from other products in dimensions that are known to affect pass-through. For example, left-digit prices may be associated with products that adjust prices less frequently or exhibit lower price volatility, which could mechanically generate lower estimated pass-through.

To address this concern, Table A5 augments the baseline specification with controls for pre-trade-war product characteristics. Specifically, we construct measures of each

barcode's pre-trade-war price volatility and frequency of price adjustment and include them as additional controls. Because these measures are computed using only pre-period observations, they are predetermined with respect to the tariff changes studied in the paper.

The results indicate that the lower pass-through of left-digit prices is not explained by differences in pre-existing pricing behavior. In the baseline specifications with lagged price-decade fixed effects (columns (1) and (3)), one-year pass-through is substantially lower for left-digit prices than for non-left-digit prices, particularly in the specification with HS6-country fixed effects. In column 3, pass-through equals 22.0% for non-left-digit prices and 5.5% for left-digit prices, implying a statistically significant difference of 16.5 percentage points.

Adding controls for pre-trade-war price volatility and adjustment frequency leaves the estimates largely unchanged. In the specification with HS6-country fixed effects (column (4)), pass-through remains 29.8% for non-left-digit prices and 11.6% for left-digit prices, yielding a statistically significant differential of 18.2 percentage points. The magnitude of the estimated effect is therefore very similar to, and if anything slightly larger than, that obtained in the baseline specification.

	(1)	(2)	(3)	(4)
1-Y PT (non-9)	0.069** (0.032)	0.137*** (0.038)	0.220*** (0.042)	0.298*** (0.071)
1-Y PT (9)	0.054** (0.024)	0.079*** (0.029)	0.055. (0.038)	0.116* (0.065)
Δ (9 - Non-9)	-0.015. (0.035)	-0.058. (0.036)	-0.165*** (0.049)	-0.182*** (0.050)
COICOP FE	Yes	Yes	No	No
HS6-Country FE	No	No	Yes	Yes
Price-decade FE	Yes	Yes	Yes	Yes
Additional controls				
Price volatility	No	Yes	No	Yes
Adjustment frequency	No	Yes	No	Yes
Observations	1,063,339	994,622	400,986	368,880
R-squared	0.001	0.001	0.007	0.008

Robust standard errors in parentheses.

Stars (*, **, ***) indicate significance at the 10%, 5%, and 1% levels.

Table A5. Tariff passthrough controlling for product's pre-trade-war characteristics

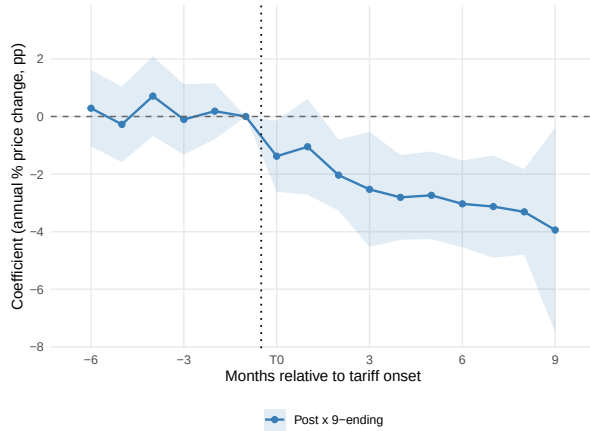
Notes: The table reports one-year tariff pass-through estimates from the distributed-lag in (??). Pass-through is allowed to differ according to whether a product's last observed pre-trade-war price was nine-ending. "1-Y PT" denotes the cumulative pass-through of a tariff change after one year. " Δ (9 – non-9)" reports the difference in pass-through between nine-ending and non-nine-ending prices. Columns (2) and (4) additionally control for barcode-level measures of pre-trade-war price volatility and price-adjustment frequency. All specifications include lagged price-decade fixed effects. Robust standard errors are reported in parentheses. Stars (*, **, ***) indicate significance at the 10%, 5%, and 1% levels.

A.8 Event-Study Estimates

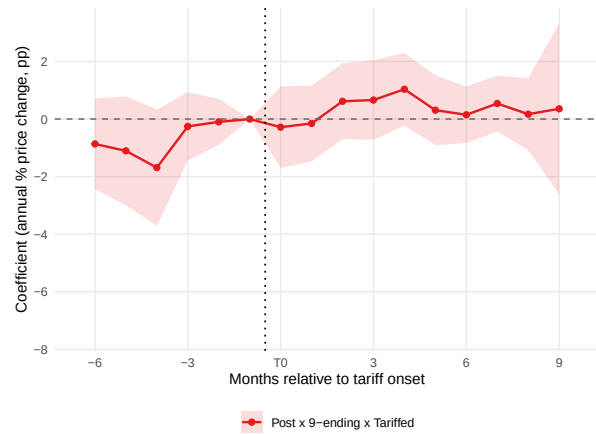
Figure A5 shows our event study specifications. Panel A and C show event studies for the non-tariffed products. Three key patterns emerge. First, the assumption of parallel trends appears defensible. None of the pre-period months has an estimate that differs significantly from the month prior to the tariffs going into effect. Second, the first month the tariffs are implemented there is a large downward movement in the estimates, suggesting that the differential effect on nine-ending prices begins immediately. Finally, the estimates are significantly negative for all post period months. Panels B and D show the

event studies for the triple difference estimates. Among just chinese products, panel D, there is no clear pattern in annual inflation with all post-period estimates not statistically different from 0. Among all products, panel D, all post period coefficients are negative, though several pre-period estimates are also negative. These analyses suggest that nine-ending tariffed products do not different significantly from non-tariffed products.

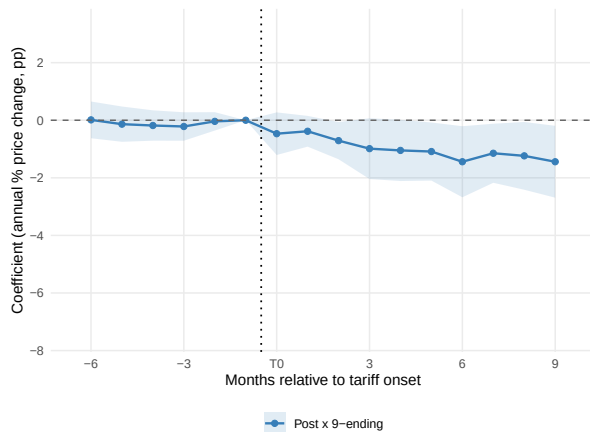
Figure A5. Event Study estimates for Difference in Difference specifications



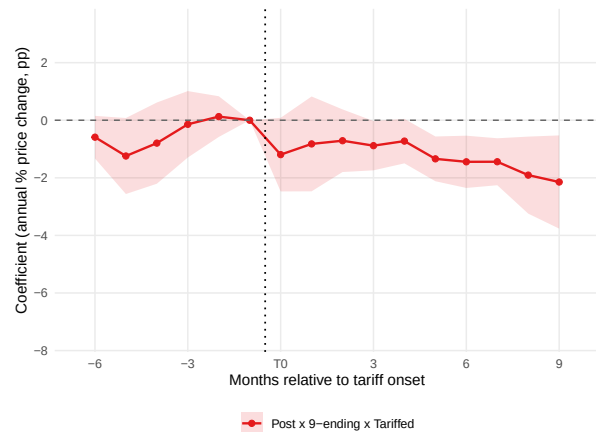
(a) China, Non-tariffed: Difference in Differences



(b) China, all products: Triple Difference



(c) All Countries, Non-tariffed: Difference in Differences



(d) All Countries, all products: Triple Difference

Note: Panels (a) and (c) show the relative time $\times$ nine-ending coefficient from the DiD estimated on non-tariffed products. Panels (b) and (d) show the triple-interaction coefficient relative time $\times$ nine-ending $\times$ tariffed from the triple difference estimated on the full sample. The reference month is the month before the tariffs go into effect. Shaded bands represent = 95% confidence intervals with standard errors clustered by COICOP.