Export VAT Rebates and Their Delivery: Evidence from China's 2015 Rebate Rate Increase*

Li Gan Yitong Wang Siyuan Zeng
Texas A&M University

Abstract

Export VAT rebates and how quickly they are delivered both matter for firms' responses. We develop a model in which higher rebate rates reduce marginal exporting costs and encourage quality upgrading, while refund delays reduce the present value of rebates and tie up working capital. Using China's 2015 rebate rate increase and city-level variation in refund delays, we employ a triple-difference design. First, higher rebate rates increase both export quantities and prices, with evidence of quality upgrading. Second, refund delays weaken the quantity response and raise the price response, with little evidence that they affect quality upgrading. These effects are concentrated among financially constrained firms, suggesting that working-capital frictions, rather than discounting, are the primary mechanism. The calibrated model shows that an additional 1.5 months of waiting reduces refund cash available for working capital by nearly one-third but lowers its present value by only 0.6 percentage points. Counterfactuals show that immediate refunds would nearly double the export response, while pledge loans can achieve comparable gains.

JEL Codes: F14, H25, H32, H83

Keywords: Value-added tax, export rebates, export upgrading, refund delay, working capital, tax administration

*We thank Pedro Bento, Jaedo Choi, Yoon Joo Jo, Karel Mertens, Adrian Monninger, Tatevik Sekhposyan, Hiroshi Toma, Kei-Mu Yi, Yuzhe Zhang, Sarah Zubairy, and seminar participants at the 2026 Texas Macro Job Candidate Conference for helpful comments. All errors are our own.

1 Introduction

Export value-added tax (VAT) rebates are widely used as an instrument of trade policy. While previous research has examined their effects on export scale, how higher rebate rates affect firms' pricing and product quality decisions remains an important question. However, export rebates are not always received immediately. Refund delays are common in developing economies, raising a second question: how do these delays shape firms' responses to higher rebate rates?

Under the VAT system, firms pay tax on purchased inputs. Since exports are zero-rated, exporters can recover these taxes through rebates calculated as a percentage of export value. A higher rebate rate, therefore, reduces the cost of exporting. China provides a setting to address both questions. First, the government sets product-specific export rebate rates. On January 1, 2015, China increased rebate rates on selected products. Second, export rebates are administered by local tax offices, and refund delays vary across cities. Using Chinese Customs data from 2012 to 2015 and city-level refund delays measured from the National Tax Survey Database, we employ a triple-difference design.

Our main results reveal two patterns. First, higher rebate rates increase both export quantities and prices. For every percentage-point increase in the rebate rate, firms expand export quantities by 1.7 percent and raise prices by 0.9 percent, resulting in a 2.6 percent increase in export value. Second, refund delays change firms' responses to the same rebate-rate increase. A one-standard-deviation increase in refund delay, equivalent to roughly 1.5 additional months of waiting, reduces the quantity response by 0.6 percentage points while raising the price response by 0.3 percentage points. These findings raise two central questions. Why do export prices rise when rebate rates increase despite lower exporting costs, and can quality upgrading explain this increase? Meanwhile, given the small present-value loss from an additional 1.5 months of waiting, what explains the substantial effects of refund delays on firms' responses?

To explain these findings, we develop a static partial-equilibrium model in which firms sell differentiated products in domestic and export markets. Firms first choose product quality, which affects consumer demand, production costs, and requires an upfront design investment. Given quality, they choose prices and quantities to maximize profits subject to demand and a working-capital constraint. Higher export rebate rates reduce firms' net tax payable, increasing profits for a given quality level. They therefore encourage export expansion and lower prices at a given quality, but they also increase the return to quality upgrading, which can raise prices. The net price response depends on the relative strength of these two opposing effects. A positive price response is more likely when the market rewards

quality more strongly and quality upgrading is less costly.

We then examine how refund delays affect firms. Firms with negative net tax payable receive rebates as delayed cash refunds, whereas firms with positive net tax payable receive an immediate reduction in taxes paid and are not exposed to refund delays. For the former firms, longer delays operate through two channels. The discounting channel reduces the present value of rebates, weakening incentives to expand exports and upgrade quality. The cash-in-use channel reduces the rebate cash available to finance current production, tightening the working-capital constraint and weakening the quantity response while raising the price response, particularly among financially constrained firms. The relative importance of these two channels depends on the present-value loss and the extent to which refund delays constrain working capital.

We then turn to the empirical evidence on quality upgrading in Section 6. We provide two pieces of evidence. First, the model predicts a stronger price response when there is greater scope for quality upgrading. Following Khandelwal et al. (2013) and Fan et al. (2015), we infer product quality from demand and use the pre-reform dispersion of inferred quality within each product as a proxy for differentiation scope. Consistent with the model, the price increase is larger for products with high quality dispersion than for those with low dispersion, whose response is close to zero. Second, on the production side, exposed firms actively upgrade their inputs: they source a significantly higher share of intermediate inputs from high-income countries and import a wider variety of inputs (Kugler and Verhoogen, 2012). As the model also predicts, firms' export profits increase following the rebate-rate increase. Furthermore, we examine alternative explanations for the price increase, finding no evidence of shifts toward higher-price export destinations, product reclassification, or export over-invoicing. Together, these findings provide evidence that quality upgrading contributes to the positive export price response.

We next examine the role of refund delays in shaping firms' responses to higher rebate rates in Section 7. The model predicts different effects across four groups defined by whether firms must wait for cash refunds and whether they face tight financial constraints before the reform. Financially tight refund claimants are exposed to both the discounting and cash-in-use channels. Consistent with this prediction, we find that longer delays weaken their quantity response and raise their price response. Financially slack refund claimants are affected only through the discounting channel; empirically, their responses show no statistically significant sensitivity to refund delays. Finally, firms without refund claims are not directly exposed to either channel, regardless of financial tightness, and we find no significant delay effects for either group. We also find little evidence that refund delays affect quality upgrading. Together, these findings support the cash-in-use mechanism, while its quantitative

importance relative to discounting remains to be established.

To quantify the relative importance of the two channels and evaluate policy counterfactuals, we calibrate the model and find that it fits the untargeted regression responses well. An additional 1.5 months of waiting reduces the present value of rebates by only 0.6 percentage points but cuts the cash available during the roughly three-month cash conversion cycle by nearly one-third. Quantitatively, the discounting channel accounts for only about 2% of the estimated delay effect. We then evaluate two policy alternatives that improve firms' access to refund cash. Immediate refunds would nearly double the export-value response to a rebate-rate increase relative to the baseline of a 2.5-month average refund delay. When accelerating refunds is impractical, financial market solutions can serve as an effective substitute. Allowing commercial banks to lend against pending refunds can achieve nearly the same gains as immediate delivery.

Our paper contributes to two strands of literature. First, the literature on export VAT rebates documents their effects on export quantities and values (Chao et al., 2001; Chandra and Long, 2013), while empirical studies of export prices find incomplete pass-through (Braakmann et al., 2020; Lee et al., 2021) or no significant response (Gourdon et al., 2022). We extend this literature by showing how conventional cost pass-through and endogenous quality upgrading jointly shape the price response, providing a unified explanation for the mixed findings in previous studies.

Second, we contribute to the literature on tax incentives and the timing of government payments. Existing studies emphasize the role of immediate cash flow in firms' investment decisions (Zwick and Mahon, 2017; Chen et al., 2023) and document the effects of delayed refunds on firm activity (Lu and Ma, 2023; Brusco et al., 2024; Pineda Pinto et al., 2024). Building on the literature on working-capital constraints in international trade (Feenstra et al., 2014; Kohn et al., 2016), we incorporate tax refund flows into firms' working-capital constraints to explain how refund delays attenuate export responses and why these effects are concentrated among financially constrained refund claimants.

The rest of the paper is organized as follows. Section 2 describes the institutional background of China's export rebate system, the 2015 policy reform, and the refund delivery process. Section 3 develops our theoretical framework of endogenous quality choice and working-capital constraints. Section 4 presents the data, the city-level refund delay measure, and the empirical strategy. Section 5 reports the main triple-difference estimates for export prices, quantities, and values. Section 6 provides empirical evidence on the quality-upgrading channel, while Section 7 investigates the refund-delay effect and the working-capital mechanism. Section 8 calibrates the model and evaluates policy counterfactuals. Section 9 concludes.

2 Institutional Background

2.1 VAT and Export Refund System

VAT system and export rebate. The VAT is collected at each stage of production. Firms charge output VAT on their domestic sales and pay input VAT on their purchases, so they remit tax only on the value they add. During our sample period, China's standard VAT rate was 17 percent.

Exports, however, are zero-rated under the destination principle (Ebrill et al., 2001). Exporters therefore charge no VAT on foreign sales, while the VAT paid on their inputs should be refunded. In China, however, export rebates are determined by product-specific rebate rates, which are generally lower than the standard VAT rate. The unrecovered portion acts as an implicit tax on exports (Feldstein and Krugman, 1990). A higher rebate rate therefore reduces the cost of exporting. By adjusting these rates, the Chinese government uses export VAT rebates as an instrument of trade and industrial policy (Chandra and Long, 2013; Braakmann et al., 2020; Gourdon et al., 2016).

In China, manufacturing exporters receive the rebate under the exemption–credit–refund method. Exports are exempt from output VAT, while input VAT credits and export rebates are first used to offset VAT owed on domestic sales. If the rebate is fully absorbed, a higher rebate rate reduces the firm's current tax payment. Otherwise, the remaining refundable amount must be claimed as a cash refund, which is paid after review by the tax authority. Thus, depending on a firm's net VAT position, a higher rebate rate can reduce its current tax payment or increase its cash refund. Trading companies follow a different refund procedure and are excluded from our analysis.

Refund Delays. In practice, cash refunds are often delayed. Acedo et al. (2024) report that in 87 percent of the 105 countries assessed, fewer than 70 percent of VAT refund claims were processed within 30 days. These delays can be substantial: Harrison and Krelove (2005) document that while refunds in developed economies are generally paid within four weeks, processing in developing and transition economies often takes several months and sometimes more than a year. Evidence from refund reforms in Honduras and South Africa shows that faster refunds can improve firm investment and performance (Pineda Pinto et al., 2024; Brusco et al., 2024).

In China, export VAT refunds are administered by local tax authorities under fiscal arrangements involving both the central and local governments. Although rebate rates are set nationally, refund claims are reviewed and approved locally, leaving scope for differences in refund processing across cities. Lu and Ma (2023) document substantial delays in China's

export VAT refunds. Using the National Tax Survey Database, we find that, on average, 21 percent of refunds due remained unpaid at year-end.

2.2 The 2015 Rebate Adjustment

On December 31, 2014, the Ministry of Finance and the State Administration of Taxation issued Caishui [2014] No. 150, announcing changes to export VAT rebate rates. The rate increases took effect on January 1, 2015, one day after the announcement. They covered selected high-value-added products, textiles and apparel, and corn-processing products. The notice also reduced or eliminated rebates for a small number of other products.

Our analysis focuses on non-textile products with rebate-rate increases.[1] Products with unchanged rebate rates serve as the comparison group.

Table 1: The 2015 Export VAT Rebate Adjustment

Panel A. HS8 products in the analysis sample

	Products	Share
All HS8 products	5,006	100.0%
Rebate rate increased	199	4.0%
Rebate rate unchanged	4,807	96.0%

Panel B. Size of the increase, among products that received one (percentage points)

	Products	Share	Mean	S.D.	p25	Median	p75	Min	Max
Increase in rebate rate	199	4.0%	4.30	3.44	2.00	4.00	4.00	1.00	13.00

Notes. The unit of observation is a unique HS8 product exported by manufacturing firms under ordinary trade in 2012–2015. Products whose rebate rate was cut and textiles and apparel (HS chapters 50–63) are excluded from the analysis sample. Panel B restricts to products whose rebate rate rose.

Rebate rates increased for 199 of the 5,006 HS8 products in the estimation sample, representing 4.0 percent of all products. These products span 64 HS4 headings and are mainly in medical instruments, automated machinery, and chemicals. They accounted for 2.89 percent of the sample's export value in 2014. Rebate rates increased by 1 to 13 percentage points, with a mean of 4.30 and a median of 4 percentage points across affected products (Table 1). Most increases were relatively small: 154 of the 199 products received increases of 2 or 4 percentage points. Products with increases of at most 4 percentage points accounted

[1]The notice raised rebate rates by one percentage point across textile and apparel products (HS chapters 50–63). During 2012–2015, however, China's textile and apparel sector experienced a structural relocation toward Southeast and South Asia (Lopez-Acevedo and Robertson, 2016), causing these products to fail the parallel pre-trends test. We therefore exclude them from the analysis.

for 94 percent of affected products' 2014 export value, while the 37 products with increases of 8 to 13 percentage points accounted for only 5.7 percent (Figure 1).

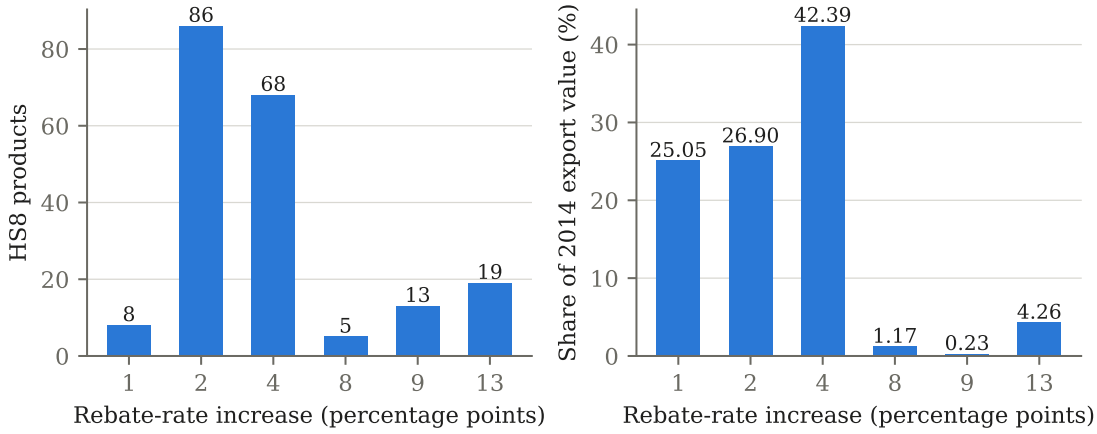


Figure 1: The 2015 Rebate Increases by Product Count and 2014 Export Value

3 Model

This section develops a partial-equilibrium economy with heterogeneous multi-product firms operating in monopolistically competitive markets. Firms choose product quality and prices under working-capital constraints. The model examines how firms respond to higher export VAT rebate rates and how refund delays affect these responses.

3.1 Environment

The economy consists of a government and a continuum of heterogeneous firms. Firms differ in productivity, produce differentiated products, and sell in both export and domestic markets. Export demand is given by

$$x_{ip} = A_p q_{ip}^{\eta_j} P_{ip}^{-\sigma_j}, \tag{1}$$

where i indexes firms, $p \in \mathcal{P}_i$ indexes products, and $j = j(p)$ denotes the product category. P_{ip} and q_{ip} are the export price and product quality, respectively. A_p is a demand parameter, $\sigma_j > 1$ is the price elasticity of demand, and $\eta_j > 0$ measures the sensitivity of export demand to quality. A higher η_j implies that improvements in quality generate a larger increase in demand at a given price.

Domestic demand is given by $d_{ip} = A_{D,p} q_{ip}^{\eta_D} P_{D,ip}^{-\sigma_D}$, where $P_{D,ip}$ is the domestic price, $A_{D,p}$ is a demand parameter, and $\sigma_D > 1$ and $\eta_D > 0$ are the price and quality elasticities of domestic demand, respectively. Product quality q_{ip} is common to both markets.

On the production side, the unit variable input cost of product p is

$$c_{ip}(q_{ip}) = \frac{q_{ip}^{\alpha}}{\varphi_i}, \tag{2}$$

where φ_i denotes firm productivity and $\alpha > 0$ measures the sensitivity of unit production cost to quality. Total variable input purchases are

$$M_i = \sum_{p \in \mathcal{P}_i} c_{ip}(q_{ip})(x_{ip} + d_{ip}). \tag{3}$$

Producing product p requires a fixed cost F_p. The firm also incurs a quality design cost

$$f_j q_{ip}^{\zeta_j}, \tag{4}$$

where $f_j > 0$ and $\zeta_j > 0$. A higher ζ_j implies that design costs increase more rapidly with quality, making quality upgrading more costly. We abstract from general-equilibrium effects through aggregate supply.

The government levies a VAT at rate τ and sets a product-specific export rebate rate $r_p \leq \tau$. Under the exemption–credit–refund system described in Section 2, the firm's net VAT payable is

$$NP_i = \tau \sum_{p \in \mathcal{P}_i} P_{D,ip} d_{ip} + \sum_{p \in \mathcal{P}_i} (\tau - r_p) P_{ip} x_{ip} - \tau M_i. \tag{5}$$

The first term is output VAT on domestic sales, the second is the non-refundable portion of VAT on exports, and the third is the input VAT credit. A higher rebate rate reduces the firm's net VAT payable, holding sales and input purchases fixed. If $NP_i \geq 0$, the firm pays VAT to the government, and a higher rebate rate immediately reduces its tax payment. If $NP_i < 0$, the firm has excess input VAT credits and receives a refund of $-NP_i$, with refund delays varying across cities. Only firms with $NP_i < 0$ are directly exposed to refund delays.

Firms make decisions in two stages. In the first stage, each firm chooses product quality and incurs quality design costs, financed with long-term funds (Shaked and Sutton, 1982; Sutton, 1991). The firm maximizes profits net of quality design costs:

$$\max_{\{q_{ip}>0\}_{p \in \mathcal{P}_i}} \left\{ \Pi_i(\mathbf{q}_i) - \sum_{p \in \mathcal{P}_i} f_j q_{ip}^{\zeta_j} \right\}, \tag{6}$$

where $\Pi_i(\mathbf{q}_i)$ denotes the anticipated profits from the second stage.

In the second stage, given product quality, the firm chooses export and domestic prices to maximize profits, subject to the demand functions in both markets and a working-capital constraint:

$$\begin{aligned}\Pi_i(\mathbf{q}_i) = \max_{\{P_{ip},P_{D,ip}\}_{p\in\mathcal{P}_i}} \quad & \sum_{p\in\mathcal{P}_i}[P_{ip}x_{ip} + (1+\tau)P_{D,ip}d_{ip}] \\ & - (1+\tau)M_i - NP_i - (1-v_c)(-NP_i)^+,\end{aligned} \tag{7}$$

$$\theta M_i + \sum_{p\in\mathcal{P}_i}(\tau - r_p)P_{ip}x_{ip} + (1-s_c)(-NP_i)^+ \leq L_i. \tag{8}$$

In the profit function, the first term is total sales revenue, including VAT collected on domestic sales. The second term is variable input costs, including input VAT, and the third is net VAT payable. The final term captures the present-value loss from delayed refunds and applies only to firms with $NP_i < 0$ (see Appendix A.2 for the derivation). For these firms,

$$v_c \equiv v(D_c) = \mathbb{E}\left[e^{-\varrho T_c}\right] \in [0,1], \quad v'(D_c) < 0 \tag{9}$$

where T_c is the waiting time to receive a refund in city c, where firm i is located, and ϱ is the discount rate. The variable D_c denotes city c's refund-delay measure.

The firm can borrow up to L_i to cover production costs and VAT payments before sales revenue is received (see Appendix A.1 for the cash flows). Following Manova (2013), the first term in the working-capital constraint represents variable input purchases that require advance financing, where $\theta \in (0,1]$ is the share financed before sales revenue arrives. The second term is the non-refundable portion of VAT on exports, which the firm must finance before receiving sales revenue. The third term applies only to firms with $NP_i < 0$. Although these firms are entitled to a refund, the cash is not immediately available to finance current production. The fraction of refunded cash available during the production cycle is

$$s_c \equiv s(D_c) = \frac{\mathbb{E}[(\ell - T_c)^+]}{\ell} \in (0,1], \quad s'(D_c) < 0 \tag{10}$$

where ℓ is the cash conversion cycle (Richards and Laughlin, 1980; Raddatz, 2006).

Assumption 1 (Financing of quality and production)**.** Quality is a durable product attribute financed with long-term funds, whereas current production is financed with working capital, and long-term funds are less constrained than working capital. The firm therefore evaluates anticipated profits $\Pi_i(\mathbf{q}_i)$ at the shadow cost of long-term funds, ψ_i, rather than at the shadow cost of the working-capital constraint (8), μ_i, with $0 \leq \psi_i < \mu_i$ whenever this

constraint binds.

A firm that has exhausted its working-capital line need not be at the limit of its long-term funds (Fazzari and Petersen, 1993).

Assumption 2 (Predetermined liquidity)**.** L_i is given within the cash conversion cycle and does not adjust to the refund claims generated during the cycle.

Assumption 2 implies that a larger refund claim is accommodated by reallocating current assets rather than by new borrowing.

3.2 Export Rebate Rates and Firm Decisions

A higher export rebate rate reduces the firm's net VAT payable, NP_i, and affects its decisions through two channels. At a given product quality, it lowers the effective marginal cost of exports, affecting prices, quantities, and profits. It also increases the return to quality investment, which can raise export prices through higher production costs while increasing demand for higher-quality products.

Production and pricing at fixed quality. At a given product quality, a higher rebate rate lowers the effective marginal cost of exporting by reducing the non-refundable portion of VAT on exports, $\sum_{p\in\mathcal{P}_i}(\tau - r_p)P_{ip}x_{ip}$, in NP_i. Taking into account the cost of working capital, the effective marginal cost of exporting product p is

$$\widetilde{c}_{ip}^{X} = c_{ip}(q_{ip}) \begin{cases} \dfrac{1+\mu_i\theta}{1-(\tau-r_p)(1+\mu_i)}, & NP_i \geq 0, \\ \dfrac{1+\tau(1-v_c)+\mu_i[\theta+\tau(1-s_c)]}{1-(\tau-r_p)(v_c+\mu_i s_c)}, & NP_i < 0, \end{cases} \tag{11}$$

where $\mu_i \geq 0$ is the shadow cost of the working-capital constraint (see Appendix A.3 for the derivation).

Under CES demand, optimal export prices and quantities are given by

$$\begin{aligned} P_{ip} &= \frac{\sigma_j}{\sigma_j - 1}\widetilde{c}_{ip}^{X}, \\ x_{ip} &= A_p q_{ip}^{\eta_j}\left(\frac{\sigma_j}{\sigma_j - 1}\widetilde{c}_{ip}^{X}\right)^{-\sigma_j}. \end{aligned} \tag{12}$$

At a given quality, a higher rebate rate reduces effective marginal cost, lowering export prices while increasing export quantities and profits.

Quality investment. A higher rebate rate also increases the return to quality investment by raising export profits. The firm chooses product quality by balancing the resulting profit gains against quality design costs. Quality upgrading raises unit production costs and consumer demand, potentially offsetting the direct reduction in export prices.

Price and quantity responses. With endogenous quality, the export-price response reflects two opposing effects:

$$\frac{\partial \ln P_{ip}}{\partial r_p} = -\Gamma_{ip} + \alpha \frac{\partial \ln q_{ip}}{\partial r_p}, \tag{13}$$

where $\Gamma_{ip} > 0$ captures the direct reduction in effective marginal cost. The first effect lowers export prices, while the second raises them through quality upgrading.

Proposition 1 (Export Price Response)**.** *Let $\lambda_{ip} \in (0, 1)$ denote the share of the marginal return to quality attributable to export sales. A higher export rebate rate increases the export price if and only if*

$$\lambda_{ip}(\eta_j + \alpha) + (1 - \lambda_{ip})[\eta_D - \alpha(\sigma_D - 1)] > \zeta_j. \tag{14}$$

See Appendix A.4 for the proof.

The price response depends on three factors: consumers' sensitivity to quality, η_j; the increase in unit production costs associated with higher quality, α; and the difficulty of quality upgrading, ζ_j. The role of α is ambiguous because higher production costs discourage quality upgrading but amplify its effect on prices. A positive price response is more likely when export demand is more sensitive to quality and quality design costs rise less rapidly.

3.3 Refund Delays and Working Capital

For firms with $NP_i < 0$, the effect of a higher rebate rate also depends on when refunds are received. Longer refund delays reduce the present value of refunds and thus profits through the final term in (7), as captured by v_c. They also tie up funds in outstanding refund claims, reducing the cash available to finance current production through the final term in (8), as captured by s_c. This second channel is particularly important when the working-capital constraint binds. In contrast, firms with $NP_i \geq 0$ benefit from immediate reductions in VAT payments and are not directly affected by refund delays.

Discounting and working capital. For firms with $NP_i < 0$, the effect of a higher rebate rate on effective marginal cost is

$$\begin{aligned} \Gamma_{ip} &\equiv -\frac{\partial \ln \widetilde{c}_{ip}^{X}}{\partial r_p} = \frac{v_c + \mu_i s_c}{1 - (\tau - r_p)(v_c + \mu_i s_c)}, \\ \frac{\partial \Gamma_{ip}}{\partial D_c} &= \frac{v'(D_c) + \mu_i s'(D_c)}{[1 - (\tau - r_p)(v_c + \mu_i s_c)]^2} < 0. \end{aligned} \tag{15}$$

In Γ_{ip}, v_c captures the present-value channel, while $\mu_i s_c$ captures the working-capital channel. When the working-capital constraint is slack ($\mu_i = 0$), only the present-value channel operates. When the constraint binds ($\mu_i > 0$), longer refund delays also reduce the working-capital benefit of a higher rebate rate. Consequently, slower refund delivery weakens the reduction in effective marginal cost induced by a higher rebate rate.

Thus, at a given quality, slower refund delivery weakens the reduction in export prices and the expansion in export quantities generated by a higher rebate rate.

Export responses with endogenous quality. When quality is endogenous, refund delays also affect the return to quality investment. A slower refund reduces direct cost relief, making the export-price response more positive at a given quality. However, changes in quality investment can reinforce or offset this effect. Because refund delays mainly tie up working capital, whereas quality is financed with long-term funds, they weaken the return to quality investment less than they weaken direct cost relief. The overall response therefore depends on how strongly refund delays affect quality upgrading.

Proposition 2 (Refund Delays and Rebate Responses)**.** *For firms with $NP_i < 0$, longer refund delays reduce the direct cost relief from a higher rebate rate. At a given quality, they make the export-price response less negative and reduce the export-quantity response. With endogenous quality, the price response becomes more positive and the quantity response smaller if the effect of refund delays on quality upgrading is sufficiently small relative to the direct cost effect.*

See Appendix A.5 for the proof.

4 Data and Empirical Design

This section describes the data and empirical strategy used to estimate exporters' responses to the 2015 rebate-rate increase and how these responses vary with refund delivery. We combine Chinese Customs records with the National Tax Survey Database to measure export

outcomes and pre-reform city-level refund delays. We then introduce the empirical specification and discuss the identifying assumptions underlying the comparisons across products and cities.

4.1 Data and Sample

Firm–Product-Level Data. We use Chinese Customs data covering firms' exports at the eight-digit Harmonized System (HS8) product level from 2012 to 2015. The data provide export value, export quantity, and unit value, along with information on trade regimes, export destinations, and firms' city codes. We aggregate the data to the firm–HS8–year level. The sample ends in 2015 because export quantities are unavailable for 2016.

We restrict the sample to manufacturing firms' general-trade exports, which are subject to the exemption–credit–refund system described in Section 2. Trading companies and processing-trade exports are excluded because they follow different rebate arrangements. We further restrict the sample to HS chapters 28–97, excluding agricultural, food, and mineral products, as well as textiles and apparel and products whose rebate rates were reduced in 2015.

The estimation sample contains 3,146,104 firm–HS8–year observations from 173,690 firms, covering 5,006 HS8 products across 240 cities. Our main outcomes are the logarithms of export unit value, quantity, and value. The treatment variable, Δr_p, is the change in the export VAT rebate rate for HS8 product p from 2014 to 2015, measured in percentage points. It equals zero for products whose rebate rates remained unchanged. Table 2 reports summary statistics for 2012–2015 and compares pre-reform export growth across treated and untreated products.

Firm-Level Tax Data. We use the National Tax Survey Database (NTSD), which provides detailed information on firms' tax payments, export VAT rebates, and balance sheets. These data allow us to measure pre-reform differences in refund delivery across cities. We also link the NTSD to the customs data to examine firm-level responses to the rebate increase and how these responses vary with firms' refund-claimant status and financial conditions.

For the firm-level analysis, we measure exposure to the rebate increase using firms' pre-reform export composition.

$$E_i = \frac{\sum_p \mathbf{1}(\Delta r_p > 0)\, X_{ip}^{\text{gen}}}{\sum_p X_{ip}}, \tag{16}$$

where X_{ip} denotes firm i's exports of product p over 2012–2013, summed across the products in the analysis sample, and X_{ip}^{gen} denotes the corresponding general-trade exports. Thus, E_i

Table 2: Summary Statistics and Pre-Reform Export Growth

Panel A. Summary statistics, 2012–2015

Variable	Obs.	Mean	S.D.	Min	Max
ln unit value	3,146,104	2.723	2.487	−7.700	17.467
ln export quantity	3,146,104	7.401	3.566	0.000	21.908
ln export value	3,146,104	10.133	2.798	0.000	21.643
Entry rate	4,310,106	0.559	0.497	0.000	1.000
Exit rate	5,405,999	0.515	0.500	0.000	1.000

Panel B. Pre-reform export growth, 2012–2014

Variable	Full Sample	Treated Products	Untreated Products (same HS4 category)
Δ ln unit value	−0.119	−0.115	−0.106
	(1.060)	(1.018)	(1.106)
Δ ln export quantity	0.200	0.143	0.192
	(2.001)	(1.960)	(1.951)
Δ ln export value	0.075	0.020	0.084
	(1.859)	(1.782)	(1.787)
Firm–HS8 pairs	465,538	13,083	25,438

Notes. Firm–HS8–year observations in the 2012–2015 estimation sample. Unit values, quantities and export values are in logs and winsorized at the 1st and 99th percentiles within product groups. Unit values and export values are in USD. In the raw data, ln unit value plus ln export quantity equals ln export value for every observation; because the three variables are winsorized separately, the means in the table differ by 0.009. The exit rate is the share of firm–HS8 pairs exporting in year t that export nothing in $t+1$ (2016 customs records are used for 2015); the entry rate is the share of pairs exporting in t that exported nothing in $t-1$, available for 2013–2015. Entry and exit rates are computed before singleton firm–HS8 pairs are removed. Panel B reports means, with standard deviations in parentheses, of the change between 2012 and 2014 within firm–HS8 pairs that export in both years. Treated HS8 are products whose rebate rate rose in 2015; the last column restricts untreated products to HS4 headings that contain a treated product.

measures the share of a firm's pre-reform exports accounted for by general-trade exports of products whose rebate rates increased. It ranges from zero to one. Detailed summary statistics on the distribution of firm-level exposure are reported in Appendix Table 27.

4.2 City Refund Delay

We measure refund delay using the NTSD, which reports firms' export VAT refunds due, refunds received, and outstanding refund balances. For each firm-year, we calculate the share of unpaid refunds as

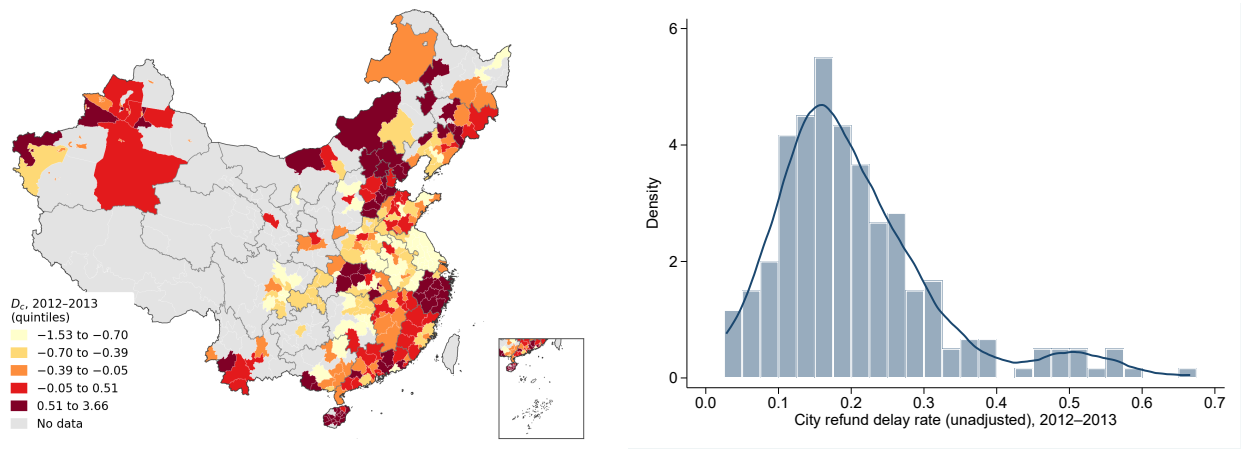
$$m_{it} = 1 - \frac{\text{Refunds received}_{it}}{\text{Refunds due}_{it} + \text{Outstanding refunds}_{i,t-1}}.$$

This measure captures the share of refund claims that remain unpaid at year-end rather than the actual time taken to process each refund. Among firms claiming refunds, 56 percent have some refunds unpaid at year-end, and 15 percent have more than half of their claims unpaid.

Because export VAT refunds are administered by local tax offices, we aggregate firm-level unpaid shares to the city level to capture differences in refund delivery across cities. To account for differences in refund patterns across industries, we subtract the national two-digit industry–year mean from each firm's unpaid share and average the adjusted shares across firm-years within each city over 2012–2013. We standardize these city averages to obtain D_c, which has a mean of zero and a standard deviation of one. We require at least 30 firm-years with refund claims per city, leaving 240 of 348 cities. A higher D_c indicates slower refund delivery.

Figure 2 illustrates the geographic variation in refund delivery. Panel (a) maps D_c, with light yellow indicating faster refunds and dark red indicating slower refunds. Substantial differences exist even between neighboring coastal provinces, such as Jiangsu and Zhejiang. Cities without a measured D_c, shown in gray, are mostly inland and account for only 0.8 percent of China's total exports over 2012–2015. Panel (b) shows the distribution of city-level unpaid shares before industry adjustment. Most cities have unpaid shares between 10 and 30 percent, with an average of 21 percent. A one-standard-deviation increase in D_c corresponds to an 11-percentage-point increase in the unpaid share.

Two additional findings support the use of D_c as a measure of local refund delivery. First, a leave-one-industry-out measure of city-level refund delay, $D_{c,-j}$, predicts a firm's unpaid share. A one-standard-deviation increase in this measure is associated with approximately a 10-percentage-point increase in a firm's unpaid share (Appendix Table 13). This suggests that refund delays reflect common city-level factors rather than merely industry-specific



(a) Geography of D_c

(b) City delay before industry adjustment

Figure 2: Refund Delay across Cities, 2012–2013

Notes. Panel (a) shades each city by the quintile of D_c; cities in grey have fewer than 30 claimant firm–years and no D_c. Panel (b) shows the distribution across the 240 cities of the mean firm delay over 2012–2013 claimant firm–years, before industry adjustment and standardization.

differences. Second, refund delay is highly persistent across years. The correlation between pre-reform D_c and city refund delay in 2015 is 0.87 (Appendix Table 16). These findings suggest that D_c captures persistent differences in refund delivery that firms faced when the higher rebate rates took effect.

4.3 Empirical Specifications

We exploit two sources of variation: product-specific rebate-rate increases in 2015 and pre-reform differences in refund delay across cities. Let i index firms, p HS8 products, $h(p)$ the corresponding HS4 heading, $c(i)$ the firm's city, and t years. For y_{ipt} equal to the log of export unit value, quantity, or value, we estimate the following triple-difference specification:

$$y_{ipt} = \beta_1 \, \Delta r_p \times \text{post}_t + \beta_2 \, \Delta r_p \times \text{post}_t \times D_{c(i)} + \alpha_{ip} + \gamma_{c(i)t} + \delta_{h(p)t} + \varepsilon_{ipt}, \tag{17}$$

where post_t equals one in 2015 and zero otherwise. The coefficient β_1 measures the percentage change in export outcomes in response to a one-percentage-point increase in the rebate rate at the average level of city refund delay ($D_c = 0$). The coefficient β_2 measures how this response changes, in percentage points, with a one-standard-deviation increase in refund delay.

The specification includes firm–product fixed effects α_{ip}, city–year fixed effects $\gamma_{c(i)t}$, and HS4–year fixed effects $\delta_{h(p)t}$. Firm–product fixed effects absorb time-invariant differences in firms' export outcomes for each product. City–year fixed effects control for shocks common

to exporters within a city, while HS4–year fixed effects absorb shocks common to closely related products. Consequently, β_1 is identified by differences in export changes across HS8 products receiving different rebate-rate adjustments within the same HS4 heading. For example, within HS4 heading 8470, cash registers received a rebate increase, whereas ticket-issuing machines did not. For a given HS8 product, β_2 captures differences in the rebate-rate response across cities with different pre-reform refund delays. Standard errors are two-way clustered by city and HS4 heading to allow for correlated shocks within cities and related product categories.

We estimate the specification both with and without additional controls. These include firms' pre-reform log exports, number of exported HS8 products, and number of export destinations, each interacted with year indicators. These interactions allow firms with different pre-reform export characteristics to follow different time paths.

The specification above is Specification B. We also consider two alternative specifications. Specification A removes the interaction with D_c to estimate the overall response to the rebate-rate increase. Specification C replaces HS4–year fixed effects with HS8–year fixed effects, which absorb the β_1 term and all shocks common to the same HS8 product in a given year. This leaves only β_2 identified through differences in export responses to the same HS8 product across cities with different pre-reform refund delays. We do not include firm–year fixed effects because delayed refunds may affect the cost of financing a firm's exports across products, a component that such fixed effects would absorb.

To examine pre-reform trends, we replace the post-reform indicator with year indicators, using 2014 as the omitted year. For presentation, we recenter the estimated coefficients around their 2012–2014 average. Joint pre-trend tests examine whether the 2012 and 2013 coefficients differ from the 2014 reference year.

Identification. The identification of β_1 relies on the assumption that, absent the reform, products receiving larger rebate-rate increases would have followed similar export trends to products receiving smaller or no increases within the same HS4 heading. Although the reform targeted selected products, treated and untreated products within the same headings show no significant differences in pre-reform growth in unit values, quantities, or export values (Appendix Table 17). They also have similar export-market characteristics and exposure to foreign-demand shocks. We further include these characteristics interacted with year indicators as additional controls in the regressions reported in Appendix Table 18, allowing products with different characteristics to follow different time trends.

The identification of β_2 requires that, absent the reform, differences in export growth across products with different rebate-rate changes would not have varied systematically with

city refund delay. We find no systematic relationship between pre-reform refund delay and relative export growth across these products (Appendix Table 15). Among treated observations, the correlation between refund delay and the size of the rebate-rate increase is only -0.015. Refund delay is also not systematically related to pre-reform city characteristics, including GDP per capita, export scale, export composition, and industrial concentration (Appendix Table 14). Finally, the event studies test for differential pre-reform trends, while Specification C absorbs HS8–year shocks that could otherwise confound the estimated refund-delay effect.

5 Export Responses to the 2015 Rebate Increase

This section examines how the 2015 rebate-rate increase affected firms' export decisions and how these responses varied with refund delays. We first show that higher rebates increased both export quantities and unit values, while slower refund delivery weakened the quantity response and amplified the unit-value response. We then examine export entry and exit to assess whether the reform also affected participation in export markets.

5.1 Export Quantities and Unit Values

Table 3 reports the estimated responses of export unit values, quantities, and values to the 2015 rebate-rate increase. Panel A reports the difference-in-differences estimates of the overall export response to the 2015 rebate-rate increase. With controls for pre-reform firm characteristics, a one-percentage-point increase in the rebate rate raises export quantity by 1.6 percent, unit value by 0.9 percent, and export value by 2.5 percent.

Panel B shows that refund delivery changes these responses. At the average level of city refund delay, a one-percentage-point rebate-rate increase raises unit value by 0.9 percent, quantity by 1.7 percent, and export value by 2.6 percent. A one-standard-deviation increase in refund delay raises the unit-value response by 0.3 percentage points but reduces the quantity response by 0.6 percentage points, both roughly one-third of their respective responses at average delay. The export-value response falls by 0.3 percentage points. These two findings are consistent with the model's predictions. First, higher rebates increase both export quantities and unit values, as can occur when quality upgrading is sufficiently strong to offset the downward price pressure from cost pass-through. Second, slower refund delivery weakens the quantity response but amplifies the unit-value response, qualitatively consistent with the model's cash-in-use channel. Further evidence on quality upgrading and the cash-in-use mechanism is presented in Sections 6 and 7, respectively.

Table 3: Rebate Increases, Refund Delay and Product-Level Exports (2012–2015)

	ln unit value		ln quantity		ln export value	
	Baseline (1)	With controls (2)	Baseline (3)	With controls (4)	Baseline (5)	With controls (6)
Panel A. Specification A: difference in differences						
$\Delta r_p \times$ post	0.009***	0.009***	0.015***	0.016***	0.025***	0.025***
	(0.002)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)
Pre-trend p	0.362	0.433	0.583	0.513	0.243	0.231
Observations	3,146,104	3,146,026	3,146,104	3,146,026	3,146,104	3,146,026
Panel B. Specification B: triple difference						
$\Delta r_p \times$ post	0.009***	0.009***	0.016***	0.017***	0.025***	0.026***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
$\Delta r_p \times$ post $\times D_c$	0.003**	0.003**	−0.007***	−0.006***	−0.003***	−0.003**
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Pre-trend p: $\Delta r_p \times$year	0.315	0.381	0.600	0.520	0.235	0.232
Pre-trend p: $\Delta r_p \times D_c \times$year	0.499	0.472	0.645	0.635	0.264	0.257
Observations	3,146,104	3,146,026	3,146,104	3,146,026	3,146,104	3,146,026
Panel C. Specification C: within product						
$\Delta r_p \times$ post $\times D_c$	0.003**	0.003**	−0.006***	−0.006***	−0.003	−0.002
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Pre-trend p	0.795	0.781	0.807	0.805	0.481	0.477
Observations	3,144,805	3,144,727	3,144,805	3,144,727	3,144,805	3,144,727
Controls	No	Yes	No	Yes	No	Yes
Firm×product FE	Yes	Yes	Yes	Yes	Yes	Yes
City×year FE	Yes	Yes	Yes	Yes	Yes	Yes
Product×year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes. Firm–HS8–year observations, 2012–2015. All specifications include firm–HS8 and city–year fixed effects, plus HS4–year (Panels A–B) or HS8–year (Panel C) fixed effects. Even columns control for pre-reform firm characteristics interacted with year. Standard errors are two-way clustered by city and HS4. *, **, *** indicate significance at the 10%, 5%, and 1% levels.

Panel C reports estimates with HS8–year fixed effects, which are consistent with the baseline results in Panel B. The unit-value and quantity estimates remain nearly unchanged and statistically significant. The export-value differential is smaller and no longer statistically significant, reflecting the offsetting responses of unit values and quantities.

The estimates remain nearly unchanged after controlling for pre-reform firm characteristics interacted with year dummies, as shown in the even-numbered columns of Table 3. The results are also robust to additional controls for policy targeting, city export trends, foreign demand, and exchange rate movements (Appendix Table 19). Placebo tests find no corresponding increase in import unit values for treated products and no statistically significant refund-delay differential for non-general-trade exports (Appendix Table 20).

Figure 3 presents the event-study estimates for the rebate-rate response and its interaction with refund delay. Both effects emerge in 2015, with no evidence of systematic differences in pre-reform trends. The joint pre-trend tests reported in Table 3 do not reject equality of the pre-reform coefficients. The within-product event study shows a similar pattern, as shown in Appendix Figure 6.

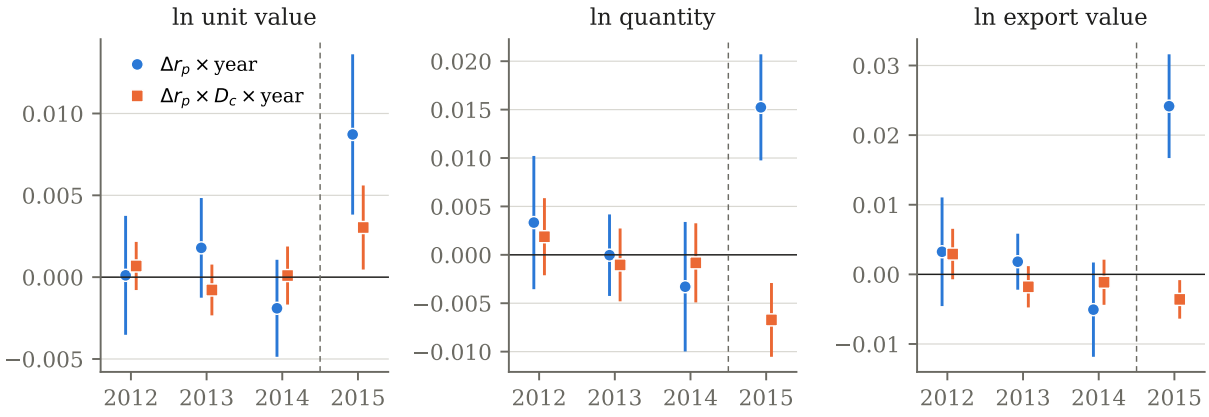


Figure 3: Event study, Specification B.

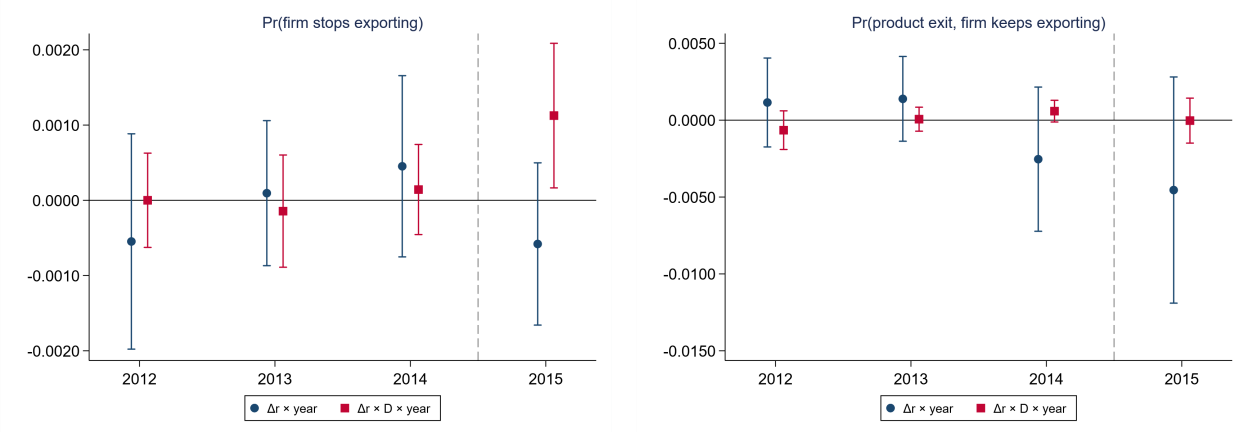
Notes: Event-study estimates normalized to the 2012–2014 mean. Circles represent the rebate-rate response at average refund delay, while squares represent the change in this response for a one-standard-deviation increase in refund delay. Both series come from one regression with firm–product, city–year and HS4–year fixed effects. Bars indicate 95% confidence intervals with two-way clustering by city and HS4.

5.2 Export Entry and Exit

We now consider whether the rebate increase and refund delays also affect export participation. We examine three margins: firm exit, when a firm stops all direct general-trade exports; product exit, when a firm stops exporting a particular product but continues exporting others; and product entry, when a firm begins exporting a new product. We estimate

Specification B for these extensive-margin outcomes using linear probability models with city–product, city–year, and HS4–year fixed effects.

The most pronounced extensive-margin effect is on firm exit. For a one-percentage-point rebate-rate increase, a one-standard-deviation increase in city refund delay raises the probability of firm exit by 0.11 percentage points, relative to the pre-reform exit rate of 9.27 percent. Figure 4a shows that this differential emerges in 2015, with no evidence of differential pre-trends.



(a) Firm exit

(b) Product exit

Figure 4: Event study, firm exit and product exit.

Notes: Panel (a) shows firm exit from general-trade exporting; Panel (b) shows product exit among continuing exporters. Estimates include city–product, city–year, and HS4–year fixed effects and are normalized to the 2012–2014 mean. Bars show 95% confidence intervals with two-way clustering by city and HS4.

By contrast, we find no statistically significant refund-delay differential for product exit, as shown in Figure 4b. This pattern is consistent with the firm-level working-capital constraint in the model. Delayed refunds restrict liquidity available to the firm as a whole, rather than changing the relative costs of exporting different products. As a result, financing pressure may cause some firms to stop exporting altogether, without necessarily inducing continuing exporters to exit specific product markets.

For product entry, a one-percentage-point rebate-rate increase is associated with a 0.04-percentage-point increase in the probability of entry at average refund delay, relative to a pre-reform entry rate of 2.06 percent. We find no statistically significant differential by refund delay. However, the entry event study rejects the pre-trend restriction, so these estimates should be interpreted cautiously.

Because the baseline estimates condition on positive exports, we also estimate export-value responses using PPML, including zero-export observations after exit. The negative refund-delay differential remains statistically significant (Appendix C.5).

6 Evidence on Quality Upgrading

Section 5 shows that higher export rebate rates increase both export quantities and unit values, although lower effective export costs would reduce prices if quality were fixed. Proposition 1 offers an explanation through endogenous quality choice: a positive price response is more likely when consumers value higher quality more strongly and products are easier to upgrade. We test this prediction by examining whether unit-value increases are concentrated in products with greater scope for quality differentiation. We then examine changes in imported inputs and firm profitability as complementary evidence of quality upgrading.

6.1 Quality Differentiation and the Unit-Value Response

Because product quality is not directly observable, we follow Khandelwal et al. (2013) to infer quality from export prices and quantities. We then use the pre-reform dispersion of inferred quality within HS8 products as a proxy for the scope for quality differentiation, following Fan et al. (2015). Specifically, we estimate the export demand relationship

$$\ln x_{ipdt} + \sigma_j \ln P_{ipdt} = \alpha_p + \delta_{dt} + \varepsilon_{ipdt}, \tag{18}$$

where i, p, d, and t index firms, HS8 products, destinations, and years, respectively; x_{ipdt} and P_{ipdt} denote export quantity and unit value; σ_j is the elasticity of substitution for product category j; and α_p and δ_{dt} are product and destination–year fixed effects. Conditional on unit value, higher export sales imply higher inferred quality, captured by the residual $\widehat{\varepsilon}_{ipdt}$. Using observations from 2012–2014, we calculate the dispersion of inferred quality within each HS8 product and divide products into high- and low-dispersion groups at the median.

Products with greater dispersion in inferred quality are considered to have more scope for vertical quality differentiation. For example, among the treated products in our sample, hearing aids and microscopes belong to the high-dispersion group, whereas aspartame and bicycle chains belong to the low-dispersion group. If quality upgrading contributes to the positive unit-value response, the model predicts a more positive response to higher rebate rates among high-dispersion products. To test this prediction, we estimate Specification B jointly for high- and low-dispersion products and test whether the rebate-rate coefficient, β_1, differs between the two groups.

Table 4 reports the results. Using HS4-varying substitution elasticities following Broda and Weinstein (2006), a one-percentage-point increase in the rebate rate raises unit values by 1.8 percent in high-dispersion products, while the response is close to zero in low-dispersion products. The difference is statistically significant. Similar patterns emerge when the elas-

ticity of substitution is fixed at five or ten, as in Fan et al. (2015). These findings are consistent with the model's prediction that quality upgrading is more likely to outweigh cost pass-through in products with greater scope for quality differentiation.

Table 4: Quality Differentiation and the Unit-Value Response to a Rebate Increase

$\Delta r_p \times$ post	High dispersion	Low dispersion	High − low
Inferred-quality measure	(1)	(2)	(3)
$\sigma = 5$	0.013*	−0.0005	0.013*
	(0.007)	(0.003)	(0.007)
$\sigma = 10$	0.011*	0.0001	0.011*
	(0.006)	(0.003)	(0.006)
HS4-varying σ_j	0.018**	0.0000	0.018**
	(0.007)	(0.002)	(0.007)
Controls	Yes	Yes	Yes
Firm×product×destination FE	Yes	Yes	Yes
Destination×year FE, by group	Yes	Yes	Yes
City×year FE, by group	Yes	Yes	Yes
HS4×year FE, by group	Yes	Yes	Yes

Notes. Firm–HS8–destination–year observations, 2012–2015. Columns (1) and (2) report rebate-rate responses evaluated at the average refund delay for high- and low-dispersion products, respectively. The two groups are estimated in one stacked regression with group-specific fixed effects. Column (3) reports the difference between the two responses. Standard errors are two-way clustered by city and HS4. *, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

We further examine whether the positive unit-value response is driven by a reallocation toward initially higher-priced varieties. We find no evidence of such reallocation or significant changes in within-product price dispersion, as reported in Appendix Table 21.

6.2 Supporting Evidence on Quality Upgrading

Evidence from Imported Inputs. We next examine firms' imported inputs as complementary evidence of quality upgrading. Producing higher-quality goods may require more sophisticated inputs, including intermediate materials and capital equipment (Kugler and Verhoogen, 2012; Bastos et al., 2018). Firms may source these inputs from high-income countries (Bas and Strauss-Kahn, 2015). Access to a wider variety of imported inputs may also facilitate quality upgrading by expanding the range of materials and components available for production (Goldberg et al., 2010; Bas and Strauss-Kahn, 2015).

We use the firm-level rebate exposure measure E_i, defined in Equation (16), which captures the share of a firm's pre-reform exports in treated products under general trade. Following the Broad Economic Categories (BEC) classification (United Nations, 2002), we dis-

tinguish between intermediate inputs, such as raw materials, industrial supplies, and components used in production, and capital goods, such as machinery and production equipment. We exclude minerals and fuels (HS 25–27) from intermediate inputs, whose origins are closely tied to resource endowments and commodity-market conditions. For each category, we measure sourcing from high-income countries by their share of import value and an indicator for any imports from these countries. We also construct an origin income index as the average log GDP per capita of source countries, weighted by import value, and measure imported input varieties by the number of distinct HS8 products. We compare changes in import sourcing across firms with different pre-reform rebate exposure.[2]

Table 5 reports the results. Panel A shows that firms more exposed to the rebate increase source more intermediate inputs from high-income countries and expand the variety of imported inputs. Moving from zero to full exposure increases the share of imports from high-income countries by 2.2 percentage points and the probability of importing from these countries by 2.9 percentage points. The import-weighted income of origin countries also increases by 0.05 log points. In addition, the number of imported input varieties rises by 6.1 percent. All four estimates are statistically significant, with no evidence of differential pre-reform trends (Appendix Figure 8). These findings are consistent with firms upgrading their production inputs in response to higher export rebates.

Panel B shows no comparable statistically significant changes in the sourcing of capital goods from high-income countries or in the number of imported varieties. The evidence of input upgrading is therefore concentrated in intermediate inputs rather than capital goods. One possible explanation is that firms can adjust materials and components more quickly than machinery and equipment, particularly given the one-year post-reform period. However, pre-trend tests reject for two capital-goods outcomes, so this contrast should be interpreted cautiously.

Appendix Table 22 reports pooled results across imported inputs. Appendix Table 30 shows similar results for intermediate inputs when firms' exposure is measured as the average rebate-rate increase weighted by exports, rather than as the share of treated exports.

[2]For each outcome, we estimate

$$y_{it} = \beta E_i \times \text{post}_t + \mathbf{X}_i'\gamma_t + \alpha_i + \lambda_{c(i)t} + \mu_{h(i)t} + \varepsilon_{it},$$

where α_i, $\lambda_{c(i)t}$, and $\mu_{h(i)t}$ denote firm, city–year, and main-export-HS4–year fixed effects, respectively. Each firm's main export HS4 category, $h(i)$, is defined by its largest export value during 2012–2013. $\mathbf{X}_i$ includes pre-reform log exports, the number of exported products, and the number of export destinations, each interacted with year indicators. Standard errors are two-way clustered by city and main export HS4.

Table 5: Imported-Input Responses to Rebate Exposure

	High-income share (1)	1(high-income origin) (2)	Origin income index (3)	ln input varieties (4)
Panel A. Intermediate inputs				
$E_i \times$ post	0.022**	0.029***	0.050**	0.061**
	(0.010)	(0.010)	(0.024)	(0.024)
Pre-trend p	0.544	0.443	0.752	0.834
Observations	170,440	170,440	165,337	170,440
Panel B. Capital goods				
$E_i \times$ post	−0.008	0.009	0.001	0.010
	(0.017)	(0.014)	(0.023)	(0.049)
Pre-trend p	0.196	0.036	0.680	0.021
Observations	93,140	93,140	89,475	93,140
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
City×year FE	Yes	Yes	Yes	Yes
Main HS4×year FE	Yes	Yes	Yes	Yes

Notes. The sample consists of firm-year observations from 2012 to 2015. Panel A covers intermediate inputs. Panel B covers capital goods. High-income origins exclude Hong Kong and Macao. Pre-trend p-values test the equality of the 2012 and 2013 event-study coefficients to the 2014 coefficient. Standard errors are two-way clustered by city and main export HS4. *, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Firm-Level Tax and Profit Responses. We also examine firm-level responses using tax and balance-sheet data from the National Tax Survey Database.[3] Table 6 shows that moving from zero to full rebate exposure reduces the share of non-refundable input VAT by 5.9 percentage points and increases profit relative to revenue by 2.9 percentage points. We also find a marginally significant increase in firm revenue, with no significant change in the export share of sales. These findings are consistent with the model, in which higher rebates reduce the effective cost of exporting and increase profits, thereby providing incentives for quality upgrading. Appendix Table 29, Panel A, reports similar results using another measure of firms' exposure.

Ruling Out Alternative Explanations. We consider several alternative explanations for the positive unit-value response. First, firms may shift exports toward destinations with higher prices (Manova and Zhang, 2012). Appendix Table 24 shows that the unit-value

[3]We estimate

$$y_{it} = \beta_1 E_i \times \text{post}_t + \beta_2 E_i \times \text{post}_t \times D_{c(i)} + X_i' \lambda_t + \alpha_i + \gamma_{j(i)t} + \delta_{c(i)t} + \varepsilon_{it}, \tag{19}$$

where α_i, $\gamma_{j(i)t}$, and $\delta_{c(i)t}$ denote firm, industry–year, and city–year fixed effects. X_i contains pre-reform firm characteristics interacted with year indicators. The sample consists of manufacturing exporters in the NTSD over 2012–2015, matched to customs records. Standard errors are clustered by city.

Table 6: Firm-Level Responses to Higher Rebates

	Non-refundable VAT share (1)	ln revenue (2)	Profit / revenue (3)	Export sales / revenue (4)
$E_i \times$ post	−0.059***	0.048*	0.029***	−0.010
	(0.007)	(0.029)	(0.008)	(0.012)
Pre-trend p	0.447	0.535	0.268	0.747
Mean of outcome	0.130	11.347	0.011	0.461
Observations	62,211	64,683	64,683	63,734
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Two-digit industry×year FE	Yes	Yes	Yes	Yes
City×year FE	Yes	Yes	Yes	Yes

Notes. The table reports β_1 from Equation (19). Pre-trend p-values test whether the 2012 and 2013 event-study coefficients are jointly zero relative to 2014. Standard errors clustered by city are in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

increase occurs within destinations, with no significant change attributable to destination composition. Second, exporters may reclassify similar products as treated HS8 products to benefit from higher rebate rates (Shi and Xu, 2023). Appendix Table 25 suggests that product reclassification does not drive the results. Third, exporters may overstate declared export prices to obtain larger rebates, as discussed in the literature on trade misreporting (Fisman and Wei, 2004; Ferrantino et al., 2012). The mirror statistics in Appendix D.3.1 provide no clear evidence that over-invoicing drives the unit-value response.

7 Evidence on the Refund-Delay Effect

Section 5 shows that slower refund delivery weakens the quantity response to a higher export rebate rate and makes the unit-value response more positive. The model in Section 3 identifies two potential channels: discounting and cash-in-use. We now examine these mechanisms through heterogeneity in firms' rebate responses and changes in their sales and tax outcomes.

7.1 Who Responds to Refund Delay?

The model predicts that the effect of refund delay depends on both firms' reliance on cash refunds and their financial conditions. Firms that receive the rebate through an immediate reduction in VAT payable are not directly exposed to refund delays. For firms awaiting

cash refunds, slower delivery reduces the present value of the rebate through the discounting channel. Financially constrained firms face an additional cash-in-use effect, as delayed refunds limit the funds available to finance current production. Consequently, slower refunds should have a stronger negative effect on the quantity response and a more positive effect on the unit-value response among financially tight refund claimants.

To test the mechanism, we classify exporters along these two dimensions using pre-reform observations from the National Tax Survey Database, matched to the customs data. A firm is classified as a refund claimant if it reports positive refunds due in every year from 2012 to 2014. We measure financial tightness by the firm's average interest expense relative to revenue over the pre-reform period, which reflects the cost of borrowing, and classify firms above the median as financially tight. Combining these two dimensions yields four groups. We estimate Specification B for these four groups to examine how the refund-delay effect varies with refund claimant status and financial tightness.

Table 7 reports the results. Among financially tight refund claimants, one standard deviation of slower refund delivery increases the unit-value response to a one-percentage-point rebate-rate increase by 0.82 percentage points, while reducing the quantity and export-value responses by 2.58 and 1.79 percentage points, respectively. Financially slack refund claimants, who are exposed to the discounting channel but not the cash-in-use channel, show no statistically significant responses. One possible explanation is that additional waiting reduces the present value of refunds only slightly. For non-claimants, the estimated delay effects are also statistically indistinguishable from zero, regardless of financial tightness, consistent with the model's prediction. The pooled comparison further shows that financially tight refund claimants differ significantly from all other firms in all three outcomes. Overall, financially tight refund claimants are most affected by refund delays.

Appendix Table 32 reports similar results using two alternative measures of financial tightness: current liabilities relative to current assets and net working capital relative to total assets.

An additional question is whether slower refunds also hinder quality upgrading. To address this question, we compare the refund-delay effects on unit values between products with high and low pre-reform dispersion in inferred quality, following the approach in Section 6. Appendix Table 23 shows that the estimated effects are similar across the two groups, with no statistically significant difference. These results provide no evidence that slower refunds affect quality upgrading.

Table 7: Refund-Delay Effects by Refund Claimant Status and Financial Tightness

	ln Unit Value (1)	ln Quantity (2)	ln Export Value (3)
Panel A. Refund-delay effects by firm group			
Tight claimants	0.008**	−0.026***	−0.018***
	(0.003)	(0.007)	(0.005)
Slack claimants	−0.001	0.000	−0.002
	(0.004)	(0.008)	(0.007)
Tight non-claimants	−0.004	0.009	0.003
	(0.006)	(0.011)	(0.009)
Slack non-claimants	0.004	0.001	0.006
	(0.004)	(0.008)	(0.007)
Panel B. Tight claimants vs. all other firms			
Difference	0.009**	−0.027***	−0.017**
	(0.004)	(0.009)	(0.007)
Pre-trend p-value	0.269	0.764	0.387
Observations		1,238,877	
Controls	Yes	Yes	Yes
Firm×product FE	Yes	Yes	Yes
City×year FE, by group	Yes	Yes	Yes
HS4×year FE, by group	Yes	Yes	Yes

Notes. The sample consists of firm–HS8–year observations matched to the National Tax Survey Database. Regressions follow Specification B, with group-specific treatment interactions, controls, and fixed effects. Panel A reports the refund-delay coefficients for the four groups. Panel B reports the difference between financially tight refund claimants and all other firms from a separate pooled regression, together with pre-trend test p-values. Standard errors are two-way clustered by city and HS4. *, **, and *** denote significance at the 10, 5, and 1 percent levels.

7.2 Firm-Level Responses to Refund Delay

Export VAT refunds are substantial relative to firms' operating resources. Using pre-reform data from the NTSD, Table 8 shows that annual refunds due amount to 23.4 percent of year-end cash holdings and 21.4 percent of net operating cash flow for the median firm in the respective samples. Relative to net profits, the median ratio reaches 44.4 percent. These magnitudes suggest that refund delays may have meaningful implications for firms' production and financing decisions.

Table 8: Export VAT Refunds Relative to Firms' Operating Resources

Refunds due divided by	P25	Median	P75	Observations
Total assets	0.4%	2.1%	6.7%	69,676
Net operating cash flow	4.1%	21.4%	75.8%	41,952
Net profits	7.2%	44.4%	179.7%	35,550
Year-end cash holdings	4.3%	23.4%	88.0%	62,440

Notes. Firm–year observations for refund claimants reporting cash-flow information in the National Tax Survey Database, 2012–2014. Each row reports the distribution of refunds due divided by the indicated measure.

We next examine how firms adjust their sales in response to slower refunds. Using Equation (19), we estimate how the responses of firms with different pre-reform rebate exposure vary with city refund delay. Table 9 reports the coefficients on $E_i \times \text{post}_t \times D_c$. For a fully exposed firm, the export share response is 1.49 percentage points smaller in a city with refund delays one standard deviation above the average, while the total revenue response does not differ significantly. The probability of paying positive VAT increases by 5.10 percentage points, while the probability of having unpaid refunds at year-end and the share of refund claims remaining unpaid fall by 4.32 and 6.74 percentage points, respectively. These findings suggest that firms shift sales toward the domestic market to reduce their reliance on delayed refunds. Such adjustments can reduce the working capital tied up in pending refunds, as captured by the model. Appendix Table 29, Panel B, reports similar results under the alternative measure of firms' exposure.

8 Calibration and Policy Counterfactuals

The empirical results show that firms expand exports less in response to higher rebate rates when refunds arrive more slowly. We calibrate the model in Section 3 to quantify the relative importance of the discounting and cash-in-use channels in explaining this difference.

Table 9: Firm-Level Responses to Refund Delay

	ln revenue (1)	Export sales / revenue (2)	1(VAT paid > 0) (3)	1(unpaid refund at year end > 0) (4)	Unpaid refund / claim (5)
$E_i \times \text{post} \times D_c$	0.013	−0.015**	0.051***	−0.043*	−0.067**
	(0.024)	(0.007)	(0.016)	(0.022)	(0.028)
Pre-trend p	0.576	0.941	0.495	0.703	0.589
Observations	64,683	63,734	64,692	48,284	37,417

Notes. The table reports β_2 from Equation (19) for firm-level outcomes over 2012–2015. Refund variables in columns (4) and (5) are defined for firms reporting the refund block; the claim in column (5) is the refund due in the year plus the refund unpaid at the start of the year. All regressions include firm, industry×year, and city×year fixed effects, with pre-reform firm controls interacted with year. Pre-trend p-values test whether the 2012 and 2013 event-study coefficients are jointly zero relative to 2014. Standard errors clustered by city are in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

We then examine how faster refund payments and loans against refunds due would affect firms' responses to a given rebate-rate increase.

8.1 Calibration and Model Fit

We calibrate the model using moments from Chinese Customs data and the National Tax Survey Database (NTSD), supplemented by externally specified parameters, as reported in Table 10. None of the six estimated rebate-rate and refund-delay coefficients is used as a calibration target. The cash conversion cycle is 85 days, or $\ell = 0.23$ years, comparable to the 71-day median across U.S. manufacturing industries reported by Tong and Wei (2009). The calibrated mean refund waiting time is 76 days, nearly as long as the cash conversion cycle. These measures anchor the cash-in-use channel of delayed refunds.

Panel A of Table 11 compares the model-implied linear-projection coefficients with the estimated rebate-rate and refund-delay effects on export quantity, unit value, and export value. The model closely reproduces both sets of empirical estimates. For example, the predicted export-value response to a one-percentage-point increase in the rebate rate is 2.54 percent, compared with the estimated 2.57 percent. The model also predicts that a one-standard-deviation increase in refund delay reduces the quantity response by 0.87 percentage points and raises the unit-value response by 0.42 percentage points, compared with empirical estimates of 0.61 and 0.31 percentage points, respectively. All six model predictions lie within the corresponding 95 percent confidence intervals. Moreover, the ratio of the estimated quantity and unit-value delay effects is approximately 2.0, close to the externally calibrated demand elasticity of $\sigma = 2.02$.

Table 10: Calibration: Parameters and Matched Moments

Parameter	Economic meaning	Matching moment or input	Value
Panel A. Chinese Customs Data			
η	Demand elasticity with respect to quality	Pre-reform slope of log unit value on inferred quality, within HS8–destination–year	1.07
Panel B. National Tax Survey Database			
ℓ	Cash conversion cycle (years)	Median inventory days + receivable days − payable days among refund claimants, 2012–2013	0.23
ξ	Annual refund-arrival rate	Mean city share of refund claims unpaid at year-end	4.81
c^{wc}	Working-capital need per yuan of revenue	Export-weighted working-capital requirement / revenue	0.10
ν	Input VAT per yuan of revenue	Export-weighted non-equipment input VAT / revenue	0.07
Φ	Share of financially constrained firms	Exposure-weighted share whose funding needs exceed available cash	0.58
ζ	Elasticity of design cost with respect to quality	Product-development spending / gross margin	0.70
Panel C. External Inputs and Normalization			
σ	Price elasticity of export demand	Broda–Weinstein elasticity (Broda and Weinstein, 2006) for treated products, weighted by exports $\times$ Δr_p	2.02
ϱ	Annual discount rate	Externally set	0.05
w	Non-refundable VAT wedge $(\tau - r)$	Post-reform rebate-rate schedule	0.04
α	Variable cost elasticity with respect to quality	Normalization of the quality scale	1.00

Notes. The table reports the calibrated parameters, their economic interpretations, and the corresponding moments. We normalize $\alpha = 1$ and calibrate η and ζ relative to this normalization. The median cash conversion cycle among refund claimants is 84.6 days, equivalent to $\ell = 0.23$ years. The refund-arrival rate ξ implies a mean waiting time of approximately 76 days.

Table 11: Model Fit and Counterfactual Baseline

	Rebate-rate response, β_1		Delay gradient, β_2	
	Model	Estimate (s.e.)	Model	Estimate (s.e.)
Panel A. Model Fit				
Log export quantity	1.64	1.67 (0.25)	−0.87	−0.61 (0.19)
Log export unit value	0.91	0.88 (0.25)	0.42	0.31 (0.13)
Log export value	2.54	2.57 (0.31)	−0.45	−0.29 (0.12)
Panel B. Counterfactual Baseline				
Model-predicted export-value response at average city delay				2.30

Notes: All responses are expressed as percentage changes associated with a one-percentage-point increase in the rebate rate. In Panel A, β_1 is the fitted rebate-rate response at mean standardized city refund delay, while β_2 measures its linear gradient with respect to refund delay. Standard errors are in parentheses. The model coefficients are obtained by applying the empirical regression specification to model-predicted outcomes across cities. Panel B reports the model-predicted export-value response at average city refund delay, which serves as the baseline for the policy counterfactuals. The two model predictions differ because the response varies nonlinearly with refund delay.

For the policy counterfactuals, we use the model-predicted export-value response of 2.30 percent under actual refund delivery in the average city as the baseline, as reported in Panel B of Table 11. The difference from the linear-projection coefficient reflects the convexity of the model-implied response to refund delay, as illustrated in Appendix Figure 9.

8.2 Quantifying the Cost of Refund Delays

The model distinguishes two channels through which delayed refunds affect firms: the discounting channel, which reduces the present value of refunds, and the cash-in-use channel, which limits the availability of refund cash to finance production. Table 12 quantifies these two channels across cities with different refund delays.

Table 12: Refund Timing, Present Value, and Cash Availability

Scenario	Average unpaid share	Mean wait (days)	Present value, v	Cash in use, s
One s.d. faster	0.096	35	0.995	0.646
Average city	0.206	76	0.990	0.418
One s.d. slower	0.317	122	0.984	0.296

Notes: The table reports refund timing and the corresponding present-value and cash-in-use factors for cities with different refund delays. v measures the expected present value of a refund relative to its face value, while s measures the expected fraction of the cash conversion cycle during which the refund is available. Refund waiting times follow an exponential distribution.

In the average city, 20.6 percent of refunds due remain unpaid at year-end, corresponding

to a mean waiting time of 76 days. In a city with one standard deviation faster refund delivery, the unpaid share is 9.6 percent and the mean wait is 35 days. By contrast, in a city with one standard deviation slower delivery, the unpaid share rises to 31.7 percent and the mean wait reaches 122 days. Thus, a one-standard-deviation increase in refund delay adds approximately 1.5 months to the expected waiting time.

The two channels differ substantially in magnitude. Moving from the average city to one with one-standard-deviation slower refund delivery reduces the present-value factor v from 0.990 to 0.984, a decline of only 0.6 percentage points. In contrast, the cash-in-use factor s falls from 0.418 to 0.296, a reduction of nearly 30 percent. With a cash conversion cycle of 85 days, the additional 46 days of waiting substantially reduces the availability of refund cash to finance current production. In the calibrated model, discounting accounts for at most 2 percent of the estimated refund-delay effect, suggesting that the cash-in-use channel is the dominant force. This finding helps explain why refund delays primarily affect financially tight refund claimants, whose production decisions depend on the timely availability of cash.

8.3 Faster Refunds and Pledge Loans

We next evaluate two policy counterfactuals that improve firms' access to refund cash: faster refund payments and loans against refunds due. Both counterfactuals use actual refund delivery in the average city as the baseline and examine firms' responses to a one-percentage-point increase in the rebate rate.

Figure 5 reports the counterfactual results. Panel (a) shows that faster refund delivery substantially strengthens the export response to a given rebate-rate increase. Moving from the average waiting time of 76 days to immediate payment raises the export value response from 2.30 percent to 4.48 percent, nearly doubling it. Even reducing the waiting time to 13 days, as in the fastest observed city, increases the response by 69 percent. Faster delivery strengthens the quantity response while reducing the unit-value response, which becomes negative under immediate payment.

In practice, governments may be unable or unwilling to accelerate refund payments because of fraud concerns or fiscal constraints (Harrison and Krelove, 2005). Pledge loans offer an alternative by allowing firms to borrow against refunds due before payment arrives.[4] Panel (b) of Figure 5 shows the export-value response to pledge loans. The top axis indicates

[4]Since 2001, Chinese banks have been permitted to lend up to 70 percent of refunds due. See People's Bank of China, Ministry of Foreign Trade and Economic Cooperation, and State Administration of Taxation, "Notice on Handling Export Tax Refund Account Custody Loans," Yinfa [2001] No. 276, August 24, 2001, published in the *Gazette of the State Council*, 2002, No. 17, `https://www.gov.cn/gongbao/content/2002/content_61482.htm`.

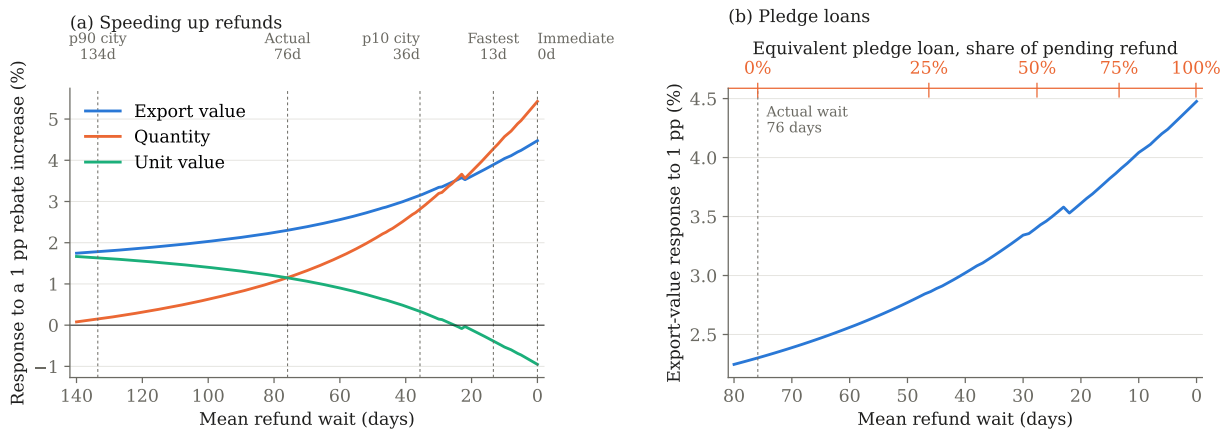


Figure 5: Counterfactual delivery: (a) speeding up refunds; (b) pledge loans, response to a one-point rebate increase in the average city.

the share of refunds due financed by pledge loans, while the bottom axis shows the equivalent waiting time under faster refund payments. At the average waiting time of 76 days, lending against 50 percent of refunds due generates approximately the same export-value response as reducing the wait to 28 days, while financing all refunds due is equivalent to immediate refund payment. By comparison, paying interest on delayed refunds has almost no effect on the export response, as it compensates firms for waiting without making cash available during production.

The magnitude of these counterfactual effects also depends on the length of the cash conversion cycle. For an industry with a longer cash conversion cycle of half a year, rather than a quarter, immediate refunds increase the export-value response by about 45 percent rather than 94 percent, while loans against 70 percent of refunds due increase it by about 30 percent. Although the gains are smaller, both policies substantially strengthen the export response by making cash available earlier in the production cycle.

9 Conclusion

Export VAT rebates are important instruments of trade and industrial policy. This paper examines how export VAT rebate rates and refund delays shape firms' export responses. Using China's 2015 rebate-rate increase, we find that higher rebate rates raise both export quantities and prices. These findings suggest that export rebates do more than reduce exporting costs: they also influence firms' incentives to upgrade product quality. The resulting price response reflects both cost pass-through and endogenous quality choice, making its direction dependent on market conditions and the cost of upgrading.

Refund delays, in contrast, weaken the quantity response and raise the price response, with effects concentrated among financially constrained refund claimants. Model calibration shows that the cash-in-use channel, rather than discounting, accounts for most of the delay effect. Immediate refunds would nearly double the export-value response to a rebate-rate increase, while lending against pending refunds can achieve comparable gains without accelerating government payments. Since VAT refund delays are common in developing and transition economies, these findings highlight the importance of considering both the incentives created by tax policy and firms' access to the resulting cash flows.

References

Acedo, J., M. Kidd, M. Mopa, and M. Nyanga (2024). 10 years of assessing tax administrations globally: Developments, achievements and remaining challenges. International Monetary Fund, Washington, DC.

Bas, M. and V. Strauss-Kahn (2015). Input-trade liberalization, export prices and quality upgrading. *Journal of International Economics 95*(2), 250–262.

Bastos, P., J. Silva, and E. Verhoogen (2018). Export destinations and input prices. *American Economic Review 108*(2), 353–392.

Borusyak, K., P. Hull, and X. Jaravel (2022). Quasi-experimental shift-share research designs. *The Review of economic studies 89*(1), 181–213.

Braakmann, N., B. Gao, and S. Maioli (2020). VAT rebates as trade policy: Evidence from China. *China Economic Review 63*, 101536.

Broda, C. and D. E. Weinstein (2006). Globalization and the gains from variety. *The Quarterly Journal of Economics 121*(2), 541–585.

Brusco, G., M. Piek, and T. Velayudhan (2024). Wait no more: how the administration of VAT refunds impacts firm behaviour. WIDER Working Paper 2024/58, UNU-WIDER.

Chandra, P. and C. Long (2013). VAT rebates and export performance in China: Firm-level evidence. *Journal of Public Economics 102*, 13–22.

Chao, C.-C., W.-L. Chou, and E. S. H. Yu (2001). Export duty rebates and export performance: theory and China's experience. *Journal of Comparative Economics 29*(2), 314–326.

Chen, Z., X. Jiang, Z. Liu, J. C. S. Serrato, and D. Y. Xu (2023). Tax policy and lumpy investment behaviour: Evidence from China's VAT reform. *The Review of Economic Studies 90*(2), 634–674.

Ebrill, L. P., M. Keen, and V. P. Perry (2001). *The Modern VAT*. International Monetary Fund.

Fan, H., Y. A. Li, and S. R. Yeaple (2015). Trade liberalization, quality, and export prices. *The Review of Economics and Statistics 97*(5), 1033–1051.

Fazzari, S. M. and B. C. Petersen (1993). Working capital and fixed investment: New evidence on financing constraints. *The RAND Journal of Economics 24*(3), 328–342.

Feenstra, R. C., Z. Li, and M. Yu (2014). Exports and credit constraints under incomplete information: Theory and evidence from china. *Review of Economics and Statistics 96*(4), 729–744.

Feldstein, M. S. and P. R. Krugman (1990). International trade effects of value-added taxation. In *Taxation in the global economy*, pp. 263–282. University of Chicago Press.

Ferrantino, M. J., X. Liu, and Z. Wang (2012). Evasion behaviors of exporters and importers: Evidence from the U.S.–China trade data discrepancy. *Journal of International Economics 86*(1), 141–157.

Fisman, R. and S.-J. Wei (2004). Tax rates and tax evasion: Evidence from "missing imports" in China. *Journal of Political Economy 112*(2), 471–496.

Goldberg, P. K., A. K. Khandelwal, N. Pavcnik, and P. Topalova (2010). Imported intermediate inputs and domestic product growth: Evidence from India. *The Quarterly Journal of Economics 125*(4), 1727–1767.

Goldsmith-Pinkham, P., I. Sorkin, and H. Swift (2020). Bartik instruments: What, when, why, and how. *American Economic Review 110*(8), 2586–2624.

Gourdon, J., L. Hering, S. Monjon, and S. Poncet (2022). Estimating the repercussions from china's export value-added tax rebate policy. *The Scandinavian Journal of Economics 124*(1), 243–277.

Gourdon, J., S. Monjon, and S. Poncet (2016). Trade policy and industrial policy in China: What motivates public authorities to apply restrictions on exports? *China Economic Review 40*, 105–120.

Harrison, G. and R. Krelove (2005). VAT refunds: A review of country experience. IMF Working Paper 05/218, International Monetary Fund.

Khandelwal, A. K., P. K. Schott, and S.-J. Wei (2013). Trade liberalization and embedded institutional reform: Evidence from Chinese exporters. *American Economic Review 103*(6), 2169–2195.

Kohn, D., F. Leibovici, and M. Szkup (2016). Financial frictions and new exporter dynamics. *International economic review 57*(2), 453–486.

Kugler, M. and E. Verhoogen (2012). Prices, plant size, and product quality. *The Review of Economic Studies 79*(1), 307–339.

Lee, W., H. Ma, and Y. Xu (2021). Export tax rebate and the margins of exports: product-level evidence from a quasi-natural experiment. *International Tax and Public Finance 28*(2), 386–404.

Lopez-Acevedo, G. and R. Robertson (Eds.) (2016). *Stitches to Riches?: Apparel Employment, Trade, and Economic Development in South Asia*. Washington, DC: World Bank.

Lu, B. and H. Ma (2023). The "matthew effect" in rebates: How does VAT rebates allocation affect firm export performance. *Journal of Public Economics 225*, 104982.

Manova, K. (2013). Credit constraints, heterogeneous firms, and international trade. *Review of Economic Studies 80*(2), 711–744.

Manova, K. and Z. Zhang (2012). Export prices across firms and destinations. *The Quarterly Journal of Economics 127*(1), 379–436.

Pineda Pinto, D., J. C. Bermúdez, and T. Scot (2024). VAT refunds and firms' performance: Evidence from a withholding reform in Honduras. Policy Research Working Paper 10996, World Bank.

Raddatz, C. (2006). Liquidity needs and vulnerability to financial underdevelopment. *Journal of Financial Economics 80*(3), 677–722.

Rauch, J. E. (1999). Networks versus markets in international trade. *Journal of International Economics 48*(1), 7–35.

Richards, V. D. and E. J. Laughlin (1980). A cash conversion cycle approach to liquidity analysis. *Financial Management 9*(1), 32–38.

Santos Silva, J. M. C. and S. Tenreyro (2006). The log of gravity. *The Review of Economics and Statistics 88*(4), 641–658.

Shaked, A. and J. Sutton (1982). Relaxing price competition through product differentiation. *The Review of Economic Studies 49*(1), 3–13.

Shi, X. and Z. Xu (2023). Export tax refund and the misreporting by chinese exporters. *Canadian Journal of Economics/Revue canadienne d'économique 56*(4), 1469–1489.

Sutton, J. (1991). *Sunk Costs and Market Structure: Price Competition, Advertising, and the Evolution of Concentration*. Cambridge, MA: MIT Press.

Tong, H. and S.-J. Wei (2009). The composition matters: Capital inflows and liquidity crunch during a global economic crisis. IMF Working Paper 09/164, International Monetary Fund.

United Nations (2002). *Classification by Broad Economic Categories: Defined in Terms of the SITC, Rev. 3 and the Harmonized System (2002)*. Number 53, Rev. 4 in Statistical Papers, Series M. United Nations Publications.

Zwick, E. and J. Mahon (2017). Tax policy and heterogeneous investment behavior. *American Economic Review 107*(1), 217–248.

A Model Derivations and Proofs

Throughout, $X_i \equiv \sum_{p\in\mathcal{P}_i} P_{ip}x_{ip}$ denotes export sales, $Y_i \equiv \sum_{p\in\mathcal{P}_i} P_{D,ip}d_{ip}$ domestic sales before VAT, and $W_i \equiv \sum_{p\in\mathcal{P}_i}(\tau - r_p)P_{ip}x_{ip}$ the non-refundable VAT on exports, so that (5) reads $NP_i = \tau Y_i + W_i - \tau M_i$. We call $NP_i \geq 0$ the settlement regime and $NP_i < 0$ the refund regime. All comparative statics hold the regime, μ_i and ψ_i fixed. We also assume

$$b_j \equiv \eta_j - \alpha(\sigma_j - 1) > 0, \qquad b_D \equiv \eta_D - \alpha(\sigma_D - 1) > 0,$$

so that quality raises variable profit in both markets.

A.1 Cash Flows and the Working-Capital Constraint

Within a cash conversion cycle of length ℓ the firm's cash flows are as follows. At the start it purchases the inputs M_i and pays input VAT τM_i to suppliers; a share θ of the pre-VAT cost must be paid before any receipts arrive and the remainder $(1-\theta)M_i$ can be paid from receipts. During the cycle it collects export receipts X_i (zero-rated, free on board) and domestic receipts inclusive of output VAT, $(1+\tau)Y_i$. At filing, at the start of the cycle, it computes NP_i in (5): if $NP_i \geq 0$ it pays NP_i immediately; if $NP_i < 0$ it files a claim for $-NP_i$, which arrives after the wait T_c. The fixed cost F_p and the design cost $f_j q_{ip}^{\zeta_j}$ are paid in the first stage from long-term funds and do not enter the cycle.

The uses of within-cycle funds that L_i must cover are the pre-financed operating outlay θM_i and the net VAT-related use of funds V_i^{wc}. In the settlement regime the firm pays τM_i at the start, collects τY_i from domestic buyers, and pays $NP_i = \tau Y_i + W_i - \tau M_i$ at filing; the net VAT cash flow is $-W_i$, so $V_i^{wc} = W_i$. In the refund regime the firm pays τM_i, collects τY_i, pays nothing, and receives the claim $-NP_i = \tau M_i - W_i - \tau Y_i$, of which the share s_c is available within the cycle; the net within-cycle VAT cash flow is $-\tau M_i + \tau Y_i + s_c(-NP_i) = -[s_c W_i + (1-s_c)\tau(M_i - Y_i)]$. The two cases can be written as

$$V_i^{wc} = W_i + (1-s_c)(-NP_i)^+ = \begin{cases} W_i & NP_i \geq 0, \\ s_c W_i + (1-s_c)\tau\big(M_i - Y_i\big) & NP_i < 0, \end{cases}$$

the non-refundable export VAT plus the part of the claim that is not yet cash. Adding θM_i and requiring the total not to exceed L_i gives (8). In the refund regime the constraint is equivalently $[\theta + (1-s_c)\tau]M_i + s_c W_i - (1-s_c)\tau Y_i \leq L_i$.

The factor s_c in (10) is the time-weighted share of a claim that is in the firm's hands: a claim filed at the start of the cycle and paid after T_c is available for $(\ell - T_c)^+$ of the

cycle, against ℓ for a claim settled at filing. With an exponential wait at rate ξ, $s_c = 1 - (1 - e^{-\xi\ell})/(\xi\ell)$ and $v_c = \xi/(\xi + \varrho)$.

A.2 The Second-Stage Objective

Second-stage profit is receipts minus input costs minus net VAT payments, with the refund valued at present value. Since $X_i + (1+\tau)Y_i - (1+\tau)M_i - NP_i = X_i - W_i + Y_i - M_i$, the objective in (7) can be written as

$$\sum_{p \in \mathcal{P}_i} (1 - \tau + r_p) P_{ip} x_{ip} + Y_i - M_i - (1 - v_c)(-NP_i)^+,$$

profit with a full and immediate refund, less the present-value loss on the claim. In the refund regime, substituting $-NP_i = \tau M_i - W_i - \tau Y_i$ gives

$$\sum_{p \in \mathcal{P}_i} \big[1 - v_c(\tau - r_p)\big] P_{ip} x_{ip} + \big[1 + (1 - v_c)\tau\big](Y_i - M_i).$$

A.3 Derivation of the Effective Marginal Cost

In the refund regime, form the Lagrangian of the objective above subject to (8) with multiplier μ_i. Collecting terms,

$$\mathcal{L} = \sum_{p \in \mathcal{P}_i} \Big[\rho_{ip} P_{ip} x_{ip} + \rho_{D,i} P_{D,ip} d_{ip} - \phi_i c_{ip}(q_{ip})(x_{ip} + d_{ip})\Big] + \mu_i L_i,$$

where

$$\begin{aligned} \rho_{ip} &\equiv 1 - (\tau - r_p)(v_c + \mu_i s_c), \\ \rho_{D,i} &\equiv 1 + (1 - v_c)\tau + \mu_i (1 - s_c)\tau, \\ \phi_i &\equiv 1 + (1 - v_c)\tau + \mu_i \big[\theta + (1 - s_c)\tau\big]. \end{aligned}$$

In the settlement regime the same expressions hold with $v_c = s_c = 1$, so that $\rho_{ip} = 1 - (\tau - r_p)(1 + \mu_i)$, $\rho_{D,i} = 1$ and $\phi_i = 1 + \mu_i\theta$. Given μ_i, the problem separates across products and markets. The first-order conditions under CES demand are

$$P_{ip} = \frac{\sigma_j}{\sigma_j - 1} \frac{\phi_i}{\rho_{ip}} c_{ip}(q_{ip}), \qquad P_{D,ip} = \frac{\sigma_D}{\sigma_D - 1} \frac{\phi_i}{\rho_{D,i}} c_{ip}(q_{ip}),$$

so $\widetilde{c}^X_{ip} = (\phi_i/\rho_{ip}) c_{ip}(q_{ip})$, which is (11) and gives (12).

Only ρ_{ip} depends on r_p. Writing $\Omega_i \equiv v_c + \mu_i s_c$ and $w_p \equiv \tau - r_p$,

$$\Gamma_{ip} = -\frac{\partial \ln \widetilde{c}_{ip}^X}{\partial r_p} = \frac{\partial \ln \rho_{ip}}{\partial r_p} = \frac{\Omega_i}{1 - w_p \Omega_i} > 0, \qquad \frac{\partial \Gamma_{ip}}{\partial \Omega_i} = \frac{1}{(1 - w_p \Omega_i)^2} = \rho_{ip}^{-2}.$$

In the refund regime $\partial \Omega_i / \partial D_c = v'(D_c) + \mu_i s'(D_c)$, which gives (15); in the settlement regime Γ_{ip} does not depend on D_c. At fixed quality, $\partial \ln P_{ip} / \partial r_p = -\Gamma_{ip}$, $\partial \ln x_{ip} / \partial r_p = \sigma_j \Gamma_{ip}$, and by the envelope theorem $\partial \mathcal{L} / \partial r_p = \Omega_i P_{ip} x_{ip} > 0$.

A.4 Quality Choice and Proof of Proposition 1

First-order condition for quality. Under Assumption 1 the first stage evaluates second-stage profits at ψ_i. Let ρ_{ip}^0, $\rho_{D,i}^0$ and ϕ_i^0 denote ρ_{ip}, $\rho_{D,i}$ and ϕ_i with μ_i replaced by ψ_i. When the working-capital constraint is slack, $\mu_i = 0$, and since long-term funds are less constrained, $\psi_i = 0$ as well, so the two sets of coefficients coincide. Let $m_j \equiv \sigma_j / (\sigma_j - 1)$ and $m_D \equiv \sigma_D / (\sigma_D - 1)$. Substituting the pricing rules into demand, variable profit from product p in each market is

$$\pi_{ip}^X(q_{ip}) = \frac{A_p m_j^{1-\sigma_j} \varphi_i^{\sigma_j - 1}}{\sigma_j} q_{ip}^{b_j} \left(\rho_{ip}^0\right)^{\sigma_j} \left(\phi_i^0\right)^{1-\sigma_j},$$
$$\pi_{ip}^D(q_{ip}) = \frac{A_{D,p} m_D^{1-\sigma_D} \varphi_i^{\sigma_D - 1}}{\sigma_D} q_{ip}^{b_D} \left(\rho_{D,i}^0\right)^{\sigma_D} \left(\phi_i^0\right)^{1-\sigma_D}.$$

The factor ρ_{ip}^0 multiplying revenue raises the exponent from $\sigma_j - 1$ to σ_j: an ad valorem subsidy scales variable profit by more than a cost shifter does. Given ψ_i, the choice of q_{ip} in (6) separates across products, with first-order condition

$$b_j \pi_{ip}^X(q_{ip}) + b_D \pi_{ip}^D(q_{ip}) = \zeta_j f_j q_{ip}^{\zeta_j}.$$

Define the export share of the marginal return to quality,

$$\lambda_{ip} \equiv \frac{b_j \pi_{ip}^X}{b_j \pi_{ip}^X + b_D \pi_{ip}^D} \in (0, 1),$$

and

$$\Delta_{ip} \equiv \zeta_j - \lambda_{ip} b_j - (1 - \lambda_{ip}) b_D.$$

The second-order condition is $\Delta_{ip} > 0$.

Response of quality. The long-run relief is

$$\Gamma_{ip}^{LR} \equiv \frac{\partial \ln \rho_{ip}^0}{\partial r_p} = \frac{v_c + \psi_i s_c}{\rho_{ip}^0} > 0, \qquad \frac{\partial \Gamma_{ip}^{LR}}{\partial D_c} = \frac{v'(D_c) + \psi_i s'(D_c)}{(\rho_{ip}^0)^2}. \tag{20}$$

Since $\psi_i \leq \mu_i$ and Γ is increasing in Ω, $\Gamma_{ip} \geq \Gamma_{ip}^{LR}$, with equality when the constraint is slack. Only π_{ip}^X depends on r_p, through ρ_{ip}^0. Log-differentiating the first-order condition gives $\lambda_{ip}\sigma_j \Gamma_{ip}^{LR}\, dr_p = \Delta_{ip}\, d\ln q_{ip}$, so

$$\frac{d\ln q_{ip}}{dr_p} = \frac{\lambda_{ip}\sigma_j}{\Delta_{ip}}\,\Gamma_{ip}^{LR} > 0. \tag{21}$$

Price, quantity and value. From $\ln P_{ip} = \ln m_j + \ln(\phi_i/\rho_{ip}) + \alpha \ln q_{ip} - \ln \varphi_i$ and $\ln x_{ip} = \ln A_p + \eta_j \ln q_{ip} - \sigma_j \ln P_{ip}$,

$$\begin{aligned}
\frac{d\ln P_{ip}}{dr_p} &= -\Gamma_{ip} + \frac{\alpha\lambda_{ip}\sigma_j}{\Delta_{ip}}\Gamma_{ip}^{LR}, \\
\frac{d\ln x_{ip}}{dr_p} &= \sigma_j\Gamma_{ip} + \frac{\lambda_{ip}\sigma_j(\eta_j - \alpha\sigma_j)}{\Delta_{ip}}\Gamma_{ip}^{LR}, \qquad (22)\\
\frac{d\ln P_{ip}x_{ip}}{dr_p} &= (\sigma_j - 1)\Gamma_{ip} + \frac{\lambda_{ip}\sigma_j b_j}{\Delta_{ip}}\Gamma_{ip}^{LR}. \qquad (23)
\end{aligned}$$

The first line is (13) with (21) substituted in. The value response is positive because $b_j > 0$.

Proof of Proposition 1. Proposition 1 states the benchmark $\Gamma_{ip}^{LR} = \Gamma_{ip}$, which holds exactly when the working-capital constraint is slack. In this case the price response is positive if and only if $\alpha\lambda_{ip}\sigma_j > \Delta_{ip}$. Substituting the definition of Δ_{ip},

$$\alpha\lambda_{ip}\sigma_j - \Delta_{ip} = \lambda_{ip}(\eta_j + \alpha) + (1 - \lambda_{ip})\big[\eta_D - \alpha(\sigma_D - 1)\big] - \zeta_j,$$

which gives (14). □

Binding working-capital constraint. When the constraint binds, $g_{ip} \equiv \Gamma_{ip}/\Gamma_{ip}^{LR} > 1$, because the direct cost relief is valued at μ_i and the return to quality at $\psi_i < \mu_i$. The price response is then positive if and only if

$$\lambda_{ip}(\eta_j + \alpha) + (1 - \lambda_{ip})\big[\eta_D - \alpha(\sigma_D - 1)\big] - \zeta_j > (g_{ip} - 1)\Delta_{ip},$$

which is stricter than (14). The quantity response in (22) is positive for every g_{ip} when $\eta_j \geq \alpha\sigma_j$. When $\eta_j < \alpha\sigma_j$, it is positive if and only if $g_{ip} > \lambda_{ip}(\alpha\sigma_j - \eta_j)/\Delta_{ip}$; at $g_{ip} = 1$ this

condition is $\zeta_j > \lambda_{ip}\alpha + (1-\lambda_{ip})b_D$, and a binding constraint makes it easier to satisfy.

Scope for quality differentiation. Γ_{ip} and Γ_{ip}^{LR} do not depend on η_j or ζ_j at given μ_i and ψ_i. At given λ_{ip}, Δ_{ip} is decreasing in η_j and increasing in ζ_j, so the upgrading term $\alpha\lambda_{ip}\sigma_j\Gamma_{ip}^{LR}/\Delta_{ip}$ is increasing in η_j and decreasing in ζ_j, while the pass-through term $-\Gamma_{ip}$ is unchanged. The price response is therefore larger where buyers reward quality more and upgrading is easier.

A.5 Proof of Proposition 2

Consider firms in the refund regime and write $\Gamma_{ip,D} \equiv \partial\Gamma_{ip}/\partial D_c < 0$ from (15). Let $Q_{ip} \equiv d\ln q_{ip}/dr_p$ and $Q_{ip,D} \equiv \partial Q_{ip}/\partial D_c$. Since $d\ln P_{ip}/dr_p = -\Gamma_{ip} + \alpha Q_{ip}$ and $d\ln x_{ip}/dr_p = \sigma_j\Gamma_{ip} + (\eta_j - \alpha\sigma_j)Q_{ip}$,

$$\frac{\partial}{\partial D_c}\frac{d\ln P_{ip}}{dr_p} = -\Gamma_{ip,D} + \alpha Q_{ip,D}, \qquad \frac{\partial}{\partial D_c}\frac{d\ln x_{ip}}{dr_p} = \sigma_j\Gamma_{ip,D} + (\eta_j - \alpha\sigma_j)Q_{ip,D}.$$

Proof of Proposition 2. That delays reduce the direct cost relief is $\Gamma_{ip,D} < 0$. At a given quality, $Q_{ip,D} = 0$: the price differential is $-\Gamma_{ip,D} > 0$ and the quantity differential is $\sigma_j\Gamma_{ip,D} < 0$. With endogenous quality, both signs are preserved if

$$|Q_{ip,D}| < \frac{|\Gamma_{ip,D}|}{\alpha}\,\min\left\{1, \frac{\alpha\sigma_j}{|\eta_j - \alpha\sigma_j|}\right\},$$

that is, if the effect of refund delays on quality upgrading is sufficiently small relative to the direct cost effect. □

The role of Assumption 1. Define

$$\omega_i \equiv \frac{\partial\Gamma_{ip}^{LR}/\partial D_c}{\Gamma_{ip,D}},$$

the share of the delay effect on effective cost that reaches the quality decision. Under Assumption 1, $0 \le \omega_i < 1$ for firms with a binding constraint: since $s'(D_c) < 0$ and $\psi_i < \mu_i$, the numerator $v' + \psi_i s'$ in (20) is smaller in magnitude than $v' + \mu_i s'$ in (15), and $\rho_{ip}^0 > \rho_{ip}$.

Treating λ_{ip} and Δ_{ip} as locally constant, $Q_{ip,D} = (\lambda_{ip}\sigma_j/\Delta_{ip})\omega_i\Gamma_{ip,D}$, and

$$\frac{\partial}{\partial D_c}\frac{d\ln P_{ip}}{dr_p} = -\Gamma_{ip,D}\Big[1-\omega_i\frac{\alpha\lambda_{ip}\sigma_j}{\Delta_{ip}}\Big],$$
$$\frac{\partial}{\partial D_c}\frac{d\ln x_{ip}}{dr_p} = \sigma_j\Gamma_{ip,D}\Big[1+\omega_i\frac{\lambda_{ip}(\eta_j-\alpha\sigma_j)}{\Delta_{ip}}\Big],$$
$$\frac{\partial}{\partial D_c}\frac{d\ln P_{ip}x_{ip}}{dr_p} = (\sigma_j-1)\Gamma_{ip,D}\Big[1+\omega_i\frac{\lambda_{ip}\sigma_j b_j}{(\sigma_j-1)\Delta_{ip}}\Big].$$

The value differential is negative for every $\omega_i \geq 0$ because $b_j > 0$. The price differential is positive if and only if $\omega_i < \Delta_{ip}/(\alpha\lambda_{ip}\sigma_j)$. This condition also makes the quantity differential negative, because $\eta_j > 0$ implies $\Delta_{ip}/(\alpha\lambda_{ip}\sigma_j) < \Delta_{ip}/[\lambda_{ip}(\alpha\sigma_j-\eta_j)]$ when $\eta_j < \alpha\sigma_j$, and the quantity bracket is positive for every ω_i otherwise. The ratio of the quantity to the price differential is $-\sigma_j[1+\omega_i\lambda_{ip}(\eta_j-\alpha\sigma_j)/\Delta_{ip}]/[1-\omega_i\alpha\lambda_{ip}\sigma_j/\Delta_{ip}]$, which equals $-\sigma_j$ at $\omega_i = 0$.

The dependence of the price differential on the scope for quality differentiation comes only from the upgrading term $\omega_i(\alpha\lambda_{ip}\sigma_j/\Delta_{ip})\Gamma_{ip,D}$, since the pass-through term $-\Gamma_{ip,D}$ does not depend on η_j or ζ_j. It is proportional to ω_i and vanishes at $\omega_i = 0$.

Single shadow cost. If quality were evaluated at the same shadow cost as current production, $\psi_i = \mu_i$, then $\omega_i = 1$ and $\Gamma_{ip}^{LR} = \Gamma_{ip}$. Each delay differential would equal the corresponding average response times $\Gamma_{ip,D}/\Gamma_{ip} < 0$. A positive average price response would then imply a negative price differential, so the price and quantity differentials could not have opposite signs when both average responses are positive. Assumption 1 is what allows delay to weaken current cost relief by more than it weakens the return to quality.

A.6 Firm-Level Implications

Spillover across products. Let $G_i \equiv [\theta+(1-s_c)\tau]M_i + s_cW_i - (1-s_c)\tau Y_i - L_i$ be the excess of funding needs over L_i in (8), in the refund regime. With the constraint binding, $G_i = 0$ and

$$\frac{d\mu_i}{dr_p} = -\frac{\partial G_i/\partial r_p}{\partial G_i/\partial \mu_i}, \qquad \frac{\partial G_i}{\partial r_p} = -s_cP_{ip}x_{ip} + h_{ip}\frac{\partial x_{ip}}{\partial r_p}\Big|_{\mu_i} + \big[\text{price terms}\big],$$

where $h_{ip} \equiv [\theta+(1-s_c)\tau]c_{ip} + s_c(\tau-r_p)P_{ip}$ is the funding absorbed by one more unit of p. A higher μ_i raises every effective cost and lowers every quantity, so $\partial G_i/\partial\mu_i < 0$. When the direct release $s_cP_{ip}x_{ip}$ exceeds the absorption term, $\partial G_i/\partial r_p < 0$ and hence $d\mu_i/dr_p < 0$; a sufficient condition, holding quality fixed and using $\partial\ln x_{ip}/\partial r_p = \sigma_j\Gamma_{ip}$ and $P_{ip} = \frac{\sigma_j}{\sigma_j-1}\widetilde{c}_{ip}^X$,

is

$$s_c > \sigma_j \Gamma_{ip} \left[\frac{\sigma_j - 1}{\sigma_j} \frac{\theta + (1 - s_c)\tau}{\phi_i / \rho_{ip}} + s_c(\tau - r_p) \right],$$

which holds for θ small relative to s_c and σ_j moderate. If in addition the release $s_c P_{ip} x_{ip}$ falls with delay faster than the absorption term, $\partial(d\mu_i/dr_p)/\partial D_c > 0$. Finally, from (11),

$$\frac{\partial \ln \widetilde{c}_{il}^{X}}{\partial \mu_i} = \frac{\theta + (1 - s_c)\tau}{\phi_i} + \frac{s_c(\tau - r_l)}{\rho_{il}} > 0 \quad \text{for every } l \in \mathcal{P}_i,$$
$$\frac{\partial \ln(\phi_i / \rho_{D,i})}{\partial \mu_i} = \frac{\theta + (1 - s_c)\tau}{\phi_i} - \frac{(1 - s_c)\tau}{\rho_{D,i}},$$

so a fall in μ_i lowers the effective cost of every export line and, when θ is not too small, of domestic sales as well.

Export contraction and the refund claim. Holding prices fixed, one more unit of product p raises the claim $-NP_i$ in (5) by $\tau c_{ip} - (\tau - r_p)P_{ip}$, which is positive whenever $P_{ip}/c_{ip} < \tau/(\tau - r_p)$; with $\tau = 0.17$ and $r_p \geq 0.13$ this allows markups over input cost of up to a factor of four. Relative to a firm in a faster city, an exposed firm in a slower city expands treated and untreated exports by less, so its claim rises by less: $\partial(d(-NP_i)/dr_p)/\partial D_c < 0$. The claim entering the queue is smaller, the probability that $NP_i \geq 0$ is higher, and the unpaid balance $(1 - s_c)(-NP_i)^+$ carried past the cycle is smaller. The domestic response is the net of a smaller fall in ϕ_i, which lowers domestic sales relative to the fast city, and the liquidity premium $\mu_i(1 - s_c)\tau$ in $\rho_{D,i}$, which raises them; its sign is not determined. Under Assumption 2, L_i is fixed, so the constraint (8) is met by a smaller left-hand side: less pre-financed export input and a smaller trapped claim.

Binding constraint. Write the constraint (8) as $\sum_{p \in \mathcal{P}_i} \kappa_{ip} P_{ip} x_{ip} + G_i^D = L_i$, where $\kappa_{ip} = [\theta + (1 - s_c)\tau] c_{ip}/P_{ip} + s_c(\tau - r_p)$ is the funding absorbed by a yuan of export revenue and G_i^D collects the domestic terms. Treating the input-cost part of κ_{ip} as constant, as when working-capital needs are measured per yuan of revenue, a change dr_p with L_i fixed and the constraint binding requires $\kappa_{ip}\, d(P_{ip}x_{ip}) - s_c P_{ip} x_{ip}\, dr_p + dG_i^D = 0$. Holding domestic sales fixed ($dG_i^D = 0$) gives

$$\frac{d \ln(P_{ip} x_{ip})}{dr_p} = \frac{s_c}{\kappa_{ip}}. \tag{24}$$

If instead the fall in μ_i expands domestic sales and exports in proportion, and a yuan of total revenue R_i absorbs c^{wc} plus the export-specific terms on the export share $\chi_i = X_i/R_i$,

the funding need is $\bar{\kappa}_i R_i$ with $\bar{\kappa}_i = c^{wc} + (\kappa_i - c^{wc})\chi_i$, and

$$\frac{d \ln X_i}{dr} = \frac{\chi_i \, s_c}{\bar{\kappa}_i},$$

which equals s_c/κ_i for a firm that only exports.

Financial tightness. With $\Gamma_{ip} = \Omega_i/(1 - w_p\Omega_i)$, $\partial^2\Gamma_{ip}/\partial\Omega_i^2 = 2w_p(1 - w_p\Omega_i)^{-3} > 0$, $\partial\Omega_i/\partial\mu_i = s_c$ and $\partial\Omega_i/\partial D_c = v' + \mu_i s'$. Then

$$\frac{\partial^2\Gamma_{ip}}{\partial D_c \, \partial\mu_i} = \frac{\partial^2\Gamma_{ip}}{\partial\Omega_i^2} \, s_c \, (v' + \mu_i s') + \frac{\partial\Gamma_{ip}}{\partial\Omega_i} \, s' < 0.$$

At $\mu_i = 0$, $\partial\Gamma_{ip}/\partial D_c = (1 - w_p v_c)^{-2} v'$.

Discounting bound. With $\mu_i = 0$ and $w_p v_c$ small, $\Gamma_{ip} \approx v_c$, so a change Δv in the present-value factor changes the fixed-quality price response $-\Gamma_{ip}\Delta r$ to a rebate increase of $\Delta r = 0.01$ by $0.01 \times \Delta v$ in absolute value, the quantity response by $\sigma_j \times 0.01 \times \Delta v$, and the value response by $(\sigma_j - 1) \times 0.01 \times \Delta v$. These are the figures used in Section 8.2.

Extensive margins. Product p is exported when first-stage variable profit net of the design cost covers F_p. This value is increasing in ρ_{ip}^0. A rebate increase raises ρ_{ip}^0 and induces entry; delay lowers ρ_{ip}^0 only through $v_c + \psi_i s_c$. Continuing as a direct exporter requires that second-stage export profit, $\sum_{p \in \mathcal{P}_i} \rho_{ip} P_{ip} x_{ip}/\sigma_j$ net of design costs, cover a firm-level fixed cost; because ρ_{ip} falls with μ_i and μ_i falls by less in slow cities, delay raises exit among exposed firms.

B City Refund Delay: Additional Results

Table 13 regresses a claimant's own delay on $D_{c,-j}$, the city delay computed from claimants outside the firm's two-digit industry. One standard deviation of $D_{c,-j}$ also raises the probability that a claimant carries an unpaid balance at year end by 6.34 percentage points (s.e. 0.88). Table 14 relates D_c to city characteristics, Table 15 compares pre-reform exporters in slow- and fast-refund cities, and Table 16 reports the correlation of city delay across years.

Table 13: City Refund Delay Predicts Firms' Own Delay

Dependent variable: own firm delay, 2012–2013	(1)	(2)	(3)	(4)
$D_{c,-j}$ (leave own industry out)	0.107***	0.108***	0.094***	0.094***
	(0.002)	(0.001)	(0.006)	(0.006)
Industry×year FE		Yes	Yes	Yes
Province FE			Yes	Yes
Controls				Yes
Observations	120,787	120,774	120,774	120,774
City clusters	238	238	238	238

$D_{c,-j}$ is the standardized 2012–2013 city mean of firm delay computed from claimants outside the firm's own two-digit industry. Controls are log revenue, log assets and leverage. Column (3) estimated year by year gives 0.087 (2012) and 0.106 (2013). Standard errors clustered by city. *, **, *** denote significance at 10, 5 and 1 percent.

Table 14: Refund Delay and the Local Economy

Dependent variable: D_c	(1)	(2)
Exposure to the reform		
Share of exports in treated products	−0.023	0.005
	(0.071)	(0.056)
Treated vs. untreated export growth, 2010–2013	−0.002	0.021
	(0.053)	(0.043)
Development and export orientation		
ln GDP per capita	0.063	−0.052
	(0.060)	(0.052)
Exports / GDP	0.128*	−0.045
	(0.072)	(0.047)
Industrial concentration		
HHI of exports across HS4	0.021	0.070*
	(0.052)	(0.037)
Composition of exports		
Processing-trade share of exports	−0.019	0.039
	(0.073)	(0.055)
Foreign-invested share of exports	−0.127**	−0.206**
	(0.059)	(0.091)
Province fixed effects	No	Yes
Joint F-test excl. foreign-invested share, p-value	0.329	0.265

Notes. Each entry is from a separate city-level regression of standardized D_c on one standardized characteristic; column (2) adds province fixed effects. Exports are from customs data, 2012–2013 (growth 2010–2013); GDP is from the China City Statistical Yearbook. The joint test excludes the foreign-invested share. Robust standard errors in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

Table 15: Exporters in Slow- and Fast-Refund Cities before the Reform

	(1) City average	(2) Treated − untreated
Exports		
ln exports	0.055	0.0053
	(0.058)	(0.0129)
ln number of products	−0.021	0.0263
	(0.068)	(0.0325)
ln number of destinations	0.002	0.0046
	(0.077)	(0.0193)
Processing-trade share	0.026	0.0025
	(0.058)	(0.0021)
Size, productivity and liquidity		
ln employment	−0.078	0.0166
	(0.061)	(0.0124)
ln sales per worker	0.087	0.0033
	(0.064)	(0.0098)
Current liabilities / current assets	0.098	−0.0008
	(0.080)	(0.0034)
Pre-reform trend		
Export growth, 2012–2014	−0.026	−0.0117
	(0.049)	(0.0107)
Joint F-test, p-value	0.297	
Observations	234–240 cities	472,020–2,546,490

Exporters in the product-level sample, with characteristics measured over 2012–2014; employment, sales per worker and the liquidity ratio come from the tax survey. Column (1) regresses standardized D_c on the city average across exporters, with robust standard errors. Column (2) regresses the characteristic of a firm–product pair on $D_c \times \mathbf{1}(\Delta r_p > 0)$ with city and HS8 fixed effects, with standard errors clustered by city. *, **, *** denote significance at 10, 5 and 1 percent.

Table 16: Persistence of City Refund Delay

	2012	2013	2014	2015	D_c
2012	1				
2013	0.88	1			
2014	0.69	0.83	1		
2015	0.81	0.90	0.90	1	
D_c (2012–2013)	0.97	0.96	0.78	0.87	1

Pearson correlations of industry-adjusted city delay across the 110 cities with at least 30 claimant firm–years in each year, 2012–2015. D_c pools 2012 and 2013.

C Main Effects: Robustness

C.1 Pre-Reform Characteristics of Treated Products

Table 17 compares treated and untreated HS8 products within the 56 HS4 headings that contain both. Before the reform, the two groups followed the same paths in unit value, quantity and export value. They were exported by similar numbers of firms to similar numbers of destinations and sent the same share of their exports to high-income countries, and treated products did not shift toward those markets between 2012 and 2014. Their inferred-quality dispersion is also similar, and they faced the same change in foreign demand in 2015. None of the ten differences is significant, and jointly the characteristics do not predict treatment ($p = 0.680$).

C.2 Event Study with HS8–Year Fixed Effects

Figure 6 reports the event study for Specification C, which replaces HS4–year with HS8–year fixed effects and so identifies only the delay differential.



Figure 6: Event study, Specification C.

Notes: $\Delta r_p \times D_c \times$year with firm–product, HS8–year and city–year fixed effects; $\Delta r_p \times$year is absorbed. Coefficients relative to their 2012–2014 mean, 95 percent confidence intervals two-way clustered by city and HS4.

C.3 Flexible Trends in Product Characteristics

The notice targeted high value-added products, so treated products may differ in ways that predict their 2015 paths even if they did not differ in pre-reform trends. Table 18 lets each pre-reform HS8 characteristic follow its own path. Column (2) adds the high-income share

Table 17: Treated and Untreated Products within HS4 Headings before the Reform

	Treated mean (1)	Untreated mean (2)	Within-HS4 difference (3)
Δ ln unit value, 2012–2014	−0.106	−0.089	0.003
			(0.024)
Δ ln quantity, 2012–2014	0.174	0.145	−0.053
			(0.065)
Δ ln export value, 2012–2014	0.098	0.067	−0.029
			(0.065)
ln number of exporting firms	4.379	3.983	−0.147
			(0.199)
ln number of destinations	3.745	3.573	−0.134
			(0.130)
High-income share of exports	0.584	0.557	0.024
			(0.032)
Δ high-income share, 2012–2014	0.012	−0.008	0.024
			(0.021)
Destination ln GDP per capita	9.704	9.630	0.049
			(0.080)
Inferred-quality dispersion	6.448	5.963	0.018
			(0.279)
Foreign-demand shock, 2014–2015	−0.074	−0.112	0.016
			(0.033)
Joint F-test, p-value			0.680
HS8 products	151–179	445–554	

Notes. HS8 products in HS4 headings that contain both treated and untreated products; characteristics are measured over 2012–2014. Columns (1)–(2) are unweighted means; column (3) regresses each characteristic on a treatment indicator with HS4 fixed effects, and the joint test regresses treatment on all ten characteristics. Unit-value levels are omitted because firm–product fixed effects absorb them. Standard errors clustered by HS4 in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

of exports, the Hong Kong–Macao share and destination income, each interacted with year dummies. Column (3) adds the 2012–2014 changes in log unit value, quantity, export value and high-income share, so that products that were already moving toward richer markets or higher prices may continue to do so. Column (4) adds all characteristics of Table 17, together with Rauch differentiation (Rauch, 1999) and size. The estimates hardly move. The rebate-induced unit-value response is 0.007–0.009 in every column and the delay interaction 0.004; the quantity responses are within 0.004 of the baseline. In the event-study version of Column (4), pre-trend p-values range from 0.43 to 0.97.

Table 18: Product-Level Estimates with Flexible Trends in Product Characteristics

		Baseline (1)	Destination mix (2)	Pre-reform trends (3)	All characteristics (4)
ln unit value	$\Delta r_p \times$ post	0.008***	0.009***	0.007***	0.009***
		(0.002)	(0.002)	(0.003)	(0.003)
	$\Delta r_p \times$ post $\times D_c$	0.004***	0.004***	0.004***	0.004***
		(0.001)	(0.001)	(0.001)	(0.001)
ln quantity	$\Delta r_p \times$ post	0.013***	0.014***	0.017***	0.016***
		(0.002)	(0.002)	(0.004)	(0.004)
	$\Delta r_p \times$ post $\times D_c$	−0.006***	−0.006***	−0.005**	−0.005**
		(0.002)	(0.002)	(0.002)	(0.002)
ln export value	$\Delta r_p \times$ post	0.022***	0.023***	0.024***	0.025***
		(0.002)	(0.002)	(0.003)	(0.004)
	$\Delta r_p \times$ post $\times D_c$	−0.002	−0.002	−0.001	−0.001
		(0.001)	(0.001)	(0.002)	(0.002)
Observations		2,884,937			

Notes. Specification B with controls, 2012–2015, on products with every characteristic. Columns add 2012–2014 HS8 characteristics, standardized and interacted with year: destination mix (high-income and Hong Kong–Macao shares, destination income); pre-reform trends (changes in unit value, quantity, export value and high-income share); and, in column (4), these plus quality dispersion, Rauch differentiation (Rauch, 1999), the change in foreign demand, and log exports, exporters and destinations. Standard errors two-way clustered by city and HS4 in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

C.4 Sequential Control Sets

Table 19 evaluates the sensitivity of the product-level estimates (Specification B) to a sequential battery of robustness controls. Column (1) reports the baseline specification of Table 3 (N = 3,146,104). Column (2) controls for pre-reform firm export characteristics (the firm's 2012–2013 log exports, log number of exported HS8 products, and log number of destinations) each interacted with year dummies, corresponding to Column (2), (4), and (6) of Table 3 in the main text.

Columns (3)–(6) introduce additional sets of controls in two sequential stages:

1. *Domestic and institutional controls (Columns 3–4)*: Column (3) controls for policy targeting by adding the pre-reform rebate rate $r_p^{2014}\times$year and $r_p^{2014} \times \text{post} \times D_c$ to address the concern that the reform targeted products with specific initial tax positions (Chandra and Long, 2013) ($N = 3{,}100{,}342$, products with a recorded pre-reform rate). Column (4) controls for the city's standardized 2012–2014 log exports interacted with $\Delta r_p \times \text{post}$ to ensure that refund delay D_c does not capture differential export trends across large coastal versus interior cities ($N = 3{,}146{,}026$).

2. *International external shocks (Columns 5–6, Comtrade-matched subsample)*: Column (5) matches firm–product declarations with destination import data from UN Comtrade (excluding China) to construct foreign-demand shift-shares $\sum_d s_{fpd} \ln M^{-\text{CHN}}_{d,h(p),t}$ fixed at 2012–2014 weights ($N = 2{,}913{,}918$), following the shift-share literature (Borusyak et al., 2022; Goldsmith-Pinkham et al., 2020). Column (6) applies the same weights to construct effective exchange rate shift-shares $\sum_d s_{fpd} \ln(\text{currency/yuan})_t$ to account for bilateral exchange rate movements ($N = 2{,}912{,}222$).

Across all six columns, the estimated delay gradient remains remarkably stable: the unit-value gradient ranges between +0.003 and +0.004, the quantity gradient between −0.005 and −0.007, and the export value gradient between −0.002 and −0.003.

C.5 Export Value With Zeros After Exit

Table 3 uses only the years in which a firm–product exports. Here each firm–product in the 2012–2015 sample enters from its first export year, and every later year without exports counts as zero. Years before the first export are left out, so the estimate adds exit but not entry. Zeros are 30 percent of observations in 2013, 42 percent in 2014 and 51 percent in 2015. The outcome is the level of export value, winsorized as in Table 3, and we estimate Specification B by Poisson pseudo-maximum likelihood (Santos Silva and Tenreyro, 2006) with firm–product, city–year and HS4–year fixed effects on 7.86 million observations.

At average delay, a one-point rebate increase raises export value by 3.86 percent (s.e. 0.57). Each standard deviation of delay lowers that response by 0.66 percentage points (s.e. 0.29), more than twice the 0.29 points in Table 3. In the event study (Figure 7) the 2015 differential relative to the 2012–2014 mean is −0.007 (s.e. 0.003). The pre-trend test does not reject ($p = 0.149$), but the 2012 coefficient is +0.003 ($p = 0.095$), as in the log value differential of Table 3.

Table 19: Product-Level Estimates with Sequential Robustness Controls

	Baseline (1)	Firm trends (2)	Policy targeting (3)	City exports (4)	Foreign demand (5)	+ Exchange rate (6)
ln *unit value*						
$\Delta r_p \times$ post	0.009***	0.009***	0.008***	0.013***	0.009***	0.009***
	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)
$\Delta r_p \times$ post $\times D_c$	0.003**	0.003**	0.003**	0.003**	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ln *quantity*						
$\Delta r_p \times$ post	0.016***	0.017***	0.018***	0.026***	0.016***	0.016***
	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.004)
$\Delta r_p \times$ post $\times D_c$	−0.007***	−0.006***	−0.005***	−0.006***	−0.007***	−0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ln *export value*						
$\Delta r_p \times$ post	0.025***	0.026***	0.026***	0.038***	0.025***	0.025***
	(0.004)	(0.003)	(0.004)	(0.009)	(0.003)	(0.003)
$\Delta r_p \times$ post $\times D_c$	−0.003***	−0.003**	−0.002*	−0.003**	−0.003*	−0.003*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Observations	3,146,104	3,146,026	3,100,342	3,146,026	2,913,918	2,912,222
Controls	—	Yes	Yes	Yes	Yes	Yes
Pre-reform rebate rate	—	—	Yes	—	—	—
City pre-reform exports	—	—	—	Yes	—	—
Foreign-demand shift-share	—	—	—	—	Yes	Yes
Exchange-rate shift-share	—	—	—	—	—	Yes
Firm×product FE	Yes	Yes	Yes	Yes	Yes	Yes
City×year FE	Yes	Yes	Yes	Yes	Yes	Yes
HS4×year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes. Specification B, 2012–2015. Column (3) adds the pre-reform rebate rate interacted with year and with post $\times D_c$; column (4) adds the city's pre-reform log exports interacted with $\Delta r_p \times$ post; columns (5)–(6) add destination-weighted foreign-demand and exchange-rate shift-shares from UN Comtrade. Standard errors two-way clustered by city and HS4 in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

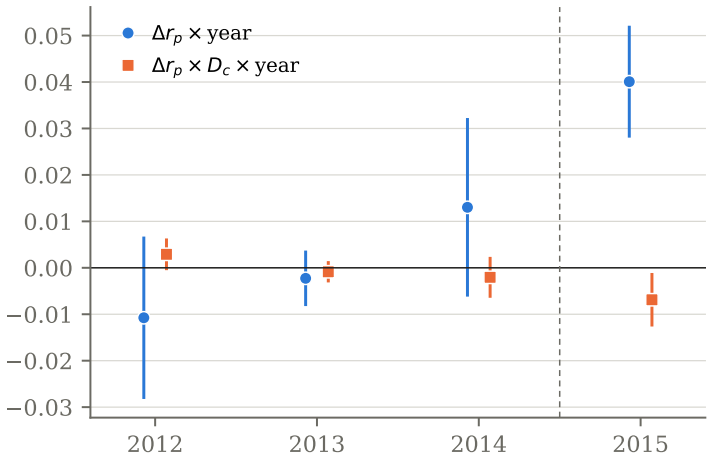


Figure 7: Event study, export value with zeros after exit.

Notes: Poisson pseudo-maximum likelihood on the level of export value, 2012–2015, with each firm–product's years after its first export and without exports set to zero. Circles are $\Delta r_p \times$year, squares $\Delta r_p \times D_c \times$year, from one regression with firm–product, city–year and HS4–year fixed effects. Coefficients relative to their 2012–2014 mean; 95 percent confidence intervals two-way clustered by city and HS4.

C.6 Placebo Tests

Table 20 reports two placebos. If the notice had picked products whose world prices rose in 2015 for other reasons, foreign suppliers' prices of the same HS8 lines into China would also rise relative to untreated lines in the same heading. Column (1) estimates the rebate interaction on the unit values of general-trade imports at the firm–HS8–origin level, excluding imports from China. The coefficient is −0.001 (s.e. 0.004), with no pre-trend ($p = 0.155$).

The rebate is paid in full only on general-trade exports. Processing with supplied materials receives none, and processing with imported materials receives it only on domestic value added. If the delay interaction reflects refund timing, it should vanish for the same products exported outside general trade. Columns (2)–(4) estimate Specification B on non-general-trade exports. The delay interaction is small and insignificant for all three outcomes, and its sign is positive for quantity and export value, where the general-trade estimates are negative. The rebate interaction on export value is positive, but its event study shows a clear pre-trend ($p = 0.001$), so we do not interpret it.

Table 20: Placebo Tests: Import Prices and Non-General-Trade Exports

	Imports into China	Non-general-trade exports		
	ln unit value	ln unit value	ln quantity	ln export value
	(1)	(2)	(3)	(4)
$\Delta r_p \times$ post	−0.001	0.008	0.025	0.034**
	(0.004)	(0.008)	(0.016)	(0.013)
$\Delta r_p \times$ post $\times D_c$		0.004	0.002	0.006
		(0.003)	(0.004)	(0.004)
Pre-trend p, $\Delta r_p \times$ post	0.155	0.654	0.218	0.001
Pre-trend p, $\Delta r_p \times$ post $\times D_c$		0.510	0.514	0.505
Observations	2,912,664	936,907	936,907	936,907

Notes. Column (1): general-trade imports into China, excluding imports from China, at the firm–HS8–origin–year level, with firm–HS8–origin, origin–year, city–year and HS4–year fixed effects; standard errors clustered by HS4 and origin. Columns (2)–(4): Specification B on non-general-trade exports of the same manufacturers; standard errors clustered by city and HS4. Pre-trend p tests that the 2012 and 2013 event-study coefficients equal the 2014 one. *, **, *** denote significance at 10, 5 and 1 percent.

D Evidence on Quality Upgrading: Additional Results

D.1 Within-Product Adjustment and Imported Inputs

Table 21: Within-Product Adjustment in High Inferred-Quality-Dispersion Products

	Low tercile	Middle tercile	High tercile
$\Delta r_p \times$ post, $\ln UV$	0.022**	0.015	0.025**
	(0.011)	(0.009)	(0.011)
p: three coefficients equal		0.741	
Export-value share	0.012	—	−0.004
	(0.009)		(0.005)
p: all three share effects jointly zero		0.327	
SD of $\ln UV$		0.001	
		(0.013)	
IQR of $\ln UV$		−0.002	
		(0.018)	
P90–P10 of $\ln UV$		−0.026	
		(0.031)	

Notes. HS8 products above the median of inferred-quality dispersion, with quality inferred using the HS4 elasticities of Broda and Weinstein (2006). Firm–HS8 cells are ranked into terciles by their 2012–2014 log unit value within HS8. Unit-value regressions include firm–HS8 fixed effects, tercile-specific city–year and HS4–year fixed effects and controls as in Table 3, with standard errors clustered by city and HS4. Share and dispersion outcomes are HS8–year regressions with HS8 and HS4–year fixed effects, clustered by HS4. *, **, *** denote significance at 10, 5 and 1 percent.

The distributional evidence in Table 21 complements the cross-product heterogeneity in the main text. Conditional on being in the high inferred-quality-dispersion group, rebate exposure shifts unit values upward across the existing price ladder rather than reallocating exports toward its top. Using the HS4 elasticities of Broda and Weinstein (2006) to infer quality, unit values rise by 2.2, 1.5 and 2.5 percent in the low, middle and high terciles, and equality across the three cannot be rejected ($p = 0.741$). Export-value shares of the low and high terciles do not change ($p = 0.327$), and the within-HS8 dispersion of unit values is unaffected. This exercise is therefore useful as a composition diagnostic: it shows that the quality-dispersion pattern is not an artifact of initially high-unit-value exporters gaining market share.

Figure 8 reports the event-study estimates for imported intermediate inputs, and Table 22 pools all imports without the BEC split.

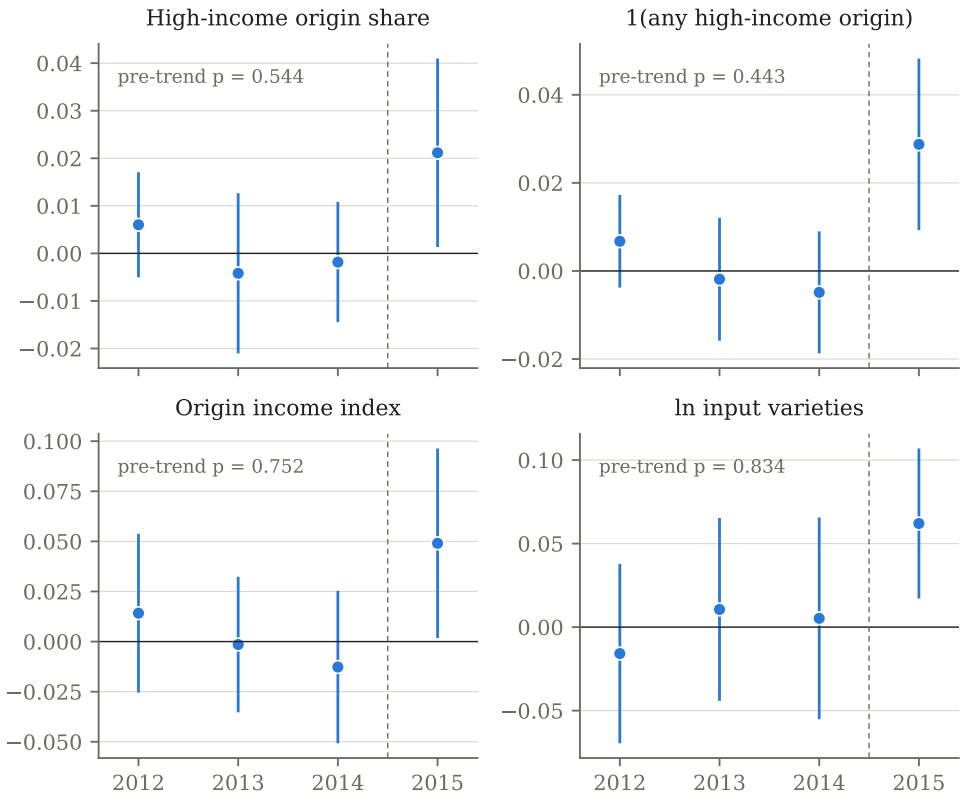


Figure 8: Event-Study Estimates: Imported Intermediate Inputs

Notes: Specifications of Table 5, Panel A (intermediate inputs), with E_i interacted with year. Coefficients relative to their 2012–2014 mean; 95 percent confidence intervals two-way clustered by city and HS4.

Table 22: Pooled Imported-Input Responses across All Imports (Unsegmented)

	High-income share (1)	1(any high-income origin) (2)	Origin income index (3)	ln input varieties (4)	ln import value (5)
$E_i \times$ post	0.026*	0.029***	0.045*	0.059**	0.249***
	(0.014)	(0.009)	(0.027)	(0.025)	(0.071)
Pre-trend p	0.810	0.817	0.910	0.983	0.295
Observations	191,481	191,481	184,529	191,481	191,481
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
City×year FE	Yes	Yes	Yes	Yes	Yes
Main HS4×year FE	Yes	Yes	Yes	Yes	Yes

Notes. All imports except HS 25–27, without the BEC split of Table 5. Variables, controls and fixed effects as in Table 5; column (5) is log total import value. Pre-trend p tests that the 2012 and 2013 event-study coefficients equal the 2014 one. Standard errors two-way clustered by city and main HS4 in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

D.2 Does Delay Affect Quality Upgrading?

In the model, delay reaches the quality decision only through ω_i, the share of the delay effect on effective cost that the design stage sees (Appendix A.5). If slow refunds changed how much firms upgrade, the delay gradient in unit values would differ between products with more and less scope for quality differentiation, as the average rebate response does. Table 23 estimates the delay gradient separately for high- and low-dispersion products. One standard deviation of additional delay raises the unit-value response by 0.41 percentage points in high-dispersion products and by 0.30 points in low-dispersion products; the difference, 0.10 points (s.e. 0.22), is small and insignificant. Delay raises unit values about equally whether or not products can be upgraded. Quality scope predicts the unit-value response to the rebate-rate increase, but not its delay gradient, so there is little evidence that delay affects upgrading.

Table 23: Quality Differentiation and the Refund-Delay Gradient in Unit Values

$\Delta r_p \times \text{post} \times D_c$	High dispersion (1)	Low dispersion (2)	High − low (3)
ln unit value	0.0041**	0.0030*	0.0010
	(0.0017)	(0.0016)	(0.0022)
Observations		3,142,585	
Controls	Yes	Yes	Yes
Firm×product FE	Yes	Yes	Yes
City×year FE, by group	Yes	Yes	Yes
HS4×year FE, by group	Yes	Yes	Yes

Notes. Firm–HS8–year observations, 2012–2015. Products are split at the median of pre-reform inferred-quality dispersion, using the elasticities of Broda and Weinstein (2006); both treatment terms are interacted with the group, and column (3) is the difference. Controls as in Table 3. Standard errors two-way clustered by city and HS4 in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

D.3 Alternative Explanations for the Unit-Value Response

Destination mix. Firms could raise their average unit value by selling more of the same product in destinations that pay higher prices. Table 24 rebuilds each firm–product unit value from its destination-level shipments and splits it into a composition index, which replaces each destination's unit value with the pre-reform price of the same HS8 product in that destination and so moves only with the firm's destination weights, and a within-destination remainder. The composition index responds neither to the rebate increase (−0.0007) nor to its interaction with delay (0.0001). The within-destination remainder carries both responses,

0.010 and 0.003, against 0.009 and 0.003 for the unit value itself. Neither the average unit-value response nor its delay gradient comes from reallocation toward high-price markets.

Table 24: Destination Composition and the Unit-Value Response

	ln unit value (1)	Composition index (2)	Within-destination remainder (3)
$\Delta r_p \times$ post	0.009***	−0.0007	0.010***
	(0.003)	(0.001)	(0.003)
$\Delta r_p \times$ post $\times D_c$	0.003**	0.0001	0.003**
	(0.001)	(0.0004)	(0.001)
Observations	3,008,697	3,008,697	3,008,697
Controls	Yes	Yes	Yes
Firm×product FE	Yes	Yes	Yes
City×year FE	Yes	Yes	Yes
HS4×year FE	Yes	Yes	Yes

Notes. Firm–HS8–year observations, 2012–2015, with destination benchmark prices for at least 90 percent of quantity. The composition index values each destination at the pre-reform mean log unit value of the same HS8 product there, excluding the firm, so it moves only with destination weights; the within-destination remainder is the log unit value minus the index, so columns (2) and (3) sum to column (1). Controls as in Table 3. Standard errors two-way clustered by city and HS4 in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

Table 25 reports three further checks. Row 1 aggregates exports to firm–HS6 cells, and row 2 drops HS6 headings in which only some HS8 lines were treated, so neither can reflect reclassification across HS8 lines within an HS6 product. Row 3 keeps firm–products that did not face the refund ceiling before the reform.

Taken together, the checks in Table 25 are best read as evidence against several specific mechanical explanations for the unit-value response, not as proof that declared customs values contain no reporting response.

D.3.1 Mirror Statistics

The refund is computed on the declared free-on-board value, so part of the unit-value response could reflect higher declared prices rather than higher transaction prices. Following Fisman and Wei (2004) and Ferrantino et al. (2012), we compare Chinese export declarations with the imports from China recorded by the destination country's customs in UN Comtrade. Importers have no reason to adjust their declarations to China's rebate rates. If exporters raise declared prices, the unit value recorded by Chinese customs rises relative to the unit value recorded by the importer, and the price gap, the log partner unit value minus

Table 25: Checks on Aggregation, Reclassification and the Refund Ceiling

Sample	ln unit value (1)	ln quantity (2)	N (3)
Firm×HS6 aggregation	0.007***	0.018***	2,935,461
	(0.002)	(0.004)	
Uniform-treatment HS6	0.008***	0.019***	2,920,193
	(0.003)	(0.002)	
Outside direct refund-ceiling incentive	0.017***	0.026***	906,848
	(0.004)	(0.006)	
Controls	Yes	Yes	

Notes. Coefficients on $\Delta r_p \times$ post in Specification B with controls. Row 1 aggregates exports to firm–HS6 cells; row 2 drops HS6 headings in which only some HS8 lines were treated; row 3 keeps firm–products that did not face the refund ceiling before the reform. Standard errors two-way clustered by city and HS4 in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

the log Chinese unit value, falls. We estimate

$$y_{kct} = b\,\Delta r_{kc} \times \text{post}_t + \mu_{kc} + \delta_{ct} + \nu_{h(k)t} + \varepsilon_{kct} \tag{25}$$

for HS6 product k, importing country c and year t in 2012–2015, where Δr_{kc} is the rebate increase of the HS8 lines within k, weighted by their 2012–2013 exports to c, and $\nu_{h(k)t}$ is an HS4–year effect. Unit values are per kilogram. The sample covers 54 importing countries. Standard errors are two-way clustered by HS4 and country.

Partner data report all Chinese exports of an HS6 product to a country, summed over exporters, trade regimes and the HS8 lines within the product. Before interpreting the gap, we check whether the Chinese unit value in these cells reproduces the firm-level response. Panel A of Table 26 shows that it does not over the full range of rebate increases: the Chinese unit value does not respond, while the firm-level response is 0.92 percent per point. The mismatch is likely to come from untreated HS8 lines within the same HS6 product, other trade regimes and changes in composition within the cell. Among products whose rebate rose by at most four points, which account for 91 percent of treated observations, the Chinese unit value rises by 1.41 percent per point, close to the firm-level 1.58 percent. We confine the mirror comparison to these products.

Within this group the price gap falls by 1.23 percent per point, significant only at the 10 percent level. Panel B splits products by the pre-reform dispersion of inferred quality used in Table 4. In high-dispersion products, where manufacturers' unit values rise by 2.11 to 2.52 percent per point, the price gap is positive under all three classifications, so the

mirror data give no evidence of inflated declarations. Under $\sigma = 5$ and $\sigma = 10$ the lower bounds of the 95 percent confidence intervals, -1.04 and -0.92 percent, are about half of the manufacturers' response, so inflated declarations account for at most about half of it. Under the Broda–Weinstein classification the interval is too wide to bound the share. In low-dispersion products the gap is negative, and significant under $\sigma = 5$. Manufacturers' unit values in these products do not change. Excluding Hong Kong and Macao, the main entrepôt destinations, the gaps for high-dispersion products are 0.017, 0.013 and 0.011.

These comparisons are limited by the structure of the partner data. Comtrade records imports only by HS6 product and country, so the gap cannot be attributed to individual exporters, to manufacturers rather than trading companies, or to direct rather than agency exports. Because a cell's unit value also moves with the mix of exporters and HS8 lines, the firm-level responses by quality dispersion are not reproduced in the aggregated Chinese unit values, and the bounds above are only indicative. The comparison is further restricted to flows measured in kilograms and reported by both sides. We therefore find no clear evidence that inflated declarations drive the unit-value response, but the mirror statistics are not precise enough to rule them out.

Table 26: Mirror Statistics: Chinese Declarations and Partner Records

Panel A. Does the Chinese unit value reproduce the firm-level response?

	Firm-level unit value	Chinese unit value	Partner unit value	Price gap (partner − China)
All rebate increases	0.009***	−0.001	−0.004	−0.004
	(0.003)	(0.005)	(0.004)	(0.004)
Increases of at most 4 points	0.016***	0.014**	0.006	−0.012*
	(0.005)	(0.007)	(0.005)	(0.007)

Panel B. Increases of at most 4 points, by pre-reform quality dispersion

	Firm-level unit value		Price gap	
Inferred-quality measure	High	Low	High	Low
Broda–Weinstein σ_j	0.025***	0.004	0.014	−0.020
	(0.007)	(0.005)	(0.020)	(0.013)
			[−0.026, 0.054]	[−0.047, 0.006]
$\sigma = 5$	0.021***	0.003	0.011	−0.026**
	(0.007)	(0.007)	(0.011)	(0.012)
			[−0.010, 0.032]	[−0.051, −0.001]
$\sigma = 10$	0.021***	0.004	0.009	−0.021*
	(0.007)	(0.007)	(0.009)	(0.012)
			[−0.009, 0.027]	[−0.046, 0.003]

Notes. Coefficients on the rebate increase times post. Firm-level unit values come from Specification A of Table 3 (Panel A) and from the regressions of Table 4 by dispersion group (Panel B). The Chinese, partner and price-gap columns estimate equation (25) on HS6–country–year cells for 54 importing countries, 2012–2015; an HS6 product is high dispersion if high-dispersion HS8 lines make up at least half of its 2012–2013 exports. Outcomes are winsorized within HS4–year, so the columns need not sum to the gap. Standard errors in parentheses; 95 percent confidence intervals in brackets. *, **, *** denote significance at 10, 5 and 1 percent.

E Evidence on the Refund-Delay Effect: Additional Results

E.1 Exposure Measured by the Rebate Increase

The main text measures a firm's exposure by the share E_i of its 2012–2013 exports in products whose rebate rose; Table 27 describes its distribution. The alternative is the export-weighted rebate increase $\text{trt}_i = \sum_p \Delta r_p \, X_{ip}^{\text{gen}} / \sum_p X_{ip}$, in percentage points. It has a long right tail (Table 28). Among exposed customs codes the median is 0.03 points, the 99th percentile 6.40 points and the maximum 13, and the top 1 percent of all units account for 87 percent of the variance, so a linear specification in trt_i rests largely on them.

Tables 29 and 30 re-estimate the firm-level and imported-input regressions with two transformations of trt_i: top-coded at its 99th percentile (1.83 points among tax-survey firms and 2.00 points among customs codes), so that coefficients are per percentage point, and $\ln(1 + \text{trt}_i)$, which compresses the tail instead of cutting it. Every coefficient keeps its sign. In the firm-level regressions, all delay interactions that are significant in Table 9 remain so under both transformations; at average delay, the revenue response loses significance in logs. For intermediate inputs, all five outcomes remain significant under both transformations; for capital goods, sourcing again does not move and the import-value response is no longer significant.

Table 27: Distribution of Firm Exposure E_i

Panel A. Units by exposure status

	Tax-survey firms		Customs codes	
	Units	Share	Units	Share
All units	18,758	100.0%	82,121	100.0%
$E_i = 0$	16,469	87.8%	70,111	85.4%
$E_i > 0$	2,289	12.2%	12,010	14.6%

Panel B. Distribution of E_i among units with $E_i > 0$

	Units	Mean	S.D.	p25	Median	p75	p90	Share at $E_i = 1$
Tax-survey firms	2,289	0.180	0.329	0.0002	0.005	0.139	0.881	4.3%
Customs codes	12,010	0.197	0.332	0.0009	0.012	0.224	0.915	5.0%

Notes. E_i is the share of a unit's 2012–2013 exports in general-trade exports of products whose rebate rate rose in 2015 (Equation (16)). Tax-survey firms are those in the firm-account regressions (Table 6); customs codes are those in the imported-input regressions (all imports except HS 25–27). Panel B restricts to units with $E_i > 0$ and gives each unit equal weight.

Table 28: Distribution of the Export-Weighted Rebate Increase trt_i among Exposed Units

Units	Mean	S.D.	p25	Median	p75	p90	p99	Max
12,010	0.561	1.359	0.002	0.031	0.582	1.859	6.397	13

Notes. $\text{trt}_i = \sum_p \Delta r_p X_{ip}^{\text{gen}} / \sum_p X_{ip}$ over 2012–2013 exports, in percentage points. The sample consists of customs codes with $\text{trt}_i > 0$ in the imported-input regressions (all imports except HS 25–27, Table 22).

Table 29: Firm-Level Responses with Exposure in Rebate Points

	$E_i = \min(\text{trt}_i, p_{99})$		$E_i = \ln(1 + \text{trt}_i)$		
Outcome	Coefficient	Pre-trend p	Coefficient	Pre-trend p	N
Panel A. At average delay: $E_i \times$ post (Table 6)					
Input VAT transferred out / input VAT	−0.035***	0.578	−0.046***	0.471	62,211
	(0.004)		(0.006)		
ln revenue	0.030*	0.723	0.028	0.920	64,683
	(0.016)		(0.021)		
Operating profit / revenue	0.018***	0.277	0.020***	0.280	64,683
	(0.004)		(0.007)		
Export sales / revenue	−0.007	0.500	−0.009	0.557	63,734
	(0.006)		(0.008)		
Panel B. Refund delay: $E_i \times post \times D_c$ (Table 9)					
Export sales / revenue	−0.010**	0.855	−0.013**	0.784	63,734
	(0.004)		(0.006)		
1(VAT paid > 0)	0.024***	0.829	0.028***	0.848	64,692
	(0.007)		(0.008)		
1(unpaid refund at year end > 0)	−0.030**	0.369	−0.040**	0.298	48,284
	(0.014)		(0.017)		
Unpaid refund / claim	−0.039**	0.583	−0.042*	0.342	37,417
	(0.017)		(0.022)		
ln revenue	−0.0008	0.598	−0.005	0.632	64,683
	(0.012)		(0.017)		

Notes. Regressions of Tables 6 and 9, with their controls and fixed effects, with E_i replaced by trt_i top-coded at its 99th percentile (1.83 points) or by $\ln(1 + \text{trt}_i)$. Pre-trend p tests that the 2012 and 2013 coefficients are zero. Standard errors clustered by city in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

Table 30: Imported-Input Responses with Exposure in Rebate Points

	High-income share (1)	1(any high-income origin) (2)	Origin income index (3)	ln input varieties (4)	ln import value (5)
Panel A. Intermediate inputs excluding HS 25–27 (Table 5, Panel A)					
$\min(\text{trt}_i, p_{99}) \times \text{post}$	0.010**	0.014***	0.025**	0.033***	0.082**
	(0.005)	(0.004)	(0.011)	(0.012)	(0.032)
Pre-trend p	0.626	0.401	0.761	0.399	0.816
$\ln(1 + \text{trt}_i) \times \text{post}$	0.019**	0.022***	0.045**	0.039**	0.092*
	(0.009)	(0.007)	(0.020)	(0.018)	(0.051)
Pre-trend p	0.796	0.511	0.648	0.394	0.744
Observations	170,440	170,440	165,337	170,440	170,440
Panel B. Capital goods (Table 5, Panel B)					
$\min(\text{trt}_i, p_{99}) \times \text{post}$	−0.0007	0.004	0.0002	−0.005	0.080
	(0.007)	(0.007)	(0.010)	(0.023)	(0.061)
$\ln(1 + \text{trt}_i) \times \text{post}$	−0.0000	0.008	0.010	−0.006	0.115
	(0.012)	(0.011)	(0.015)	(0.039)	(0.099)
Observations	93,140	93,140	89,475	93,140	93,140
Panel C. All imports except HS 25–27 (Table 22)					
$\min(\text{trt}_i, p_{99}) \times \text{post}$	0.012*	0.014***	0.016	0.028**	0.122***
	(0.006)	(0.004)	(0.013)	(0.011)	(0.031)
Pre-trend p	0.915	0.529	0.642	0.712	0.576
$\ln(1 + \text{trt}_i) \times \text{post}$	0.021**	0.021***	0.033	0.034*	0.153***
	(0.010)	(0.007)	(0.021)	(0.017)	(0.048)
Pre-trend p	0.976	0.553	0.445	0.674	0.600
Observations	191,481	191,481	184,529	191,481	191,481
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
City×year FE	Yes	Yes	Yes	Yes	Yes
Main HS4×year FE	Yes	Yes	Yes	Yes	Yes

Notes. Regressions of Tables 5 and 22 with E_i replaced by trt_i top-coded at its 99th percentile (2.00 points) or by $\ln(1 + \text{trt}_i)$; each row is a separate regression. Standard errors two-way clustered by city and main HS4 in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

E.2 Alternative Measures of Financial Tightness

Table 31 reports the number of firms and observations in each group under the three measures of financial tightness. Financial tightness is not closely related to refund-claimant status: the share of firms classified as tight is 49 to 51 percent among claimants and 48 percent among non-claimants.

Table 31: Firms and Observations by Refund Claimant Status and Financial Tightness

	Claimant		Non-claimant	
Tightness measure	Tight	Slack	Tight	Slack
Panel A. Firms				
Interest expense / revenue	18,078	18,684	8,606	9,335
Current liabilities / current assets	23,311	22,716	9,720	10,691
Net working capital / assets	23,303	22,855	9,872	10,574
Panel B. Firm–HS8–year observations				
Interest expense / revenue	406,884	550,147	112,470	168,786
Current liabilities / current assets	577,891	609,038	148,697	179,490
Net working capital / assets	569,326	619,315	147,430	181,351

Notes. Counts are from the four-group regressions of Tables 7 and 32. Firms are tight if interest expense over revenue or current liabilities over current assets is above the median, or if net working capital over assets is below the median.

Table 32 repeats Table 7 with two balance-sheet measures of tightness: current liabilities over current assets (tight above the median) and net working capital over assets (tight below the median). Tight refund claimants are again the only group with significant delay coefficients: unit value 0.006 (significant at the 10 percent level), quantity −0.018 and −0.019, export value −0.013 and −0.014 (10 percent level). Their differences from all other exporters are significant for unit value and quantity, at the 10 or 5 percent level. For export value the differences, −0.012 and −0.014, are not significant. Because the log of export value is the sum of the logs of unit value and quantity, which move in opposite directions, its response nets two partly offsetting effects and is estimated less precisely; the insignificance does not show that the groups respond alike. In Panel A the pre-trend p-value of the export-value difference is 0.061. The balance-sheet ratios separate firms less sharply than the interest burden, and the differences in quantity are two-thirds to three-quarters of that in Table 7.

Table 32: Refund Delay by Refund Claimant Status: Balance-Sheet Measures of Tightness

	Financially tight			Financially slack		
	ln unit value (1)	ln quantity (2)	ln export value (3)	ln unit value (4)	ln quantity (5)	ln export value (6)
Panel A. Current liabilities / current assets						
Claimants	0.006*	−0.018**	−0.013*	0.001	−0.005	−0.003
	(0.003)	(0.007)	(0.007)	(0.004)	(0.007)	(0.005)
Non-claimants	−0.001	−0.005	−0.005	−0.003	0.011	0.008
	(0.007)	(0.010)	(0.007)	(0.006)	(0.012)	(0.011)
Tight claimants − all others	0.006*	−0.018*	−0.012			
	(0.003)	(0.010)	(0.009)			
Pre-trend p	0.178	0.748	0.061			
Observations			1,515,619			
Panel B. Net working capital / assets						
Claimants	0.006*	−0.019***	−0.014*	0.002	−0.002	0.000
	(0.003)	(0.007)	(0.008)	(0.004)	(0.007)	(0.005)
Non-claimants	−0.003	−0.002	−0.005	0.001	0.009	0.010
	(0.008)	(0.010)	(0.006)	(0.006)	(0.011)	(0.011)
Tight claimants − all others	0.006**	−0.020**	−0.014			
	(0.003)	(0.010)	(0.010)			
Pre-trend p	0.313	0.714	0.133			
Observations			1,517,927			
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm×product FE	Yes	Yes	Yes	Yes	Yes	Yes
City×year FE, by group	Yes	Yes	Yes	Yes	Yes	Yes
HS4×year FE, by group	Yes	Yes	Yes	Yes	Yes	Yes

Notes. As Table 7, with financial tightness measured by current liabilities over current assets (Panel A, tight above the median) or net working capital over assets (Panel B, tight below the median). Standard errors two-way clustered by city and HS4 in parentheses. *, **, *** denote significance at 10, 5 and 1 percent.

F Policy Counterfactuals: Additional Results

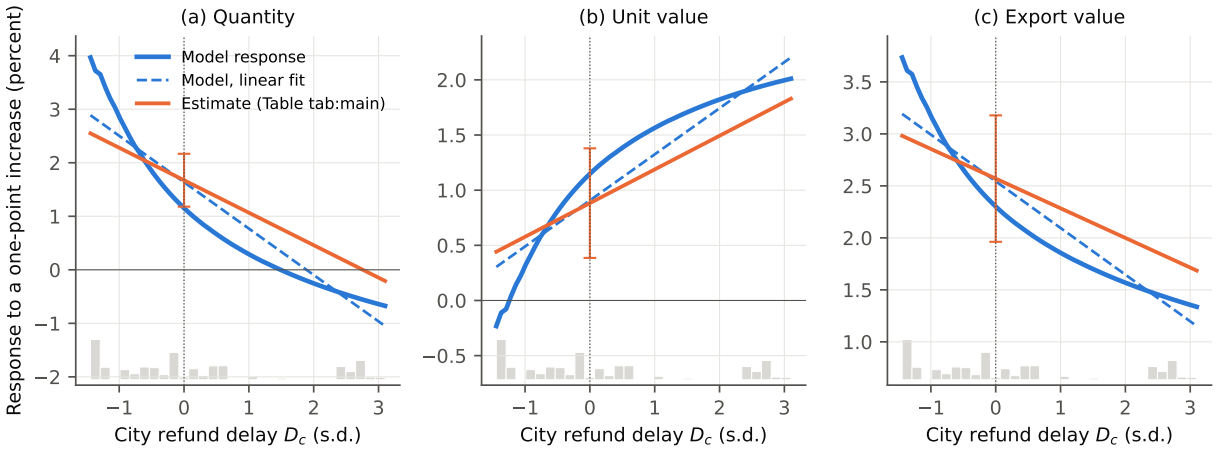


Figure 9: Calibrated model and estimates: response to a one-point increase by city delay.
Notes: Solid blue: the model response with every exposed firm placed in a city with delay D_c. Dashed blue: the linear projection of the model's firm-level responses on D_c (Panel A of Table 11). Orange: $\beta_1 + \beta_2 D_c$ from Specification B with controls, with the 95 percent confidence interval of β_1. Grey bars: distribution of exposed firms' D_c, weighted by affected exports.