Firms' Strategic Responses to Rules of Origin: Evidence from the USMCA*

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Abstract

Free Trade Agreements (FTAs) are prevalent and increasingly complex. This paper analyzes firms' strategic responses to stricter Rules of Origin (RoO) in the automotive industry introduced during the renegotiation of the US-Mexico-Canada Agreement (USMCA). Using Mexican customs administrative data, we show that tighter RoO increased the share of Mexican exports to the U.S. subject to tariffs and prompted car manufacturers in Mexico to source more inputs from North America. Consistent with the conceptual framework, we find that firms respond strategically to the new RoO: firms that have already complied or are far from compliance respond less than those near the threshold. Therefore, the effect on inputs sourced from the region is inversely U-shaped with the ex ante share of imports from the region. Finally, we show that these higher costs are passed on to consumers: among cars sold in the United States, those that were not ex-ante compliant with USMCA saw prices rise by an additional 2% compared to compliant vehicles.

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Free trade agreements have increased dramatically, from 22 in 1990 to over 370 by 2025. As value chains become more complex, these FTAs have also evolved in how they determine tariff exemptions for goods. Manufacturing location alone no longer qualifies for these exemptions. Modern FTAs increasingly include detailed Rules of Origin (RoO) that set regional content requirements. Although RoOs are designed to increase production within the trading bloc, they may have the opposite effect if firms relocate production entirely.

How do firms strategically respond to new rules of origin or to the tightening of existing ones? Theoretically, the effects are ambiguous (Grossman, 1981; Head, Mayer, & Melitz, 2024; Krishna, 2005). If the cost the firm incurs to fulfill the RoO is lower than the tariff, the firm will comply with the rule by producing or importing more intermediate inputs from within the trading block. Otherwise, it will continue or increase its imports of intermediate goods from outside the block and pay the tariff. Therefore, firms with very high compliance costs and those with zero compliance costs (already in compliance) should increase sourcing of intermediate inputs from within the trading block the least. Conversely, firms with moderate compliance costs should increase sourcing from the trading block, resulting in an inverse U-shaped relationship between intermediate-input sourcing from the trading block and a firm's compliance cost. We formalize this logic in a simple conceptual framework.

This paper leverages administrative transaction-level data from Mexican customs and the shock stemming from the US-Mexico-Canada Trade Agreement (USMCA) renegotiation to estimate the effect of stricter RoO on automotive exporters in Mexico. The USMCA governs one of the world's largest trading blocs, encompassing nearly 30% of the global economy, with trade flows exceeding US$3 million per minute. The automotive industry is a key component of the agreement because it accounts for 10%, 18%, and 11% of the manufacturing GDP of the U.S., Mexico, and Canada, respectively. The USMCA tightened tariff-free eligibility criteria for the automotive industry, raising the regional content

requirement from 62.5% to 75% and adding requirements for sourcing steel, aluminum, and core parts, as well as a high-wage labor content rule.

We use a difference-in-differences framework, exploiting the agreement's phased implementation and the differential change in RoO across industries. In particular, we compare automakers, subject to new, significantly stricter rules of origin, with exporters of other similarly complex manufactured goods whose rules of origin remained unchanged. We then test the theoretically predicted inverse U-shaped relationship between the firm's response and compliance costs. We approximate compliance costs using the firm's degree of integration with the trade bloc (the share of imports from the US and Canada) prior to the renegotiation.[1]

During our study period from 2018 to 2024, we find that, on average, the stricter RoOs introduced by USMCA increased the share of exports subject to tariffs for Mexico-based automotive firms by about 8 percentage points (pp). In the same period, automakers in Mexico also increased the share of their inputs from the U.S. and Canada by 3 pp. These net effects mask differentiated strategic responses across firms. Some firms chose to pay the tariff, and others adjusted to comply.

As our conceptual framework predicts, we document that the effect on dutiable exports is inversely related to the ex-ante share of inputs from North America, and that it is smaller for light trucks, which face higher tariffs and thus have a stronger incentive to comply. Moreover, the effect on inputs from North America follows an inverse U pattern. Firms around the median ex-ante share of inputs from North America increased their share of regional imports the most. In contrast, those with the lowest and highest ex-ante regional content responded the least.

Stricter rules of origin increase costs for automakers that were not ex-ante compliant, as they now must either pay a tariff or adjust their production processes to comply. How much of this cost increase do consumers bear? We document that, relative to 2021 prices,

[1] Ideally, we would also use the share of the product attributable to Mexico; however, that information is not available.

cars sold in the United States that were not ex-ante compliant with the USMCA experienced a 2% larger price increase than those that were. The estimates suggest at least an 80% pass-through to consumers, since the maximum possible cost increase is 2.5% (the tariff under the World Trade Organization's Most-Favored-Nation).

The paper contributes to the literature on rules of origin in Free Trade Agreements. First, it builds on critical theoretical advances that characterize how rules of origin affect firms' incentives. Krishna and Krueger (1995) and Falvey and Reed (2000) show that RoO distort resource allocation by forcing producers to shift from more efficient global suppliers to higher-cost regional suppliers to meet content requirements. Ornelas and Turner (2024) show that RoO can boost investment and welfare when applied to high-productivity suppliers.

The most closely related paper is likely Head et al. (2024), which uses a heterogeneous-firm model to introduce a Laffer curve for RoO, in which stricter content requirements initially increase regional sourcing but ultimately decline when compliance costs outweigh the benefits. We derive our main theoretical predictions from this literature, but instead of calibrating a model to fit part cost shares for autos sold in North America, as in Head et al. (2024), we use transaction-level microdata to test whether heterogeneous strategic responses across firms exist and exhibit the expected inverse U-shaped pattern.

This paper also relates to the empirical literature on Rules of Origin, which remains scarce because these rules are complex and hard to quantify. By exploiting cross-product and cross-country variation over time, Conconi, García-Santana, Puccio, and Venturini (2018) examine changes in tariff classification and show that NAFTA's RoO led to significant reductions in imports of intermediate goods from third countries relative to NAFTA partners. Similarly, Anson et al. (2005) assess the effects of RoO restrictiveness on bilateral trade volumes and document that compliance with NAFTA's RoO imposed substantial costs on Mexican firms, effectively negating the tariff advantages for many exporters. Additionally, López Espino (2024) explores the potential effects of RoO changes on the

Mexican automotive sector during the transition from NAFTA to USMCA if firms did not respond to the changes. She finds that, compared with NAFTA, applying USMCA's RoO in 2017 would have reduced the compliance rate by 9.7%.

The remainder of the paper is organized as follows. Section 1 describes the institutional background. Section 2 presents the conceptual framework. Section 3 describes our data. Section 4 discusses our empirical design. Section 5 presents results. Section 6 examines the pass-through to consumer prices. Section 7 concludes.

1 Background

The United States-Mexico-Canada Agreement (USMCA), which replaced the North American Free Trade Agreement (NAFTA), took effect in July 2020. Talks began in August 2017, and the three countries signed the agreement in November 2018. Ratification, however, remained uncertain until December 2019, when they signed a Protocol of Amendment that addressed labor and environmental concerns raised by the U.S. Congress. The automotive sector, which accounts for 10%, 18%, and 11% of manufacturing GDP in the U.S., Mexico, and Canada, respectively, played a central role in the renegotiation. Compared with NAFTA, which set a single regional content requirement of 62.5% for light vehicles (cars and light trucks), the USMCA introduced stricter, more complex rules for tariff exemptions.

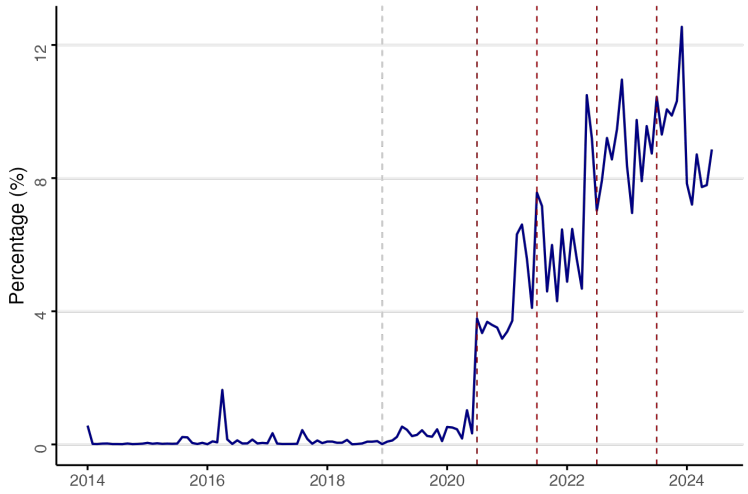
The key USMCA content requirements affecting the automotive industry included changes to regional value content (RVC), steel and aluminum sourcing, and origin rules for core parts. Vehicles must meet all of them to gain tariff-free status. Between July 2020 and July 2023, the agreement phased in higher RVC thresholds, raising the requirement from 62.5% to 75% for passenger vehicles and light trucks.[2] Furthermore, vehicle producers must buy at least 70% of their steel and aluminum from originating sources in the

[2]The requirement rose in four annual steps: 66% in July 2020, 69% in July 2021, 72% in July 2022, and 75% in July 2023. Producers could also request a longer transition, until July 2025, for part of their production, and may average the RVC over a fiscal year across vehicles of the same model (USMCA, Chapter 4).

region. Core parts such as engines, transmissions, axles, and suspensions face their own regional content thresholds, which reach 75% by 2023. In addition to these stricter content requirements, the USMCA introduced a first-of-its-kind Labor Value Content (LVC) requirement: by 2023, 40% of a passenger vehicle's content (45% for a light truck) must come from facilities with an average production wage of at least US$16 per hour.

These new requirements significantly altered trade incentives. When automakers fail to meet the content or wage requirements, they face MFN tariffs of 2.5% for passenger vehicles and 25% for light trucks, a substantial cost relative to industry gross profit margins, which are usually below 20%. After the USMCA took effect, the share of U.S. light vehicle imports from Mexico subject to tariffs rose from less than 2% to nearly 12% (Figure 1).

Figure 1: Share of U.S. Car Imports from Mexico Subject to Tariffs



Author calculations based on data from the U.S. Census Bureau. The vertical dashed line marks the date the USMCA was signed (gray), and the dates mark when it entered into force (red).

Access to tariff exemptions is especially crucial for Mexico's export-driven automotive industry. Over 85% of vehicles produced in Mexico are destined for international markets, with the United States and Canada as primary buyers (AMIA, 2021). In fact, one in every five new automobiles sold in the U.S. originates from Mexico.[3] Firms may need to prioritize North American suppliers and inputs over non-regional alternatives to com-

[3] Authors' calculations based on VinAudit listings of new vehicles sold by U.S. dealerships.

ply with regional content rules. However, this likely raises costs for manufacturers and might ultimately lead them to pay tariffs instead, or even consider offshoring production altogether.

Beyond the automotive sector, other manufacturing industries, including machinery, electrical equipment, and aerospace, experienced only relatively minor changes to their rules of origin under the USMCA (Gantz, 2019). Changes in these sectors were primarily intended to update provisions negotiated 25 years earlier and did not make the rules stricter (Abbyad, Litwin, Powers, & Ubee, 2021). Most other similarly complex goods retained regional content requirements of 50%-60%, similar to NAFTA-era thresholds.

2 Conceptual Framework

This section formalizes the intuition outlined in the introduction and motivates our empirical specifications. We characterize five objects as a function of a firm's ex-ante regional input share: (i) the tariff the firm pays before the renegotiation, (ii) the change in tariffs paid holding sourcing fixed, (iii) the probability that a firm complies by increasing its regional input share, (iv) the resulting expected change in tariffs paid once this sourcing response is taken into account, and (v) the expected change in the share of inputs sourced from the region.[4] Throughout, we abstract from general equilibrium effects and focus on the partial-equilibrium decision of an exporter that has already chosen to produce in the region.

Setup

Consider a multinational firm i that produces a single final good in Mexico and exports it to the United States. Let $s_i \in [0, 1]$ denote the share of input value sourced from within the

[4]Figures 2–4 are generated from a parametrized version of the model with a linear integration cost and logit choice probabilities. Online Appendix A describes it and reports the parameter values (Tables A.1 and A.2). The values are illustrative, not estimated.

bloc (the U.S., Mexico, and Canada), and let s_i^0 denote its ex-ante (pre-USMCA) value. Let $\underline{s}$ be the initial (NAFTA) RoO threshold and $\bar{s} > \underline{s}$ the new (USMCA) threshold.[5] Denote by τ the MFN tariff applied to non-compliant exports and by V_i the firm's export value. The tariff bill faced by firm i under the NAFTA and USMCA thresholds is

$$T(s_i; \underline{s}) \;=\; \tau\, V_i\, \mathbb{1}\{s_i < \underline{s}\} \qquad \text{and} \qquad T(s_i; \bar{s}) \;=\; \tau\, V_i\, \mathbb{1}\{s_i < \bar{s}\}. \tag{1}$$

Absent any RoO, firm i would source a share s_i^* from the region, its unrestricted cost-minimizing share. Sourcing a higher regional share $s_i \geq s_i^*$ instead costs the firm an integration cost $C_i(s_i - s_i^*)$, specific to the firm, continuous, with $C_i(0) = 0$, and strictly increasing in $s_i - s_i^*$. Any excess of the firm's ex-ante share over s_i^* carries an integration cost, which we denote:

$$\kappa_i \;\equiv\; C_i(s_i^0 - s_i^*) \;\geq\; 0. \tag{2}$$

In addition, whenever the firm changes its sourcing away from s_i^0, i.e., whenever $s_i \neq s_i^0$, it incurs a fixed cost $F > 0$, which corresponds to the cost of restructuring its supply chain: the one-time cost of finding and certifying new suppliers, renegotiating supplier contracts, and reorganizing procurement. This supply chain restructuring cost does not depend on the size of the change. Unlike F, the tariff and the integration cost recur every period the firm operates under a given sourcing share; we take V_i and $C_i(\cdot)$ to already denote the present value of these recurring flows, so that τV_i and $C_i(\cdot)$ are directly comparable to the one-time cost F. After the renegotiation, the firm chooses s_i to minimize the sum of tariffs paid under the new threshold, its integration cost, and the restructuring cost:

$$\min_{s_i \geq s_i^*} \;\; \tau\, V_i\, \mathbb{1}\{s_i < \bar{s}\} \;+\; C_i(s_i - s_i^*) \;+\; F\, \mathbb{1}\{s_i \neq s_i^0\}. \tag{3}$$

[5] The thresholds are defined in terms of the regional value content (RVC) of the vehicle. For simplicity, we place them directly on the regional input share. Because the RVC is increasing in the regional input share, mapping the thresholds onto the input share would shift their location on the horizontal axis but would not change the shapes in Figures 2–4.

Because C_i is increasing, the firm never sources more than necessary: if it complies, it sets $s_i = \bar{s}$; if it does not, and is willing to pay F to change its sourcing at all, it moves all the way to s_i^* — a choice we call disintegrating, following the mechanism formalized in Head et al. (2024). The firm therefore compares three options: comply, at cost $C_i(\bar{s} - s_i^*) + F$ and zero tariff; pay the tariff without changing its sourcing, at cost $\tau V_i + \kappa_i$; or pay the tariff and disintegrate to s_i^*, at cost $\tau V_i + F$. The firm complies whenever doing so is cheaper than both alternatives, that is, whenever

$$C_i(\bar{s} - s_i^*) + F \;\leq\; \tau V_i \;+\; \min\{\kappa_i,\, F\}. \tag{4}$$

Since complying and disintegrating both require paying F, it cancels from that particular comparison, which reduces to $C_i(\bar{s} - s_i^*) \leq \tau V_i$. If instead equation (4) does not hold, complying is not worthwhile, and the firm disintegrates to s_i^* whenever doing so is worth its own fixed cost,

$$\kappa_i \;\geq\; F, \tag{5}$$

and otherwise — if $\kappa_i < F$ as well — the firm's best option, having already ruled out both complying and disintegrating, is simply to stay at s_i^0: it keeps paying the tariff, but incurs no fixed cost.

Under NAFTA, the firm chose s_i^0 by minimizing $\tau V_i \mathbb{1}\{s_i < \underline{s}\} + C_i(s_i - s_i^*)$, so $s_i^0 = s_i^*$ when $s_i^* \geq \underline{s}$ or when complying with the initial rule was not worthwhile ($C_i(\underline{s} - s_i^*) > \tau V_i$), and $s_i^0 = \underline{s}$ otherwise. Hence a firm sources more than its unrestricted cost-minimizing share only if the initial rule binds for it. Firms that comply with the initial rule are therefore of two kinds. *Unconstrained* firms have an unrestricted cost-minimizing share at or above $\underline{s}$: they source exactly that share, $s_i^0 = s_i^*$, so $\kappa_i = 0$, and disintegrating is never worthwhile for them. *Constrained* firms have an unrestricted cost-minimizing share below the initial threshold, $s_i^* < \underline{s}$, and source more from the region only to avoid the tariff. They sit at $\underline{s}$ or

within a small safety margin above it, because the regional content of a vehicle is uncertain (it moves with input prices, exchange rates, and the tracing of suppliers' content) and falling below the threshold means paying the tariff. They are the only firms with $\kappa_i > 0$, and hence the only ones that may disintegrate.

Who Pays a Tariff Before the Renegotiation

Before the renegotiation, only firms with $s_i^0 < \underline{s}$ pay the MFN tariff. All firms with $s_i^0 \geq \underline{s}$ are already in compliance with the initial RoO and pay zero tariff. Equation (1) therefore implies a step function in the ex-ante regional input share, illustrated in Panel A of Figure 2: the tariff the firm pays equals τV_i to the left of the initial RoO and zero to the right of it. In our setting, the empirical counterpart of this benchmark is consistent with very low rates of tariff payment by automotive exporters under NAFTA, because virtually all ex-ante exporters already complied with the 62.5% threshold.

Effect of the Tightening of the RoO on Tariffs Paid

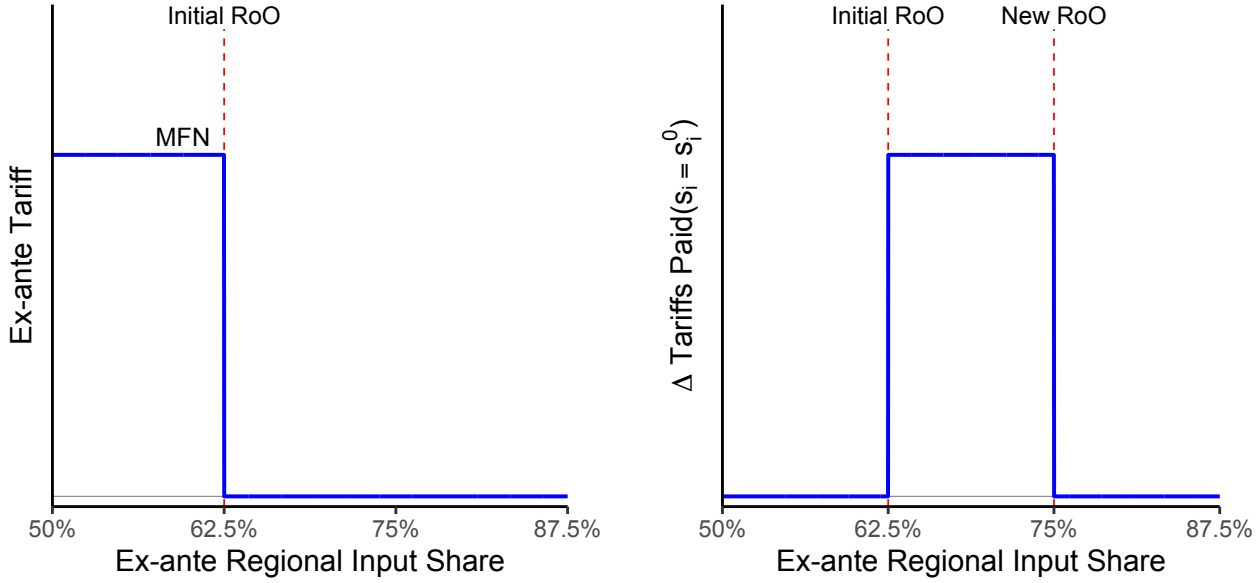
The renegotiation shifts the relevant threshold from $\underline{s}$ to $\bar{s}$; we treat this as a single before/after shift, consistent with our pre/post empirical design, abstracting from the actual multi-year phase-in of the USMCA requirement. For a firm with ex-ante share s_i^0 and realized post-renegotiation sourcing s_i, define the change in tariffs paid as

$$\Delta T_i \;\equiv\; T(s_i;\bar{s}) \;-\; T(s_i^0;\underline{s}). \tag{6}$$

Absent any sourcing response ($s_i = s_i^0$), equation (6) gives

$$\Delta T_i \;=\; \tau\, V_i \Big[\mathbb{1}\{s_i^0 < \bar{s}\} - \mathbb{1}\{s_i^0 < \underline{s}\}\Big]. \tag{7}$$

Equation (7) delivers three regions, depicted in Panel B of Figure 2. First, firms with $s_i^0 < \underline{s}$ were already paying the tariff and continue to pay it: $\Delta T_i = 0$. Second, firms with $s_i^0 \geq \bar{s}$



Panel A: Tariff Paid Before the Renegotiation

Panel B: Tariffs Holding Inputs Fixed

Figure 2: Tariffs Paid Before and After the Renegotiation

Notes: Horizontal axis: ex-ante regional input share s_i^0. Dashed vertical lines mark the initial ($\underline{s}$) and new ($\bar{s}$) RoO thresholds. Figures are generated from the parametrized model described in Online Appendix A; magnitudes are illustrative, so the vertical axes show no values. Panel A: tariff paid before the renegotiation. Panel B: change in tariffs paid holding sourcing fixed, equation (7).

were already complying with both rules and continue to pay zero: $\Delta T_i = 0$. Third, the new "trapped" region $\underline{s} \leq s_i^0 < \bar{s}$ contains firms that complied under the initial RoO but do not under the new one. These firms were paying zero before the renegotiation and are now exposed to the MFN tariff, so $\Delta T_i = \tau V_i > 0$. The change in tariffs paid is therefore a rectangular bump between the two RoO thresholds.

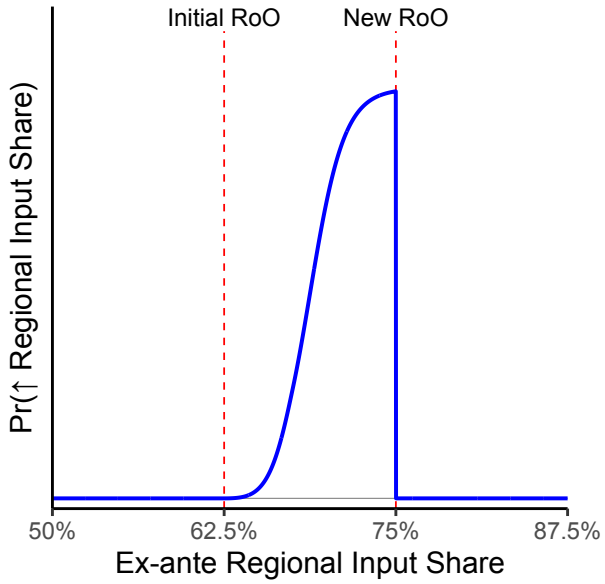
Who Complies with the New Rule

We now turn to the firms' adjustment decision. Firms with $s_i^0 < \underline{s}$ did not find it worthwhile to comply with the initial threshold $\underline{s}$, so they still do not find it worthwhile to comply with the stricter $\bar{s}$; nor does the renegotiation change their incentive to disintegrate, since condition (5) does not depend on the threshold. Firms with $s_i^0 \geq \bar{s}$ already comply with the new rule and likewise have no incentive to change their sourcing. All of the action, in either direction, is therefore confined to the trapped region $\underline{s} \leq s_i^0 < \bar{s}$.

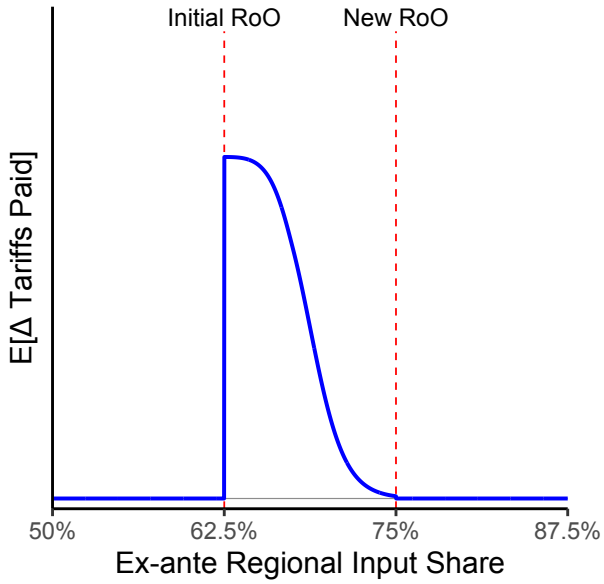
Within the trapped region, the firm increases its regional input share to $\bar{s}$ if and only if condition (4) holds. Firms with the same ex-ante share s_i^0 vary in their export value V_i, their cost function $C_i(\cdot)$, and their unrestricted cost-minimizing share s_i^* (near $\underline{s}$, constrained and unconstrained firms coexist), and hence in κ_i. The probability that a firm complies is therefore

$$p\big(s_i^0\big) \;=\; \Pr\big(C_i(\bar{s} - s_i^*) + F \;\leq\; \tau V_i + \min\{\kappa_i, F\}\big)\,, \tag{8}$$

the probability that condition (4) holds for a firm with ex-ante share s_i^0. As long as staying is cheaper than disintegrating ($\kappa_i < F$), condition (4) can be written as $C_i(\bar{s} - s_i^*) - C_i(s_i^0 - s_i^*) + F \leq \tau V_i$: the firm compares the tariff with the cost of moving from its ex-ante share to $\bar{s}$. For unconstrained firms, this cost is simply $C_i(\bar{s} - s_i^0)$. Either way, the closer a firm is to $\bar{s}$, the smaller the adjustment it needs, and the cheaper complying becomes. Constrained firms for which disintegrating is the relevant alternative ($\kappa_i \geq F$) instead compare $C_i(\bar{s} - s_i^*)$ with τV_i, which does not depend on s_i^0. As long as export values



Panel A: Prob. of Increasing Regional Input Share



Panel B: Expected Change in Tariffs Paid

Figure 3: Compliance and Tariffs Paid After the Renegotiation

Notes: Horizontal axis: ex-ante regional input share s_i^0. Dashed vertical lines mark the initial ($\underline{s}$) and new ($\bar{s}$) RoO thresholds. Figures are generated from the parametrized model described in Online Appendix A; magnitudes are illustrative, so the vertical axes show no values. Both panels use a high F. Panel A: probability of complying, equation (8). Panel B: expected change in tariffs paid accounting for the sourcing response, equation (9).

and integration costs do not vary systematically with s_i^0, $p(s_i^0)$ is therefore increasing in s_i^0 across the trapped region.[6]

At and above $\bar{s}$, by contrast, firms are already compliant and have nothing left to adjust, so $p(s_i^0)$ — the probability of *adjusting* — is zero. Panel A of Figure 3 illustrates this pattern: zero at or below the initial RoO, rising across the trapped region, peaking just below the new RoO, and dropping to zero at and above $\bar{s}$.

Expected Tariffs Paid After the Renegotiation

Panel B of Figure 2 holds sourcing fixed and therefore overstates the tariff exposure of firms in the trapped region, since some of them respond to the tighter rule by adjusting their sourcing and avoid the tariff altogether. Once sourcing can adjust, ΔT_i as defined in equation (6) depends on both the firm's ex-ante share s_i^0, which determines the pre-renegotiation tariff $T(s_i^0; \underline{s})$, and its realized post-renegotiation sourcing s_i, which determines the new tariff $T(s_i; \bar{s})$. A firm with ex-ante share s_i^0 in the trapped region paid $T(s_i^0; \underline{s}) = 0$ before the renegotiation, since $s_i^0 \geq \underline{s}$. Under the new rule, $s_i = \bar{s}$ with probability $p(s_i^0)$ (it complies), in which case $T(\bar{s}; \bar{s}) = 0$ and $\Delta T_i = 0$; and with the complementary probability it does not comply, so it keeps paying the tariff regardless of whether it stays at s_i^0 or disintegrates to s_i^* as discussed above — either way $T(s_i; \bar{s}) = \tau V_i$, since both $s_i^0 < \bar{s}$ and $s_i^* < \bar{s}$, and $\Delta T_i = \tau V_i$. Averaging over these two outcomes, the expected change in tariffs paid for a firm with ex-ante share s_i^0 in the trapped region is

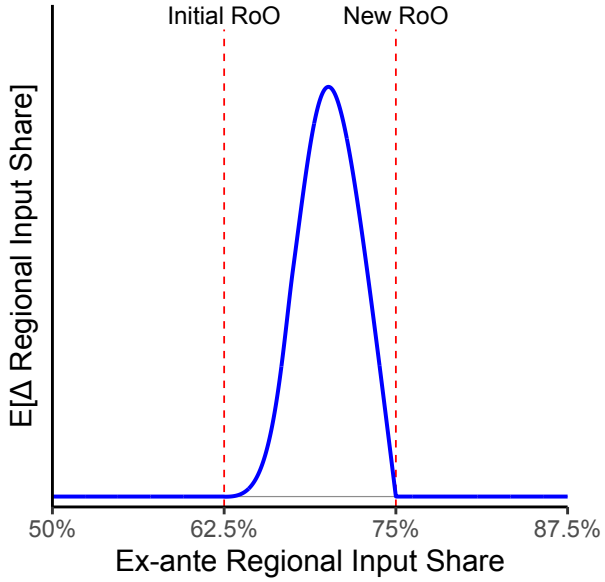
$$\mathbb{E}[\Delta T_i] \;=\; \tau\, V_i \left(1 - p(s_i^0)\right), \qquad s_i^0 \in [\underline{s}, \bar{s}), \tag{9}$$

and zero outside the trapped region, where $1 - p(s_i^0)$ is the probability of not complying from equation (8). This generalizes the fixed-sourcing calculation in equation (7), which corresponds to the special case $s_i = s_i^0$ imposed with certainty. Because $p(s_i^0)$ rises as s_i^0

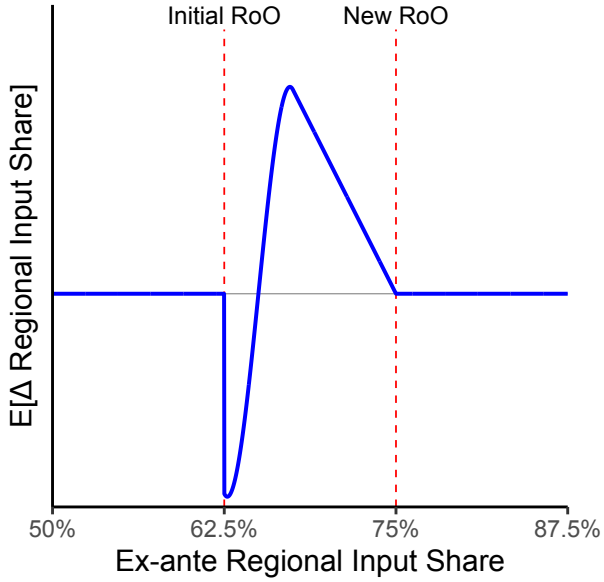
[6] If, instead, firms closer to $\bar{s}$ had systematically higher integration costs or lower export values, $p(s_i^0)$ need not be monotonic.

approaches $\bar{s}$, equation (9) declines over the trapped region rather than remaining flat at τV_i as in Panel B of Figure 2. Panel B of Figure 3 plots this expected change in tariffs paid: it is highest just above $\underline{s}$, where few firms comply, and falls toward zero as s_i^0 approaches $\bar{s}$ and more firms comply with the new RoO.

Sourcing Effect: Expected Change in the Regional Input Share



Panel A: Expected Change in Reg. Share (High F)



Panel B: Expected Change in Reg. Share (Low F)

Figure 4: The Sourcing Response to the Renegotiation

Notes: Horizontal axis: ex-ante regional input share s_i^0. Dashed vertical lines mark the initial ($\underline{s}$) and new ($\bar{s}$) RoO thresholds. Figures are generated from the parametrized model described in Online Appendix A; magnitudes are illustrative, so the vertical axes show no values. Panel A: expected change in the regional input share when F is high, equation (11). Panel B: expected change in the regional input share when F is low, a possible case in which constrained firms near the initial RoO disintegrate.

Not every non-complying firm remains at s_i^0: having ruled out compliance, a firm disintegrates to s_i^* whenever $\kappa_i \geq F$, as in equation (5). Because only constrained firms have $\kappa_i > 0$, disintegration is concentrated near $\underline{s}$. The probability that a firm with ex-ante share s_i^0 disintegrates is then

$$q\big(s_i^0\big) \;=\; \Pr(\text{condition (4) fails and } \kappa_i \geq F)\,. \tag{10}$$

A firm's realized change in regional input share therefore falls into one of three cases: it complies and moves up to $\bar{s}$, with probability $p(s_i^0)$; it does not comply but disintegrates to s_i^*, with probability $q(s_i^0)$; or it does not comply and does not disintegrate, remaining exactly at s_i^0 and contributing zero change. The expected change in a firm's regional input share is

$$\mathbb{E}[\Delta s_i] \;=\; \underbrace{p\big(s_i^0\big)\,\big(\bar{s} - s_i^0\big)}_{\text{compliance}} \;-\; \underbrace{q\big(s_i^0\big)\,\big(s_i^0 - s_i^*\big)}_{\text{disintegration}}, \tag{11}$$

for s_i^0 in the trapped region, and zero outside it. Firms that neither adjust to comply nor disintegrate do not appear as separate terms because their $\Delta s_i = 0$.

Panels A and B of Figure 4 illustrate equation (11) for a high and a low fixed cost. Panel A is our baseline case. When F is high, it exceeds κ_i for every firm, so no firm disintegrates: $q(s_i^0) = 0$, and the expected effect simplifies to $p(s_i^0)(\bar{s} - s_i^0)$. This is an inverse U (Panel A of Figure 4): the probability of complying rises toward $\bar{s}$, while the size of the required adjustment falls. Panel B illustrates a possibility that the framework allows but does not require. A lower F makes changing sourcing cheaper in either direction. Unconstrained firms comply more, so the positive effect grows. Constrained firms for which complying with the new rule costs more than the tariff, $C_i(\bar{s} - s_i^*) > \tau V_i$, now disintegrate, since $\kappa_i \geq F$. When such firms are common near $\underline{s}$, as in our parametrization, the expected effect turns negative there (Panel B of Figure 4). A low F alone does not make disintegration dominate, because F is paid both to comply and to disintegrate; the effect turns negative because the firms that pay $\kappa_i > 0$ are those for which complying is too costly. This is the tension that generates the Laffer-curve relationship between RoO stringency and aggregate regional content documented by Head et al. (2024). Whether this case arises depends on how common such firms are and on how cheaply they can

restructure their supply chains, so we do not take it as a prediction: it shows that a stricter rule can lower regional sourcing for some firms.

Testable Predictions

The framework delivers three predictions that we take to the data.

Prediction 1. Among firms that complied with the initial rule, the increase in tariffs paid is largest for the least integrated ones, which are the least likely to comply with the new rule (equation (9) and Panel B of Figure 3).

Prediction 2. The change in the regional input share follows an inverse U in ex-ante integration: firms near the initial RoO rarely comply, and firms near the new RoO comply but need only small adjustments (equation (11) and Panel A of Figure 4).

Prediction 3. A higher tariff makes compliance more likely: an increase in τV_i raises the right-hand side of condition (4), so $p(s_i^0)$ rises at every ex-ante share. We test this prediction by comparing passenger cars, which face a 2.5% MFN tariff, with light trucks, which face a 25% tariff.

The negative effect near the initial RoO in Panel B of Figure 4 is not among these predictions: it arises only if constrained firms for which complying is too costly can restructure their supply chains cheaply.

3 Data

3.a Data Sources

Customs Data. The primary data source for this project is transaction-level customs data for Mexico, accessed through Econlab at *Banco de México*. This includes all import and export operations. For each transaction, we observe the Firm ID, the product at the HS 6-digit level, the type of operation (export/import), the trade value in USD and Mexican Pesos, the origin/destination of the transaction, whether the transaction is classified as

an intermediate or final good, and a self-reported variable indicating if the transaction benefited from preferential tariffs through a Free Trade Agreement. We use data between January 2018 and July 2024, and we aggregate it at the firm-product-quarter level.

U.S. Automobile Price Data. Our price data source is VinAudit USA, INC, which collects online vehicle listings from U.S. dealerships at the VIN level (over 15 million listings per year). We purchased this data for academic research. The raw data are at the vehicle level and include the VIN number (a unique vehicle identifier), advertised price shown in the listing, detailed vehicle characteristics (make, model, model year, trim, body type), seller information (dealer identifier and location when available), and listing metadata (posting date and other listing attributes). We focus on listings for new vehicles observed from 2021 to 2024, the period for which these data are available. This window begins after the USMCA entered into force in July 2020, a limitation we discuss in Section 6.

NHTSA Data. We enrich the VinAudit listings using VIN information from the National Highway Traffic Safety Administration (NHTSA). The NHTSA provides a VIN decoder tool that returns standardized vehicle descriptors, which we use to construct consistent make-model-trim identifiers across listings. These standardized identifiers are the key link that allows us to map information across our data sources.

American Automobile Labeling Act Reports. To determine whether specific models and trims were produced in compliance with the USMCA, we also use the American Automobile Labeling Act (AALA) Reports. The AALA Reports provide detailed content and origin information, including: (i) the percentage U.S./Canadian parts content; (ii) the names of up to two non-U.S./Canadian countries that each contribute at least 15 percent of parts content, along with their shares; (iii) the final assembly location; (iv) the country of origin of the engine; and (v) the country of origin of the transmission. We map AALA records to VinAudit listings by matching on the standardized make-model-trim identifiers constructed from the decoded VIN.

For our main outcome, we use the listing price reported by VinAudit. This measure is

closer to the price faced by consumers in the marketplace than MSRP because it reflects the price displayed by the seller and can incorporate dealer-level pricing decisions.

Finally, because the data are collected from online listings, the timing at which a given dealership begins to appear in the scraped data may be endogenous. To minimize concerns that changes in coverage drive our results, our baseline specification is estimated on a balanced panel of dealerships that are observed continuously over the sample period. In robustness checks, we show that the results are similar when using the full unbalanced panel while controlling for dealership entry into the data and common time effects.

Instituto Mexicano del Seguro Social (IMSS). Employment and wages come from administrative social security records that cover all formal private-sector employees in Mexico. The EconLab at Banco de México links these records to the customs data using each firm's tax identifier (RFC), and we access the linked data through the EconLab. IMSS records classify each firm's workers by the economic activity they perform. For each firm, we compute the average total and manufacturing employee counts. We use these pre-USMCA averages for the size restriction and as covariates in the matched control group and the doubly robust estimator.

3.b Treatment and Control Group Definitions

To be candidates for inclusion in our treatment or control groups, firms must be in the manufacturing sector rather than merely import or export agencies. We restrict attention to firms that, on average before the USMCA, employed more than 100 manufacturing workers and more than 250 workers in total. We further restrict the analysis to a balanced panel of firms observed between the first quarter of 2018 and the third quarter of 2024.

Treatment group. Motor vehicle exporters ($AutoExp_i = 1$) are firms for which passenger vehicles and light trucks account for at least 60 percent of pre-USMCA exports. This group covers the universe of automakers operating in Mexico.

Clustering Procedure for Control Group Rather than hand-pick the control industries,

we let the data select them. We apply k-means clustering to manufacturing industry characteristics and retain the industries that are most consistently grouped with automakers.

The unit of observation is the four-digit industry of SCIAN 2018, the Mexican version of the North American Industry Classification System. The data come from the 2019 Mexican Economic Census (INEGI, 2020), which covers 2018. We use published tabulations for value added, employment, compensation, fixed assets, and the number of establishments, and census microdata for the four trade measures, accessed from INEGI's Microdata Laboratory. We also use data from the Input-Output tables for 2018 to construct a measure of upstreamness.

These slow-moving characteristics are measured largely before the agreement was signed (November 2018) and well before it entered into force (July 2020). Automakers correspond to industry 3361, motor vehicle manufacturing. Our treatment group comprises the firms in this industry that export passenger vehicles and light trucks. We start with all manufacturing industries and exclude those with five or fewer exporting establishments, because data confidentiality rules make export intensity unavailable. The resulting sample contains 79 industries.

For each industry, we compute eleven characteristics: value added, capital, and compensation per worker; average value added, capital, and workers per establishment, the ratio of fixed assets to value added, the ratio of wage bill to value added, the share of establishments that export, the share that import, export intensity (the share of exports in total sales) and import intensity (the share of imports in total expenditures in goods and services); upstreamness, computed as proposed by Antràs, Chor, Fally, and Hillberry (2012) using Mexico's input–output table for year 2018. To place the characteristics on a common, unit-free scale and limit outliers' influence on the squared Euclidean distances that k-means minimizes, we replace each characteristic with its rank across industries, coarsened into 50 quantile groups.

We compute 10,000 iterations of k-means clustering that differ in the random assign-

ment of which characteristics are included, the number of clusters formed, and the algorithm starting point. In particular, in each iteration, (i) each of the eleven characteristics enters independently with probability 0.6, so iterations use 6.6 characteristics on average; (ii) the number of clusters is a rounded draw from a uniform distribution between 3 and 7; and (iii) k-means partitions the industries starting on randomly chosen industries as initial centroids.[7]

Let $g_b(\ell)$ denote the cluster to which run b assigns industry ℓ. We measure the similarity between industry ℓ and automakers by the share of runs in which the two are assigned to the same cluster:

$$\pi_\ell \;=\; \frac{1}{10{,}000} \sum_{b=1}^{10{,}000} \mathbf{1}\{g_b(\ell) = g_b(3361)\}. \tag{12}$$

Therefore, π_ℓ is high for industries that stay close to automakers across specifications and low for those that rarely join them. The baseline control group consists of industries with $\pi_\ell > 0.3$.[8] Regardless of π_ℓ, we exclude from all control groups firms that could be directly affected by the new automotive rules or that supply automakers: firms that export any motor vehicle, and firms whose main industry is auto parts (SCIAN 3363), basic iron and steel (3311), iron and steel products (3312), forged and stamped metal products (3321), or other metal products (3329), when that industry accounts for more than 20% of their exports. The USMCA also tightened the rules of origin for auto parts and introduced steel and aluminum sourcing requirements for automakers; since these firms supply automakers, including them in the control group would contaminate the comparison. Online Appendix Table B.1 reports π_ℓ for every industry.

Alternative Control Groups We re-estimate our main specifications under three alternative control groups. The first raises the co-clustering threshold to $\pi_\ell > 0.4$. The second matches automakers to machinery and equipment exporters on their pre-USMCA log

[7] We use Stata's `cluster kmeans` command with Euclidean distance. The number of clusters is the rounded value of a uniform draw on $[3, 7]$, so it equals 4, 5, or 6 with probability 0.25 each and 3 or 7 with probability 0.125 each. All draws come from a single fixed seed, so the selection is reproducible.

[8] We assign each firm to the four-digit industry that accounts for the largest share of its pre-USMCA exports. The control group includes all firms in these industries that meet the sample restrictions above.

wage, log employment, and share of inputs imported from the U.S. and Canada, using the Mahalanobis distance with a caliper of 0.5 standard deviations. The third consists of exporters of machinery and equipment (HS chapters 84–86, 88, and 89), excluding vehicle exporters and suppliers of auto parts and other automotive inputs, as in the other control groups. Their rules of origin remained unchanged under the USMCA, and their share of inputs from the U.S. and Canada is similar to that of automakers. We further re-estimate the baseline and machinery-and-equipment specifications with the doubly robust estimator of Sant'Anna and Zhao (2020), using the same pre-USMCA covariates as in the matching. All automakers face the same legal schedule, so this does not correct for staggered adoption; instead, it reweights the comparison group by combining inverse propensity score weighting with an outcome regression. For the effects by quartile, we estimate Equation 14 weighting control firms with the same propensity scores.

3.c Descriptive Statistics

Table 1 presents summary statistics for motor vehicle exporters and for firms in the baseline control group, averaged over our study period (2018–2024). Motor vehicle exporters are much larger than control firms, with about 7,200 workers on average compared with about 1,300, and pay higher wages. Both groups source a similar share of their inputs and of their steel from the U.S. and Canada.

Table 1: Summary Statistics for Motor Vehicles and the Baseline Control Group

Motor Vehicles					
Number of Firms:					15
Number of Establishments:					36
Total Employment:					106,728
Variable	Mean	Std Dev	p25	p50	p75
Number of Establishments	2.3	1.6	1.0	2.0	3.6
Share of Exports to North America	78.9	19.1	66.9	84.4	94.2
Share of Exports to North America with Tariff	36.1	39.8	3.4	19.0	68.8
Share of US-Can Inputs	49.1	34.5	17.2	48.9	82.3
Share of US-Can Steel	50.2	37.2	13.0	55.8	82.5
Number of Workers	7,243.7	5,739.2	2,925.6	5,226.1	11,379.8
Daily Wage for Manuf Workers (MXN)	704.6	176.9	564.1	698.9	860.2
Baseline Control Group (Co-clustering, $\pi_\ell > 0.3$)					
Number of Firms:					388
Number of Establishments:					709
Total Employment:					488,437
Variable	Mean	Std Dev	p25	p50	p75
Number of Establishments	1.8	3.7	1.0	1.0	1.8
Share of Exports to North America	77.5	32.0	66.4	95.2	100.0
Share of Exports to North America with Tariff	66.6	39.9	27.3	95.7	100.0
Share of US-Can Inputs	49.0	31.2	19.3	53.4	77.4
Share of US-Can Steel	49.2	33.8	14.2	52.2	81.0
Number of Workers	1,284.3	1,960.6	391.8	688.7	1,349.8
Daily Wage for Manuf Workers (MXN)	481.6	199.7	361.3	437.5	541.3

4 Empirical Strategy

We estimate a firm-level Difference-in-Differences specification to assess the effect of the USMCA's more stringent regulations. We compare motor vehicle exporting firms, whose RoO became stricter, to exporters of other similarly complex manufactured goods, whose RoOs remained unchanged. We estimate the following equation:

$$y_{i,t} = \alpha_i + \gamma_t + \sum_{j \neq t_0} \tau_j \mathbb{1}(j = t) \times AutoExp_i + \epsilon_{i,t} \tag{13}$$

Where $y_{i,t}$ represents the outcome of interest for firm i at time t (share of exports subject

to tariffs, the share of inputs from the U.S. and Canada, among other outcomes). The firm fixed effects are α_i and the year $\times$ calendar-quarter fixed effects are γ_t. $AutoExp_i$ is a dichotomous variable that takes the value of 1 if the firm is a motor vehicle exporter and 0 if it is a similar manufacturing exporter, and $\mathbb{1}(j = t)$ is a time indicator for each quarter of our window of study, from the first quarter of 2018 to the third quarter of 2024. Our coefficients of interest are τ_j – the estimates of the effect of USMCA. We use the third quarter of 2019 as our omitted period: it is the last quarter before the Protocol of Amendment, signed in December 2019, resolved the uncertainty about the agreement's ratification. Normalizing relative to this quarter lets the event-study coefficients capture any anticipatory adjustment between ratification and the agreement's entry into force in July 2020, and ensures the reference period predates the COVID-19 pandemic.

Heterogeneous Effects of USMCA by Input Composition

We then test the predicted inverse U-shape in the response in terms of the intensity of use of inputs from the U.S. or Canada by motor vehicle manufacturers based on their degree of integration with the block by estimating their responses in groups according to quartiles of integration. We measure integration using the share of U.S. and Canadian inputs before USMCA (2018q1–2019q3), therefore assuming that firms that imported more from the U.S. and Canada relied more on production within the bloc.[9] Specifically, we estimate the following difference-in-differences equation:

$$y_{i,t} = \alpha_i + \gamma_t + \sum_{q=1}^{q=4} \gamma_q Post_t \times AutoExp_i \times Q^{Pre}_{I,q(i)} + \epsilon_{i,t} \qquad \text{where} \tag{14}$$

$$Q^{Pre}_{I,q(i)} = \mathbf{1}\{USCanShare^{Pre}_{I,i} \in \text{Quartile } q\} \qquad \text{and} \qquad USCanShare_{I,i} = \frac{M^{\text{U.S. and Canada}}_{I,i}}{M^{\text{World}}_{I,i}};$$

$Q^{Pre}_{I,q(i)}$ is a dummy indicating the quartile of the automotive industry q of firm i's share of imports (M) of input I from the U.S. and Canada ($USCanShare^{Pre}_{I}$), where I corresponds

[9] We do not observe the Mexican input content, so we use the share of US and Canada as a proxy for the share of inputs from within the bloc.

to (1) all inputs, (2) steel and aluminum, or (3) core parts. The $USCanShare_I^{Pre}$ is measured over the pre-USMCA period, from the first quarter of 2018 to the third quarter of 2019. $y_{i,t}$ is our outcome that varies across specifications, including the share of firm i's exports subject to tariffs and its share of inputs from the U.S. and Canada at time t. α_i are firm fixed effects, and $Post_t$ is a dummy variable that takes the value 1 from the fourth quarter of 2019 onward, after the Protocol of Amendment resolved uncertainty about the agreement's ratification. Equation 14 does not include the uninteracted $Post_t$ dummy. Therefore, there is no reference quartile and the coefficients of interest γ_q are absolute (not relative) effects.

Threats to Identification

A challenge to identification is that USMCA implementation coincided with severe disruptions to economic activity caused by the COVID-19 pandemic. The pandemic also disrupted global production, affecting input supply (particularly the microchip shortage in 2021, which significantly affected the automotive and electronics industries). If businesses had to switch input suppliers due to unavailability, our 2021 results could be contaminated. However, this threat is mitigated in later years as supply disruptions gradually resolve. In Section 5, we re-estimate our main specification excluding the years when the pandemic and the microchip shortage were most severe. Moreover, the paper's main result is the heterogeneous response of automakers, where common shocks to the automotive industry cancel out.

A second concern is whether exporters in the control industries provide a credible counterfactual for automakers, which are larger (Table 1). Two features of our design address this concern. First, the data select control industries through the co-clustering procedure described in Section 3, which accounts for firm size. Second, the absence of differential pre-trends in our event-study estimates indicates that, before the USMCA, automakers' and control firms' outcomes evolved in parallel, suggesting the control group reasonably proxies what would have happened to automakers absent the tighter rules of

origin. In Section 5, we further show that our estimates are similar under three alternative control groups—a stricter co-clustering threshold, a firm-level matched sample, and machinery and equipment exporters—and under a doubly robust estimator.

5 Results

With the introduction of USMCA, the share of exports to the United States and Canada subject to tariffs increased by about 8 percentage points (pp) more for automakers than for other similar manufacturing exporting firms unaffected by USMCA on average over the period of study, an effect that is statistically significant at the 10% level. Figure 5 presents the estimates of Eq. 13, in which we observe a gradual increase in the share of exports paying tariffs until reaching an increase of about 20 pp in mid-2022 and continuing to rise to about 30 pp by 2024. Column 1 of Table 2 presents the average effect across periods.

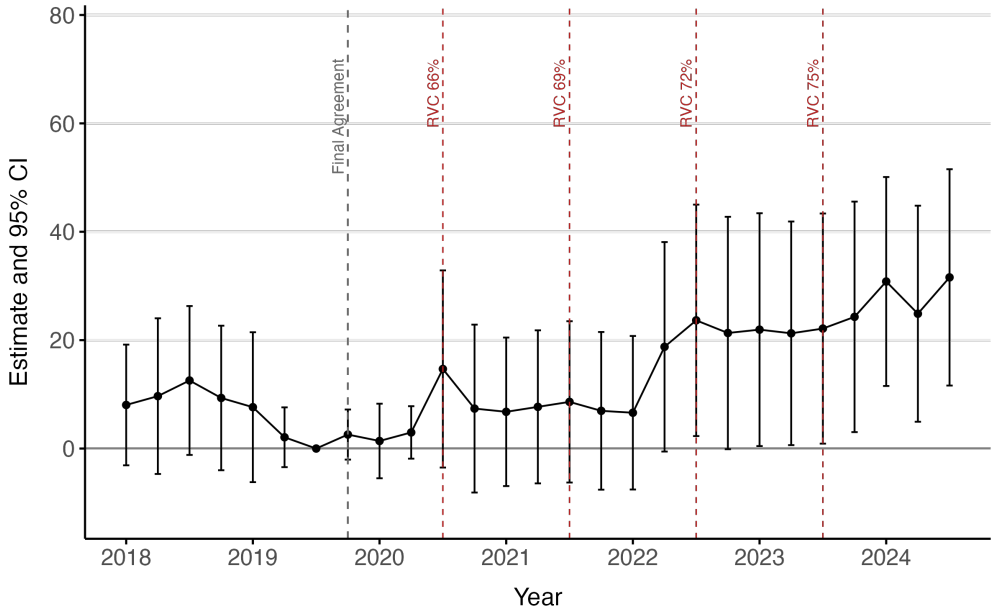


Figure 5: Share of Exports to the U.S. and Canada Subject to Tariffs

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3). Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

The increase in the share of exports to the U.S. and Canada that are subject to tariffs

was greater for passenger vehicles (cars) than for light trucks. The MFN tariff is 2.5% for cars and 25% for light trucks. Firms must weigh compliance costs against tariff costs, and if compliance costs are similar, a higher tariff makes it more likely the firm will opt to comply (Prediction 3 in Section 2). Although we lack data on compliance costs, the response aligns with the idea that higher tariffs increase compliance. Consistently, Figure 6 documents that light trucks, which face a higher tariff, are less likely to become non-compliant with the rule of origin.

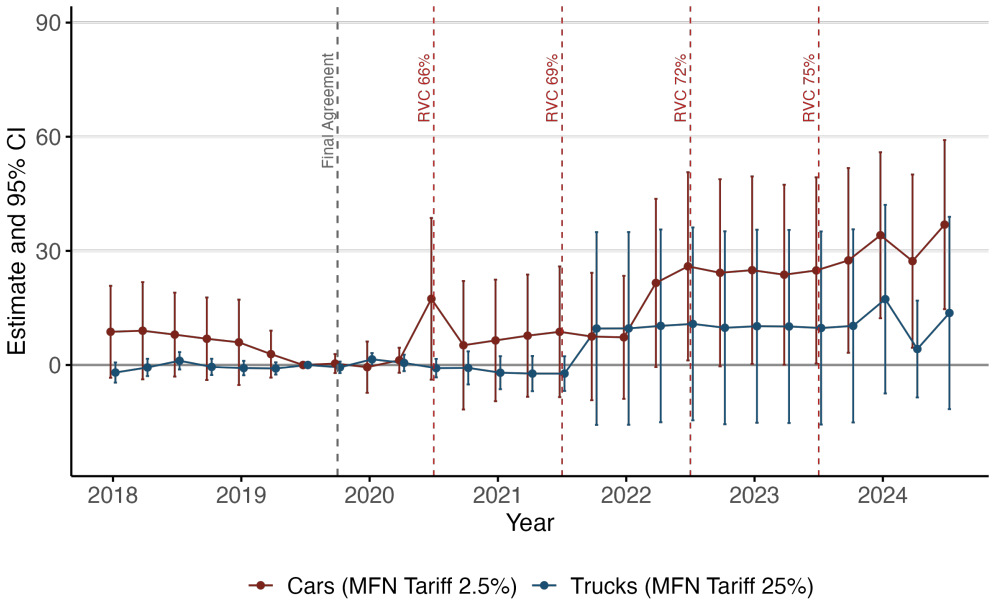


Figure 6: Share of Exports to the U.S. and Canada Subject to Tariffs: Cars vs. Light Trucks

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3), separately for passenger vehicles and light trucks. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

The average share of inputs from the U.S. and Canada increased by 3 pp (Column 2 of Table 2), and the probability that an automaker increased this share by at least 5 pp rose by 10 pp (Column 4). The average share of American and Canadian steel imports increased by 4.4 pp, but it is not statistically significant (Column 3 of Table 2). Figure 7 displays the dynamic pattern of the effect on the share of inputs from the United States and Canada. For all automakers, the quarterly coefficients are positive after the introduction of the

Table 2: Impact of the USMCA on Trade Dynamics

	Share of Exports with Tariff (1)	Share of US-Can Inputs (2)	Share of US-Can Steel (3)	Prob. of Increasing US-Can Input Share ≥5pp (4)
Panel A: Post from 2019q4 (Protocol of Amendment)				
Automaker × *post*	8.141*	3.014**	4.353	0.101*
	(4.445)	(1.251)	(2.742)	(0.055)
N	9,116	10,220	9,239	10,215
Panel B: Post from 2020q3 (entry into force), excluding 2019q4–2020q2				
Automaker × *post*	10.360*	3.523**	4.856	0.121*
	(5.311)	(1.422)	(3.034)	(0.064)
N	8,111	9,085	8,206	9,081
Clustered standard errors at the firm level in parentheses				
* p<0.10, ** p<0.05, *** p<0.01				

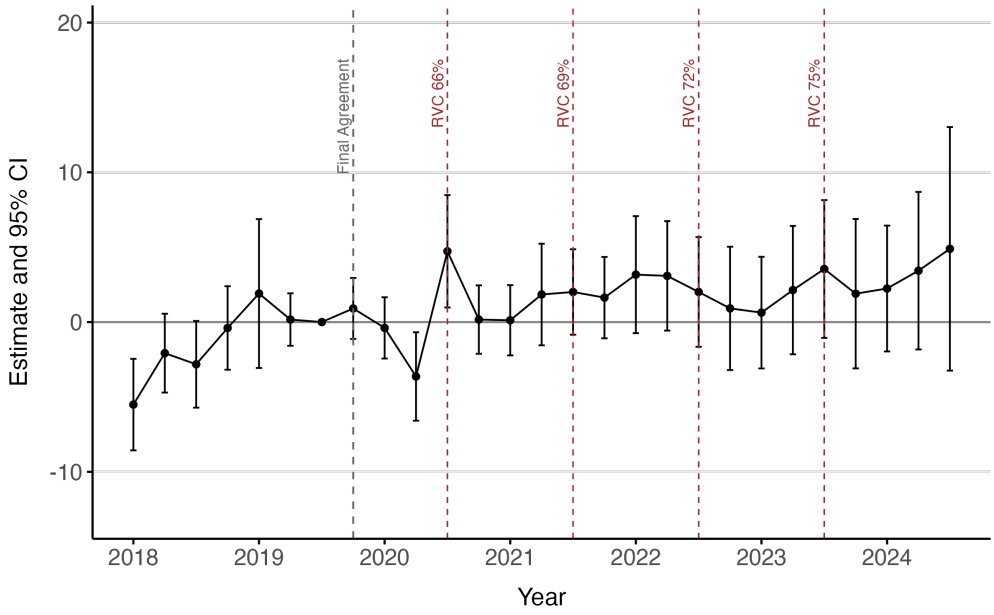
Note: The table presents the effect of the USMCA using the baseline control group (industries with $\pi_\ell > 0.3$). *Automaker* is a dummy that equals 1 if the firm is a Motor Vehicle Exporter and 0 if it exports other, similarly complex manufacturing goods. In Panel A, *post* equals 1 from the fourth quarter of 2019 onward. In Panel B, *post* equals 1 from the third quarter of 2020 onward, when the USMCA entered into force, and excludes the quarters between the reference period and entry into force. The interaction *Automaker* × *post* captures the differential effect of the USMCA on motor vehicle exporters relative to other similar manufacturing exporters. Columns 1–3 are in percentage points; Column 4 is a probability. All models include firm and quarter fixed effects.

USMCA but are estimated imprecisely and are not individually significant. In contrast, as we show below, the dynamic response of automakers in the second quartile of ex-ante integration is statistically significant (Figure 10).

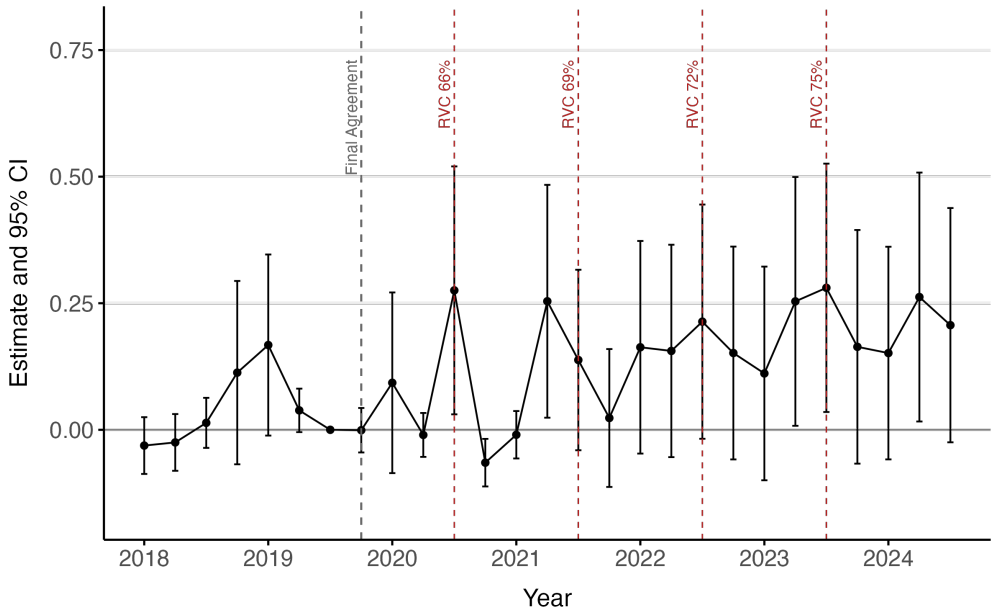
The effect on the share of exports subject to tariffs is likely heterogeneous between firms. Firms that were not complying before USMCA and chose to pay the tariff rather than adjust their production processes to the new RoO should drive the tariff effect. On the other hand, some firms may not have been compliant with the new USMCA rules but adjusted their production processes to source more inputs from the bloc and comply. These firms drive the effect on the share of inputs from the U.S. and Canada.

Effects by Ex-ante Input Composition

There are three potential groups of automakers based on how the change in incentives of the USMCA affected their behavior based on their individual relative cost of the tariff and the adjustment of the production process. The first group, *ex-ante compliers*, includes those already in compliance with the RoO of the USMCA before its implementation, for



Panel A: Share of Inputs from U.S. and Canada



Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure 7: Effect on Share of Inputs from U.S. and Canada

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

whom the new regulations did not affect incentives. The second group, *compliers*, consists of those who adjusted their production process to comply with the new rules and avoid paying the tariff. Finally, the third group, *non-compliers*, are those that opted to pay the tariff.

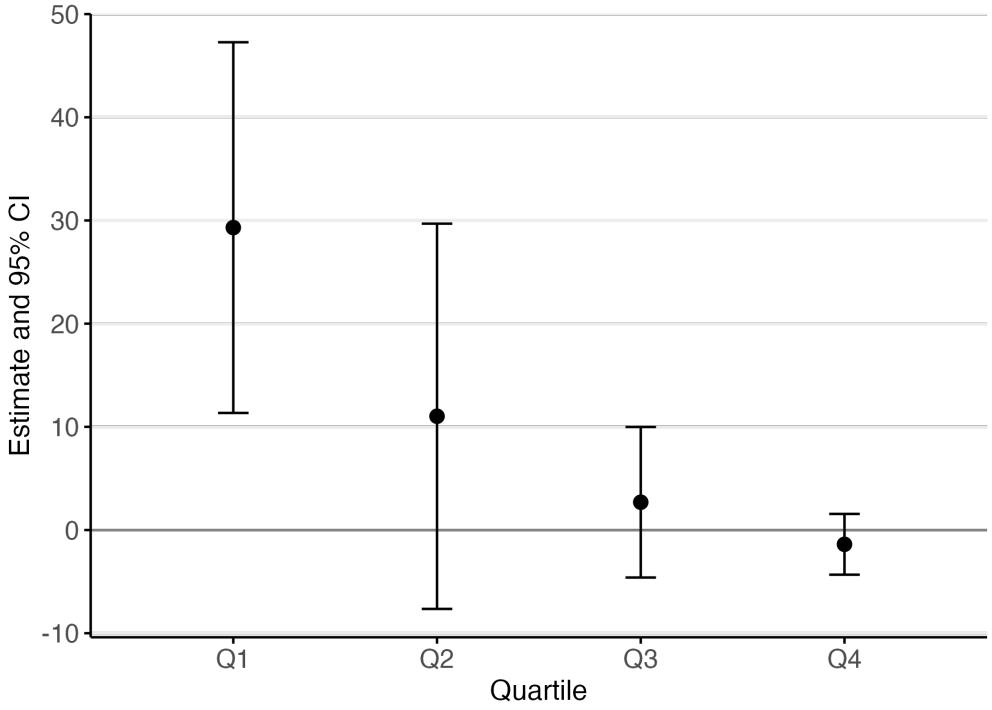


Figure 8: Share of Mexican Exports Subject to Tariffs

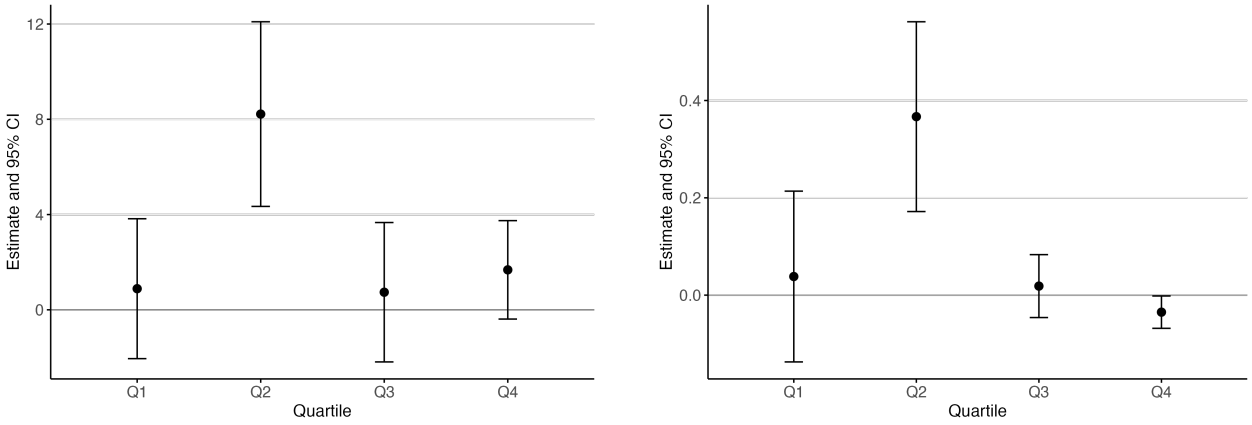
Notes: Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.

Overall, the less integrated an automaker is into the bloc, the higher the costs of complying with the new rules. As a result, it is more likely to be a *non-complier* that pays the tariff. Conversely, the more integrated a firm is into the bloc, the more likely it is to have been an *ex-ante complier*. We evaluate how integrated an automaker is into the bloc—and thus their likelihood of being in these different groups—by examining the share of imported inputs from the U.S. and Canada prior to the USMCA.

Prior to the USMCA, the automotive industry was paying virtually zero tariffs to export to the U.S. and Canada. Therefore, we would expect the automakers least integrated into the bloc to be those who experience the largest increase in their share of exports sub-

ject to tariffs. This is indeed what we observe in Figure 8, consistent with Prediction 1. For the least integrated group, the first quartile, the share of exports subject to tariffs increased dramatically, by nearly 30 pp (Column 1 of Table 3). When ex-ante integration is measured with the U.S.-Canada share of steel and aluminum or core-part imports, the largest increases are again in the bottom half of the distribution, although they are estimated less precisely (Online Appendix Table B.4).

We now proceed to test the inverse U-shape pattern in automakers' responses in terms of the change in the share of inputs from the bloc based on their degree of ex-ante integration into the bloc. The inverse U-shape is expected to arise because the *non-compliers* and the *ex-ante compliers* do not adjust their production process to source more inputs from the bloc, and only those in between, the *compliers*, are increasing their sourcing of inputs from the bloc to avoid paying tariffs.



Panel A: Share of Inputs from U.S. and Canada

Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure 9: Inverse U-Shape Response: Effect on Share of Inputs from U.S. and Canada

Notes: Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.

As Prediction 2 states, firms' responses exhibit an inverse U-shape pattern. Firms in the second quartile show the largest increase in their share of inputs sourced from North America (8 pp; Figure 9). This indicates that firms with intermediate share of North American inputs were the most responsive to the new requirements, as they were likely the ones

Table 3: Effects by Ex-ante Integration into the Bloc

	Share of Exports with Tariff (1)	Share of US-Can Inputs (2)	Share of US-Can Steel (3)	Prob. of Increasing US-Can Input Share ≥5pp (4)
Automaker × *post* × *Q1*	29.308***	0.887	7.015*	0.038
	(9.135)	(1.494)	(3.624)	(0.089)
Automaker × *post* × *Q2*	11.024	8.218***	11.078***	0.367***
	(9.495)	(1.972)	(3.512)	(0.099)
Automaker × *post* × *Q3*	2.693	0.739	-1.610	0.019
	(3.711)	(1.488)	(5.364)	(0.033)
Automaker × *post* × *Q4*	-1.384	1.678	1.676	-0.035**
	(1.497)	(1.051)	(5.162)	(0.017)
N	9,116	10,220	9,239	10,215
Clustered standard errors at the firm level in parentheses * p<0.10, ** p<0.05, *** p<0.01				

Note: The table presents the estimates of γ_q in Equation 14, using the baseline control group (industries with $\pi_\ell > 0.3$). Q1–Q4 are the quartiles of the automotive industry distribution of the share of inputs imported from the U.S. and Canada, measured from the first quarter of 2018 to the third quarter of 2019. Each coefficient is the total (not relative) effect for the corresponding quartile. *post* equals 1 from the fourth quarter of 2019 onward. Columns 1–3 are in percentage points; Column 4 is a probability. All models include firm and quarter fixed effects.

closest to, but below, the compliance threshold. For firms in this group, increasing their input share, despite incurring higher costs, proved to be more profitable than paying tariffs. Conversely, firms with either very low or very high pre-USMCA North American input shares (quartiles 1, 3, and 4) did not make substantial adjustments. The first quartile likely includes the *non-compliers* who opted to pay the tariff instead, a pattern consistent with the effect on paying tariffs (Figure 8). In contrast, the third and fourth quartiles are likely *ex-ante compliers* because they did not have to increase their input sourcing from the bloc in order to avoid paying additional tariffs. The inverse U-shape is also present when automakers are grouped into quintiles (Online Appendix Figure C.11).

Having identified the second quartile as the locus of adjustment, we now turn to the dynamics of its response. Specifically, we re-estimate Equation 13 restricting the treated group to motor vehicle exporters whose pre-USMCA share of inputs from the United States and Canada falls in the second quartile of the within-industry distribution. Automakers in the first, third, and fourth quartiles are dropped from the estimation, while the control group is unchanged.

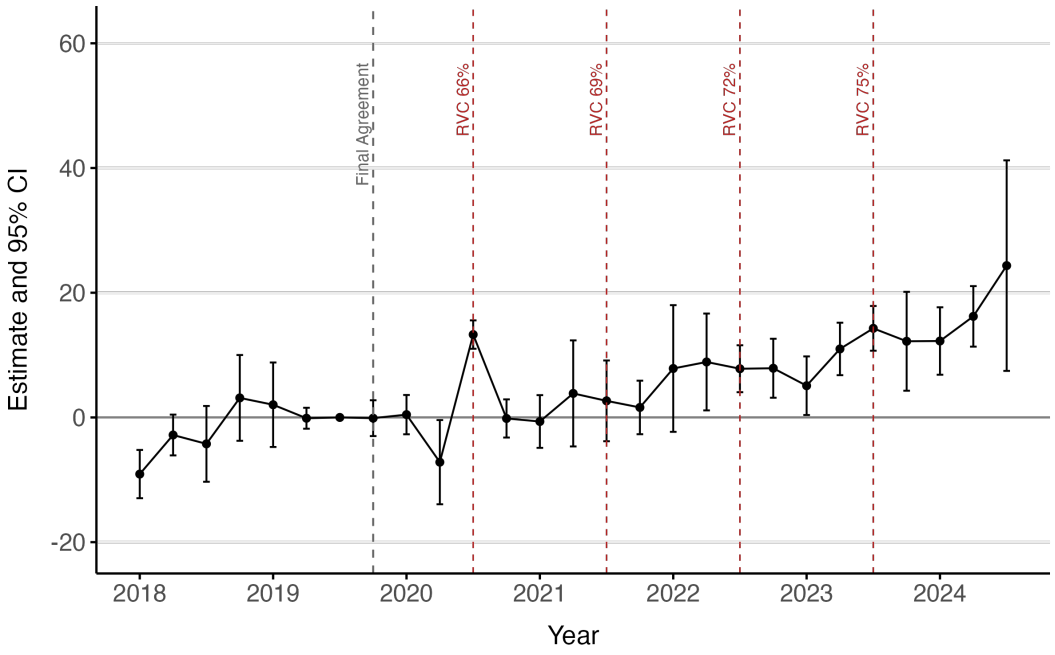


Figure 10: Effect on Share of Inputs from U.S. and Canada—Second-Quartile Automakers

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3), estimated from Equation 13 on the subsample of motor vehicle exporters in the second quartile of the pre-USMCA distribution of the share of inputs imported from the United States and Canada, together with the full set of other similar manufacturing exporters as control. We exclude auto exporters in the first, third, and fourth quartiles from the estimation. Error bars represent 95% confidence intervals, with standard errors clustered at the firm level. The vertical dashed line represents the signing of the USMCA (gray) and the dates of its implementation stages (red).

Figure 10 reports the dynamic difference-in-differences estimates for the share of inputs sourced from the United States and Canada among second-quartile automakers. Three patterns emerge. First, pre-USMCA coefficients show no systematic trend and cluster around zero, supporting the parallel-trends assumption for this subsample and ruling out the alternative interpretation that second-quartile automakers were on a differential trajectory for reasons unrelated to the agreement. Second, the response in the share of regional inputs is substantially larger than the 3 percentage point average effect estimated for all automakers in Column 2 of Table 2, consistent with second-quartile firms accounting for the bulk of the adjustment captured by the average. Third, the increase emerges after July 2020 and persists through the end of the sample, mirroring the timing of USMCA's entry into force and its phased thresholds. Taken together with the near-zero responses

in the first, third, and fourth quartiles, this evidence indicates that the inverse U-shape in Figure 9 reflects a genuine, time-localized strategic response by firms whose ex-ante input composition placed them inside the trapped region of the conceptual framework.

Robustness

Our identifying variation comes from the unexpected renegotiation of NAFTA and the cross-industry variation in the changes for the RoO. In particular, while comparing automakers to other manufacturing exporters before and after USMCA, three concerns could threaten the validity of the difference-in-difference comparison: (i) the control group is not a credible counterfactual for automakers, (ii) the pandemic and the 2021 microchip shortage differentially affected the automotive sector, and (iii) the post-treatment window is mis-specified given the phased entry into force of USMCA. Across these exercises, the estimates are qualitatively similar to those of the main specification..

Control-group composition. We re-estimate the main results under three alternative control groups and two reweighted specifications; Online Appendix Table B.2 reports the average effects under each alternative control group. Raising the co-clustering threshold to $\pi_\ell > 0.4$ imposes a stricter similarity criterion that trades sample size for comparability (Online Appendix Figures C.1, C.6, C.12, C.17, C.22, and C.27). Matching automakers to machinery and equipment exporters on pre-USMCA wages, employment, and regional input shares addresses the same concern of finding a comparable control group as the clustering but at the firm rather than the industry level (Figures C.2, C.7, C.13, C.18, C.23, and C.28). Using exporters of machinery and equipment instead of the clustering procedure provides a transparent benchmark whose firms source a similar share of their inputs from the U.S. and Canada as automakers but whose rules of origin largely remained unchanged (Figures C.3, C.8, C.14, C.19, C.24, and C.29).

We also re-estimate the machinery-and-equipment and baseline specifications with the doubly robust estimator of Sant'Anna and Zhao (2020), which reweights the comparison

group by combining inverse propensity score weighting on pre-USMCA wages, employment, and regional input shares with an outcome regression and remains consistent if either component is correctly specified. For the effects by quartile, we weight control firms in Equation 14 with the same propensity scores. Because all automakers are treated at the same date, the estimator is used here for this reweighting and not as a correction for staggered adoption (Figures C.4, C.9, C.15, C.20, and C.25 for machinery and equipment; Figures C.5, C.10, C.16, C.21, and C.26 for the baseline group).

Pandemic-era confounding. USMCA's entry into force overlapped with the COVID-19 shock and the 2021 microchip shortage, both of which were particularly disruptive to the auto sector. We re-estimate Table 2 dropping the years when the pandemic and the microchip shortage were most severe (Online Appendix Table B.3, Panel C). The point estimates remain positive and are larger for the share of exports with tariffs and the share of regional inputs, which can be explained by the staggered implementation of the higher RoO.

Treatment-window specification. The final version of the USMCA was signed in December 2019 (gray dashed line in our event-study figures) and implemented in four phased RVC thresholds beginning July 2020 (red dashed lines). This generates ambiguity about when the post-treatment period should begin. In addition to our main specification, we estimate two alternative specifications. The first redefines the post indicator to switch on at the first implementation date, and the second at the last one; both hold the pre-period fixed and exclude all periods in between (Panel B of Table 2 and Online Appendix Table B.3). The estimated effect remains positive across specifications and, consistent with the event-study pattern in Figure 5, grows as the post-period is restricted to later phases of the rollout.

6 Pass-through Discussion: Effect on Prices

Stricter rules of origin increase costs for automakers that were not complying ex-ante, as they must now either pay a tariff or adjust their production processes to comply. In this section, we estimate the effect of the USMCA's new rules on the prices in the United States of cars produced within the USMCA region that were not ex-ante in compliance with the USMCA using the following estimating equation,

$$p_{v,t} = \alpha_{i(v)} + \gamma_{c(i),t} + \sum_{j \neq t_0} \tau_j \mathbb{1}(j = t) \times NonComp^{Pre}_{i(v)} + \epsilon_{v,t} \tag{15}$$

where $p_{v,t}$ is the log price of car v, identified by its VIN, sold at time t, which we measure as the date on which the listing was removed from the dealer's portal; $i(v)$ denotes the car's model and trim and $c(i)$ the company that produces it; $\alpha_{i(v)}$ and $\gamma_{c(i),t}$ are the model $\times$ trim and time $\times$ company fixed effects; $NonComp^{Pre}_{i}$ is a dummy variable that equals one if model and trim i was not produced in compliance with the USMCA rules of origin before the agreement came into force.

For our main specification, we consider cars sold in the United States and manufactured within the USMCA region, and we maintain a balanced panel of retailers between 2021 and 2024. We compare compliant and non-compliant model-trims produced within the region, rather than vehicles produced in Mexico and Canada with those imported from other origins, so that our estimates are not confounded by origin-specific shocks to the cost of shipping vehicles to the United States, such as the surge in international freight costs in 2021 and 2022.

We construct $NonComp^{Pre}_{i}$ by matching each VIN to its specific model and trim in the AALA Reports for model years 2017 to 2019 (see Section 3). The USMCA requires a regional value content (RVC) of at least 75% for passenger vehicles and light trucks and requires core parts, such as the engine and the transmission, to originate in the region. Because the AALA Reports do not directly measure the RVC, we approximate it

as $RVC_i = x + (1 - x)\, s_i$, where s_i is the share of parts content from the U.S., Canada, and Mexico, and $x = 0.15$ is the share of assembly in the vehicle's value, which counts as regional because all vehicles in our sample are assembled within the USMCA region.[10] We classify a model and trim as non-compliant if its approximated RVC is below the 75% legal requirement or if its engine or transmission originates outside the USMCA region. Because our approximation understates the RVC, model-trims classified as compliant are likely to meet the USMCA requirements, while some compliant model-trims may be classified as non-compliant; such misclassification would bias our estimates toward zero.

The estimates may also be a lower bound because we include time $\times$ company fixed effects, which remove company-specific shocks, such as input shortages. Therefore, we observe price effects only if carmakers pass through the additional model-specific cost increases to the models with the cost increase. For example, if, as a response to the cost increase in vehicle A due to USMCA's new rules, the manufacturer increased the price of model A and model B (which was not affected by USMCA), then the estimated effect on A's price would be biased downward since the *control* group also experienced a price increase.

Relative to May 2021 prices, cars that were not ex-ante compliant with USMCA experienced a 2% larger price increase than those that were. Online Appendix Figure C.30 reports the estimates separately for cars and light trucks. This effect becomes evident toward the end of 2021 and persists through the end of our data span in mid-2024, without the 72% and 75% rules of origin having additional effects. The estimates suggest at least an 80% pass-through to consumers, since the maximum possible cost increase is 2.5% (the tariff's value). We interpret our results as suggestive because our price data start in 2021, after the first phase of the USMCA entered into force.

[10] The AALA content refers to parts only, whereas a vehicle's value comprises parts and assembly. Estimates of the assembly share range from 15% (Head et al., 2024) to 36% (INEGI, 2020); we use the lower bound. In addition, the AALA Reports record Mexican parts content only when Mexico is one of the two largest non-U.S./Canadian sources and accounts for at least 15% of the parts content; otherwise, it enters s_i as zero. Both features bias our approximation of the RVC downward.

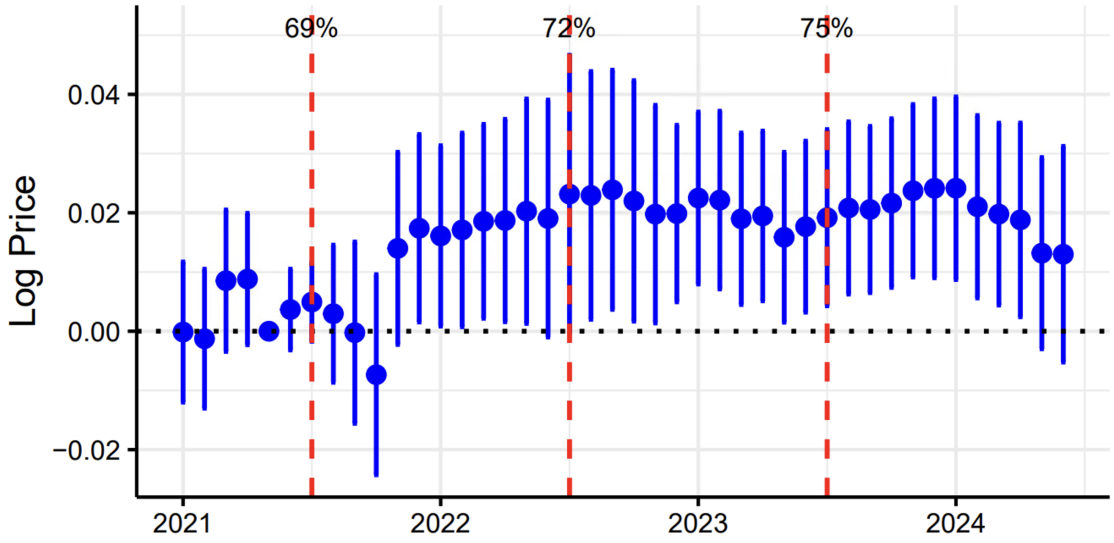


Figure 11: Price Effects on Affected Models and Trims

Notes: The figure displays the effect of USMCA rules on prices of vehicles that were not ex-ante complying with the additional requirements, estimated using equation 15. Standard errors are clustered at the automaker level, and all coefficients are displayed with 95% confidence intervals. The dotted red lines indicate the point in time at which the RoO for cars increased.

7 Conclusions

This paper provides novel empirical evidence on how firms strategically respond to stricter RoO by leveraging transaction-level customs data from Mexico and the exogenous policy shock introduced by the renegotiation of the USMCA. Aligning with theoretical predictions, our findings reveal an inverse U-shaped relationship between firms' pre-existing regional integration and their responses to the new RoO. Firms with low and high levels of ex-ante North American integration adjust the least, while those with intermediate levels respond the most. Consequently, firms with lowest ex-ante integration end up paying tariffs rather than sourcing more inputs from the region. This finding underscores that when RoO are too strict, they may fail to promote stronger regional integration.

The more stringent USMCA rules can significantly impact welfare. First, they have increased U.S. government revenue from tariff collection, and the use of that revenue should enhance welfare. However, these stricter rules come with various costs. Initially, there is

the cost of inefficiency inherent in any definition of RoO, no matter how stringent: since firms now need to solve a constrained profit optimization problem, profits may be lower, and costs are likely to be higher. These increased costs, whether from paying tariffs or adjusting production processes, will be passed on to consumers to some extent, affecting the welfare of consumers who buy cars or use services impacted by car costs (e.g., ride-hailing). Moreover, there could be spillover effects in automakers' pricing strategies. Firms that did not encounter increased costs because they were already complying with the new rules may see an opportunity: as their competitors raise prices, they can improve their markups by doing the same. Additionally, any inefficiency will have a cost in terms of the region's competitiveness, and may put it in a disadvantageous position to compete with the rest of the world in car production.

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ONLINE APPENDIX

Firms' Strategic Responses to Rules of Origin: Evidence from the USMCA

by Angel Espinoza E, María José Orraca, and Miguel Ángel Talamás Marcos

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A Parametrization of the Conceptual Framework

Figures 2–4 are generated from a parametrized version of the model in Section 2. The values are illustrative, not estimated: they are chosen to satisfy a small set of inequalities, described below, that determine the shapes of the curves. Other values satisfying the same inequalities move the peaks and magnitudes but not the shapes, which is why the figures show no values on the vertical axes. All objects have closed forms, so the figures require no optimization or simulation.

Two Kinds of Firms in the Trapped Region

Because firms chose their sourcing optimally under the initial rule, a firm sources above its unrestricted cost-minimizing share, $s_i^0 > s_i^*$, only if that rule binds for it. The trapped region $\underline{s} \leq s_i^0 < \bar{s}$ therefore contains two kinds of firms:

- *Unconstrained firms.* Their unrestricted cost-minimizing share is at or above the initial threshold, so they source exactly that share: $s_i^0 = s_i^*$ and $\kappa_i = 0$. Disintegrating would leave their sourcing unchanged, so they choose between complying, at cost $c\,(\bar{s} - s_i^0) + F$, and paying the tariff, at cost τV.
- *Constrained firms.* Their unrestricted cost-minimizing share is below the initial threshold, $s_r^* < \underline{s}$, and they source more from the region only to avoid the tariff under the initial rule. Their integration cost is $C_r(d) = c_r\, d$. They choose among the three options of Section 2: complying, at $c_r(\bar{s} - s_r^*) + F$; staying, at $\tau V + \kappa_i$, with $\kappa_i = c_r(s_i^0 - s_r^*)$; and disintegrating, at $\tau V + F$.

Constrained firms sit at the initial threshold or within a safety margin of L percentage points above it, because the regional content of a vehicle is uncertain (it moves with input prices, exchange rates, and the tracing of suppliers' content) and falling below the threshold means paying the tariff. Among firms with ex-ante share s, the share of constrained

firms is

$$w(s) \;=\; 1 - 3x^2 + 2x^3, \qquad x = \frac{s - \underline{s}}{L}, \qquad \text{for } \underline{s} \le s < \underline{s} + L, \tag{16}$$

and zero otherwise. All firms exactly at $\underline{s}$ are constrained, and all firms above $\underline{s} + L$ are unconstrained. Between these two points, $w(s)$ falls smoothly from one to zero, with no kinks at either end.

Heterogeneity and Choice Probabilities

Firms of the same kind and with the same ex-ante share face the same costs $K_a(s)$ for each option a, listed in Table A.1. The fixed cost F, the supply chain restructuring cost, is common to all firms. Heterogeneity comes from firm-specific shocks: firm i's cost of option a is $K_a(s_i^0) + \varepsilon_{ia}$, where ε_{ia} is i.i.d. type-I extreme value with scale σ, independent of s_i^0. The shocks capture differences across firms in export values, integration costs, and supplier networks that the model does not otherwise represent. They are drawn once and are permanent, so firms outside the trapped region, whose options are unchanged or became less attractive, keep their choice under the initial rule. The share of firms with ex-ante share s that choose option a is

$$P_a(s) \;=\; \frac{\exp(-K_a(s)/\sigma)}{\sum_{a'} \exp(-K_{a'}(s)/\sigma)}, \tag{17}$$

where the sum runs over the two options of unconstrained firms or the three options of constrained firms.

The figures average over firms with the same ex-ante share. Writing P_a^u and P_a^r for the choice probabilities of unconstrained and constrained firms, the objects in Figures 3 and 4

Table A.1: Options and Costs in the Parametrized Model

Option a	New share	Cost $K_a(s)$	
		Unconstrained	Constrained
Comply	$\bar{s}$	$c\,(\bar{s}-s)+F$	$c_r(\bar{s}-s_r^*)+F$
Pay tariff, keep sourcing	s	τV	$\tau V + c_r(s-s_r^*)$
Pay tariff, disintegrate	s_r^*	—	$\tau V + F$

Notes: s is the firm's ex-ante regional input share. Unconstrained firms already source their unrestricted cost-minimizing share, so disintegrating is not a distinct option for them.

are, for s in the trapped region,

$$p(s) = \big(1 - w(s)\big)\, P^u_{\text{comply}}(s) \;+\; w(s)\, P^r_{\text{comply}}(s), \tag{18}$$

$$\mathbb{E}[\Delta T] = \tau V \,\big(1 - p(s)\big), \tag{19}$$

$$\mathbb{E}[\Delta s] = p(s)\,(\bar{s} - s) \;-\; w(s)\, P^r_{\text{disint}}(s)\,\big(s - s_r^*\big), \tag{20}$$

and zero outside it. Equations (19) and (20) are the parametrized counterparts of equations (9) and (11).

Calibration

Table A.2 reports the values. The thresholds and the tariff are policy values: the NAFTA and USMCA requirements for passenger vehicles and their MFN tariff. We normalize export value to $V = 100$, so that all costs are expressed in percent of export value; as in Section 2, τV and $C(\cdot)$ are present values of recurring flows and F is a one-time cost. The remaining values are assumptions, chosen as follows.

- *Scale of the shocks and unconstrained firms.* We set $\sigma = 0.1$. For an unconstrained firm, complying costs $c\,(\bar{s} - s) + F - \tau V$ more than paying the tariff. We choose c and the high value of F so that this difference equals $+5\sigma$ at $\underline{s}$ and -5σ just below $\bar{s}$. Then 0.7% of unconstrained firms comply at the initial threshold and 99.3% just below the new one, which gives $F = \tau V - 5\sigma = 2$ and $c = 10\sigma/(\bar{s} - \underline{s}) = 8$.

- *Low F.* Panel B of Figure 4, which illustrates a possible case rather than a prediction, sets $F = 0.5$. All other values are the same as in the other panels.
- *Constrained firms.* Two inequalities determine their behavior. First, complying costs them more than the tariff, by the same 5σ margin: $c_r(\bar{s} - s_r^*) = 3 = \tau V + 5\sigma$. Second, the cost of staying lies between the two values of F: $\kappa_i = c_r(s - s_r^*)$ ranges from 1.125 at $\underline{s}$ to 1.875 at $\underline{s} + L$, above the low F (0.5) and below the high F (2). With high F they stay, and fewer than 1% of firms disintegrate at any ex-ante share; with low F, 99% of constrained firms disintegrate. Both inequalities hold with $c_r = 15$, $s_r^* = 55\%$, and $L = 5$ percentage points. Under the initial rule, sourcing at $\underline{s}$ cost them $1.125 < \tau V$ (and at most $1.875 < \tau V$ within the safety margin), so complying with it was optimal, consistent with their being constrained.

Table A.2: Parameter Values in the Conceptual Framework

Parameter	Value	Type	Interpretation
$\underline{s}$, $\bar{s}$	62.5%, 75%	Policy	NAFTA and USMCA requirements
τ	2.5%	Policy	MFN tariff on passenger vehicles
V	100	Normalization	Costs in percent of export value
σ	0.1	Assumption	Scale of the cost shocks
c	8	Assumption	0.7% comply at $\underline{s}$, 99.3% just below $\bar{s}$
F (high / low)	2 / 0.5	Assumption	Restructuring cost: Fig. 3 and Fig. 4A / Fig. 4B
c_r	15	Assumption	Complying costs constrained firms $\tau V + 5\sigma$
s_r^*	55%	Assumption	Unrestricted cost-minimizing share of constrained firms
L	5 pp	Assumption	Safety margin of constrained firms

Notes: *Policy* values come from the rules of origin and tariffs. The *normalization* sets units and does not affect the shapes. *Assumptions* are illustrative values, not estimates. Costs are in percent of the present value of exports; F is a one-time cost.

B Additional Tables

Table B.1: Similarity of Manufacturing Industries to Motor Vehicle Manufacturing

SCIAN	Industry	π_ℓ	SCIAN	Industry	π_ℓ
3352	Household appliances	0.68	3333	Commercial and service machinery	0.17
3363	Motor vehicle parts†	0.59	3315	Metal foundries	0.16
3334	HVAC and refrigeration equipment	0.58	3332	Machinery for manufacturing	0.16
3322	Hand tools and metal kitchenware	0.57	3222	Paper and paperboard products	0.16
3324	Boilers, tanks and metal containers	0.47	3326	Wire products and springs	0.16
3342	Communications equipment	0.43	3261	Plastic products	0.15
3365	Railroad equipment	0.43	3272	Glass and glass products	0.15
3159	Clothing accessories, n.e.c.	0.40	3111	Animal food	0.15
3252	Resins, synthetic rubber and fibers	0.36	3221	Pulp, paper and paperboard	0.14
3254	Pharmaceuticals	0.34	3259	Other chemical products	0.14
3311	Iron and steel basic industry	0.33	3321	Forged and stamped metal products	0.14
3359	Other electrical equipment	0.33	3121	Beverages	0.13
3256	Soaps, detergents and toiletries	0.31	3113	Sugar and confectionery	0.13
3336	Engines, turbines and transmissions	0.30	3313	Aluminum basic industry	0.12
3339	Other general-purpose machinery	0.30	3335	Metalworking machinery	0.11
3364	Aerospace equipment	0.30	3116	Meat processing	0.10
3314	Nonferrous metals, except aluminum	0.29	3132	Fabrics	0.10
3344	Electronic components	0.29	3115	Dairy products	0.08
3331	Farm and construction machinery	0.29	3273	Cement and concrete products	0.07
3325	Hardware and locks	0.28	3212	Plywood and engineered wood	0.06
3345	Measuring and navigation instruments	0.28	3391	Medical and laboratory equipment	0.05
3353	Electric power equipment	0.27	3274	Lime and gypsum products	0.05
3262	Rubber products	0.26	3327	Machine shops and screws	0.04
3328	Metal coating and finishing	0.26	3279	Other nonmetallic mineral products	0.03
3133	Textile finishing and coated fabrics	0.25	3379	Mattresses and window coverings	0.03
3255	Paints, coatings and adhesives	0.25	3118	Bakeries and tortillas	0.03
3114	Preserved fruits and vegetables	0.24	3399	Other manufacturing	0.02
3329	Other fabricated metal products	0.24	3141	Carpets, linens and similar	0.02
3131	Fiber preparation and spinning	0.23	3152	Cut and sew apparel	0.02
3251	Basic chemicals	0.21	3371	Furniture, except office	0.01
3362	Motor vehicle bodies and trailers	0.21	3162	Footwear	0.01
3117	Seafood processing	0.21	3169	Other leather products	0.01
3312	Iron and steel products	0.19	3271	Clay and refractory products	0.01
3241	Petroleum and coal products	0.19	3151	Knit apparel	0.01
3119	Other food manufacturing	0.18	3372	Office furniture and shelving	0.01
3112	Grain and oilseed milling	0.18	3323	Metal structures and ironwork	0.01
3351	Lighting fixtures	0.18	3219	Other wood products	0.01
3253	Fertilizers and agrochemicals	0.17	3149	Other textile products	0.01
3161	Leather tanning and finishing	0.17	3231	Printing and related services	0.00

Notes: π_ℓ is the share of the 10,000 randomized k-means runs in which four-digit industry ℓ is assigned to the same cluster as motor vehicle manufacturing (SCIAN 3361), as defined in equation (12). Industries are listed in descending order of π_ℓ.
†Auto parts are excluded from control groups regardless of π_ℓ, because their rules of origin also tightened under the USMCA and because they supply automakers.

Table B.2: Average Effects under Alternative Control Groups

	Share of Exports with Tariff (1)	Share of US-Can Inputs (2)	Share of US-Can Steel (3)	Prob. of Increasing US-Can Input Share ≥5pp (4)
Panel A: Baseline control group (industries with $\pi_\ell > 0.3$)				
Automaker × post	8.141*	3.014**	4.353	0.101*
	(4.445)	(1.251)	(2.742)	(0.055)
N	9,116	10,220	9,239	10,215
Panel B: Stricter co-clustering threshold (industries with $\pi_\ell > 0.4$)				
Automaker × post	7.181	3.732**	5.118*	0.116**
	(4.720)	(1.519)	(2.932)	(0.058)
N	3,599	3,836	3,677	3,836
Panel C: Matched control group				
Automaker × post	13.242***	1.283	2.690	0.061
	(4.572)	(1.317)	(2.977)	(0.058)
N	3,127	3,284	3,199	3,284
Panel D: Machinery and equipment				
Automaker × post	9.882**	3.130***	4.515*	0.090*
	(4.324)	(1.125)	(2.654)	(0.054)
N	35,345	38,586	33,960	38,478
Clustered standard errors at the firm level in parentheses				
* p<0.10, ** p<0.05, *** p<0.01				

Note: The table re-estimates Panel A of Table 2 under alternative control groups. Panel A reproduces the baseline estimates. In Panel B, the control group comprises industries with $\pi_\ell > 0.4$. In Panel C, control firms are machinery and equipment exporters matched to automakers on pre-USMCA wages, employment, and regional input shares. In Panel D, the control group comprises exporters in the machinery and equipment industries. *post* equals 1 from the fourth quarter of 2019 onward. Columns 1–3 are in percentage points; Column 4 is a probability. All models include firm and quarter fixed effects.

Table B.3: Average Effects under Alternative Definitions of the Post-Treatment Period

	Share of Exports with Tariff (1)	Share of US-Can Inputs (2)	Share of US-Can Steel (3)	Prob. of Increasing US-Can Input Share $\geq$5pp (4)
Panel A: Post from 2019q4 (Protocol of Amendment)				
Automaker $\times$ *post*	8.141*	3.014**	4.353	0.101*
	(4.445)	(1.251)	(2.742)	(0.055)
N	9,116	10,220	9,239	10,215
Panel B: Post from 2020q3 (entry into force), excluding 2019q4–2020q2				
Automaker $\times$ *post*	10.360*	3.523**	4.856	0.121*
	(5.311)	(1.422)	(3.034)	(0.064)
N	8,111	9,085	8,206	9,081
Panel C: Post from 2023q3 (final RVC threshold), excluding 2019q4–2023q2				
Automaker $\times$ *post*	19.645**	4.491*	2.737	0.174*
	(8.650)	(2.440)	(3.235)	(0.095)
N	4,058	4,542	4,116	4,541
Clustered standard errors at the firm level in parentheses				
* p<0.10, ** p<0.05, *** p<0.01				

Note: The table presents the effect of the USMCA using the baseline control group (industries with $\pi_\ell > 0.3$) under alternative definitions of the post-treatment period. Panels A and B reproduce Table 2. In Panel C, *post* equals 1 from the third quarter of 2023 onward, when the final RVC threshold took effect, and the quarters between the reference period and the third quarter of 2023 are excluded. Columns 1–3 are in percentage points; Column 4 is a probability. All models include firm and quarter fixed effects.

Table B.4: Effects by Ex-ante Integration into the Bloc: Alternative Measures of Integration

	Share of Exports with Tariff (1)	Share of US-Can Inputs (2)	Share of US-Can Steel (3)	Prob. of Increasing US-Can Input Share ≥5pp (4)
Panel A: Quartiles of the pre-USMCA U.S.-Canada share of steel and aluminum imports				
Automaker × *post* × *Q1*	19.093	4.634	2.543*	0.253*
	(13.474)	(3.242)	(1.518)	(0.142)
Automaker × *post* × *Q2*	4.426**	4.244**	10.066**	0.147
	(2.104)	(2.039)	(4.460)	(0.112)
Automaker × *post* × *Q3*	9.080	4.064***	10.040***	0.078
	(9.080)	(1.544)	(1.623)	(0.081)
Automaker × *post* × *Q4*	1.952	-0.483	-5.515	-0.035**
	(3.841)	(1.091)	(5.866)	(0.017)
N	9,116	10,220	9,239	10,215
Panel B: Quartiles of the pre-USMCA U.S.-Canada share of core-part imports				
Automaker × *post* × *Q1*	13.645	8.747***	8.848*	0.438***
	(13.893)	(2.077)	(4.558)	(0.078)
Automaker × *post* × *Q2*	18.190**	3.178	5.261	0.119
	(7.561)	(1.950)	(3.570)	(0.075)
Automaker × *post* × *Q3*	2.838	-0.116	2.702	-0.033
	(4.415)	(1.195)	(6.501)	(0.023)
Automaker × *post* × *Q4*	-1.384	1.678	1.676	-0.035**
	(1.497)	(1.051)	(5.162)	(0.017)
N	9,116	10,220	9,239	10,215
Clustered standard errors at the firm level in parentheses				
* p<0.10, ** p<0.05, *** p<0.01				

Note: The table re-estimates Table 3 defining the quartiles of ex-ante integration with the U.S.-Canada share of imports of steel and aluminum (Panel A) and of core parts (Panel B), measured from the first quarter of 2018 to the third quarter of 2019. Each coefficient is the total (not relative) effect for the corresponding quartile, estimated from Equation 14 with the baseline control group (industries with $\pi_\ell > 0.3$). *post* equals 1 from the fourth quarter of 2019 onward. Columns 1–3 are in percentage points; Column 4 is a probability. All models include firm and quarter fixed effects.

C Additional Figures

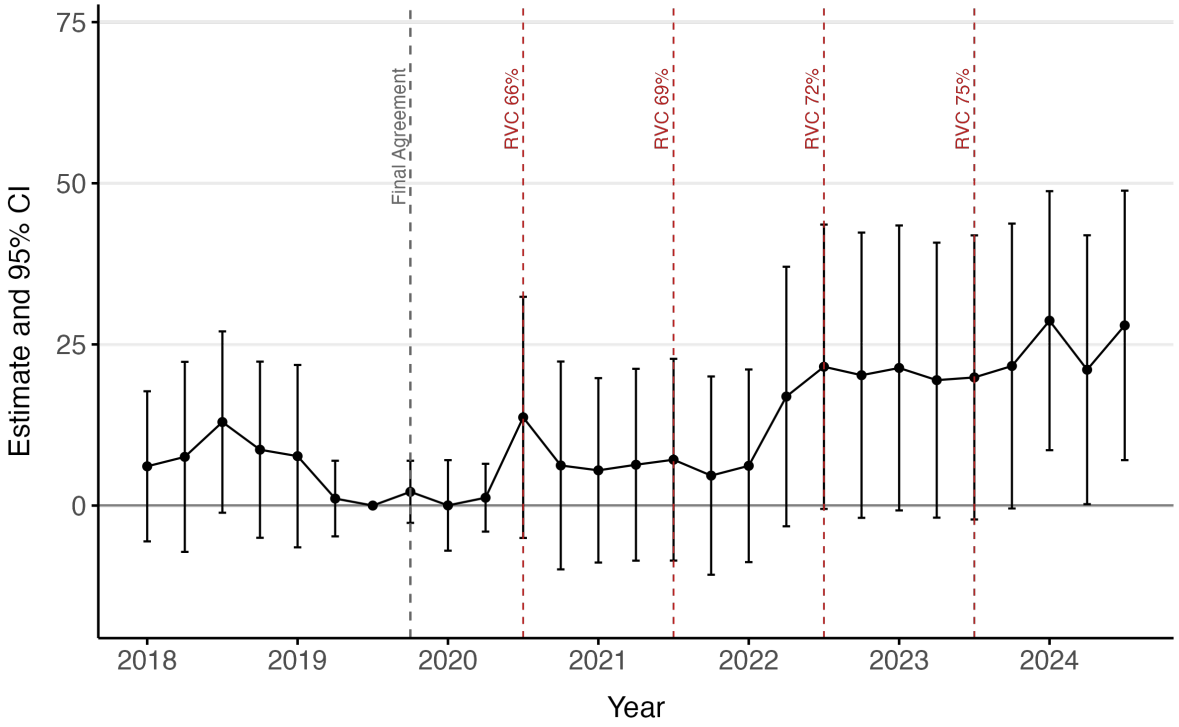


Figure C.1: Share of Exports Subject to Tariffs — Robustness: Stricter Co-clustering Threshold (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3). Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

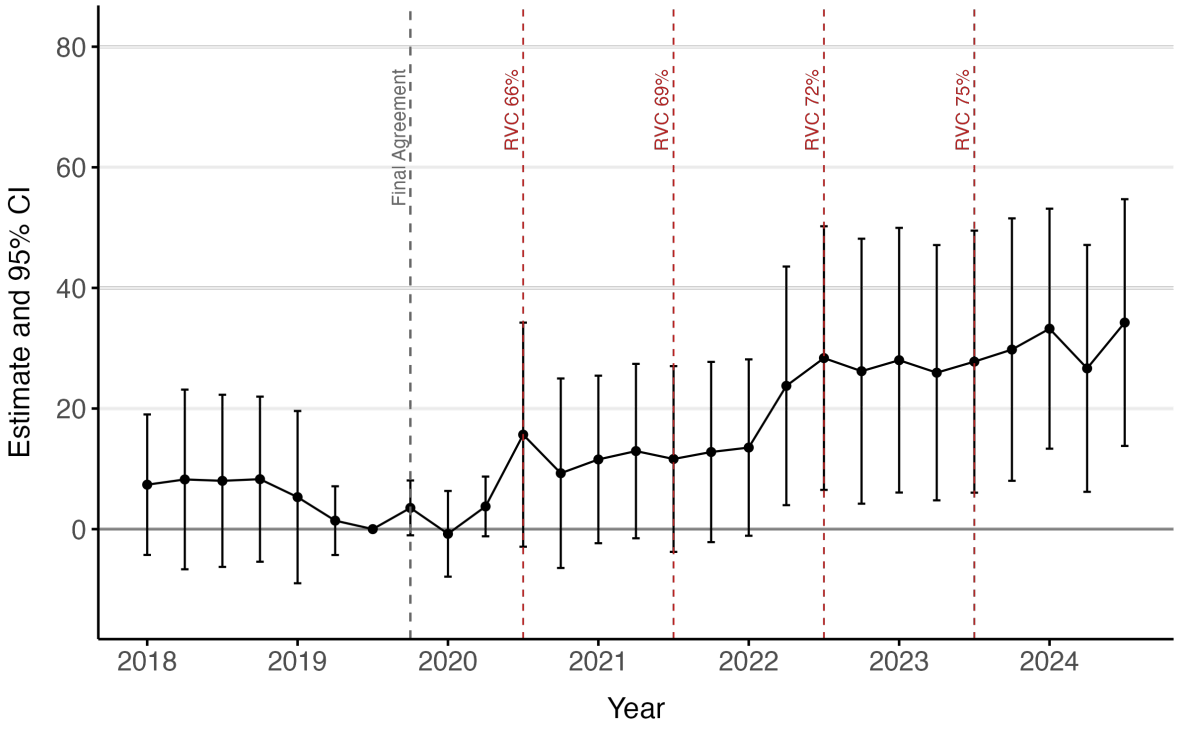


Figure C.2: Share of Exports Subject to Tariffs — Robustness: Matched Control Group (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3). Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

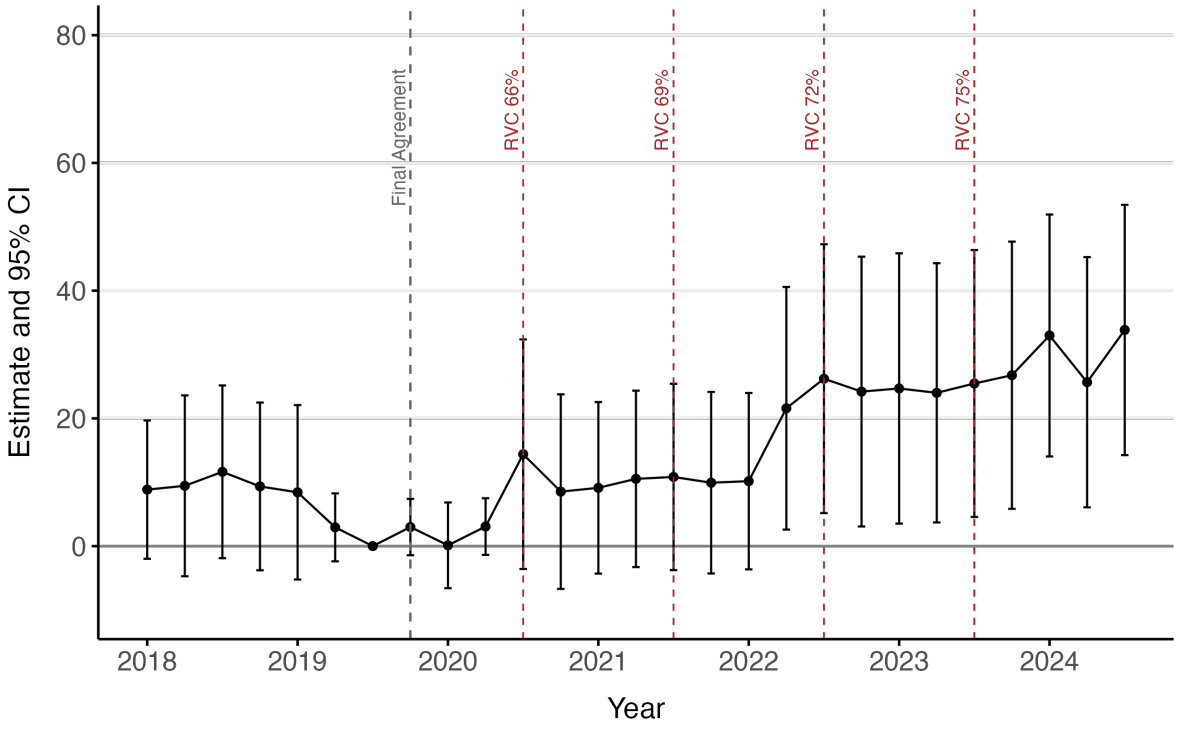


Figure C.3: Share of Exports Subject to Tariffs — Robustness: Machinery and Equipment (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3). Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

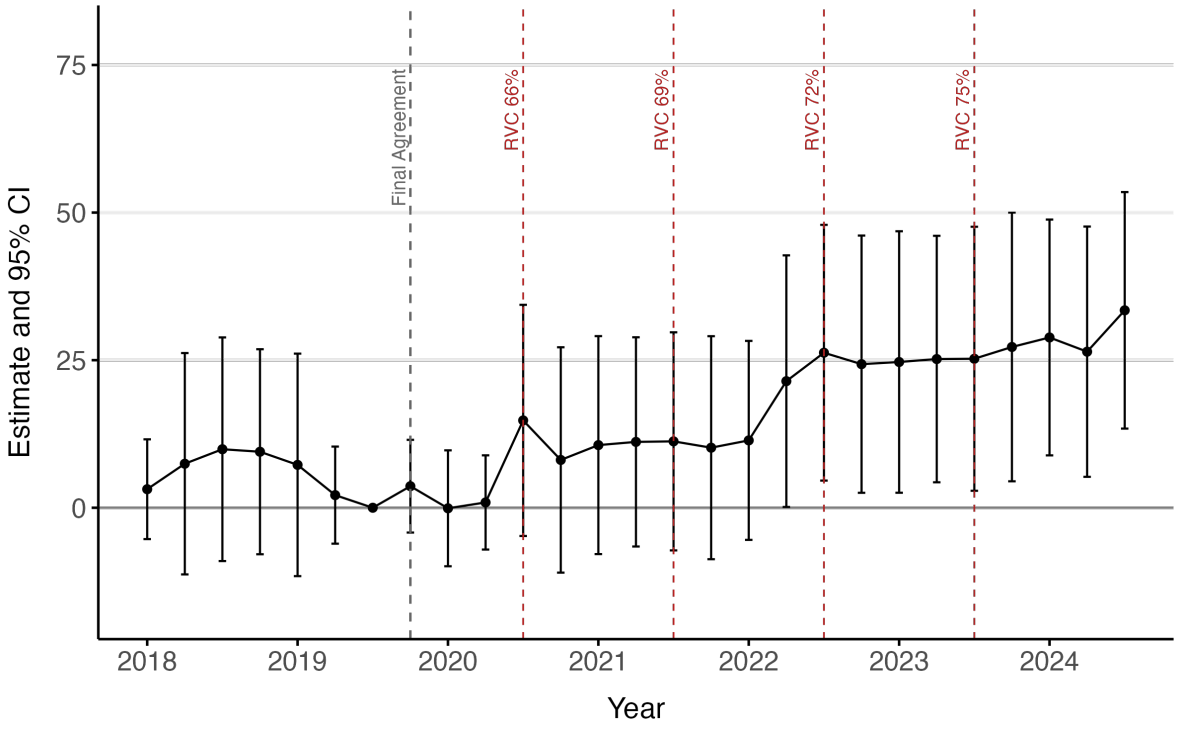


Figure C.4: Share of Exports Subject to Tariffs — Robustness: Machinery and Equipment (Doubly Robust)

Notes: Callaway–Sant'Anna doubly-robust estimates. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

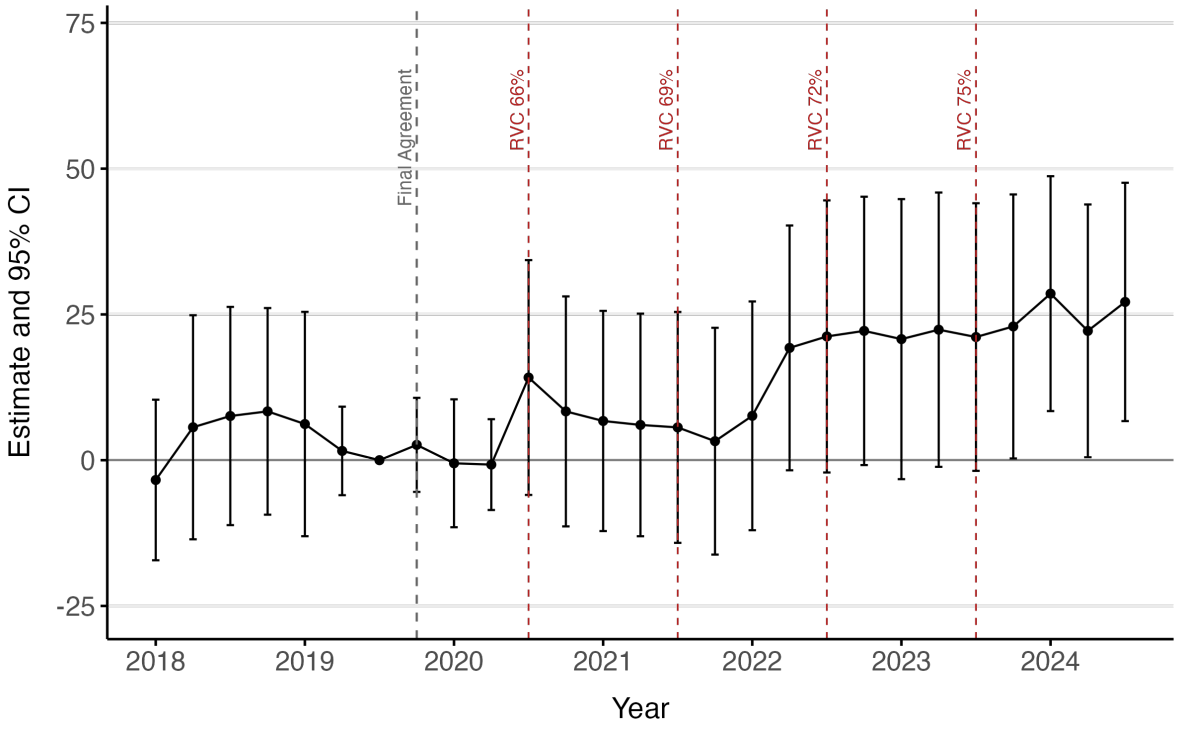
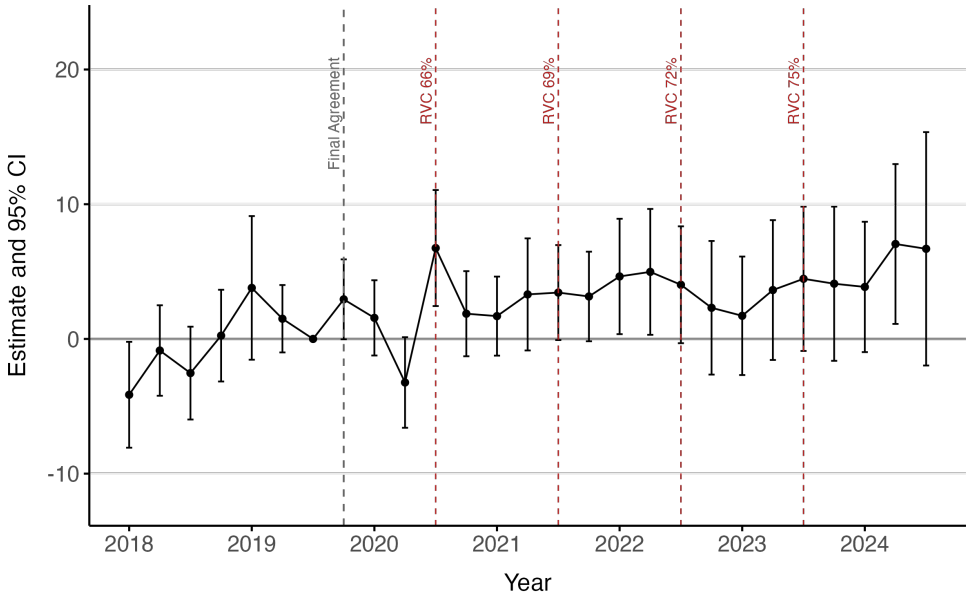
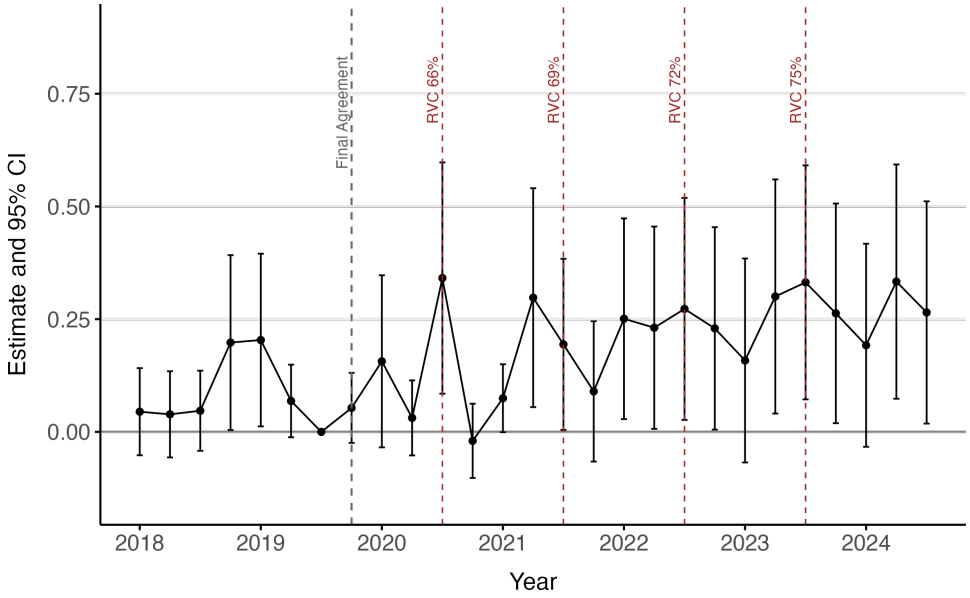


Figure C.5: Share of Exports Subject to Tariffs — Robustness: Baseline Control Group (Doubly Robust)

Notes: Callaway–Sant'Anna doubly-robust estimates. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).



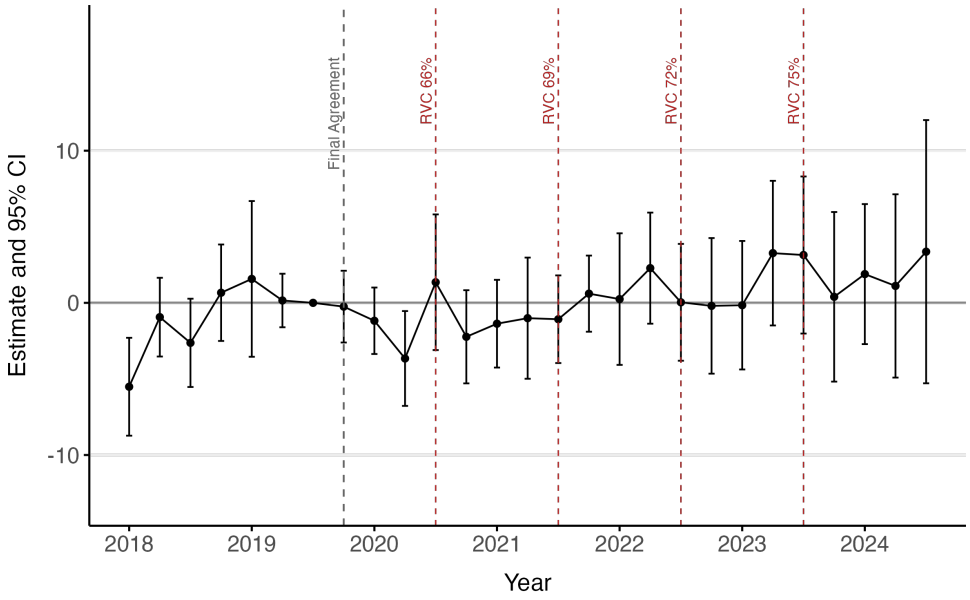
Panel A: Share of Inputs from U.S. and Canada



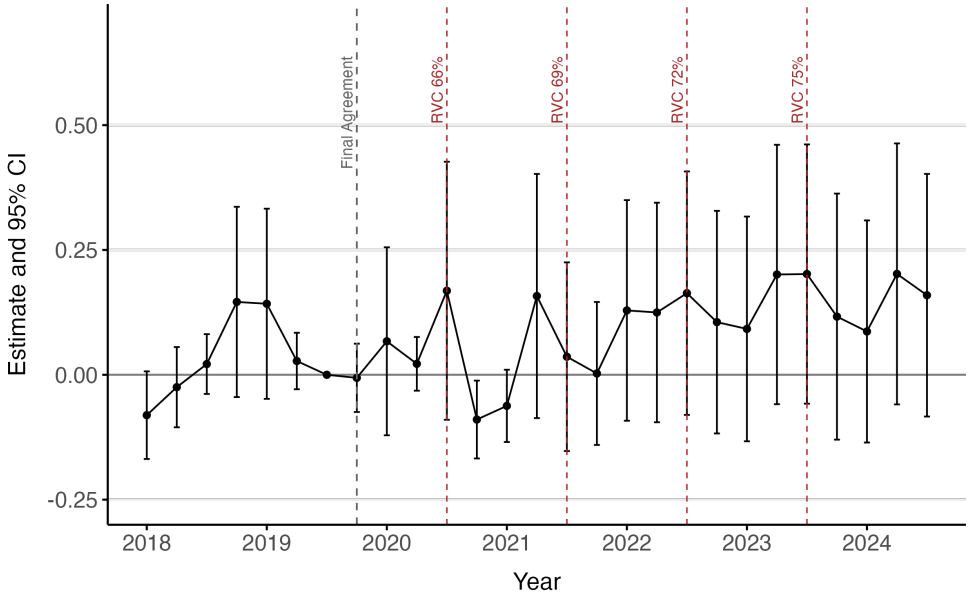
Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.6: Effect on Share of Inputs from U.S. and Canada — Robustness: Stricter Co-clustering Threshold (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).



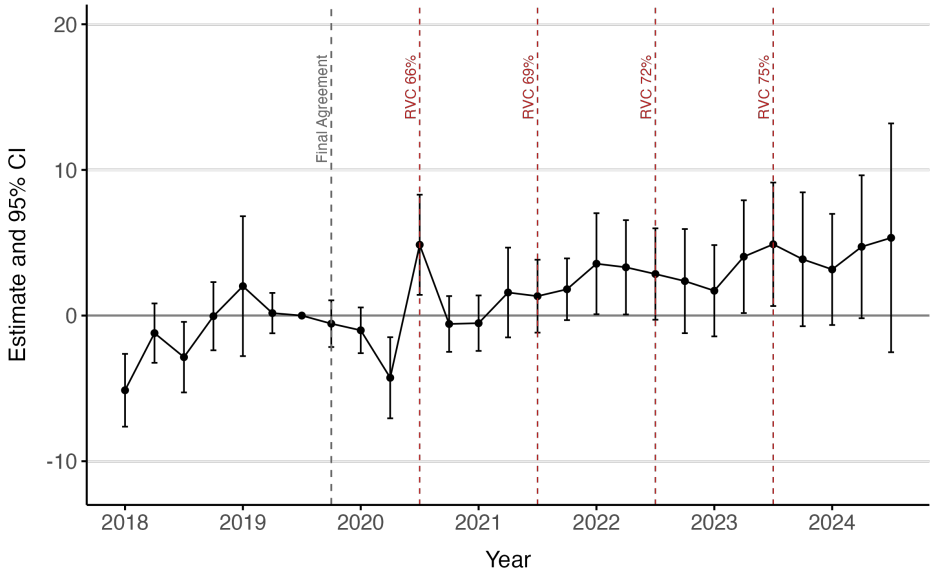
Panel A: Share of Inputs from U.S. and Canada



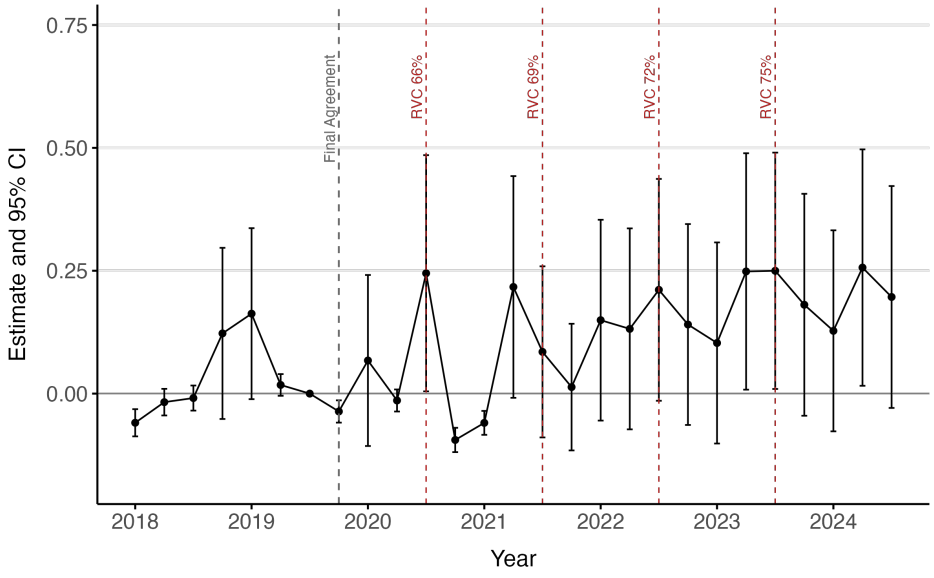
Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.7: Effect on Share of Inputs from U.S. and Canada — Robustness: Matched Control Group (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).



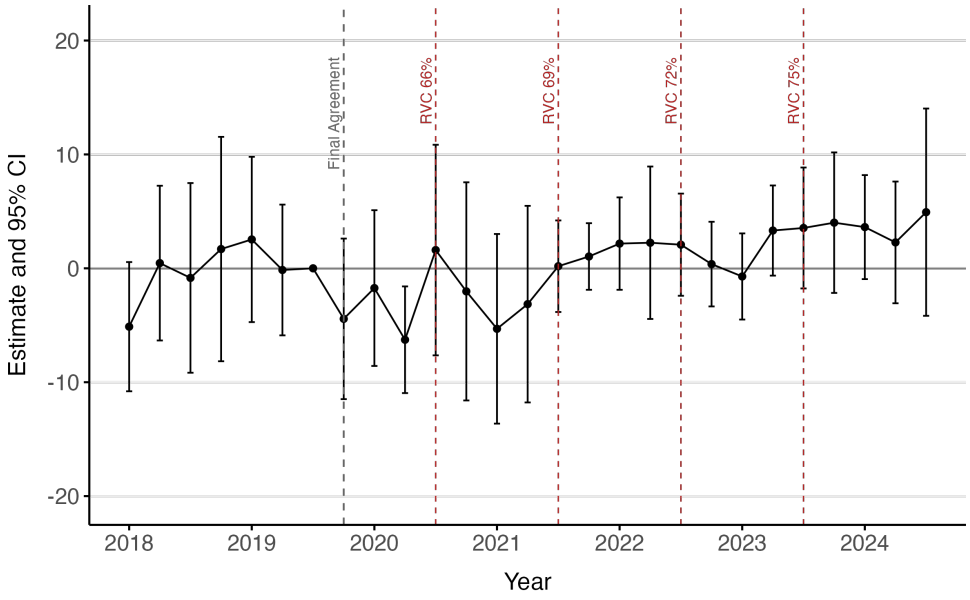
Panel A: Share of Inputs from U.S. and Canada



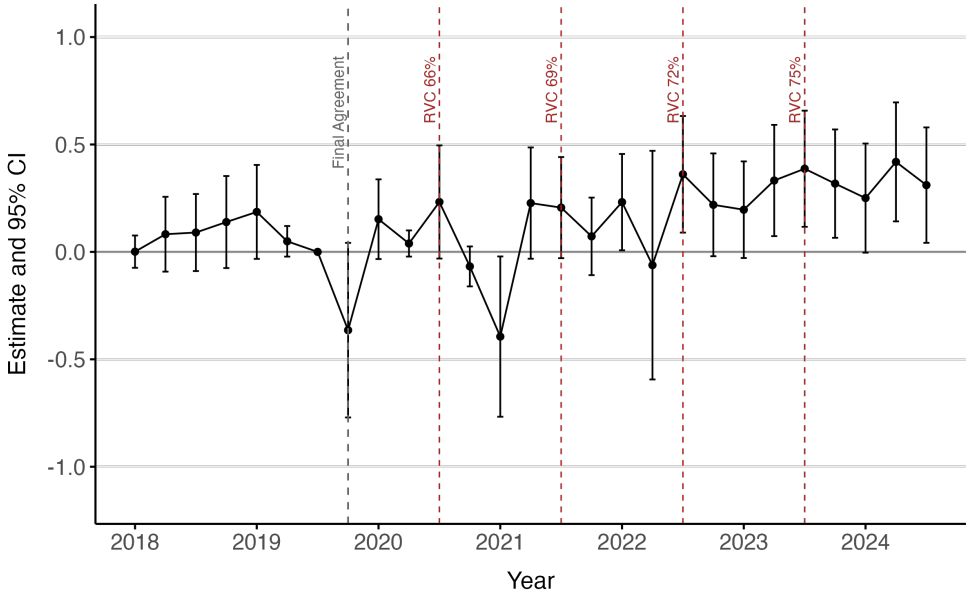
Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.8: Effect on Share of Inputs from U.S. and Canada — Robustness: Machinery and Equipment (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).



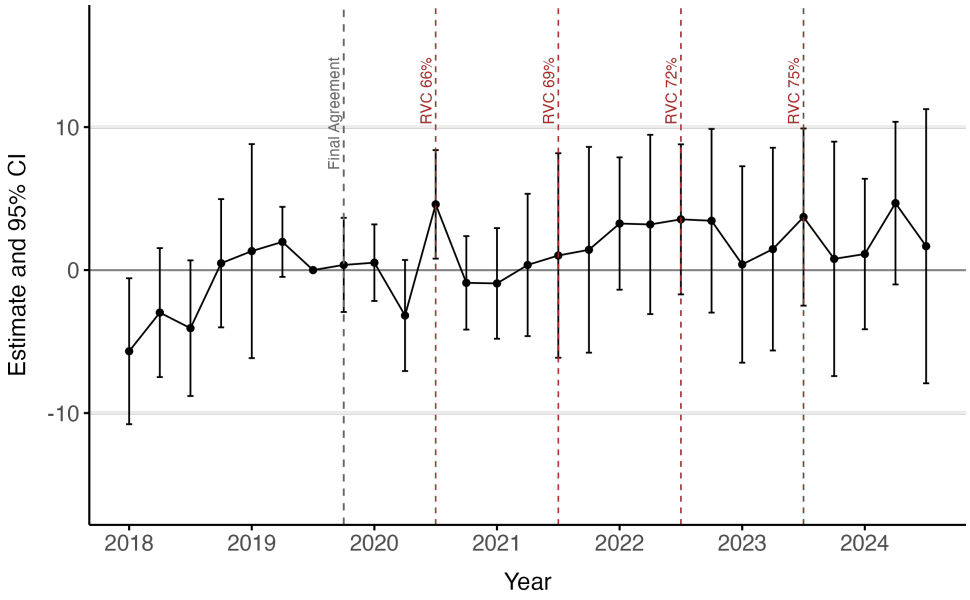
Panel A: Share of Inputs from U.S. and Canada



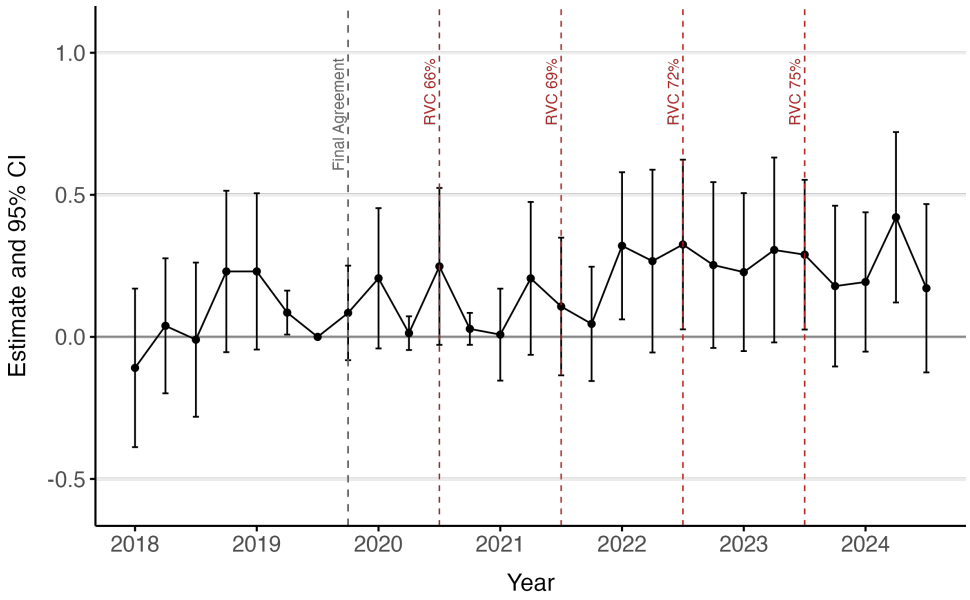
Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.9: Effect on Share of Inputs from U.S. and Canada — Robustness: Machinery and Equipment (Doubly Robust)

Notes: Callaway–Sant'Anna doubly-robust estimates. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).



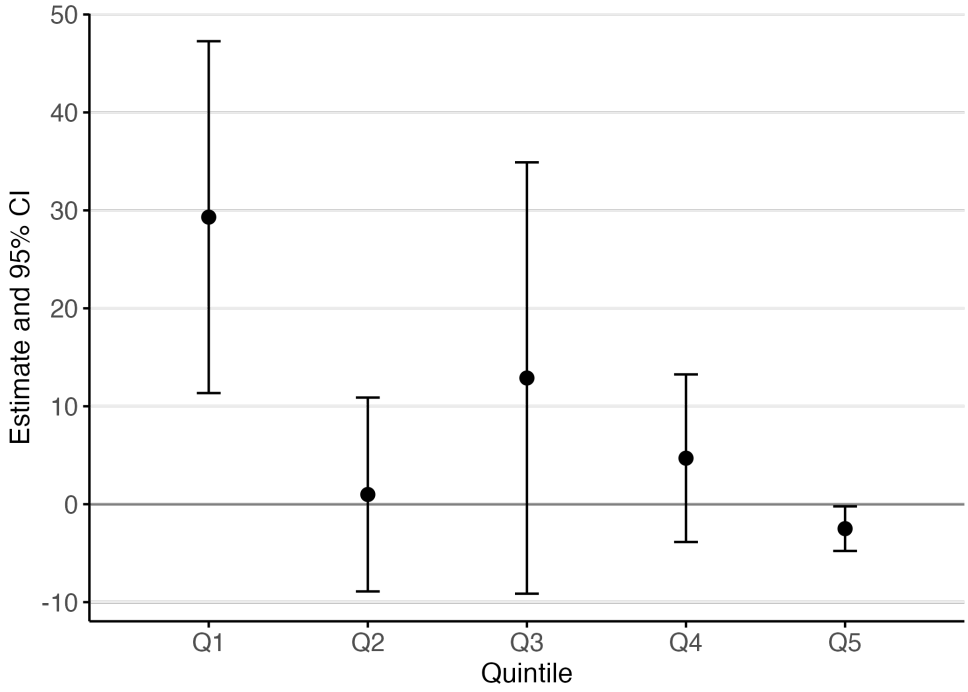
Panel A: Share of Inputs from U.S. and Canada



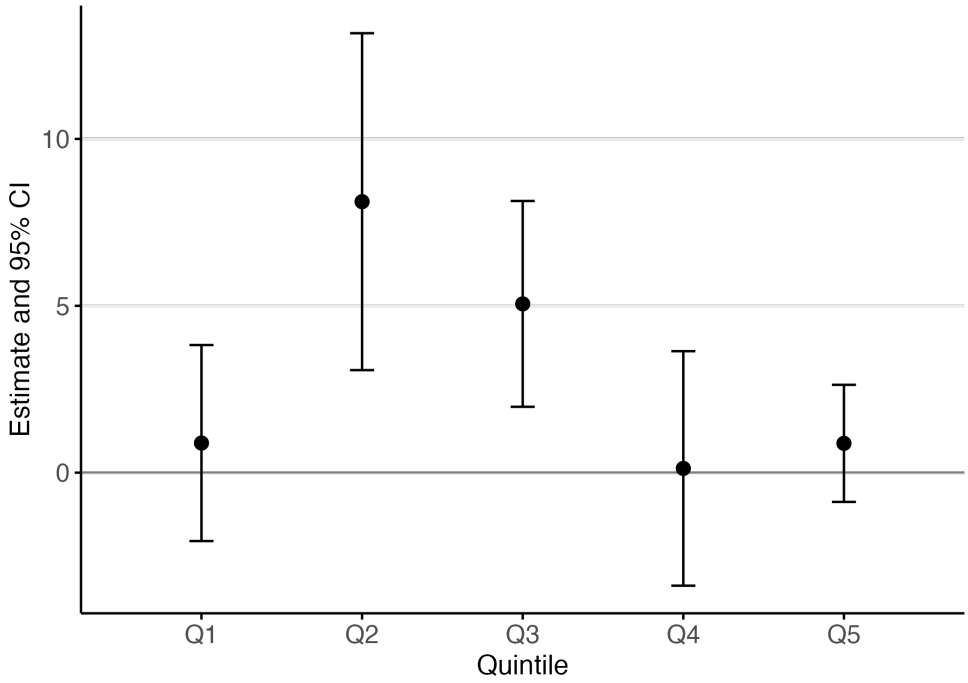
Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.10: Effect on Share of Inputs from U.S. and Canada — Robustness: Baseline Control Group (Doubly Robust)

Notes: Callaway–Sant'Anna doubly-robust estimates. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).



Panel A: Share of Exports Subject to Tariffs



Panel B: Share of Inputs from U.S. and Canada

Figure C.11: Effects by Quintile of Ex-ante Integration into the Bloc (TWFE)

Notes: Circles show point estimates for the total effect on each quintile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, estimated from Equation 14 with quintiles instead of quartiles and the baseline control group (industries with $\pi_\ell > 0.3$), with 95% confidence intervals.

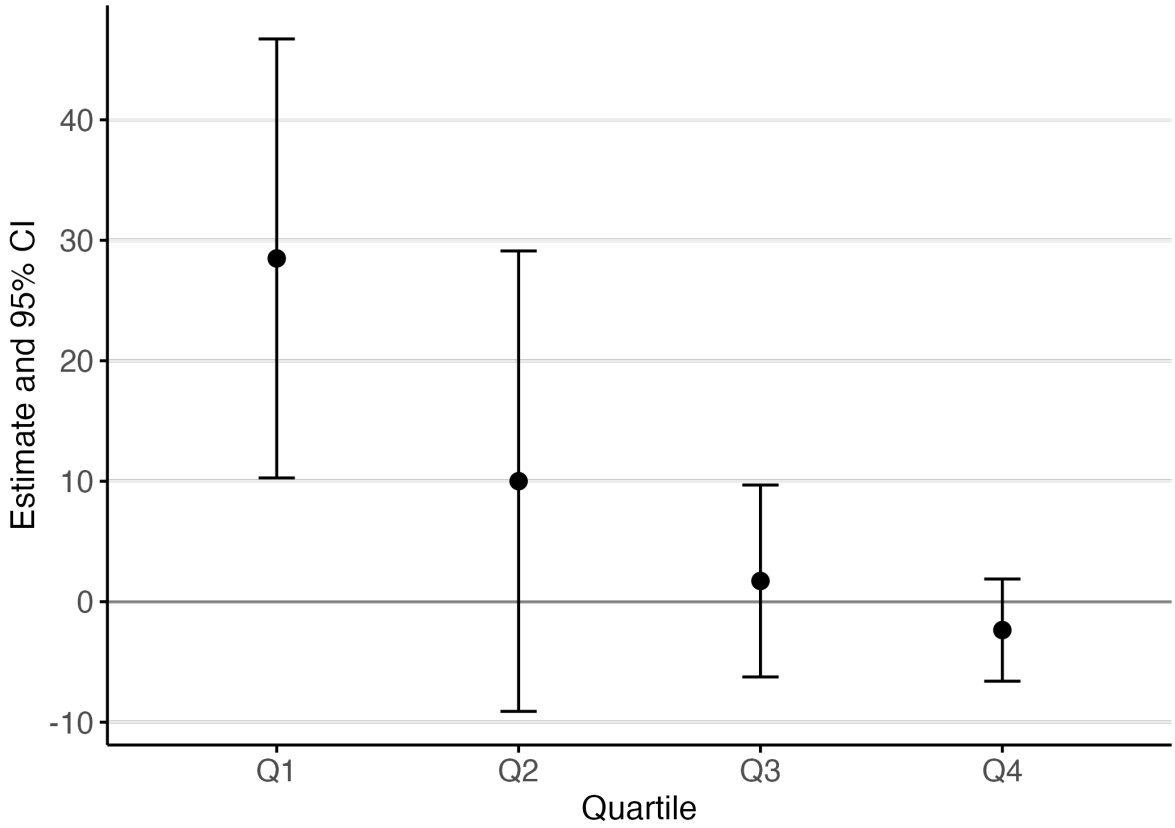


Figure C.12: Share of Mexican Exports Subject to Tariffs, by Quartile — Robustness: Stricter Co-clustering Threshold (TWFE)

Notes: Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.

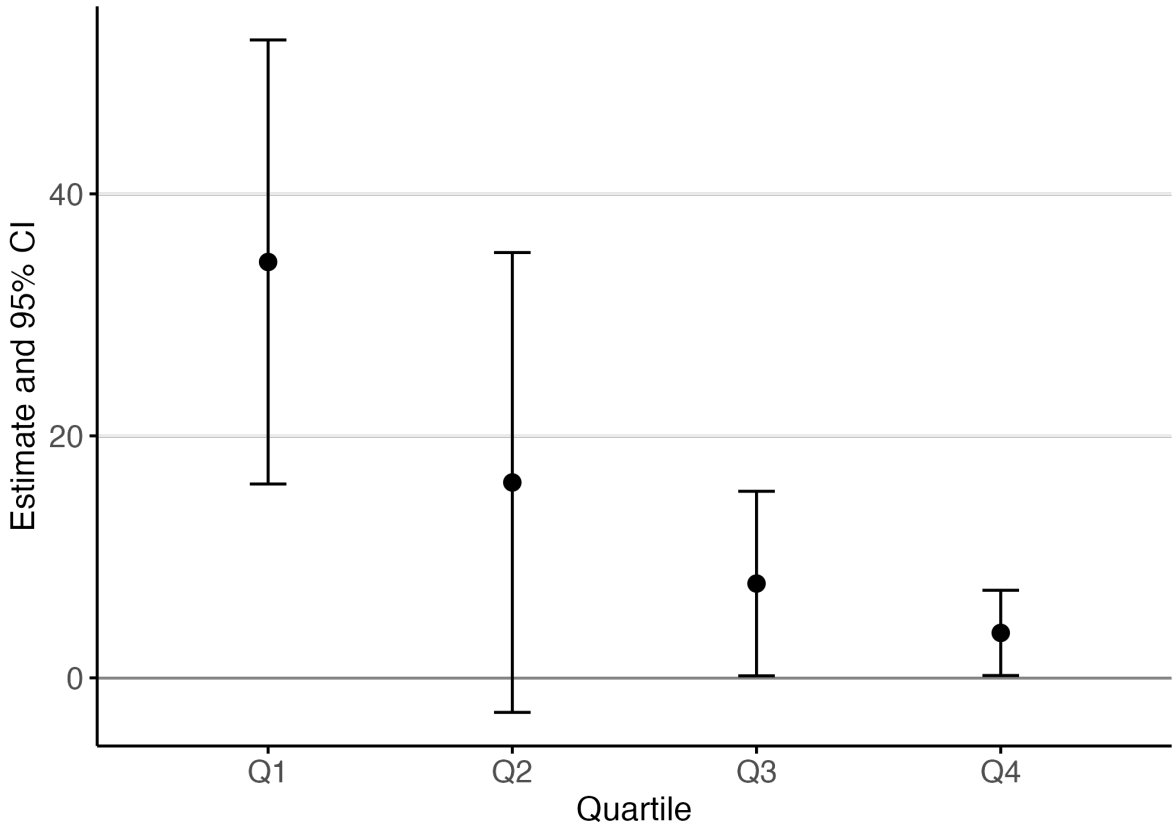


Figure C.13: Share of Mexican Exports Subject to Tariffs, by Quartile — Robustness: Matched Control Group (TWFE)

Notes: Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.

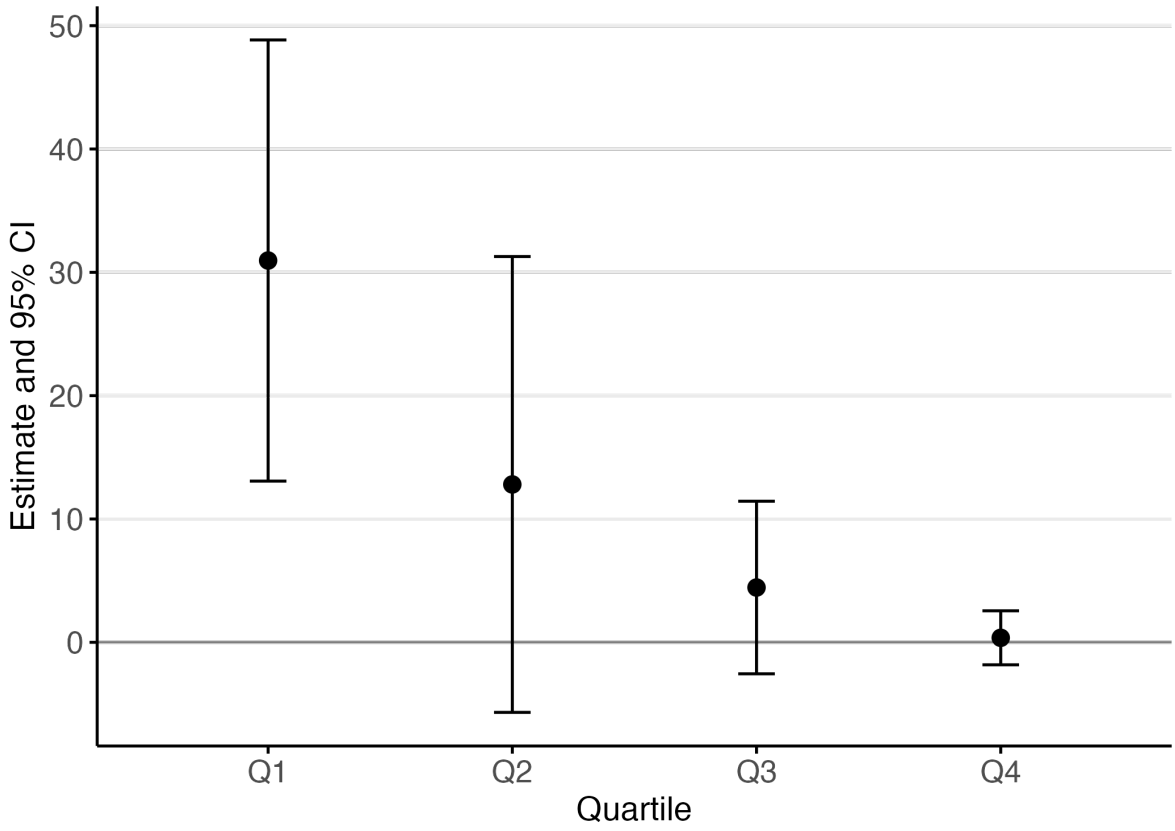


Figure C.14: Share of Mexican Exports Subject to Tariffs, by Quartile — Robustness: Machinery and Equipment (TWFE)

Notes: Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.

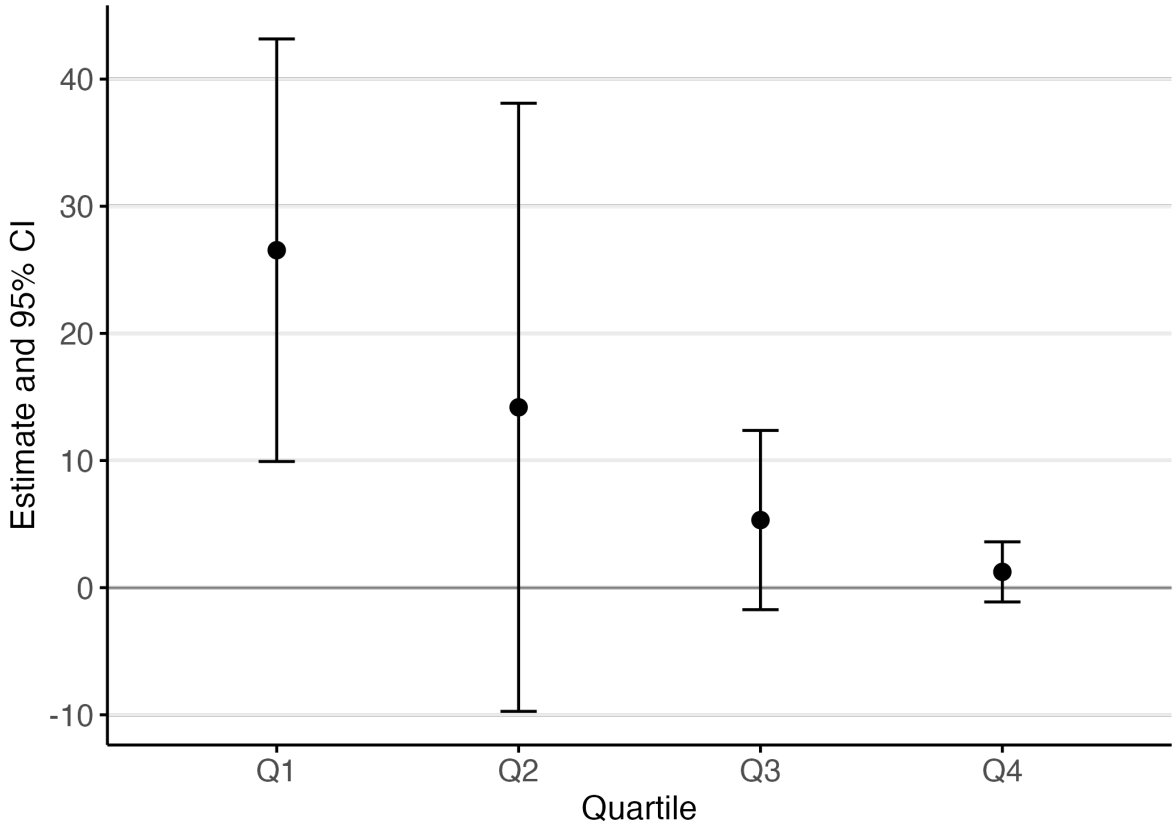


Figure C.15: Share of Mexican Exports Subject to Tariffs, by Quartile — Robustness: Machinery and Equipment (Propensity Score Weighting)

Notes: Estimates of Equation 14 weighting control firms with the propensity scores of the doubly robust estimator. Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.

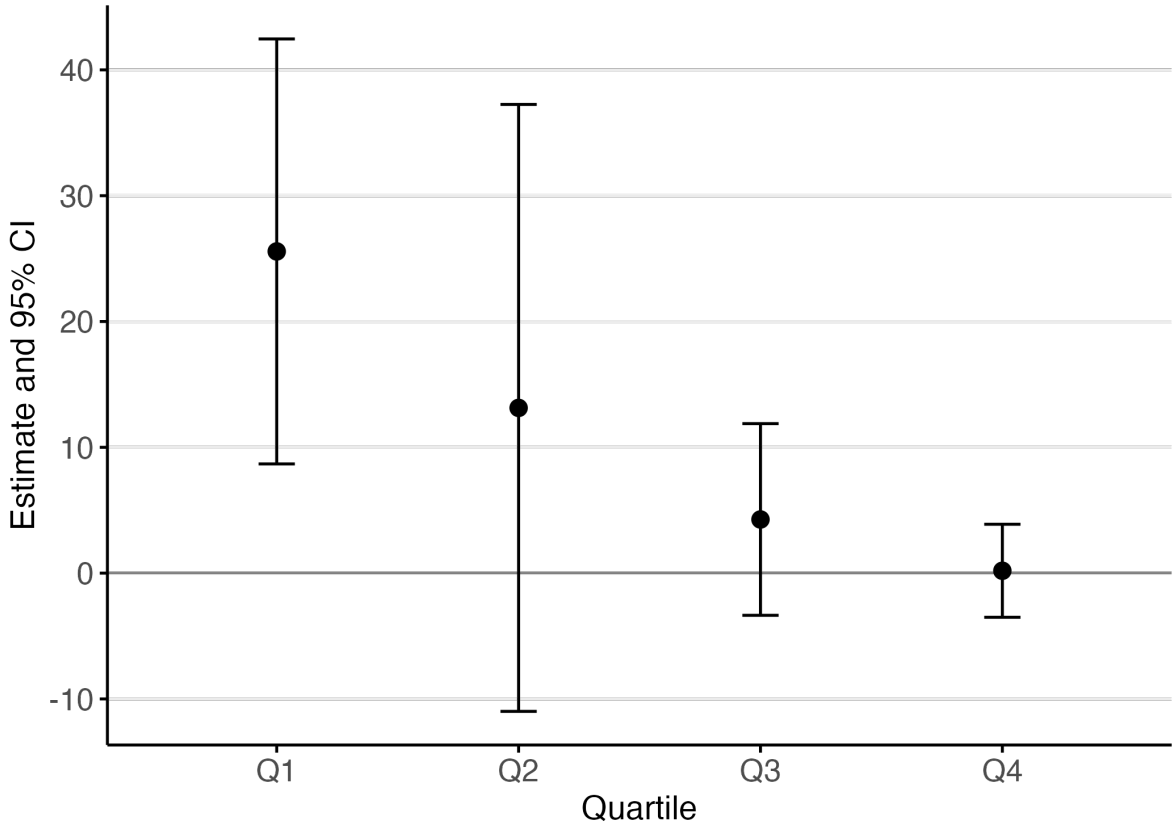
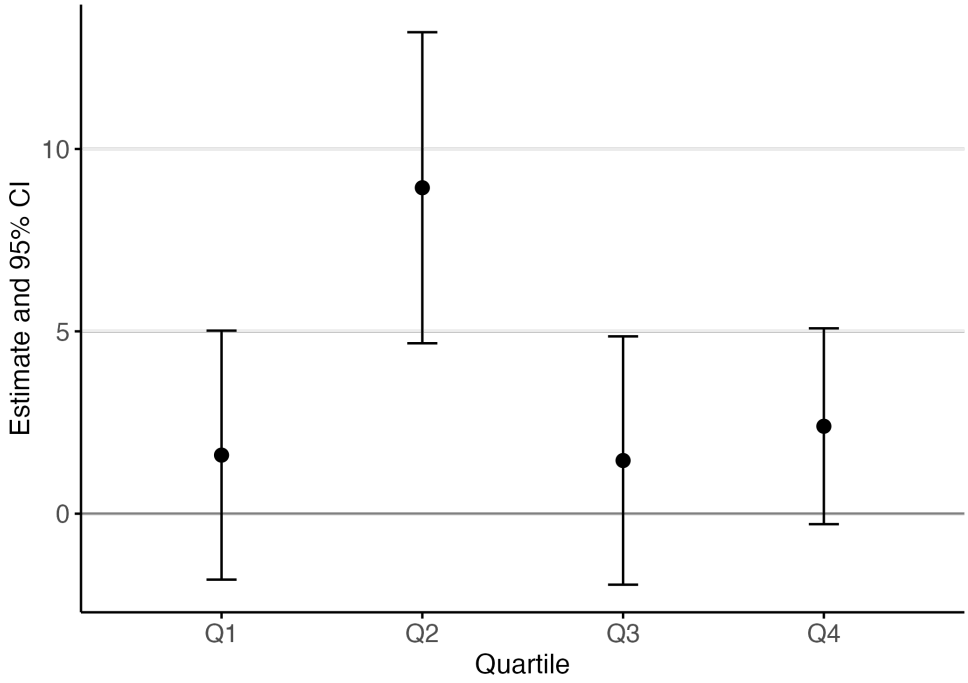
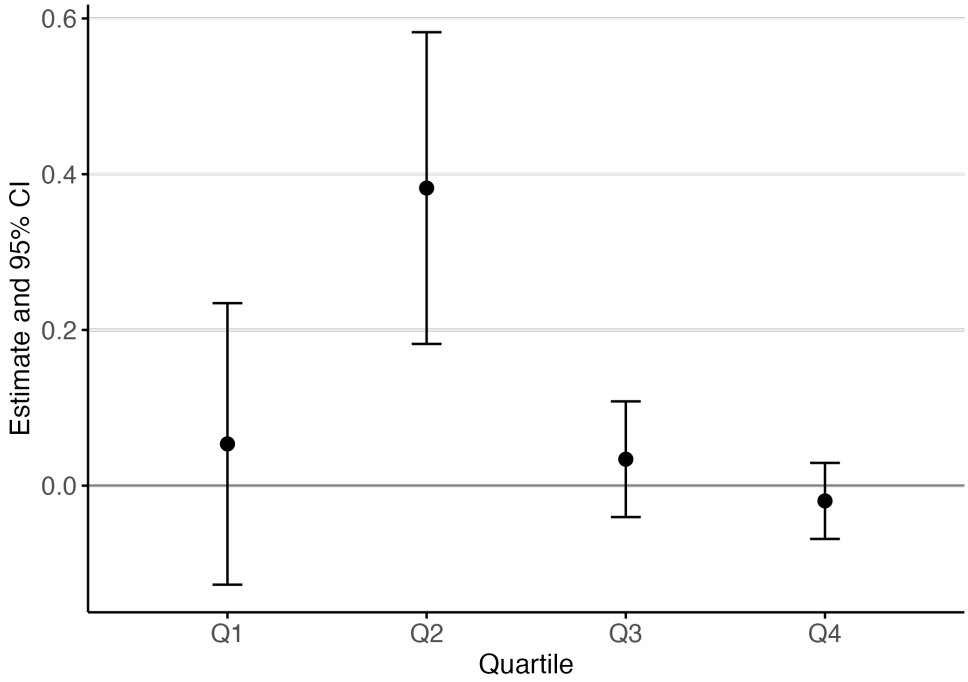


Figure C.16: Share of Mexican Exports Subject to Tariffs, by Quartile — Robustness: Baseline Control Group (Propensity Score Weighting)

Notes: Estimates of Equation 14 weighting control firms with the propensity scores of the doubly robust estimator. Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.



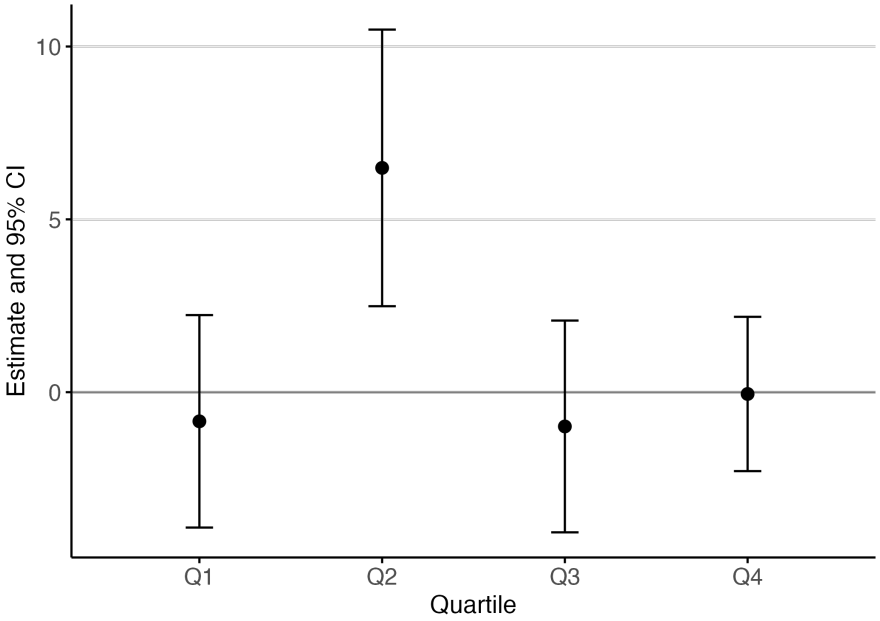
Panel A: Share of Inputs from U.S. and Canada



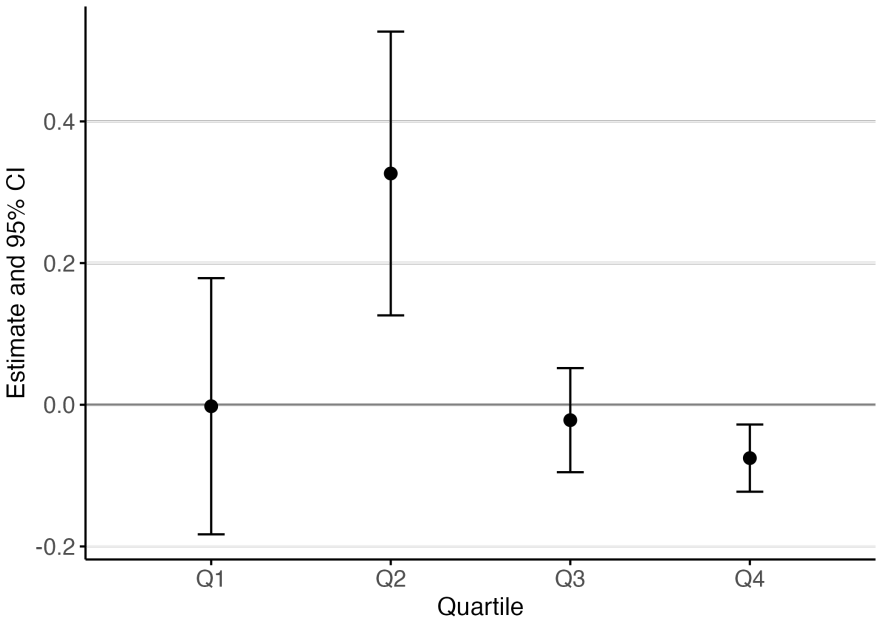
Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.17: Inverse U-Shape Response — Robustness: Stricter Co-clustering Threshold (TWFE)

Notes: Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.



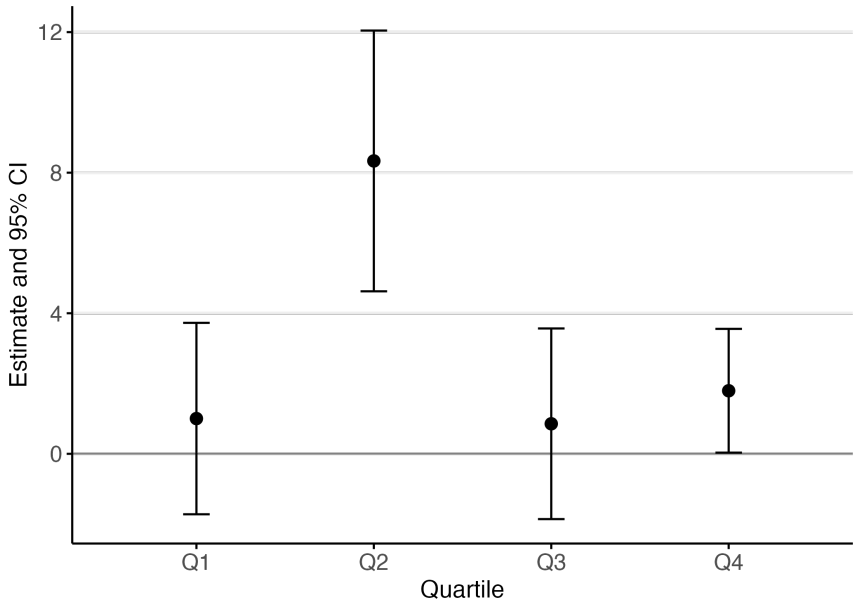
Panel A: Share of Inputs from U.S. and Canada



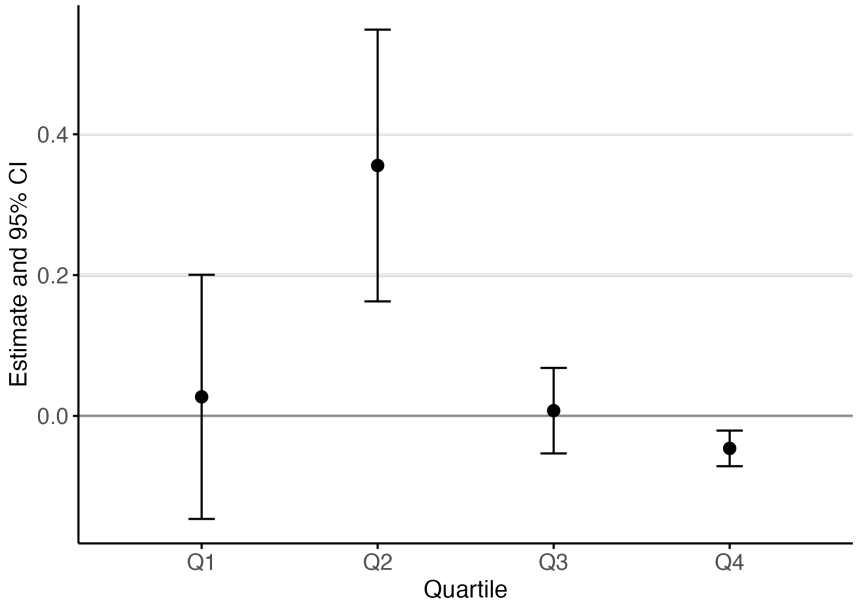
Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.18: Inverse U-Shape Response — Robustness: Matched Control Group (TWFE)

Notes: Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.



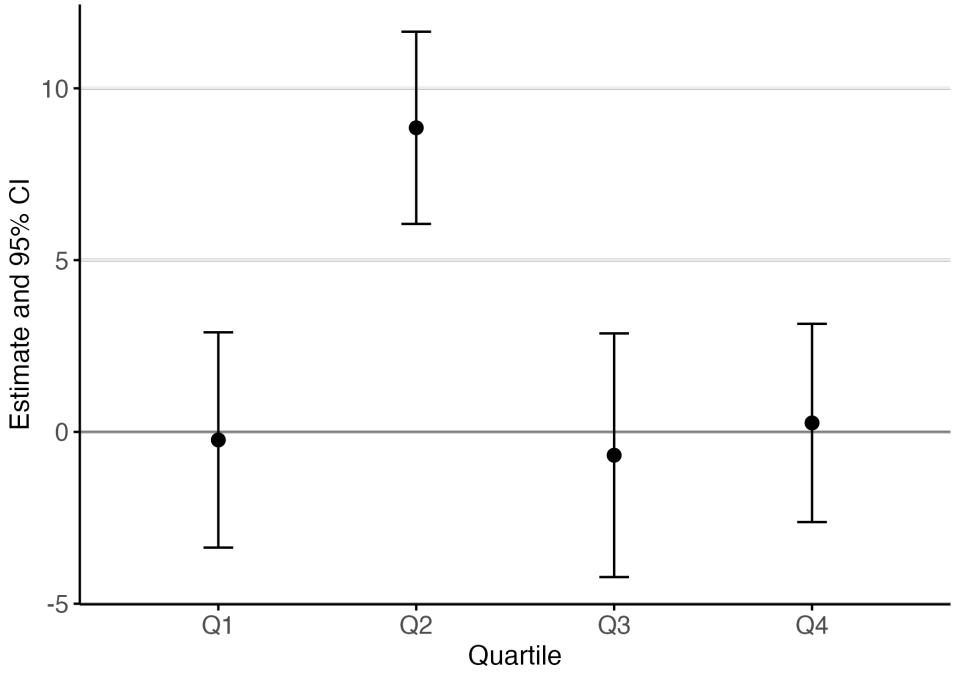
Panel A: Share of Inputs from U.S. and Canada



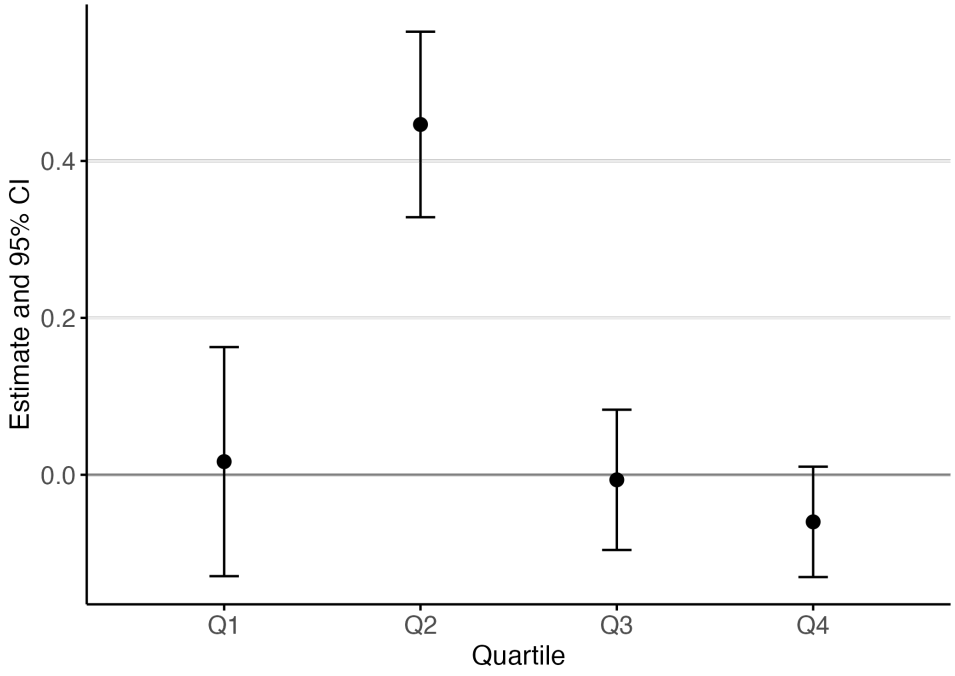
Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.19: Inverse U-Shape Response — Robustness: Machinery and Equipment (TWFE)

Notes: Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.



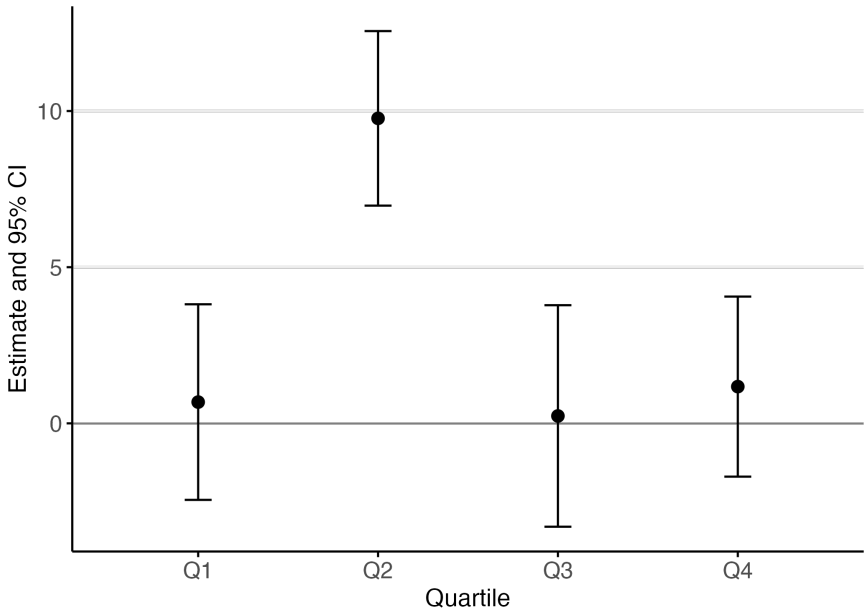
Panel A: Share of Inputs from U.S. and Canada



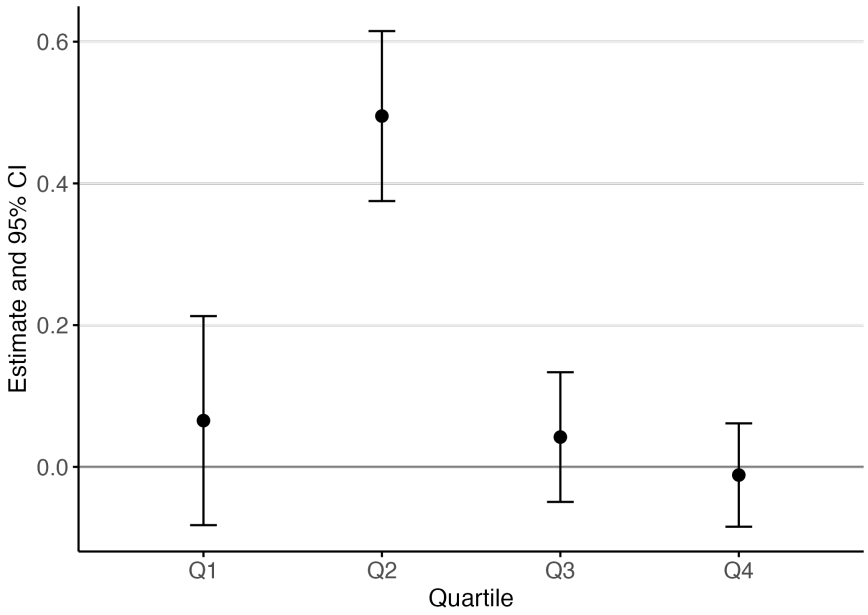
Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.20: Inverse U-Shape Response — Robustness: Machinery and Equipment (Propensity Score Weighting)

Notes: Estimates of Equation 14 weighting control firms with the propensity scores of the doubly robust estimator. Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.



Panel A: Share of Inputs from U.S. and Canada



Panel B: Prob. of Increasing U.S.-Canada Input Share by ≥5pp

Figure C.21: Inverse U-Shape Response — Robustness: Baseline Control Group (Propensity Score Weighting)

Notes: Estimates of Equation 14 weighting control firms with the propensity scores of the doubly robust estimator. Circles show point estimates for the total effect on each quartile of the pre-USMCA distribution of the share of inputs imported from the U.S. and Canada, with 95% confidence intervals.

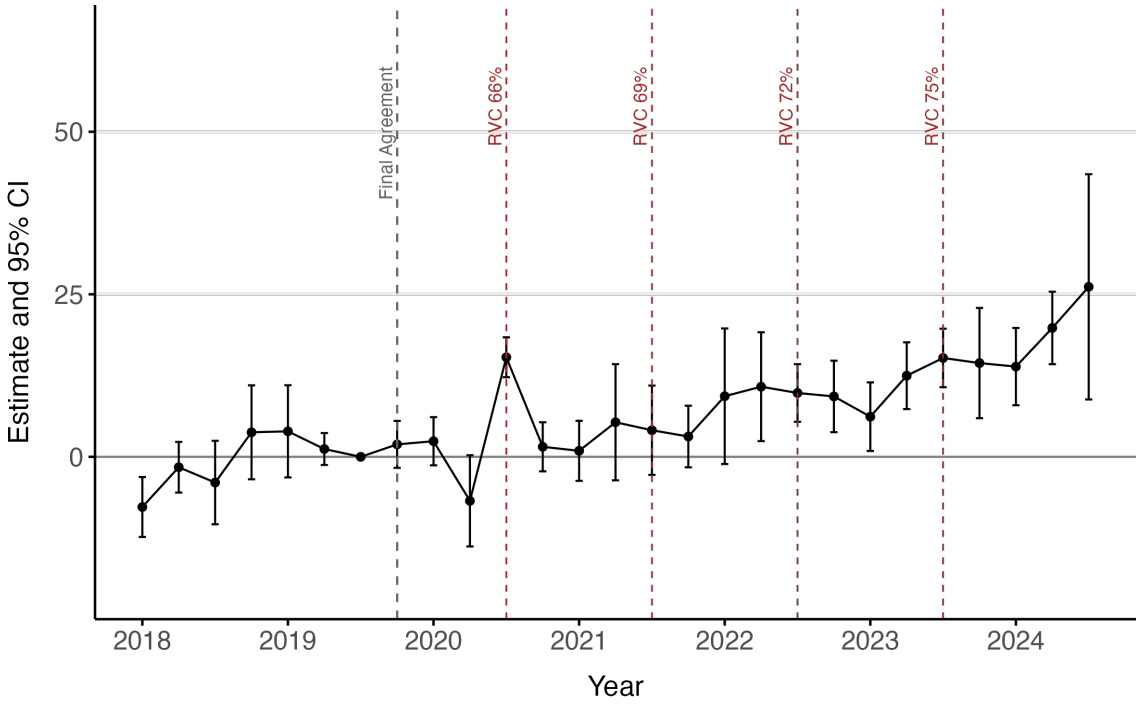


Figure C.22: Second-Quartile Automakers: Dynamic Effect on Input Share — Robustness: Stricter Co-clustering Threshold (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3), estimated on the subsample of motor vehicle exporters in the second quartile of the pre-USMCA distribution of the share of inputs imported from the United States and Canada. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

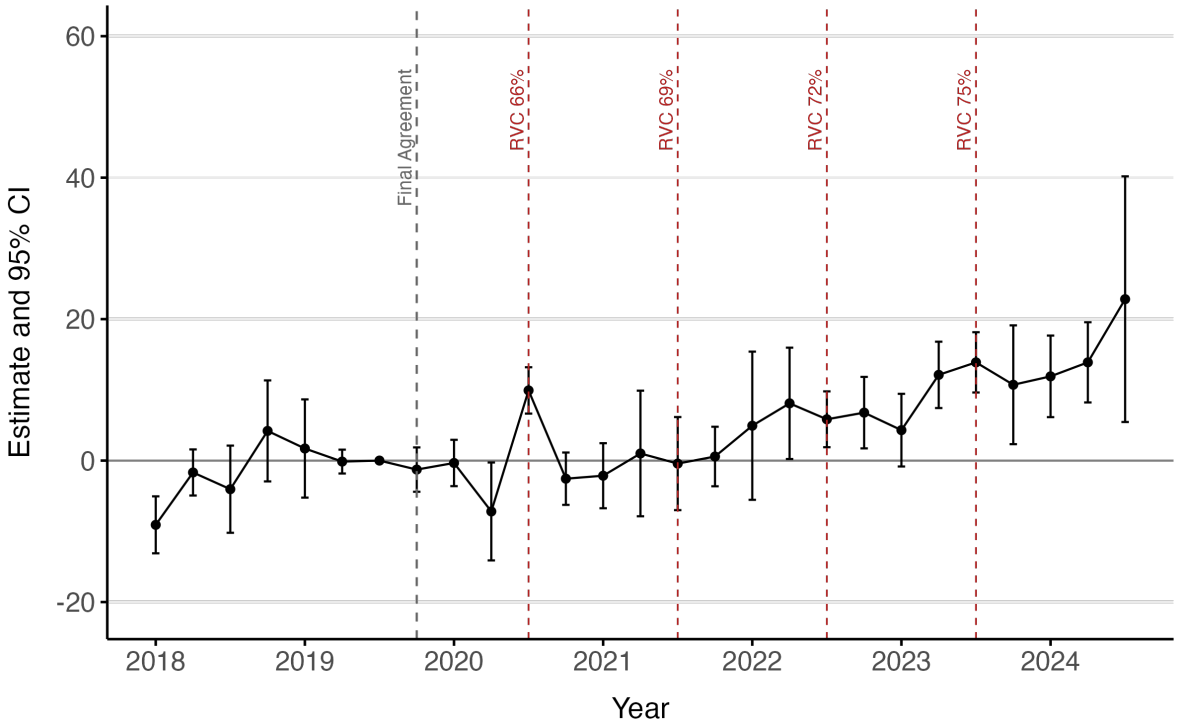


Figure C.23: Second-Quartile Automakers: Dynamic Effect on Input Share — Robustness: Matched Control Group (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3), estimated on the subsample of motor vehicle exporters in the second quartile of the pre-USMCA distribution of the share of inputs imported from the United States and Canada. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

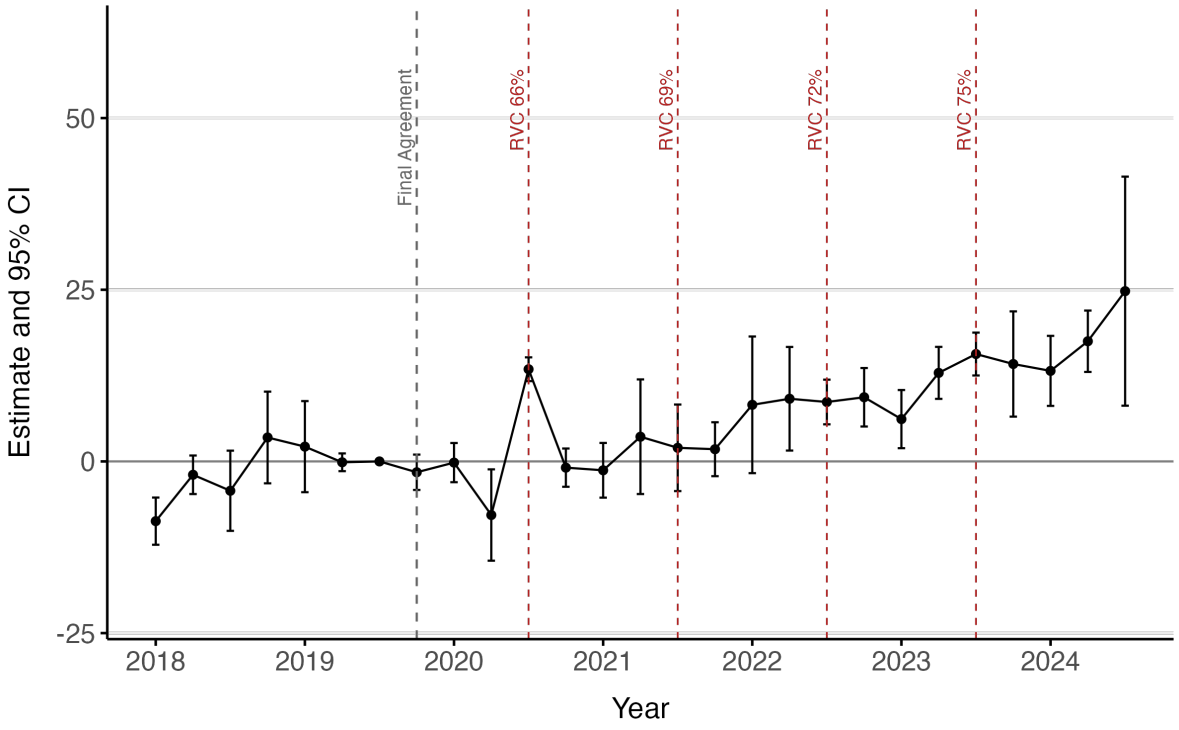


Figure C.24: Second-Quartile Automakers: Dynamic Effect on Input Share — Robustness: Machinery and Equipment (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3), estimated on the subsample of motor vehicle exporters in the second quartile of the pre-USMCA distribution of the share of inputs imported from the United States and Canada. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

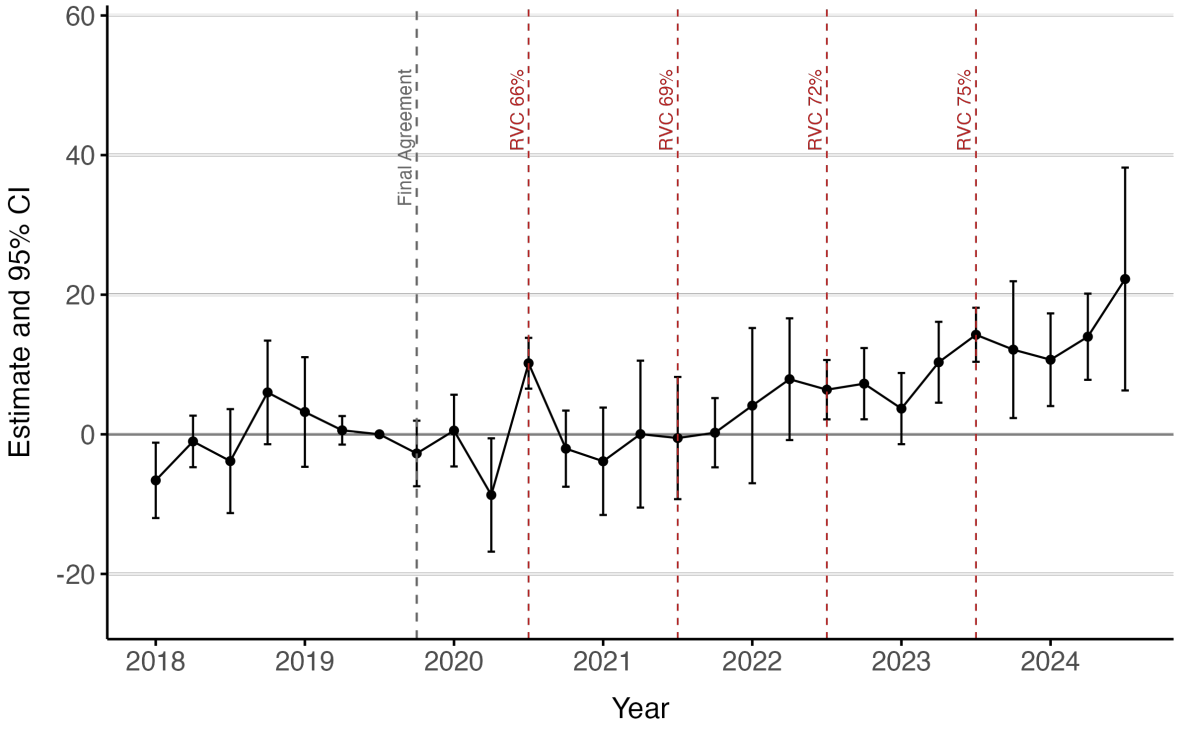


Figure C.25: Second-Quartile Automakers: Dynamic Effect on Input Share — Robustness: Machinery and Equipment (Doubly Robust)

Notes: Callaway–Sant'Anna doubly-robust estimates, estimated on the subsample of motor vehicle exporters in the second quartile of the pre-USMCA distribution of the share of inputs imported from the United States and Canada. Error bars represent 95% confidence intervals.

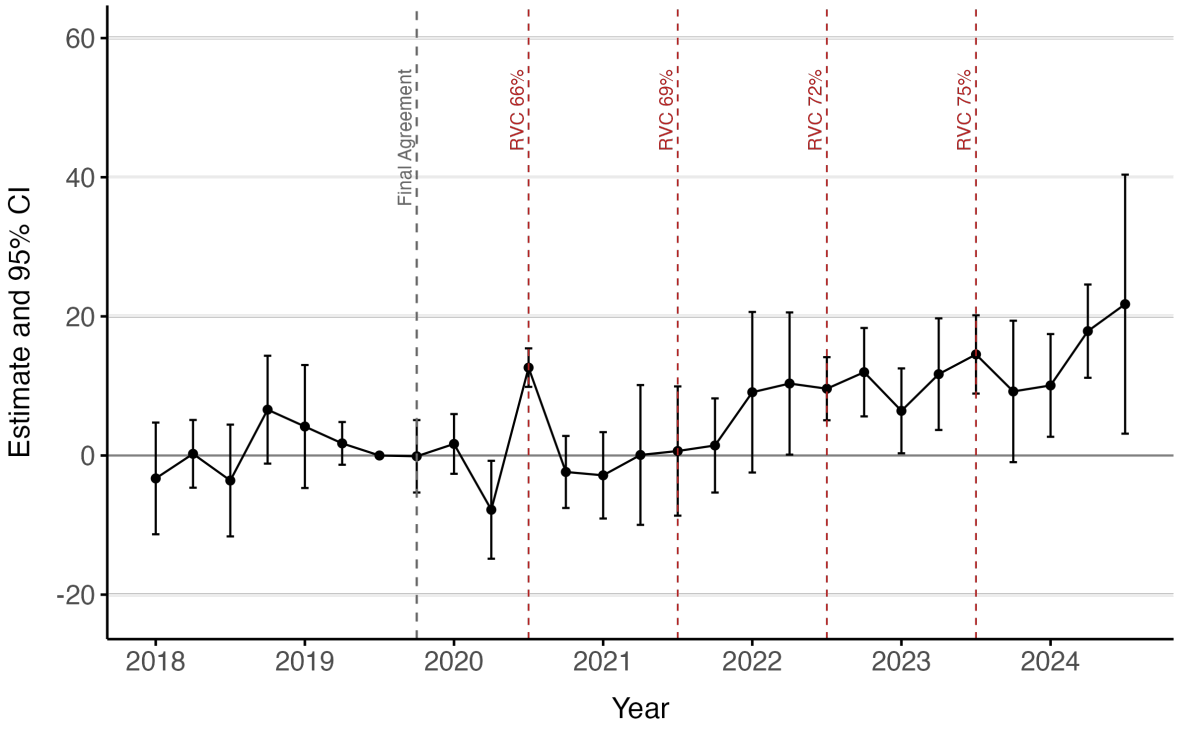


Figure C.26: Second-Quartile Automakers: Dynamic Effect on Input Share — Robustness: Baseline Control Group (Doubly Robust)

Notes: Callaway–Sant'Anna doubly-robust estimates, estimated on the subsample of motor vehicle exporters in the second quartile of the pre-USMCA distribution of the share of inputs imported from the United States and Canada. Error bars represent 95% confidence intervals.

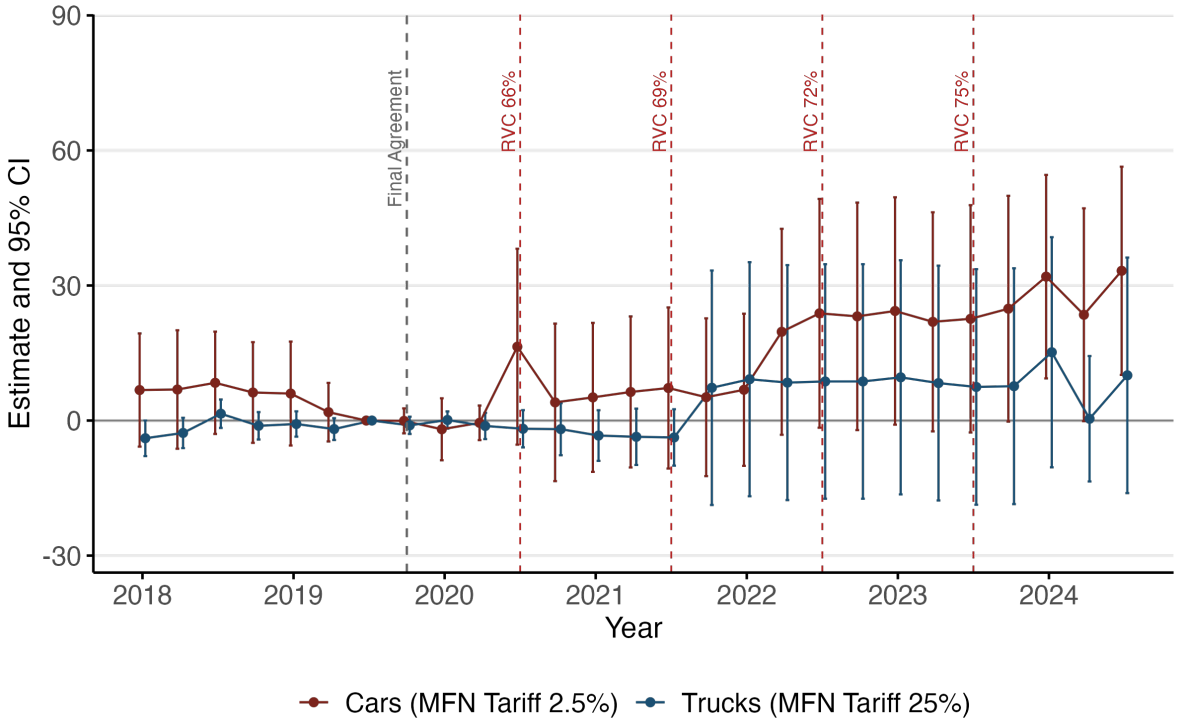


Figure C.27: Cars vs. Light Trucks — Robustness: Stricter Co-clustering Threshold (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3), separately for passenger vehicles (cars) and light trucks. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

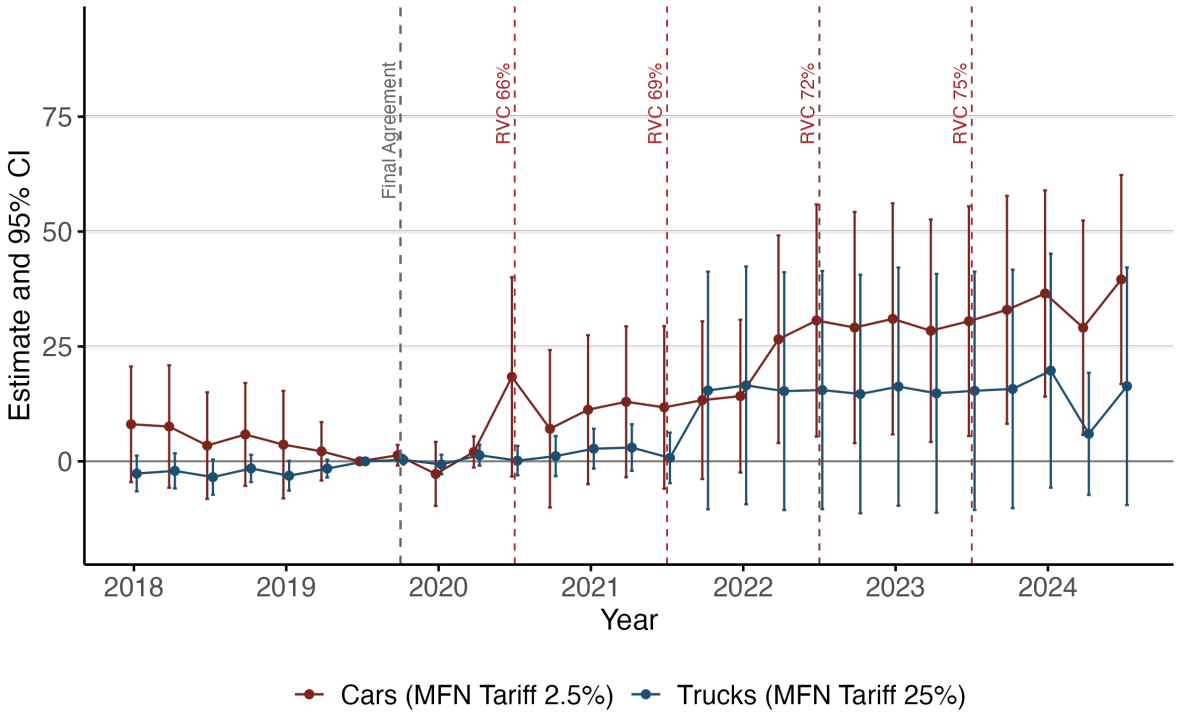


Figure C.28: Cars vs. Light Trucks — Robustness: Matched Control Group (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3), separately for passenger vehicles (cars) and light trucks. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).

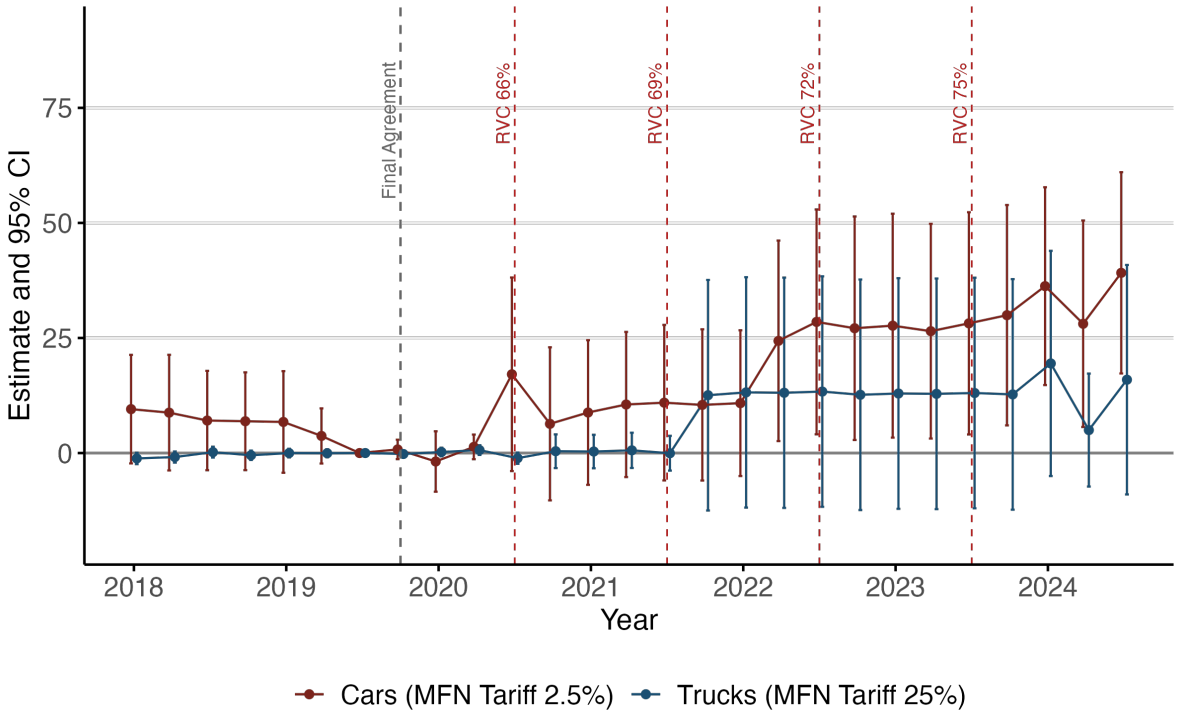
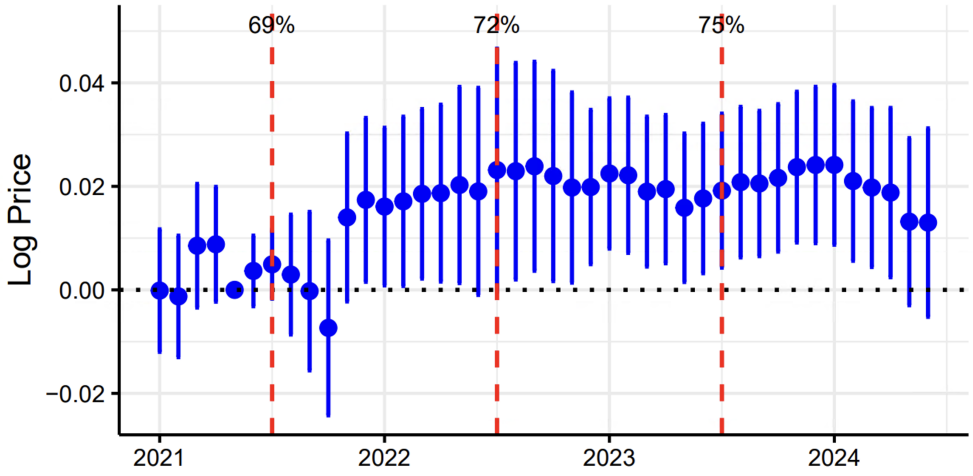
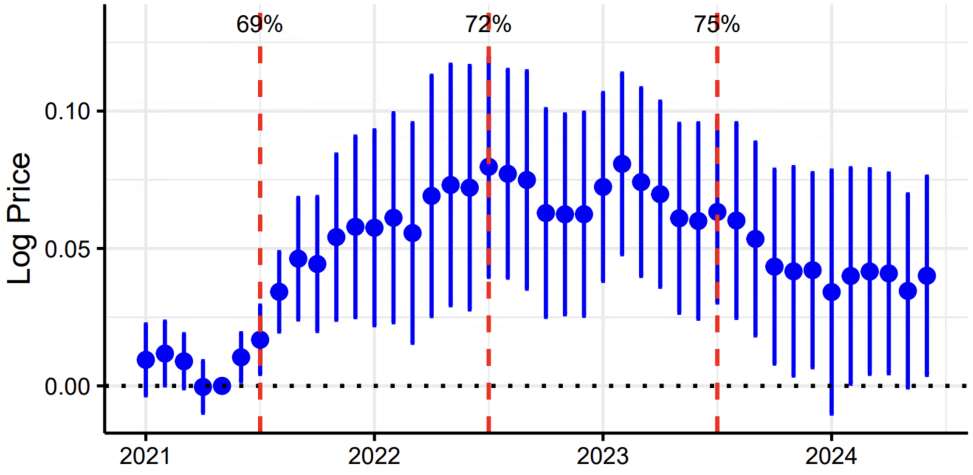


Figure C.29: Cars vs. Light Trucks — Robustness: Machinery and Equipment (TWFE)

Notes: Each circle corresponds to the point estimate of the treatment indicator for different quarters relative to the reference period (2019q3), separately for passenger vehicles (cars) and light trucks. Error bars represent 95% confidence intervals. The vertical dashed line represents the signing of the USMCA (gray), and the dates of its implementation stages (red).



Panel A: Cars



Panel B: Light Trucks

Figure C.30: Price Effects on Affected Models and Trims (Cars vs. Light Trucks)

Notes: The figure displays the effect of USMCA rules on prices of vehicles that were not ex-ante complying with the additional requirements, estimated using equation 15. Standard errors are clustered at the automaker level, and all coefficients are displayed with 95% confidence intervals. The dotted red lines indicate the point in time at which the RoO for cars or light trucks increased.