Unveiling the Global Ripples: How EU ETS Influences Chinese Exporters

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Research Question

- Emissions Trading System (ETS)
  - Limits total emissions
  - Allows quota trading and banking
  - Carbon allowance prices affect regulated firms' costs
- The EU ETS is the first and largest market-based climate policy in the world, and it has reduced regulated firms' carbon dioxide emissions by 14–16% (Colmer et al., 2024).
- However, if EU consumers substitute toward carbon-intensive products from markets with weaker regulation, the overall benefits may be offset or even reversed.
- **Research Question:** Do EU ETS prices affect foreign exporters' behavior? Specifically, does it lead to carbon leakage via increased imports of regulated goods, and if so, how large is this effect?
- We focus on China, the world's largest exporter, to provide micro-based evidence.

Roadmap

- Preview of Empirical Results:
  1. Both transaction-level and industry-level evidence show that higher ETS prices stimulate exports to the EU.
  2. Adjustments are mainly within-firm; between-firm and entry/exit effects are minor.
  3. Transaction-level shift-share instrumental variable (SSIV) estimates: Higher ETS prices raise export volume and value, but not unit prices.
  4. Aggregate-level regressions: A 1% increase in the EU ETS price increases HS4–country export value by around 0.14%.
- Back-of-the-envolope Calculations:
  1. If ETS prices had remained at their 2008 peak from 2008 to 2012, the cumulative export value of regulated products to the EU would have been about 11% higher.
  2. Price fluctuations drove most within-firm effects.
- Theoretical Model:
  1. Export prices are unaffected by EU carbon prices.
  2. Export value increases with EU carbon prices by changing competitiveness in EU market(θ_{EU}).
  3. Heterogeneity (e.g., TFP) shapes these effects.

Literature Review and Contribution I

1. The effects of the EU ETS on regulated European firms.
   - Substantial evidence of emission reductions (Colmer et al., 2024).
   - Mixed findings on firms' competitiveness, including employment, value-added, and capital investment (Wagner et al., 2014; Dechezleprêtre et al., 2023).
   - Our paper extends this literature by examining potential spillover effects from a distinct non-EU perspective.
2. Environmental regulation and international trade.
   - Focuses on the "pollution haven" effect (PHE) but mainly relied on macro model or industry-level specification(Copeland and Taylor, 1994; Ederington et al., 2005).
   - Closest paper: Examine the impacts of air quality standards on local firms' export behavior (Cherniwchan and Najjar, 2022).
   - Our paper contributes by providing more granular empirical evidence and focus on the important problem of carbon leakage, uncovering mechanisms underlying aggregate responses to regulation.

Literature Review and Contribution II

3 Spillover effects of ETS.

- EU: Evidence is mixed, but most studies find limited overall spillover effects in FDI (Borghesi et al., 2020; Nils aus dem Moore et al., 2019), plant relocation (Colmer et al., 2024; Dechezleprêtre et al., 2023), and input sourcing (Colmer et al., 2024), with substantial heterogeneity across industries.
- Global: Kyoto Protocol increased imports from non-committed countries(Aichele and Felbermayr, 2015), while California's cap-and-trade shifted financially constrained firms' activities to less regulated states(Bartram et al., 2022).
- China: Evidence is mixed regarding the PHE (Cui et al., 2021; Chen et al., 2025), with additional findings on green innovation and product reorientation (Shi and Xu, 2018; Liu et al., 2024).
- Our contributions are twofold:
  - First, unlike prior DID studies on FDI, sourcing, and relocation, we analyze aggregate final-good substitution using detailed empirical evidence and a GE model.
  - Second, while prior work focuses on ETS phase cutoffs, we exploit SSIV to identify effects of ETS price variation.

The EU Emissions Trading System

- EU ETS is a cap-and-trade system limiting total emissions while allowing trading to minimize costs.
- It covers electric utilities, major industrial sectors, and all domestic airline emission across the EU-28 plus Norway, Iceland, and Liechtenstein.
- Four phases (2005–2007, 2008–2012, 2013–2020, and 2021–2030), each tightening the cap, expanding sectoral coverage, and refining allocation rules.
- We focus on Phase II: Phase I had no banking mechanism and unstable prices, while Phase III overlapped with the emergence of other carbon markets (e.g., California, China) that also influenced Chinese export behavior.

EU ETS Prices Change over Phase II

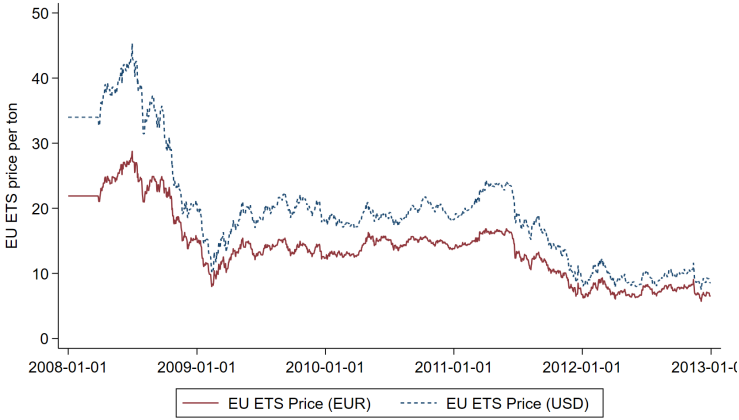


Figure 1: EU ETS Price over Phase II

Data

- China Customs Dataset
  1. 2005-2012 yearly data;
  2. Export and import values at the firm-product-country-year level for all exporters and importers in China.
  3. Use early data (2005-2007) to calculate the weights for SSIV, use later data (2008-2012) to trace Chinese exporters' changes.
- China's State Administration of Taxation
  1. 2008-2012 yearly data;
  2. The counterpart of the IRS in China, including approximately 700,000 enterprises nationwide.
  3. Consists of variables such as basic company information, financial statements, and detailed information related to taxation.
- Daily price of EUA December future constracts
  1. Detailed daily price data;
  2. Fill in missing values for non-trading days with the nearest available price and calculate the annual average.

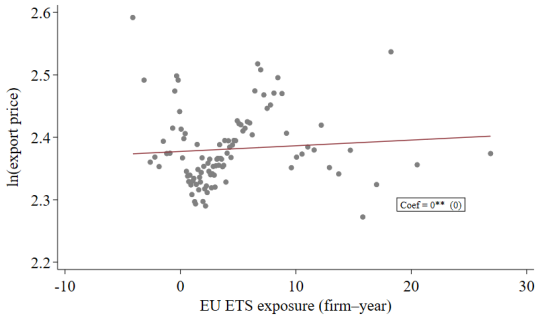
SSIV: EU ETS Price Exposure Measures

- To capture firms' exposure to EU ETS price fluctuations, we employ a shift-share approach (Bartik, 1991; Topalova and Khandelwal, 2011; Goldsmith-Pinkham et al., 2020).

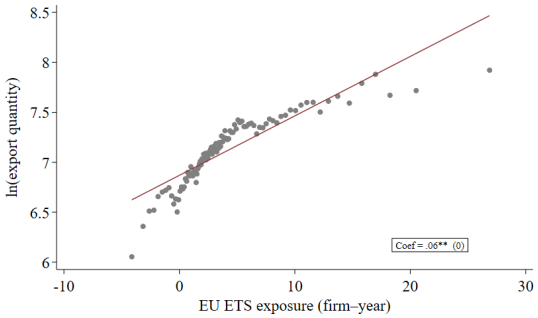
$$\text{ETS\_Shock}_{it}^{\text{export}} = \sum_{n \in N_{i0}^{E}} \sum_{\omega \in \Omega_{i0}^{E}} \frac{X_{in\omega 0}}{\sum_{m \in N_{i0}^{E}} \sum_{s \in \Omega_{i0}^{E}} X_{ims0}} \cdot \text{price}_{n\omega t},$$

- $\text{price}_{n\omega t}$ denotes the EU ETS price in year t for product ω exporting to country n. For EU affected products, it's the annual average price while 0 for other situations.
- N_{i0}^{E}: firm i's export countries' set in the base period.
- Ω_{i0}^{E}: firm i's export products' set in the base period.
- Original period: For each firm, we use the nearest available export record (2007 if available, otherwise 2006, and if not, 2005) to construct the HS6 product distribution.

Facts I: Higher ETS Price Shocks Lead Firms to Export More



(a) Export Price



(b) Export Quantity

Figure 2: Bin-scatter Plots of Firms' Export Outcomes under EU ETS Exposure

Notes: These scatter plots show the relationship between firm-level EU ETS shocks and (a) export price and (b) export quantities. We control product fixed effect, destination fixed effect and year fixed effect. X-variable are split into 100 equal-sized bins.

Facts II: Aggregate Export Ratio Move Positive with EU ETS Price

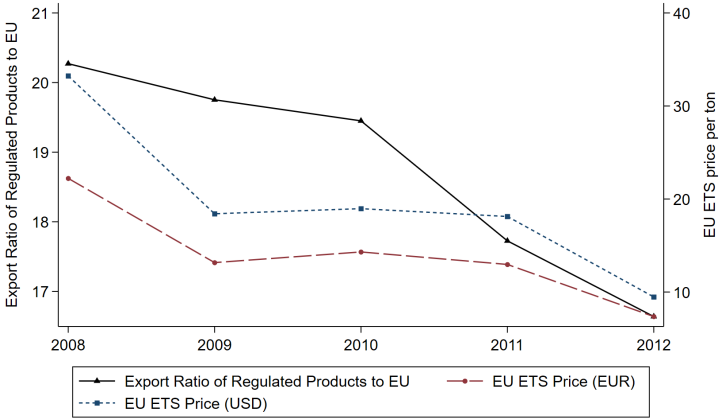


Figure 3: Export Ratio of Regulated Products to EU Markets and EU ETS Prices over Phase II

Facts III: Decomposition of ΔES_t

First, we define firm i's market share of the regulated goods and export ratio to the EU market at time t as ω_{it} and ES_{it} as follows:

$$\omega_{it} = \frac{\text{Export}_{\text{regulated},it}}{\sum_i \text{Export}_{\text{regulated},it}},$$

$$ES_{it} = \frac{\text{Export}_{\text{EU\_regulated},it}}{\text{Export}_{\text{regulated},it}}.$$

The aggregate export ratio of regulated products to EU markets ES_t can also be written as a weighted average of ES_{it}, weighted by ω_{it}

$$\begin{aligned} ES_t &= \frac{\sum_i \text{Export}_{\text{EU\_regulated},it}}{\sum_i \text{Export}_{\text{regulated},it}} = \sum_i \frac{\text{Export}_{\text{regulated},it}}{\sum_i \text{Export}_{\text{regulated},it}} \cdot \frac{\text{Export}_{\text{EU\_regulated},it}}{\text{Export}_{\text{regulated},it}} \\ &= \sum_i \omega_{it} ES_{it}. \end{aligned}$$

Facts III: Decomposition of ΔES_t

Therefore, the year-to-year change in the aggregate export ratio of regulated products to the EU can be decomposed into three parts: (1) the within-firm adjustments in export ratio, (2) between-firm heterogeneity in responses to the EU ETS, and (3) the the entry-exit effect.

$$
\begin{aligned}
\Delta \text{ES}_t = & \sum_{i \in S} \omega_{it-1} \left(\text{ES}_{it} - \text{ES}_{it-1} \right) \\
& + \sum_{i \in S} \left(\omega_{it} - \omega_{it-1} \right) \left(\text{ES}_{it-1} - \text{ES}_{t-1} \right) + \sum_{i \in S} \left(\omega_{it} - \omega_{it-1} \right) \left(\text{ES}_{it} - \text{ES}_{it-1} \right) \\
& + \sum_{i \in entry} \omega_{it} \left(\text{ES}_{it} - \text{ES}_{t-1} \right) \\
& - \sum_{i \in exit} \omega_{it-1} \left(\text{ES}_{it-1} - \text{ES}_{t-1} \right), \qquad (1)
\end{aligned}
$$

where ES_{t-1} denotes the aggregate export ratio in regulated products to the EU market in the previous year, referred to as the reference export share level.

Facts III: Within-firm Effects Dominate

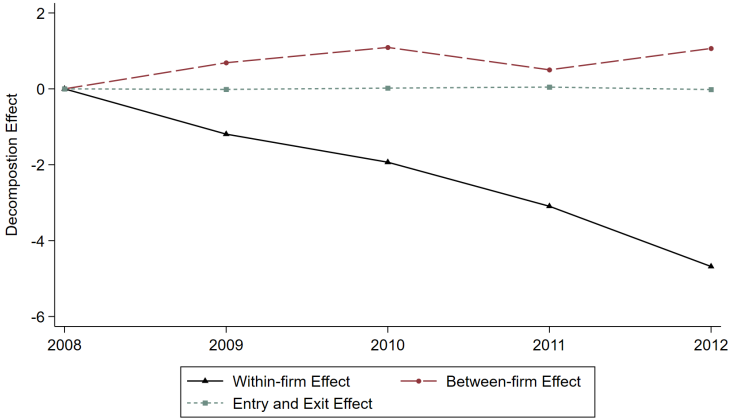


Figure 4: Decomposition of the Export Ratio over Phase II

Transaction-level Empirical Specification

We consider TWFE regressions as follows:

$$Y_{icjt} = \alpha + \beta_1 \cdot \text{ETS\_Shock}_{it}^{\text{export}} + \gamma' X_{it} + \lambda_i + \mu_{ct} + \mu_{jt} + \epsilon_{icjt}, \tag{2}$$

where

- Restrict the sample to exports of regulated industries to the EU market.
- i: the firm, c: the export destination, j: the HS-4 products, t: the year.
- Y_{icjt} include $\ln \text{export}_{icjt}$, $\ln \text{price}_{icjt}$ and $\ln \text{quantity}_{icjt}$.
- $\text{ETS\_Shock}_{it}^{\text{export}}$: main independent variable (SSIV).
- $X_{i,t}$: control variables, including
  1. The weighted averaged EUETS shocks transmitted by import network;
  2. The TFP of firm i in year t (Ackerberg et al., 2015).
- λ_i, μ_{ct} and η_{jt} are firm, destination-time and product-time fixed effects.

Aggregate-level Empirical Specification

We aggregate firm-level transactions to the product–destination level and estimate:

$$\ln \text{export}_{cjt} = \alpha + \beta_2 \cdot \ln \text{ETS\_Price}_t + \mu_{cj} + \epsilon_{cjt}, \tag{3}$$

where

- Restrict the sample to exports of regulated industries to the EU market.
- c: export destination, j: HS-4 product, t: year.
- $\ln \text{export}_{cjt}$: total export value of product j to country c in year t.
- $\ln \text{ETS\_Price}_t$: annual average EU ETS price.
- μ_{cj}: product–destination fixed effects. (Results are robust to including product and destination FE separately.)
- Limited variation in the independent variable motivates aggregating transaction-level regressions for counterfactual analysis.

Baseline: Higher Export Volumes, Constant Prices

Table 1: How the EU ETS Carbon Price Affects Chinese Firms' Exports

DEP. VAR.	Ln(value)		Ln(price)		Ln(quantity)	
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{ETS\_Shock}^{\text{export}}$	0.021***	0.021***	0.002	0.002	0.019***	0.019***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
$\text{ETS\_Shock}^{\text{import}}$	-0.002	-0.001	-0.004**	-0.004*	0.003	0.003
	(0.004)	(0.004)	(0.002)	(0.002)	(0.004)	(0.004)
Ln(TFP_acf)	0.002	0.002	0.012	0.011	-0.007	-0.007
	(0.010)	(0.010)	(0.008)	(0.008)	(0.012)	(0.012)
Observations	559 619	554 361	555 983	550 734	555 983	555 983
R^2	0.356	0.387	0.678	0.693	0.498	0.498
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
HS4–Year FE	Yes	No	Yes	No	Yes	No
Destination–Year FE	Yes	No	Yes	No	Yes	No
HS4–Destination–Year FE	No	Yes	No	Yes	No	Yes

Notes: The dependent variable is logarithmic term of export value, export price and export quantity in the firm-HS4-destination-year level. The main independent variable is $\text{ETS\_Shock}^{\text{export}}$. Standard errors are shown in parentheses. Statistical significance is indicated as: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Robustness Checks and Firm Heterogeneity

- Robustness 1: Examination of the Impacts of EU ETS's First Stage. See detailed robustness results in Appendix: Robustness 1.
- Robustness 2: Assessment of the Exogeneity of EU ETS Price. See detailed robustness results in Appendix: Robustness 2.
- Robustness 3: Excluding the Impact of Exchange Rate. See detailed robustness results in Appendix: Robustness 3.
- Robustness 4: Excluding the Impact of the Global Financial Crisis. See detailed robustness results in Appendix: Robustness 4.
- Robustness 5: Product reclassification at the HS 2-Digit Level. See detailed robustness results in Appendix: Robustness 5.
- Firm Heterogeneity: Larger responses come from more productive, larger and financially unconstrained firms. See detailed results in Appendix: Firm Heterogeneity.

Aggregate: Higher ETS Price, More Aggregate Export

Table 2: EU ETS Price Increases China's Aggregate Exports of Regulated Products to the EU

	(1)	(2)
DEP. VAR.	EU-ln(value)	EU-ln(value)
$\ln \mathrm{ETS\_Price}$	0.137***	0.146***
	(0.035)	(0.036)
Observations	30,404	31,091
R-squared	0.891	0.688
HS4-Destination FE	YES	NO
HS4 FE	NO	YES
Destination FE	NO	YES

Notes: The dependent variable is logarithmic term of export value in the HS4-destination-year level. The main independent variable is $\ln \mathrm{ETS\_Price}$. The coefficient is rough elasticity. Standard errors are shown in parentheses. Statistical significance is indicated as: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Back-of-the-Envelope Analysis

Based on transaction-level regressions, we construct counterfactual exports with different EU ETS price shocks and finally aggregate them to the macro level.

$$\widehat{\text{Exports}}_{icjt,\text{c}} = \text{Exports}_{icjt,\text{actual}} \cdot \exp\left\{\widehat{\beta_1} \cdot \left(\text{ETS\_Shock}_{it}^{\text{counter}} - \text{ETS\_Shock}_{it}^{\text{export}}\right)\right\},$$

- If we assume that there is no environmental regulation in EU market, then $\text{ETS\_Shock}_{i,t}^{\text{counter}} = 0$ uniformly for all firm i in year t.
- If we assume that the EU ETS price shock is not that severe, then

  $$\text{ETS\_Shock}_{it}^{\text{counter}} = \min_t \text{ETS\_Shock}_{it}^{\text{export}}$$

  for all firm i in year t.
- If we assume that the EU ETS price shock is quite severe, then

  $$\text{ETS\_Shock}_{it}^{\text{counter}} = \max_t \text{ETS\_Shock}_{it}^{\text{export}}$$

  for all firm i in year t.

Higher Price, Higher Exports

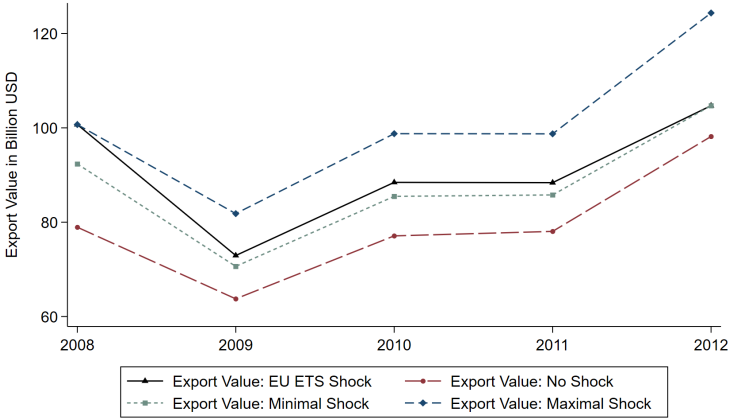


Figure 5: Export Value under different Shocks over Phase II

Higher Price, Higher Exports Ratio

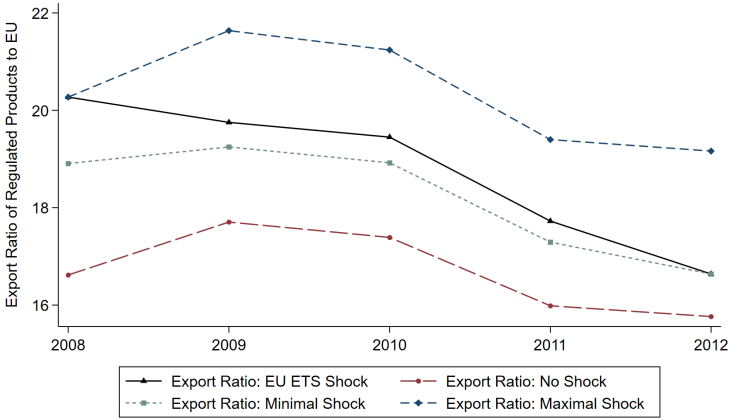
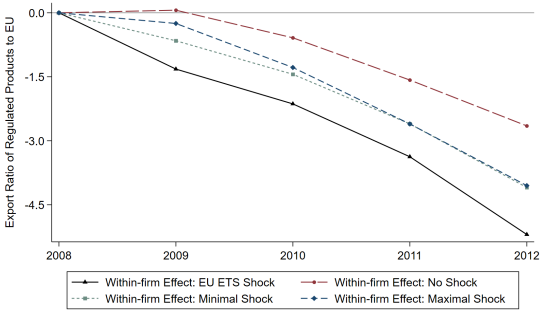
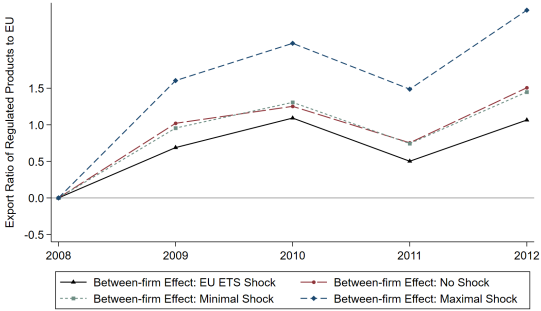


Figure 6: Export Ratio under different Shocks over Phase II

Quantitative assessment: Decomposition



(a) Within-firm Effect



(b) Between-firm Effect

Figure 7: Decomposition of Counterfactual results

Setting and Utility Function

Following Chaney (2008), we assume there are N potentially asymmetric countries that produce goods using both labor and "dirty" inputs such as fossil fuels, which emit CO_2 when burned.
Country n has a population L_n. Consumers in each country maximize utility derived from the consumption of goods from $H+1$ sectors. The utility function is shown as follows.

$$U \equiv q_0^{\mu_0} \prod_{h=1}^{H} \left(\int_{\Omega_h} q_h(\omega)^{(\sigma_h - 1)/\sigma_h} \right)^{[\sigma_h/(\sigma_h - 1)]\mu_h}, \tag{4}$$

where $\mu_0 + \sum_{h=1}^{H} \mu_h = 1$ and $\sigma_h > 1$.

Trade Barriers and Technology I

- **Numeraire:** Homogeneous good 0 is freely traded and produced with CRS: one unit of labor in country n yields w_n units. Normalize $p_0 = 1$; if a country produces good 0, then the wage equals w_n.
- **Differentiated sectors:** Produced with labor and "dirty" inputs. The carbon price in country n, t_n, is set by the carbon market and treated as exogenous.
- **Trade costs (per sector h):**
  - Variable iceberg cost τ_{ij}^h: shipping one unit from i to j delivers $1/\tau_{ij}^h$ units.
  - Fixed export cost f_{ij}^h: paid by a firm from i to serve j.
- **Unit cost:** increase in wage and carbon price: $c_i \equiv c(w_i, t_i)$.
- **Productivity:** Each firm draws unit labor productivity φ from Pareto distribution with shape $\gamma_h > \max\{\sigma_h - 1, 1\}$ over $[1, \infty)$:

$$\mathbb{P}(\tilde{\varphi}_h < \varphi) = G_h(\varphi) = 1 - \varphi^{-\gamma_h}.$$

Trade Barriers and Technology II

- **Total and marginal cost to sell q units in j:**

$$c_{ij}^h(q) = \frac{c_i\,\tau_{ij}^h}{\varphi}\,q + f_{ij}^h, \qquad \text{MC: } \frac{c_i\,\tau_{ij}^h}{\varphi}.$$

- **Optimal price:**

$$p_{ij}^h(\varphi) = \frac{\sigma_h}{\sigma_h - 1}\frac{c_i\,\tau_{ij}^h}{\varphi}.$$

- **Entry:** Following Chaney (2008), the mass of potential entrants in each differentiated sector in country n is proportional to $w_n L_n$ (larger/richer countries host more entrants).
- **Income/ownership:** Each worker owns w_n shares of a global fund that pools firms' profits and redistributes in the numeraire.

Equilibrium

Theorem 1

In general equilibrium, exports $x_{ij}(\varphi)$ from country i to country j by an individual firm with productivity φ, the productivity threshold $\bar{\varphi}_{ij}$ above which firms in i export to j, aggregate output Y_j, and dividends per share π are given as follows:

$$\begin{cases} x_{ij}(\varphi) & = \lambda_3 \times \left(\frac{Y_j}{Y}\right)^{(\sigma-1)/\gamma} \times \left(\frac{\theta_j}{c_i \tau_{ij}}\right)^{\sigma-1} \times \varphi^{\sigma-1} \times \mathbb{1}_{\{\varphi \geq \bar{\varphi}_{ij}\}}, \\ \bar{\varphi}_{ij} & = \lambda_4 \times \left(\frac{Y}{Y_j}\right)^{1/\gamma} \times \left(\frac{c_i \tau_{ij}}{\theta_j}\right) \times f_{ij}^{1/(\sigma-1)}, \\ Y_j & = (1+\pi) \times w_j L_j, \quad \text{and} \quad \pi = \frac{\sum_{h=1}^{H} \left(\frac{\sigma_h - 1}{\gamma_h}\right) \frac{\mu_h}{\sigma_h}}{1 - \sum_{h=1}^{H} \left(\frac{\sigma_h - 1}{\gamma_h}\right) \frac{\mu_h}{\sigma_h}}, \end{cases}$$

where $\lambda_3 = \sigma \lambda_4^{1-\sigma}$, $\lambda_4 = \left[\frac{\sigma}{\mu} \times \frac{\gamma}{\gamma-(\sigma-1)} \times \frac{1}{1+\pi}\right]^{1/\gamma}$ and $\theta_j^{-\gamma} = \sum_{k=1}^{N} \left(\frac{Y_k}{Y}\right) (c_k \tau_{kj})^{-\gamma} \times f_{kj}^{1-\gamma/(\sigma-1)}$.

Theorem 2: Higher ETS prices increase export values but leave export prices unchanged

Theorem 2

For a firm with productivity φ in home country i:

1. Its export price to country j is not related with the carbon price t_j:

$$\frac{\partial p_{ij}(\varphi)}{\partial t_j} = 0. \tag{5}$$

2. Its export value to country j is positively related with the carbon price t_j:

$$\frac{\partial x_{ij}(\varphi)}{\partial t_j} > 0. \tag{6}$$

In conjunction with the property outlined above, the incremental impact of the carbon price arises solely from the equilibrium price index, hence the term "Global Ripples".

Theorem 3: Firm heterogeneity shapes the magnitude of spillover effects

Theorem 3

For a firm with productivity φ in home country i, the responses vary significantly across productivity levels.

1. The positive relationship between its export value to country j and the carbon price t_j is stronger when its productivity φ increases:

$$\frac{\partial^2 x_{ij}(\varphi)}{\partial t_j \partial \varphi} > 0. \tag{7}$$

Main Takeaways

- Declines in EU ETS prices significantly reduce Chinese exports in volume and value, while average prices remain stable.
- ETS reshapes competition in the EU market and drives firms to adjust their export values and export ratio to the EU market.
- Larger responses come from more productive, larger and financially unconstrained firms, underscoring the role of liquidity and productivity.
- By aggregating the transaction results into macro level, within-firm adjustments dominate aggregate outcomes.
- Counterfactual: If ETS prices had stayed at the 2008 peak, total exports would be 11% higher. Decomposition results show that across the four cases, within-firm effects reduce export ratios by 2–5% despite positive between-firm effects, and price fluctuations—not levels—cause the most changes of within-firm effects.

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Robustness 1

Table 3: Robustness Check: Excluding Industries Existing Before Phase I of the EU ETS

DEP. VAR.	(1) Ln(value)	(2) Ln(price)	(3) Ln(quantity)
$\text{ETS\_Shock}^{\text{export}}$	0.020^{***}	-0.001	0.020^{***}
	(0.004)	(0.004)	(0.005)
Observations	170 798	170 197	170 197
R^2	0.335	0.656	0.515
Control variables	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
HS4–Year FE	Yes	Yes	Yes
Destination–Year FE	Yes	Yes	Yes

Notes: Robust standard errors are in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Robustness 2

Table 4: Robustness Check: Checking the Exogeneity of EU ETS Price

DEP. VAR.	EU ETS price					
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(value_Affected)	16.0201					
	(11.9159)					
L1.Ln(value_Affected)		10.9311				
		(14.5628)				
L2.Ln(value_Affected)			1.7412			
			(16.5847)			
Ln(value_Unaffected)				16.8492		
				(9.7325)		
L1.Ln(value_Unaffected)					12.6918	
					(8.7913)	
L2.Ln(value_Unaffected)						3.6766
						(7.6400)
Observations	36	35	34	36	35	34
R^2	0.8681	0.8398	0.8369	0.8618	0.8435	0.8378
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Dependent variable is EU ETS price measured in EUR. Robust standard errors are in parentheses. L1. and L2. denote the first and second lags, respectively.

Robustness 3

Table 5: Robustness Check: Using Euro-Denominated EU ETS Prices

DEP. VAR.	(1) Ln(value)	(2) Ln(price)	(3) Ln(quantity)
$\text{ETS\_Shock}^{\text{export}}$	0.037***	0.002	0.034***
	(0.006)	(0.004)	(0.007)
Observations	448 865	445 341	445 341
R^2	0.347	0.656	0.468
Control variables	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
HS4–Year FE	Yes	Yes	Yes
Destination–Year FE	Yes	Yes	Yes

Notes: Robust standard errors are in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Robustness 4

Table 6: Robustness Check: Accounting for the Impact of Global Financial Crisis

DEP. VAR.	(1) Ln(value)	(2) Ln(price)	(3) Ln(quantity)	(4) Ln(value)	(5) Ln(price)	(6) Ln(quantity)
$\text{ETS\_Shock}^{\text{export}}$	0.010***	-0.003	0.013***	0.013***	0.002	0.010**
	(0.004)	(0.002)	(0.004)	(0.004)	(0.002)	(0.004)
Crisis Dummy $\times$ $\text{ETS\_Shock}^{\text{export}}$	0.007***	0.004**	0.004			
	(0.002)	(0.001)	(0.002)			
US Exporter Dummy $\times$ $\text{ETS\_Shock}^{\text{export}}$				0.013***	-0.000	0.014***
				(0.005)	(0.003)	(0.005)
Observations	552 019	548 471	548 471	552 019	548 471	548 471
R^2	0.354	0.677	0.497	0.354	0.677	0.497
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
HS4–Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination–Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors are in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Robustness 5

Table 7: Robustness Check: Reclassifying Products at the HS 2-Digit Level

DEP. VAR.	(1) Ln(value)	(2) Ln(price)	(3) Ln(quantity)
$\text{ETS\_Shock}^{\text{export}}$	0.025***	0.001	0.023***
	(0.003)	(0.002)	(0.003)
Observations	363 573	362 110	362 110
R^2	0.393	0.664	0.498
Control variables	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
HS4–Year FE	Yes	Yes	Yes
Destination–Year FE	Yes	Yes	Yes

Notes: Robust standard errors are in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Firm Heterogeneity

Table 8: Which Types of Firms Are More Susceptible to the Spillover Effect?

DEP. VAR. Ln(value)	(1)	(2) Constraint_Dummy (cash ratio)	(3)	(4) Ln(TFP_acf)	(5)	(6) Size_Dummy (income)
$\text{ETS\_Shock}^{\text{export}}$	0.025***	0.025***	0.016***	0.016***	0.026***	0.026***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)
Constraint_Dummy $\times$ $\text{ETS\_Shock}^{\text{export}}$	-0.010**	-0.011**				
	(0.005)	(0.005)				
Ln(TFP_acf) $\times$ $\text{ETS\_Shock}^{\text{export}}$			0.005***	0.005***		
			(0.002)	(0.002)		
Size_Dummy $\times$ $\text{ETS\_Shock}^{\text{export}}$					-0.008*	-0.009*
					(0.005)	(0.005)
Observations	559 619	554 361	559 619	554 361	559 619	554 361
R^2	0.356	0.387	0.356	0.387	0.356	0.387
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
HS4–Year FE	Yes	No	Yes	No	Yes	No
Destination–Year FE	Yes	No	Yes	No	Yes	No
HS4–Destination–Year FE	No	Yes	No	Yes	No	Yes

Notes: Sample at the firm–HS4–destination-year level. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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