Returns to Scale, Productivity, and Markup: Revisit the Export Premium

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Motivation

The productivity effect of export has been the foundation for many trade policies.

- Widely documented in theory and case studies.
  (Rhee et al., 1984; Clerides et al., 1998; Holmes and Schmitz, 2001; Melitz, 2003...)

However, a puzzle:

- Empirical research detected mixed/limited productivity effect of export using revenue data (TFPR).
  (Bernard and Jensen, 1999; Keller, 2004; Greenaway and Kneller, 2007)

A common belief: revenue productivity (TFPR) captures all possible efficiency gains.

- Hence the above empirical research implies that export has no efficiency gains.
- This has policy implications.

$\Rightarrow$ This belief may be wrong!

Motivation

Recent study of Garcia-Marin and Voigtländer (2019, JPE) :

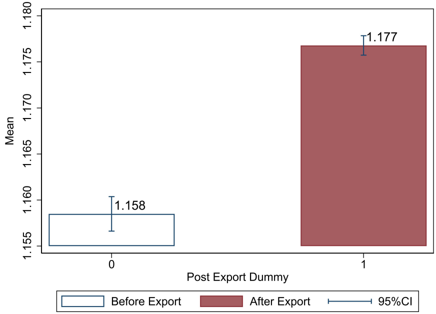
- After export, the increase in productivity and reduction in output prices offset each other in the TFPR. ($TFPR = TFPQ + p_{jt}$)
- One key result: with CRS assumption, TFPR increases iff markup increases. $\Delta \text{TFPR} = \Delta p + \Delta TFPQ = \Delta \ln \mu + \underbrace{\Delta mc + \Delta TFPQ}_{=0 \textit{ in CRS}}$.
- Confirmed in Chilean and Colombian firms.

We show that Garcia-Marin and Voigtländer (2019, JPE) is not the whole story. Returns to scale (RTS) play an important role.

Motivation: Export increases Markup (Fact 1)

Raw Markup: $\tilde{\mu}_{jt} \equiv \frac{Revenue_{jt}}{TVC_{jt}}$ [1]

Figure 1: Raw markup comparison before&after export for Chinese exporters



- Significant increase of markup, but still limited export effects on TFPR. Why?

What is missing in Garcia-Marin etc. (2019)?

[1] $\mu_{jt} = \tilde{\mu}_{jt} * (\alpha_L + \alpha_M)$, which is highly consistent with De Loecker (2011) with constant output elasticities.

Motivation: Export reduces Prices (Fact 2)

$$AveragePrice_{jt} = \beta_0^P + \beta_{exp}^P D_{jt}^{exp} + \beta^X \mathbf{X}_{jt} + \gamma_j + \gamma_t + \xi_{jt}^P, \quad (1)$$

Table 1: Output Price Changes after Export

Parameter	(1) P_{jt}	(2) $\ln(P_{jt})$	(3) P_{jt}	(4) $\ln(P_{jt})$
D_{jt}^{exp}	-7.063**	0.010	-8.985***	-0.033***
	(2.8332)	(0.0100)	(2.8299)	(0.0100)
Firm Size (Sales)			YES	YES
Capital Intensity			YES	YES
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Adjusted R^2	0.762	0.919	0.762	0.921
Observations	88,487	88,487	88,487	88,487

Note: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$

Single-Product

Implications: $P_{jt} \downarrow + \mu_{jt} \uparrow \Rightarrow MC_{jt} \downarrow$ (export efficiency gain in production).

Research Questions

1. Are there any production efficiency gains (and beyond) from export? Sources?
2. Why does the literature (TFPR) fail to capture these gains?
3. Role of (flexible) returns to scale?

What we do:

- **A new method**: to estimate productivity, markup, and returns to scale jointly using revenue and inputs expenditure.
  - Inherit the key insight of De Leocker and Warzynski (2012).
  - But use the cost share-markup relationship in the production estimation.
- **Revisit the gains from export; and its policy implications.**

Key Insight: Returns to Scale and TFPR

Why may TFPR fail to capture the export premium?

The change of TFPR can be written as:

$$\begin{aligned}\Delta \text{TFPR} &= \Delta p + \Delta\omega = \Delta \ln \mu + \Delta mc + \Delta\omega \\ &= \Delta \ln \mu + \underbrace{\frac{1-(\alpha_L+\alpha_M)}{\alpha_L+\alpha_M}\Delta y - \frac{1}{\alpha_L+\alpha_M}\Delta\omega}_{\Delta mc} + \Delta\omega \\ &= \Delta \ln \mu + \left(1 - \frac{1}{\alpha_L+\alpha_M}\right)(\Delta\omega - \Delta y). \qquad (2)\end{aligned}$$

Implications: RTS matters.

- Garcia-Marin etc. (2019): CRS, $\Delta\text{TFPR} = \Delta \ln \mu$.
- IRS ($\alpha_L + \alpha_M > 1$): $\omega \uparrow \Rightarrow$ TFPR $\uparrow$, conditional on output level.
  - With IRS, the $\uparrow$ of productivity is not fully offset by the $\downarrow$ in MC.
- IRS: export $\Rightarrow \triangle y \uparrow \Rightarrow$ TFPR $\downarrow$.
  - Marginal cost decreases when producing more.

The question: Is technology IRS?

Main Findings

1. Detect increasing returns to scale.
   - **RTS** are around 1.1, indicating the IRS after recognizing heterogeneity in markup. Opposite to the DRS as shown in traditional methods that ignore markup.
2. Export increases productivity and markup.
   - **Productivity**: Export increases exporter productivity by 1.5%, but the effect is negligible when using TFPR.
   - **Demand & Markup**: Export increases the demand by 19.4% and markup by 1%.
3. Large production efficiency gains from export.
   - Export reduces production MC by 2.7%.
   - A half is contributed by the IRS. The other half is due to improved productivity.

$\Longrightarrow$ Improved exporter profits and consumer welfare.

- Higher markup and improved efficiency $\Rightarrow$ exporter profits $\uparrow$ **25%**.
- Improved efficiency allows firms to charge a higher markup at a lower price $\Rightarrow$ consumers prices $\downarrow$**1.7%**.

Literature and Contributions

1. Gains from export.
    - **Export premium**: Garcia-Marin and Voigtländer (2019), De Loecker (2013) (focussing on exporting effect on productivity), De Loecker et al. (2016) (with quantity data), Brandt et al. (2017), Li et al. (2017)...
    - Large gains in marginal costs and markup: Role of IRS.

2. A new method to estimate the markup and productivity, using revenue data (together with variable costs).
    - **Production function estimation**: Klette and Griliches (1996), Olley and Pakes(1996), Levinsohn and Petrin (2003), Ackerberg et al. (2015), Diewert and Fox (2008)...
    - **Markup estimation**: De Loecker (2011), De Loecker and Warzynski (2012), Bond et al. (2021)...

3. New growth and trade theories: firm-level IRS.
    - **Increasing returns to scale**: Romer (1986), Krugman (1980, 1995), Basu and Fernald (1997)...

The Model

Model

- **Cobb-Douglas Production Function:**

$$y_{jt} = \alpha_L l_{jt} + \alpha_M m_{jt} + \alpha_K k_{jt} + \omega_{jt} + \xi_{jt} \tag{3}$$

- **Productivity Evolution Process:**

$$\omega_{jt} = \beta_0^{\omega} + \beta_1^{\omega}\omega_{jt-1} + \beta_{exp}^{\omega} D_{jt}^{exp} + \epsilon_{jt}^{\omega} \tag{4}$$

  - D_{jt}^{exp} is dummy variable indicating whether a firm is an exporter or not.

Model

- **Demand Function**:

$$y_{jt} = \eta_{jt}(p_{jt} - \bar{p}_{Jt}) + \varphi_{jt} \quad (5)$$

  - η_{jt} is the demand elasticity. φ_{jt} is the demand shifter. Following Klette and Griliches (1996), $\varphi_{jt} = \bar{y}_{Jt} + \beta^D_{exp} D^{exp}_{jt} + (1 + \eta_{jt})\,\epsilon_{jt}$. Export may $\uparrow$ demand.
  - ϵ_{jt} is an i.i.d demand shock.

- **Markup** is defined as $\mu_{jt} \equiv \eta_{jt}/(\eta_{jt} + 1)$, and the revenue $r_{jt} = p_{jt} + y_{jt}$. **Revenue Production Function** becomes:

$$r_{jt} = \underbrace{\frac{\alpha_L}{\mu_{jt}} l_{jt} + \frac{\alpha_M}{\mu_{jt}} m_{jt} + \frac{\alpha_K}{\mu_{jt}} k_{jt}}_{\textit{Biased output elasticity}} + \underbrace{\frac{1}{\mu_{jt}} \omega_{jt} + (1 - \frac{1}{\mu_{jt}})\varphi_{jt}}_{\omega_{jt}^{revenue}} + \underbrace{\frac{1}{\mu_{jt}}(\xi_{jt} + \epsilon_{jt})}_{\textit{Endogeneity}} \quad (6)$$

- Consequences of ignoring μ_{jt}:
  1. Understate RTS if markup > 1 (Klette and Griliches, 1996).
  2. Bias the effect of export&other policies if ω_{jt}&μ_{jt} both changed ($\mu_{jt} \uparrow$ by export).
  3. $\frac{1}{\mu_{jt}}\xi_{jt}$: Hard to find IV to solve the endogeneity problem.

A Method to Control for Markup

- **Cost Minimization:**

$$\mathcal{L} = P^L_{jt} L_{jt} + P^M_{jt} M_{jt} + \lambda_{jt} \left(Y_{jt} - e^{(\omega_{jt} + \xi_{jt})} L_{jt}^{\alpha_L} M_{jt}^{\alpha_M} K_{jt}^{\alpha_K} \right) \tag{7}$$

- **Markup.** Sum up the FOCs w.r.t. L_{jt} and M_{jt}, the markup:

$$\begin{aligned} \mu_{jt} \equiv \frac{P_{jt}}{\lambda_{jt}} &= (\alpha_L + \alpha_M) \cdot \frac{R_{jt}}{P^L_{jt} L_{jt} + P^M_{jt} M_{jt}} \\ &= (\alpha_L + \alpha_M) \cdot \tilde{\mu}_{jt} \end{aligned} \tag{8}$$

$(\alpha_L + \alpha_M)$ is the RTS of variable inputs (RTSV), $\tilde{\mu}_{jt}$ is the raw markup.

- **Our new method:**
  - Same spirit of De Loecker and Warzynski (2012) in using (8).
  - But instead of estimating RTS first and use (8) to calculate markup in DLW (2012), $\Rightarrow$ we use (8) to control for unobserved markup in revenue function and estimate output elasticities consistently using revenue data.

Estimation Equation

Using (8) to replace unobserved markup in the revenue function (6), we get

- **The estimation equation**:

$$\begin{aligned} \tilde{\mu}_{jt} \cdot (r_{jt} - \bar{r}_{Jt}) = & \frac{\alpha_L}{(\alpha_L + \alpha_M)} l_{jt} + \frac{\alpha_M}{(\alpha_L + \alpha_M)} m_{jt} + \frac{\alpha_K}{(\alpha_L + \alpha_M)} k_{jt} \\ & + \frac{1}{(\alpha_L + \alpha_M)} \omega_{jt} - \frac{1}{(\alpha_L + \alpha_M)} \bar{y}_{Jt} + \beta^D_{exp} \tilde{\mu}_{jt} D^{exp}_{jt} \\ & - \frac{\beta^D_{exp}}{(\alpha_L + \alpha_M)} D^{exp}_{jt} + \frac{1}{(\alpha_L + \alpha_M)} (\xi_{jt} + \epsilon_{jt}) \end{aligned} \quad (9)$$

Notes:

- Identification: $l_{jt}, m_{jt}, k_{jt}, \tilde{\mu}_{jt} D^{exp}_{jt}, D^{exp}_{jt}$, and $\bar{y}_{Jt}$ (in the spirit of K&G, 1996).
- K&G (1996) realized the impact of (constant) markup on estimates of output elasticity.
- **Our contribution**:
  1. Extend K&G (1996) to allow for variable markup.
  2. Combine insight of De Leocker and Warzynski (2012) to estimate productivity, output elasticities, and markup consistently using revenue data.

Two-step Estimation Procedures

Following Levinsohn and Petrin (2003), we use $m_{jt} = m(k_{jt}, \omega_{jt})$ as a control function to recover $\omega_{jt} = m^{-1}(m_{jt}, k_{jt})$.

- **The first step**:

$$\tilde{\mu}_{jt}(r_{jt} - \bar{r}_{Jt}) = \frac{\alpha_L}{(\alpha_L + \alpha_M)} l_{jt} + \phi_{jt}(m_{jt}, k_{jt}, \bar{y}_{Jt}, D_{jt}^{exp}, \tilde{\mu}_{jt} D_{jt}^{exp}) + \frac{1}{(\alpha_L + \alpha_M)}(\xi_{jt} + \epsilon_{jt}) \tag{10}$$

  - $\phi_{jt}(m_{jt}, k_{jt}, \bar{y}_{Jt}, D_{jt}^{exp}, \tilde{\mu}_{jt} D_{jt}^{exp})$ is a non-parametric function, and we use a cubic polynomial as an approximation of it.

- **The second step**: express the ϵ_{jt}^{ω} as a function of parameters to be estimated $\epsilon_{jt}(\alpha_M, \alpha_K, \beta_{exp}^{D})$ and adopt GMM with moment conditions as follows:

$$E\left(\epsilon_{jt}(\alpha_L, \alpha_M, \beta_{exp}^{D}) \begin{pmatrix} m_{jt-1} \\ k_{jt} \\ \tilde{\mu}_{jt-1} D_{jt-1}^{exp} \end{pmatrix}\right) = 0 \tag{11}$$

Empirical Analysis

Data

Matched data from two datasets :

- **Annual Survey of Industrial Enterprises (ASIE)**: All SOEs + non-SOEs with 5 million(+) RMB Sales. (1998-2007)
- **China's General Administration of Customs (GAC)**: 2000-2006

Productivity Effects and RTS

Table 2: Estimation Results

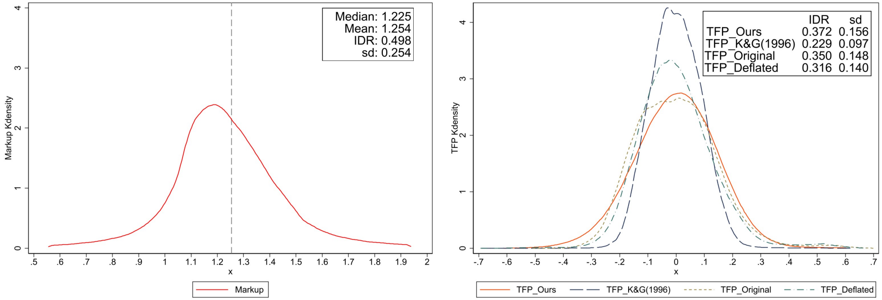
Parameter	Ours	K&G(1996)	Original	Deflated
β^{ω}_{exp} (Productivity Effect)	0.015	0.002	0.002	0.003
	(0.0005)	(0.0005)	(0.0002)	(0.0003)
β^{D}_{exp} (Demand Effect)	0.194	0.028	0.019	0.015
	(0.0064)	(0.0015)	(0.0009)	(0.0011)
α_L	0.081	0.057	0.041	0.042
	(0.0008)	(0.0007)	(0.0004)	(0.0004)
α_M	0.980	0.926	0.910	0.917
	(0.0051)	(0.0053)	(0.0042)	(0.0066)
α_K	0.032	0.024	0.015	0.018
	(0.0006)	(0.0032)	(0.0015)	(0.0020)
S (RTS)	1.093	1.007	0.965	0.976
	(0.0052)	(0.0017)	(0.0028)	(0.0045)
S^V (RTSV)	1.061	0.983	0.951	0.959
	(0.0056)	(0.0048)	(0.0041)	(0.0065)
Observations	1,234,292	1,234,292	1,234,292	1,234,292

Note: Standard errors (clustered at the firm level) in parentheses.

- **Productivity Effect**: $\uparrow$ 1.5%, but much smaller in traditional methods.
- **Demand**: demand factor $\uparrow$ 19.4%, much smaller in traditional methods.
- **IRS**: *Consistent with De Loecker et al. (2016): 68% obs are IRS; Also in Diewert&Fox(2008) Export$\Rightarrow$ $\uparrow$Sales $\Rightarrow$ $\downarrow$ Marginal Cost (not in DRS case).

Distribution of Estimated Markup and Productivity

Figure 2: Markup and productivity dispersion (LP)



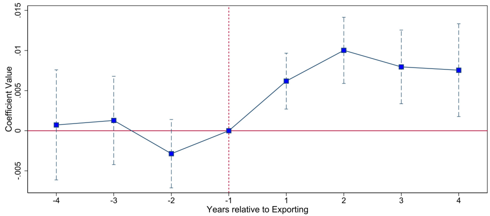
Markup (IDR=0.498) is more dispersed than productivity (IDR=0.372).

Export Effects on Markup: Average VS Dynamic

$$\mu_{jt} = \beta_0^{\mu} + \beta_{exp}^{\mu} D_{jt}^{exp} + \beta^X \mathbf{X}_{jt} + \gamma_j + \gamma_t + \xi_{jt}^{\mu} \quad (12)$$

	(1) Markup	(2) Markup
D_{jt}^{exp}	0.008***	0.010***
	(0.0015)	(0.0015)
Firm Size (L)		YES
Capital Intensity		YES
Firm FE	YES	YES
Year FE	YES	YES
Observations	1,234,292	1,234,292
Adjusted R^2	0.326	0.326

Note: Standard errors (clustered at the firm level) in parentheses.



Validation with the Quantity Data

We validate our methods by:

- Product Output quantity Survey (quantity survey): smaller sample

With the following adjustments:

- **Sample:** Keep only single-product firms:
  118,671 firms (321,280 obs), among which 19,838 firms (16.72%) are exporters.

- **One concern:** input quality and output quality may be positively correlated as in De Loecker et al. (2016), which affect input and output prices.
  $\Rightarrow$ Use output quality data adjust the output quality but not input quality: bias down output elasticity. Bias

- **Solution:** use the input-output price/quality correlation to control for input quality/price differences.
  - Specifically, construct the firm-level input deflator by output price, industry output price index & industry input price index: $P_{Mjt} = \frac{P_{Mt}}{P_t} P_{jt}$.
  - Plan to use De Loecker et al. (2016) method to further control for market share.

Validation with the Quantity Data

Table 3: Results from Quantity Output Estimation & Revenue Output Estimation Methods

	Quantity Output	Revenue Output		
Parameter		Ours	K&G(1996)	Deflated
β^{ω}_{exp} (Productivity Effect)	0.005	0.006	0.002	0.001
	(0.0006)	(0.0004)	(0.0008)	(0.0003)
β^{D}_{exp} (Demand Effect)		0.183	0.029	0.025
		(0.0097)	(0.0046)	(0.0017)
α_L	0.019	0.052	0.038	0.023
	(0.0006)	(0.0008)	(0.0010)	(0.0006)
α_M	1.003	0.963	0.984	0.974
	(0.0005)	(0.0011)	(0.0012)	(0.0004)
α_K	0.057	0.020	0.015	0.001
	(0.0188)	(0.0010)	(0.0043)	(0.0008)
S (RTS)	1.079	1.035	1.038	0.998
	(0.0190)	(0.0013)	(0.0039)	(0.0009)
S^V (RTSV)	1.021	1.015	1.023	0.997
	(0.0008)	(0.0012)	(0.0009)	(0.0007)
Observations	321,280	321,280	321,280	321,280

Note 1: Here we only keep the single-product firms (with quantity information) in the sample.

Note 2: Standard errors (clustered at the firm level) in parentheses.

*Similar to our main results. *Consistent with De Loecker et al. (2016): 68% obs are IRS, using quantity.

Robustness Check

Results are robust to:

1. More flexible production function (output elasticity): Translog. Translog
2. Industry-by-industry analysis. Industry-by-Industry
3. Alternative estimation approach: ACF. ACF
4. Export IV. Lagged Export Status

Questions we are interested in...

Summary: Our analysis so far shows that export...

- Reduces marginal costs: increases in productivity; IRS when producing more.
- Increases markup.

We are interested in the following questions:

1. How does export affect firm profitability? By how much?
2. How does export affect consumer welfare (as measured by changes in product prices)?

Back-of-Envelop Calculation

By cost minimization, **marginal cost** can be expressed as:

$$mc_{jt} = \frac{1-(\alpha_L+\alpha_M)}{\alpha_L+\alpha_M} y_{jt} - \frac{1}{\alpha_L+\alpha_M}\omega_{jt} + \frac{\alpha_M}{\alpha_L+\alpha_M} p_{jt}^M + \frac{\alpha_L}{\alpha_L+\alpha_M} p_{jt}^L - \frac{\alpha_M}{\alpha_L+\alpha_M}\ln(\alpha_M) - \frac{\alpha_L}{\alpha_L+\alpha_M}\ln(\alpha_L) - \frac{\alpha_K}{\alpha_L+\alpha_M} k_{jt} - \frac{1}{\alpha_L+\alpha_M}\xi_{jt} \quad (13)$$

The marginal cost change caused by export can be expressed as:

$$\Delta mc^{exp} = \frac{1-(\alpha_L+\alpha_M)}{\alpha_L+\alpha_M}\Delta y^{exp} - \frac{1}{\alpha_L+\alpha_M}\beta_{exp}^{\omega}, \quad (14)$$

$$\Delta \ln \mu^{exp} = \Delta p^{exp} - \Delta mc^{exp}, \quad (15)$$

$$\Delta r^{exp} = \Delta p^{exp} + \Delta y^{exp}. \quad (16)$$

Combing (14)-(16) yields the solution for Δp^{exp}, Δy^{exp} and Δmc^{exp} as the functions of observed estimates ($\Delta \ln \mu^{exp}$, Δr^{exp}, β_{exp}^{ω}) as follows:

$$\Delta y^{exp} = (\alpha_L+\alpha_M)\left[\Delta r^{exp} - \Delta \ln(\mu)^{exp}\right] + \beta_{exp}^{\omega} \quad (17)$$

$$\Delta p^{exp} = \left[1-(\alpha_L+\alpha_M)\right]\Delta r^{exp} + (\alpha_L+\alpha_M)\Delta \ln(\mu)^{exp} - \beta_{exp}^{\omega} \quad (18)$$

$$\Delta mc^{exp} = \left[1-(\alpha_L+\alpha_M)\right]\left[\Delta r^{exp} - \Delta \ln(\mu)^{exp}\right] - \beta_{exp}^{\omega} \quad (19)$$

Gains From Export

- **Consumers Gain**:

Table 4: Export Effects on Output Prices

$\Delta mc_{jt} \downarrow 2.68\%$			
IRS	$\Delta\omega^{exp}$	$\Delta\mu^{exp}$	Price
$\downarrow 1.302\%$	$\downarrow 1.381\%$	$\uparrow 1\%$	$\downarrow 1.683\%$

- **Exporters profits**: $\Pi_{jt} = R_{jt} - (P^L_{jt} L_{jt} + P^M_{jt} M_{jt}) = R_{jt}(\tilde{\mu}_{jt} - 1)/\tilde{\mu}_{jt}$

$$\Delta\pi^{exp} \simeq \Delta y^{exp} + \Delta p^{exp} + \frac{1}{\tilde{\mu}^{exp=0}\left(\tilde{\mu}^{exp=0} - 1\right)} \Delta\tilde{\mu}^{exp} \tag{20}$$

- **Gains from Export**:

Table 5: Gains from Export

	(1) Exporter Profits	(2) Consumers Welfare
Gains from Exporting	25.322%	1.683%

Conclusion

- **A new method**: to estimate productivity, markup, and returns to scale jointly and consistently using revenue and inputs expenditure.

- **Returns to scale**: detected IRS after controlling for unobserved markup heterogeneity. IRS helps exporters lower marginal costs when exporting.

- **Export premium**:
  - Export improves production efficiency (MC $\downarrow$ 2.68%): half due to productivity, the other due to IRS.
  - Export increases markup by 1%.
  - TFPR fails to capture these gains $\Rightarrow$ TFPR bad measure of export premium.

- **Firms and consumers**:
  - Firm profits increase by 25%: due to increased efficiency and markup.
  - Consumers pay lower prices by 1.68%: improved efficiency allows firms to charge a lower price at higher markup.

Appendix

Extension: Translog-Form Production Function

- Limitation of CD: output elasticities are constant.
- More flexible Translog production function,

$$\begin{aligned} y_{jt} =& \alpha_L l_{jt} + \alpha_M m_{jt} + \alpha_K k_{jt} + \alpha_{LL} l_{jt} l_{jt} + \alpha_{MM} m_{jt} m_{jt} + \alpha_{KK} k_{jt} k_{jt} \\ &+ \alpha_{LM} l_{jt} m_{jt} + \alpha_{LK} l_{jt} k_{jt} + \alpha_{MK} m_{jt} k_{jt} + (\omega_{jt} + \xi_{jt}) \,. \end{aligned} \tag{21}$$

The key relationship still holds

$$\mu_{jt} = (\alpha_L^* + \alpha_M^*) \cdot \frac{R_{jt}}{P_{jt}^L L_{jt} + P_{jt}^M M_{jt}} = (\alpha_L^* + \alpha_M^*) \cdot \tilde{\mu}_{jt}. \tag{22}$$

- The output elasticities are variable:

$$\alpha_L^* \equiv \alpha_L + 2\alpha_{LL} l_{jt} + \alpha_{LM} m_{jt} + \alpha_{LK} k_{jt} \tag{23}$$

$$\alpha_M^* \equiv \alpha_M + 2\alpha_{MM} m_{jt} + \alpha_{LM} l_{jt} + \alpha_{MK} k_{jt} \tag{24}$$

$$\alpha_K^* \equiv \alpha_K + 2\alpha_{KK} k_{jt} + \alpha_{LK} l_{jt} + \alpha_{MK} m_{jt} \tag{25}$$

Function to be Estimated (Translog-form)

Translog-form Function to be Estimated: After substituting the expression of markup into the above equation, we can derive the translog-form function to be estimated:

$$\begin{aligned}\tilde{\mu}_{jt}\cdot(r_{jt}-\bar{r}_{Jt}) &= \frac{\alpha_L}{(\alpha_L^*+\alpha_M^*)}l_{jt}+\frac{\alpha_M}{(\alpha_L^*+\alpha_M^*)}m_{jt}+\frac{\alpha_K}{(\alpha_L^*+\alpha_M^*)}k_{jt}+\frac{\alpha_{LL}}{(\alpha_L^*+\alpha_M^*)}l_{jt}l_{jt}\\ &+\frac{\alpha_{MM}}{(\alpha_L^*+\alpha_M^*)}m_{jt}m_{jt}+\frac{\alpha_{KK}}{(\alpha_L^*+\alpha_M^*)}k_{jt}k_{jt}+\frac{\alpha_{LM}}{(\alpha_L^*+\alpha_M^*)}l_{jt}m_{jt}+\frac{\alpha_{LK}}{(\alpha_L^*+\alpha_M^*)}l_{jt}k_{jt}\\ &+\frac{\alpha_{MK}}{(\alpha_L^*+\alpha_M^*)}m_{jt}k_{jt}+\frac{1}{(\alpha_L^*+\alpha_M^*)}\omega_{jt}-\frac{1}{(\alpha_L^*+\alpha_M^*)}\bar{y}_{Jt}\\ &+\tilde{\mu}_{jt}\beta^D_{exp}D^{Exp}_{jt}-\frac{1}{(\alpha_L^*+\alpha_M^*)}\beta^D_{exp}D^{Exp}_{jt}+\frac{1}{(\alpha_L^*+\alpha_M^*)}(\xi_{jt}+\epsilon_{jt}) \qquad (26)\end{aligned}$$

Note: In the case of the Translog-form production function, since we cannot separate the error term ξ_{jt} and the RTSV, i.e., $(\alpha_L^*+\alpha_M^*)$, where the l_{jt}, m_{jt}, and k_{jt} are all contained, the OLS method is no longer suitable for estimating ξ_{jt} as in the Cobb-Douglas case.

The above two-stage procedure still hold. Model can be estimated via GMM.

Estimation (Translog) - First Step

First Step: We rearrange equation (26) to express ξ_{jt} and proxy it by a function as $\xi_{jt} = \bar{y}_{Jt} - \Phi_{jt}\left(\tilde{\mu}_{jt}\left(r_{jt} - \bar{r}_{Jt}\right), l_{jt}, m_{jt}, k_{jt}, \tilde{\mu}_{jt} D_{jt}^{exp}\right)$ where Φ_{jt} a cubic polynomial of $\tilde{\mu}_{jt}\left(r_{jt} - \bar{r}_{Jt}\right), l_{jt}, m_{jt}, k_{jt}$, and $\tilde{\mu}_{jt} D_{jt}^{exp}$. Then, since ξ_{jt} is assumed to be the measurement error and is i.i.d across firms and years, the following moment conditions should be satisfied:

$$E\left(\xi_{jt}\left(\breve{\beta}\right)\left(\begin{array}{c} \left(\tilde{\mu}_{jt-1}\left(r_{jt-1} - \bar{r}_{Jt-1}\right)\right)^{a} l_{jt}^{b} m_{jt}^{c} k_{jt}^{d}\left(\tilde{\mu}_{jt} D_{jt}^{Exp}\right)^{e} \\ D_{jt}^{Exp} \end{array}\right)\right) = 0 \quad (27)$$

where $\quad a + b + c + d + e \in \{0, 1, 2\}$

By making use of the above moment conditions, we can derive the estimated value of the error term by GMM, which is denoted by $\hat{\xi}_{jt}$.

Estimation (Translog) - Second Step

Second Step: Make use of equation (4) to express the ϵ^{ω}_{jt} (the current innovation shock on firm j's productivity) as a function of α_L, α_M, α_K, α_{LL}, α_{MM}, α_{KK}, α_{LM}, α_{LK}, α_{MK}, and β^D_{exp}. Then, we can conduct the second-step GMM estimation based on the moment conditions:

$$E\left(\epsilon_{jt}(\alpha_L,\alpha_M,\alpha_K,\alpha_{LL},\alpha_{MM},\alpha_{KK},\alpha_{LM},\alpha_{LK},\alpha_{MK},\beta^D_{Exp})\begin{pmatrix} l_{jt-1} \\ m_{jt-1} \\ k_{jt} \\ l_{jt-1}l_{jt-1} \\ m_{jt-1}m_{jt-1} \\ k_{jt}k_{jt} \\ l_{jt-1}m_{jt-1} \\ l_{jt-1}k_{jt} \\ m_{jt-1}k_{jt} \\ \tilde{\mu}_{jt-1}D^{Exp}_{jt-1} \\ D^{Exp}_{jt-1} \end{pmatrix}\right) = 0 \tag{28}$$

Single-Product Firms' Price Change

Robustness: Price Change
As a robustness check for the firms' price change, we here look at the single-product firms' price change after export.

Table 6: Single Product Firms' Price Change

	(1)	(2)	(3)	(4)
Parameter	P_{jt}	$\ln(P_{jt})$	P_{jt}	$\ln(P_{jt})$
D_{jt}^{exp}	-8.335	0.015	-12.449*	-0.037***
	(6.9451)	(0.0104)	(6.9448)	(0.0103)
Firm Size (Sales)			YES	YES
Capital Intensity			YES	YES
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Adjusted R^2	0.715	0.935	0.715	0.937
Observations	69,367	69,367	69,367	69,367

Note: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$

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Revenue/Quantity Outputs & Deflated Input Correlations

Table 7: Correlations b/w Revenue/Quantity Outputs & Industry-level-Deflated E^M

	y_{jt}	r_{jt}
m_{jt}	0.305	0.977
	(0.0000)	(0.0000)

Note: *P*-values in parentheses.

$$y_{jt} + \chi_{jt}^{Output} = \alpha_L l_{jt} + \alpha_M \left(m_{jt} + \chi_{jt}^{Input} \right) + \alpha_K k_{jt} + \omega_{jt} + \xi_{jt}, \quad (29)$$

Estimate:

$$y_{jt} = \alpha_L l_{jt} + \alpha_M \left(m_{jt} + \chi_{jt}^{Input} \right) + \alpha_K k_{jt} + \omega_{jt} + (\xi_{jt} - \chi_{jt}^{Output}), \quad (30)$$

Result: under bias α_M because $(\chi_{jt}^{Input}, \xi_{jt} - \chi_{jt}^{Output}) < 0$.

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ACF(2015) Method

Robustness: Method of Ackerberg et al. (2015).

Table 8: Robustness Check (ACF)

Parameter	Ours	K&G(1996)	Original	Deflated
S (RTS)	1.090	1.057	0.961	0.963
	(0.0054)	(0.0098)	(0.0050)	(0.00199)
β^{ω}_{exp}	0.014	-0.004	0.002	0.003
	(0.0005)	(0.0020)	(0.0003)	(0.0009)
β^{D}_{exp}	0.212	0.035	0.022	0.020
	(0.0065)	(0.0060)	(0.0011)	(0.0027)
β^{μ}_{exp}	0.010			
	(0.0015)			
p	$\downarrow$ 1.561%			
π	$\uparrow$ 25.340%			
Observations	1,234,292	1,234,292	1,234,292	1,234,292

Note: Standard errors (clustered at the firm level) in parentheses.

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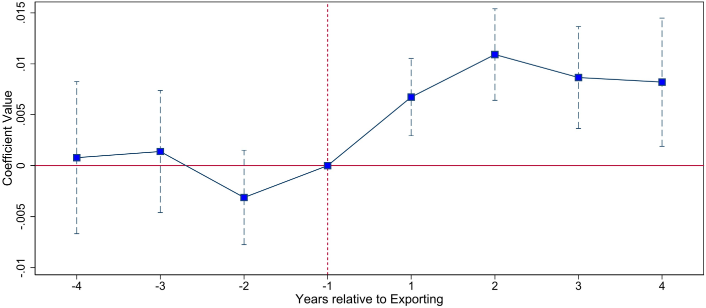
ACF - Dynamic Export Effects on Markup

- **Dynamic Export Effects on Markup**

Figure 3: Dynamic Export Effects on Markup (ACF)



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Note: From equation (8), we know that in the LP case, $\hat{\mu}_{jt}^{LP} = (\hat{\alpha}_L^{LP} + \hat{\alpha}_L^{LP})\tilde{\mu}_{jt}$, and in the ACF case, $\hat{\mu}_{jt}^{ACF} = (\hat{\alpha}_L^{ACF} + \hat{\alpha}_L^{ACF})\tilde{\mu}_{jt}$. Since $(\hat{\alpha}_L^{ACF} + \hat{\alpha}_L^{ACF})$ is very close to $(\hat{\alpha}_L^{LP} + \hat{\alpha}_L^{LP})$, the two dynamic effects are similar.

Translog Form - Estimation Results

Table 9: Robustness Check (Translog Form v.s. CD Form)

Parameter	Translog Form	CD Form (LP)	CD form (ACF)
β^{ω}_{exp}	0.030	0.015	0.014
	(0.0006)	(0.0005)	(0.0005)
β^{D}_{exp}	0.220	0.194	0.212
	(0.0044)	(0.0064)	(0.0065)
β^{μ}_{exp}	0.013	0.010	0.010
	(0.0016)	(0.0015)	(0.0015)
S (RTS)	1.109	1.093	1.090
S^V (RTSV)	1.070	1.061	1.059
α^*_L $(\partial y_{jt}/\partial l_{jt})$	0.074	0.081	0.045
α^*_M $(\partial y_{jt}/\partial m_{jt})$	0.996	0.980	1.014
α^*_K $(\partial y_{jt}/\partial k_{jt})$	0.039	0.032	0.031
α_L	0.066	0.081	0.045
α_M	0.800	0.980	1.014
α_K	-0.023	0.032	0.031
α_{LL}	0.034		
α_{MM}	0.017		
α_{KK}	0.008		
α_{LM}	-0.023		
α_{LK}	-0.012		
α_{MK}	-0.002		
Observations	1,234,292	1,234,292	1,234,292

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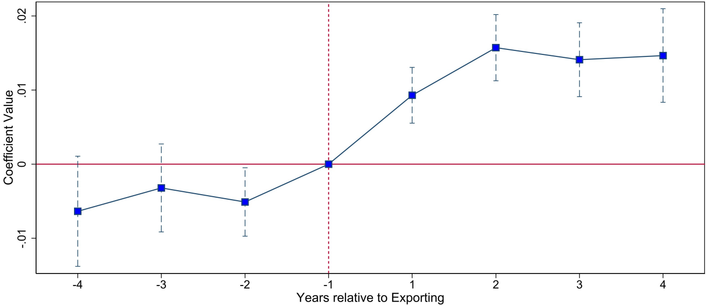
Translog Form - Dynamic Export Effects on Markup

Figure 4: Dynamic Export Effects on Markup (Translog Form)



Note: In the CD case, $\hat{\mu}_{jt}^{CD} = (\hat{\alpha}_L + \hat{\alpha}_L)\tilde{\mu}_{jt}$, and in the Translog case, $\hat{\mu}_{jt}^{Trans} = (\hat{\alpha}_L^* + \hat{\alpha}_L^*)\tilde{\mu}_{jt}$. The similar pattern shown here proves the strong robustness of the dynamic exporting effect on markup, even if the $(\hat{\alpha}_L^* + \hat{\alpha}_L^*)$ is no longer a constant as in the CD case. Back to Robustness

Translog Form - Estimation Results

Table 10: Robustness Check (Translog Form v.s. CD Form)

Parameter	Translog Form	CD Form (LP)	CD form (ACF)
β^{ω}_{exp}	0.030	0.015	0.014
	(0.0006)	(0.0005)	(0.0005)
β^{D}_{exp}	0.220	0.194	0.212
	(0.0044)	(0.0064)	(0.0065)
β^{μ}_{exp}	0.013	0.010	0.010
	(0.0016)	(0.0015)	(0.0015)
S (RTS)	1.109	1.093	1.090
S^V (RTSV)	1.070	1.061	1.059
α^*_L $(\partial y_{jt}/\partial l_{jt})$	0.074	0.081	0.045
α^*_M $(\partial y_{jt}/\partial m_{jt})$	0.996	0.980	1.014
α^*_K $(\partial y_{jt}/\partial k_{jt})$	0.039	0.032	0.031
α_L	0.066	0.081	0.045
α_M	0.800	0.980	1.014
α_K	-0.023	0.032	0.031
α_{LL}	0.034		
α_{MM}	0.017		
α_{KK}	0.008		
α_{LM}	-0.023		
α_{LK}	-0.012		
α_{MK}	-0.002		
Observations	1,234,292	1,234,292	1,234,292

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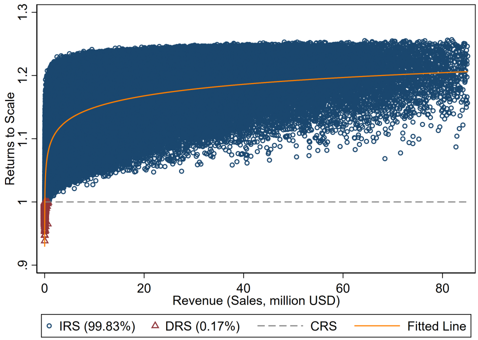
Translog Form - Firm Size & RTS

Figure 5: Firm Size (Sales) & RTS



Note: The translog production function is estimated by ACF method.

Industry-by-Industry Analysis

Table 11: Industry Separated Estimation Results (Ours, LP)

Industry Code (name)	β^{ω}_{exp}	β^{D}_{exp}	α_L	α_M	α_K	S **(RTS)**	S^V **(RTSV)**	**Marginal Cost Decomposition**: **Marginal Cost**	**IRS**	**Productivity**
13 (Processing of Food from Agricultural Products)	0.001	0.018	0.044	0.983	0.044	1.072	1.027	-0.006	-0.005	-0.001
14 (Manufacture of Foods)	0.013	0.166	0.048	0.969	0.022	1.039	1.017	-0.016	-0.003	-0.013
15 (Manufacture of Beverages)	0.023	0.159	0.064	0.927	0.040	1.031	0.991	-0.022	0.002	-0.024
16 (Tobacco)	0.346	-4.517	0.063	0.738	0.076	0.877	0.801	-0.255	0.177	-0.432
17 (Textiles)	0.008	0.169	0.069	1.080	0.030	1.179	1.149	-0.034	-0.027	-0.007
18 (Garment, Foot Ware, and Caps)	0.022	0.179	0.085	0.770	0.039	0.894	0.855	-0.003	0.024	-0.026
19 (Leather, Fur, Feathers, and Related Products)	0.011	0.110	0.106	1.143	0.010	1.259	1.249	-0.053	-0.044	-0.009
20 (Timber, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products)	-0.002	0.160	0.073	1.139	-0.029	1.182	1.211	-0.021	-0.023	0.002
21 (Furniture)	0.010	0.269	0.054	1.036	0.007	1.098	1.090	-0.028	-0.019	-0.009
22 (Paper and Paper Products)	0.009	0.377	0.049	0.949	0.030	1.028	0.998	-0.008	0.000	-0.009
23 (Printing, Reproduction of Recording Media)	0.007	0.220	0.074	0.948	0.056	1.078	1.022	-0.011	-0.005	-0.007
24 (Articles for Culture, Education, and Sport Activities)	0.007	0.155	0.092	0.973	0.018	1.084	1.065	-0.013	-0.006	-0.006
25 (Petroleum, Coking, and Processing of Nuclear Fuel)	0.099	2.204	0.026	0.780	0.052	0.858	0.806	-0.087	0.036	-0.123
26 (Raw Chemical Materials and Chemical Products)	0.011	0.172	0.056	1.021	0.026	1.104	1.078	-0.025	-0.015	-0.010
27 (Manufacture of Medicines)	0.010	0.230	0.050	1.006	0.052	1.108	1.057	-0.016	-0.007	-0.009
28 (Chemical Fibers)	0.001	0.565	0.043	0.985	0.018	1.047	1.028	-0.005	-0.004	-0.001
29 (Rubber)	-0.003	0.219	0.059	1.064	0.007	1.129	1.123	-0.021	-0.023	0.002
30 (Plastics)	0.004	0.355	0.058	0.968	0.030	1.056	1.026	-0.008	-0.004	-0.004
31 (Non-Metallic Mineral Products)	0.010	0.293	0.058	0.996	0.019	1.073	1.054	-0.019	-0.001	-0.009
32 (Smelting and Pressing of Ferrous Metals)	0.018	0.279	0.043	1.059	0.040	1.142	1.102	-0.014	0.002	-0.016
33 (Smelting and Pressing of Non-Ferrous Metals)	0.002	1.665	0.047	0.798	0.059	0.904	0.845	0.025	0.027	-0.002
34 (Metal Products)	0.001	0.173	0.059	1.086	0.033	1.178	1.145	-0.019	-0.018	-0.001
35 (General Purpose Machinery)	0.005	0.222	0.057	1.048	0.030	1.134	1.105	-0.023	-0.018	-0.005
36 (Special Purpose Machinery)	0.020	0.278	0.061	0.991	0.016	1.068	1.052	-0.027	-0.008	-0.019
37 (Transport Equipment)	0.009	0.153	0.071	0.991	0.031	1.093	1.062	-0.022	-0.014	-0.008
39 (Electrical Machinery and Equipment)	0.006	0.127	0.065	1.036	0.040	1.141	1.101	-0.021	-0.015	-0.006
40 (Communication Equipment, Computers, and Other Electronic Equipment)	0.008	0.138	0.112	1.060	0.010	1.182	1.172	-0.028	-0.021	-0.007
41 (Measuring Instruments and Machinery for Cultural Activities and Office Work)	0.008	0.241	0.076	1.013	0.017	1.107	1.089	-0.019	-0.012	-0.007
42 (Artwork and Other Manufacturing)	0.010	0.143	0.084	0.942	0.023	1.050	1.027	-0.012	-0.003	-0.009
Mean	0.010	0.239	0.063	1.003	0.029	1.095	1.066	-0.028	-0.001	-0.027
Observations	1,234,292									

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Industry-by-Industry Analysis Std. Err.

Table 12: Industry Separated Estimation Results (Ours, LP)

Industry Code (name)	β^{ω}_{exp}	β^{D}_{exp}	α_L	α_M	α_K	S (RTS)	S^V (RTSV)	Marginal Cost Decomposition: Marginal Cost	IRS	Productivity
13 (Processing of Food from Agricultural Products)	0.001	0.018	0.044	0.983	0.044	1.072	1.027	-0.006	-0.005	-0.001
	(0.0025)	(0.0206)	(0.0022)	(0.0224)	(0.0020)	(0.0223)	(0.0234)	(0.0050)	(0.0042)	(0.0024)
14 (Manufacture of Foods)	0.013	0.166	0.048	0.969	0.022	1.039	1.017	-0.016	-0.003	-0.013
	(0.0030)	(0.0448)	(0.0043)	(0.0323)	(0.0061)	(0.0288)	(0.0344)	(0.0075)	(0.0069)	(0.0029)
15 (Manufacture of Beverages)	0.023	0.159	0.064	0.927	0.040	1.031	0.991	-0.022	0.002	-0.024
	(0.0142)	(0.1435)	(0.0071)	(0.0740)	(0.0126)	(0.0671)	(0.0791)	(0.0173)	(0.0187)	(0.0163)
16 (Tobacco)	0.346	-4.517	0.063	0.738	0.076	0.877	0.801	-0.255	0.177	-0.432
	(0.3996)	(1.9147)	(0.0318)	(0.1432)	(0.0729)	(0.0959)	(0.1530)	(0.3984)	(0.1295)	(0.4499)
17 (Textiles)	0.008	0.169	0.069	1.080	0.030	1.179	1.149	-0.034	-0.027	-0.007
	(0.0020)	(0.0178)	(0.0029)	(0.0328)	(0.0017)	(0.0339)	(0.0351)	(0.0061)	(0.0068)	(0.0019)
18 (Garment, Foot Ware, and Caps)	0.022	0.179	0.085	0.770	0.039	0.894	0.855	-0.003	0.024	-0.026
	(0.0088)	(0.0718)	(0.0314)	(0.2848)	(0.0040)	(0.3193)	(0.3161)	(0.0345)	(0.0442)	(0.0106)
19 (Leather, Fur, Feathers, and Related Products)	0.011	0.110	0.106	1.143	0.010	1.259	1.249	-0.053	-0.044	-0.009
	(0.0039)	(0.0224)	(0.0083)	(0.0731)	(0.0071)	(0.0740)	(0.0803)	(0.0147)	(0.0155)	(0.0032)
20 (Timber, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products)	-0.002	0.160	0.073	1.139	-0.029	1.182	1.211	-0.021	-0.023	0.002
	(0.0065)	(0.0542)	(0.0045)	(0.0297)	(0.0226)	(0.0155)	(0.0317)	(0.0116)	(0.0089)	(0.0054)
21 (Furniture)	0.010	0.269	0.054	1.036	0.007	1.098	1.090	-0.028	-0.019	-0.009
	(0.0163)	(0.3675)	(0.0083)	(0.1217)	(0.0097)	(0.1206)	(0.1288)	(0.0137)	(0.0324)	(0.0216)
22 (Paper and Paper Products)	0.009	0.377	0.049	0.949	0.030	1.028	0.998	-0.008	0.000	-0.009
	(0.0165)	(0.2316)	(0.0056)	(0.0957)	(0.0049)	(0.0966)	(0.1004)	(0.0141)	(0.0125)	(0.0158)
23 (Printing, Reproduction of Recording Media)	0.007	0.220	0.074	0.948	0.056	1.078	1.022	-0.011	-0.005	-0.007
	(0.0080)	(0.1481)	(0.0058)	(0.0359)	(0.0047)	(0.0397)	(0.0396)	(0.0089)	(0.0090)	(0.0086)
24 (Articles for Culture, Education, and Sport Activities)	0.007	0.155	0.092	0.973	0.018	1.084	1.065	-0.013	-0.006	-0.006
	(0.0060)	(0.0860)	(0.0097)	(0.0895)	(0.0076)	(0.0915)	(0.0982)	(0.0047)	(0.0101)	(0.0070)
25 (Petroleum, Coking, and Processing of Nuclear Fuel)	0.099	2.204	0.026	0.780	0.052	0.858	0.806	-0.087	0.036	-0.123
	(0.0464)	(0.8794)	(0.0047)	(0.0467)	(0.0091)	(0.0402)	(0.0475)	(0.0510)	(0.0277)	(0.0610)
26 (Raw Chemical Materials and Chemical Products)	0.011	0.172	0.056	1.021	0.026	1.104	1.078	-0.025	-0.015	-0.010
	(0.0026)	(0.0176)	(0.0023)	(0.0102)	(0.0022)	(0.0097)	(0.0111)	(0.0029)	(0.0024)	(0.0025)
27 (Manufacture of Medicines)	0.010	0.230	0.050	1.006	0.052	1.108	1.057	-0.016	-0.007	-0.009
	(0.0133)	(0.1779)	(0.0076)	(0.1167)	(0.0116)	(0.1132)	(0.1228)	(0.0118)	(0.0187)	(0.0162)
28 (Chemical Fibers)	0.001	0.565	0.043	0.985	0.018	1.047	1.028	-0.005	-0.004	-0.001
	(0.0180)	(0.1708)	(0.0066)	(0.0491)	(0.0072)	(0.0465)	(0.0520)	(0.0146)	(0.0103)	(0.0184)
29 (Rubber)	-0.003	0.219	0.059	1.064	0.007	1.129	1.123	-0.021	-0.023	0.002
	(0.0329)	(0.1510)	(0.0074)	(0.0825)	(0.0135)	(0.0743)	(0.0872)	(0.0314)	(0.0183)	(0.0292)
30 (Plastics)	0.004	0.355	0.058	0.968	0.030	1.056	1.026	-0.008	-0.004	-0.004
	(0.0152)	(0.2898)	(0.0069)	(0.1043)	(0.0079)	(0.1031)	(0.1107)	(0.0052)	(0.0199)	(0.0194)
31 (Non-Metallic Mineral Products)	0.010	0.293	0.058	0.996	0.019	1.073	1.054	-0.019	-0.001	-0.009
	(0.0110)	(0.3818)	(0.0070)	(0.1118)	(0.0124)	(0.1064)	(0.1186)	(0.0171)	(0.0256)	(0.0145)
32 (Smelting and Pressing of Ferrous Metals)	0.018	0.279	0.043	1.059	0.040	1.142	1.102	-0.014	0.002	-0.016
	(0.0079)	(0.0579)	(0.0038)	(0.0182)	(0.0029)	(0.0180)	(0.0192)	(0.0099)	(0.0058)	(0.0073)
33 (Smelting and Pressing of Non-Ferrous Metals)	0.002	1.665	0.047	0.798	0.059	0.904	0.845	0.025	0.027	-0.002
	(0.0141)	(0.3265)	(0.0033)	(0.0149)	(0.0037)	(0.0157)	(0.0155)	(0.0148)	(0.0077)	(0.0165)
34 (Metal Products)	0.001	0.173	0.059	1.086	0.033	1.178	1.145	-0.019	-0.018	-0.001
	(0.0035)	(0.0227)	(0.0031)	(0.0134)	(0.0024)	(0.0141)	(0.0145)	(0.0049)	(0.0039)	(0.0031)
35 (General Purpose Machinery)	0.005	0.222	0.057	1.048	0.030	1.134	1.105	-0.023	-0.018	-0.005
	(0.0023)	(0.0204)	(0.0023)	(0.0102)	(0.0016)	(0.0103)	(0.0110)	(0.0031)	(0.0025)	(0.0021)
36 (Special Purpose Machinery)	0.020	0.278	0.061	0.991	0.016	1.068	1.052	-0.027	-0.008	-0.019
	(0.0033)	(0.0816)	(0.0047)	(0.0526)	(0.0052)	(0.0515)	(0.0561)	(0.0077)	(0.0092)	(0.0038)
37 (Transport Equipment)	0.009	0.153	0.071	0.991	0.031	1.093	1.062	-0.022	-0.014	-0.008
	(0.0031)	(0.0260)	(0.0037)	(0.0156)	(0.0026)	(0.0153)	(0.0170)	(0.0037)	(0.0042)	(0.0029)
39 (Electrical Machinery and Equipment)	0.006	0.127	0.065	1.036	0.040	1.141	1.101	-0.021	-0.015	-0.006
	(0.0024)	(0.0220)	(0.0031)	(0.0239)	(0.0024)	(0.0242)	(0.0257)	(0.0041)	(0.0039)	(0.0022)
40 (Communication Equipment, Computers, and Other Electronic Equipment)	0.008	0.138	0.112	1.060	0.010	1.182	1.172	-0.028	-0.021	-0.007
	(0.0057)	(0.0341)	(0.0082)	(0.0628)	(0.0055)	(0.0664)	(0.0696)	(0.0076)	(0.0091)	(0.0051)
41 (Measuring Instruments and Machinery for Cultural Activities and Office Work)	0.008	0.241	0.076	1.013	0.017	1.107	1.089	-0.019	-0.012	-0.007
	(0.0080)	(0.0614)	(0.0068)	(0.0385)	(0.0046)	(0.0409)	(0.0419)	(0.0073)	(0.0058)	(0.0075)
42 (Artwork and Other Manufacturing)	0.010	0.143	0.084	0.942	0.023	1.050	1.027	-0.012	-0.003	-0.009
	(0.0018)	(0.0249)	(0.0045)	(0.0319)	(0.0031)	(0.0328)	(0.0352)	(0.0042)	(0.0041)	(0.0018)
Mean	0.010	0.239	0.063	1.003	0.029	1.095	1.066	-0.028	-0.001	-0.027
Observations	1,234,292									

Note: Standard errors (clustered at the firm level) in parentheses.

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IV Results

Robustness: Instrumental Variable: Lagged Export Status

Table 13: Estimation Results of Export Instrument

Parameter	Ours
β^{ω}_{exp} (Productivity Effect)	0.013
	(0.0037)
β^{ω}_{exp} (Demand Effect)	0.250
	(0.0868)
α_L	0.081
	(0.0007)
α_M	0.980
	(0.0020)
α_K	0.031
	(0.0008)
S (RTS)	1.092
	(0.0016)
S^V (RTSV)	1.061
	(0.0023)
Observations	1,234,292

Note: Standard errors (clustered at the firm level) in parentheses.

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