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This Paper: Yu (2015)

Yu, M. (2015). Processing trade, tariff reductions and firm productivity: evidence from Chinese firms. *The Economic Journal*, 125(585), 943-988.

An empirical exploration of how reductions in input and output tariffs affect the productivity of large Chinese trading firms.

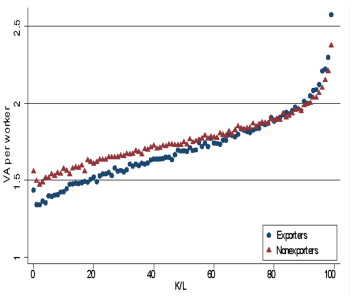
Two Interesting Questions.

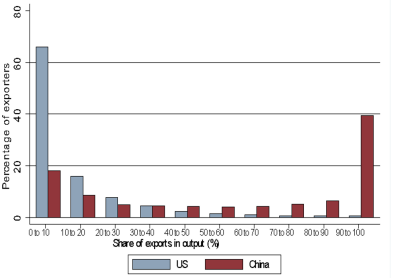
1. What is the sign of impact from reductions in INPUT and OUTPUT tariffs on PRODUCTIVITY, and what is the relative strength (**at firm-level**)?
2. How does this impact behave along the direction of PROCESSING trade (**in China**)?

Some Background: Processing Trade in China

Lu (2010) documents two (counter-Melitz) facts.

1. China's exporters are typically **less productive**.
2. The distribution of export intensity exhibits **U-shape**.





Dai, Maitra, and Yu (2016) finds more.

1. Processing exporters are **less productive** than both non-processing exporters and non-exporters.
2. Once processing exporters are accounted for, the productivity abnormalities are **eliminated or alleviated**.

Contribution: Three Ways

1. Micro-foundationed China's rapid economic growth on huge foreign trade volume.
2. Connected productivity gains from trade reform to processing trade, under the special tariff treatments.
3. Constructed novel measures of firm-specific input and output tariffs.

All analyses are conducted in a FIRM- & PRODUCT-level dataset.

Imports: Four Type

1. Ordinary imports
2. Processing imports with assembly
   - obtains the raw from its foreign trading partners with **no** payment
   - sells the products to the **same** partners by charging an assembly fee.
3. Processing imports with inputs
   - **pays** for the raw from a foreign seller
   - sells its final goods to **other** foreign countries.
4. Other types of processing imports[1]

One critical feature is that processing imports are **duty-free**.

[1] eg: foreign aid (code: 12), compensation trade (13), goods on consignment (16), goods on lease (17), border trade (19), contracting projects (20), outward processing (22), barter trade (30), customs warehouse trade (33), and entrepot trade by bonded area (34).

Firms: Four Type

1. Non-importing Firms
2. Non-processing Importers
   - purchase from or sell to both domestic and foreign markets
   - only import **non-processing** intermediate inputs
3. Pure-processing Importers
   - purchase **all** from abroad and re-**export** final value-added goods
4. Hybrid-processing Importers
   - a combination of both **non-** and **pure-** processing

The key difference is the privilege of **free duty**.

Merged Dataset: 3 to 1

Three Disaggregated, Large Panel Datasets.

1. Tariff data
   - Tariff data can be accessed directly from the WTO and the trade analysis and information system (TRAINS).
2. Firm-level production data
   - Filter One: basic rules of the GAAP in three accounting statements
   - Filter Two: no production but only "buy low sell high"
3. Product-level trade data
   - extremely disaggregated product-level trade transaction data
   - most importantly, include info of specific types of (processing) trade

Two methods of merging.

1. using each firm's Chinese name and year
2. using each firm's postal code and phone number

Summary Statistics

In summary, 76,823 observations from 2000 to 2006.

Firm Types	
Ordinary Importers	28.0
Processing Importers	45.5
- Hybrid processing Importers	22.6
- Pure processing Importers	22.9
Total Importers	56,459 Importers
Non- Importers	26.5
Total Firms	76,823 Importers

The merged sample is skewed towards large firms.

Comparison:	Merged Data Mean	Filtered Full Sample Mean
Sales (RMB 1,000)	150,053	85,065
Exports (RMB 1,000)	53,308	16,544
Number of employees	478	274

TFP: Concerns

1. **endogeneity (reverse causality)**

   technology process is not completely exogenous.

2. **sample bias**

   firm with low productivity exits and hence not included in dataset.

3. **unobserved heterogeneity**

   control for Industry and add dummies of
   - Assembly, Processing,
   - Importing, Exporting,
   - SOE, Multinational,
   - Pre-WTO,
   - ...

4. **simultaneity**

   firms could learn by processing imports hence productivity gains occur simultaneously with investment.

5. **deflation (REAL-ize)**

   price deflators at firm-level are not available only at industry-level. (nominal terms at industry-level pick up differences in price, price-cost markups and even more)

6. **labor abundance**

   firms re-optimise their production by only adjusting labor when facing an unobserved productivity shock.

TFP: Approach & Results

The augmented Olley-Pakes approach (Olley and Pakes, 1996) and system-GMM estimation (Blundell and Bond, 1998).

The basic formulation of regression includes CURRENTs, ONE-LAGs, DUMMYs, INTERACTIONs and some fixed effects as well as errors.

Overall, the estimation indicates a 2.62% annual growth rate of TFP.

Firm-specific Input Tariffs: Definition

Firm-specific Input Tariff index (FIT_{it}): weighted sum.

$$FIT_{it} = \sum_{k \in \mathbf{O}} \omega_i^k \tau_t^k \text{ and } \omega_i^k = \frac{m_{i,\text{initial year}}^k}{\sum_{k \in \mathbf{M}} m_{i,\text{initial year}}^k}$$

where

- **M** is the set of firm's total imports, while **O** is non-processing imports and **P** is processing imports (duty-free and hence not shown).
- ω_i^k is **time-invariant** weights to avoid the endogeneity of weighted tariffs: imports are negatively associated with tariffs (downward bias).
- $m_{i,\text{initial year}}^k$ is value of firm i's imports of product k in the **initial** year the firm appearing in the sample (Topalova and Khandelwal, 2011).

Firm-specific Output Tariffs: Definition

Firm-specific Output Tariff index (FOT_{it}): weighted sum.

$$FOT_{it} = \sum_k \omega_i^k \tau_t^k \text{ and } \omega_i^k = \frac{X_{i,\text{initial year}}^k}{\sum_k X_{i,\text{initial year}}^k}$$

where

- $\sum_k$ takes in all products.
- ω_i^k is time-invariant weights and $X_{i,\text{initial year}}^k$ is (export) value.

Industry-specific Tariffs: Input & Output

For industry f across all products n at time t, use China's input-output table for 2002.

1. the Industry-specific Input Tariffs (IIT_{ft}).

$$IIT_{ft} = \sum_n \left(\frac{IN^n_{f,\text{year 2002}}}{\sum_n IN^n_{f,\text{year 2002}}} \right) \tau^n_t$$

2. the Industry-specific Output Tariffs (IOT_{ft}).

$$IOT_{ft} = \sum_n \left(\frac{OUT^n_{f,\text{year 2002}}}{\sum_n OUT^n_{f,\text{year 2002}}} \right) \tau^n_t$$

Estimation: A *ex ante* Summary

Till now,

- firm-level (and industry-level) data has been constructed with a special identification of processing trade
- TFPs are measured using system-GMM
- input & output tariff indices are constructed in both firm-level and industry-level

So estimations are ready.

Formulation

$$\begin{aligned}\ln(TFP_{ift}) = {} & \beta_0 + \beta_1 FIT_{it} + \beta_2 FOT_{it} + \beta_3 \mathbb{E}[Pext_{it}|\mathbf{Z}_{it}] \\ & + \beta_4 FIT_{it} \times \mathbb{E}[Pext_{it}|\mathbf{Z}_{it}] + \beta_5 FOT_{it} \times \mathbb{E}[Pext_{it}|\mathbf{Z}_{it}] \\ & + \theta \mathbf{X}_{it} + \omega_i + \eta_t + \mu_{it}\end{aligned}$$

where

- $\ln(TFP_{ift})$ is the logarithm of firm i's measured TFP (in industry j) in year t.
- $Pext_{it}$ is a continuous measure of the extent of processing engagement of firm i in year t.

$$Pext_{it} = \left(\frac{\text{processing imports}}{\text{total imports}} \right)_{it}$$

- $\mathbf{X}_{it}$ controls other firm i characteristics in year t.
- $\mu_{it} = (\beta_3 + \beta_4 FIT_{it} + \beta_5 FOT_{it})\epsilon_{it} + e_{it}$ is conditionally uncorrelated with exogenous variables.

Note, decision of extent to engage in processing trade is **endogenous** to firms (Heckman and Vytlacil, 1998).

$$Pext_{it} = \mathbb{E}[Pext_{it}|\mathbf{Z}_{it}] + \epsilon_{it} \text{ with } \mathbb{E}[\epsilon_{it}|\mathbf{Z}_{it}] = 0$$

Conclusion One: Tariff Reduction VS. Firm Productivity

$\ln(TFP_{ift}^{GMM})$	Output tariffs	Output tariffs × Pext	Input tariffs	Input tariffs × Pext	Pext
industry-level tariff	-1.069***	-0.604***	-1.379**	2.251***	-0.077***
firm-level tariff	-0.315***	-0.234***	-0.572***	2.409***	-0.180***

Notes. Significant at **5% and ***1%.

Conclusion One

Both types of tariff reductions have positive impacts on Firm productivity, and such impact decrease as firms' share of processing imports grows.

Corollary

The impact of input tariff reductions on productivity improvement, overall, is weaker than that of output tariff reductions, for processing firms.

Quantitatively, the processing extent used here is set at 49.0%, mean of the fitted extent of processing in sample, while based on my calculation any value greater than 9.8% would suffice.

Conclusion One Appendix

Conclusion Two: Processing Trade VS. Firm Productivity

Productivity Difference: $\ln(TFP_{ift}^{GMM})$	Overall
Non-processing firms over Processing firms	0.025***

Comparison: Nearest-neighbor Matching (Imbens, 2004)	Overall
Average Treatment on the Treated (ie, processing firms)	0.031***
Average Treatment on the Control	0.027***

Notes. Significant at ***1%.

Conclusion Two

Overall, productivity for processing firms is lower than that for similar non-processing firms.

Conclusion Two Appendix

Conclusion Three: Economic Magnitudes & Welfare Contributions[2]

Welfare Analysis follows Domar-weight (Domar, 1961). The following economic magnitudes provide starting point.

- A 10% fall in output (input) tariffs for **non-processing** firms leads to a productivity gain of 13.2 (17.1)%.
- A 10% fall in output (input) tariffs for **processing** firms leads to a productivity gain of 9.2 (5.1)%.

Corollary (Updated)

The impact of input tariff reductions on productivity improvement, overall, is weaker than that of output tariff reductions, for processing firms; the opposite is true for non-processing firms.

Conclusion Three

Both output and input tariff reductions, on average, lead to productivity gains of 7.6%, and hence contribute 14.5% to economy-wide productivity growth.

[2] the processing extent is set at .49, mean of the fitted extent of processing in sample.

Closing Remarks

Really great paper and really great author.

- Royal Economic Society Prize
- Prof Yu is the first Chinese economist awarded
- TONS of patience

3 questions.

1. possibility of incorporating adjustment cost
2. interaction term: $FIT_{it} \times FOT_{it}$
3. relative strength: input tariff "liquidity trap"

Closing Remarks: One fun challenge

Find how your paper's author connects to our Prof Garetto.

I accomplished!

- Prof Garetto is student of Prof Chris Broda (Ph.D. 2001, MIT)
- Prof Broda is student of Prof Rudiger Dornbusch (Ph.D. 1971, Chicago)
- Prof Dornbusch has another student: Prof Paul Krugman (Ph.D. 1977, MIT)
- Prof Krugman has a student: Prof Robert Feenstra (Ph.D. 1981, MIT)
- Prof Feenstra has a student: Prof Miaojie Yu (Ph.D. 2005, UC Davis)

A GREAT way to know Trade Family (thanks to Prof Alan Deardorff)!

Literature

Tariff Reductions Impacts.

- Levinsohn (1993) Harrison (1994), Krishna and Mitra (1999), Pavcnik (2002), Schor (2004), Amiti and Konings (2007), Fernandes (2007), Goldberg et al. (2010), Bustos (2011), Topalova and Khandelwal (2011), ...

Productivity.

- Horn et al. (1995), Blundell and Bond (1998), Levinsohn-Petrin (2003), Amiti and Konings (2007), Goldberg et al. (2010), Bustos (2011), De Loecker (2011), De Loecker et al. (2012), De Loecker (2013), ...

Imports: Change Over Time

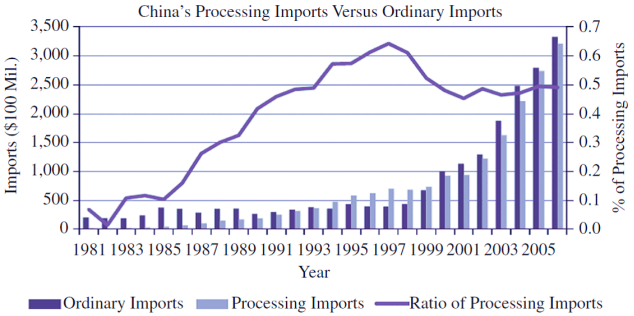


Fig. 1. *China's Processing Imports Versus Ordinary Imports*

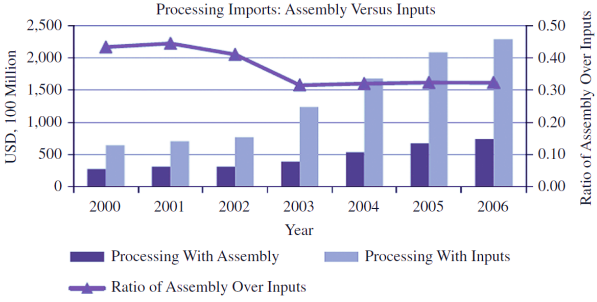


Fig. 2. *China's Processing Imports: Assembly Versus Inputs*
Sources. Customs trade data (2000–6), author's own compilation.

Firms: Picture Demo

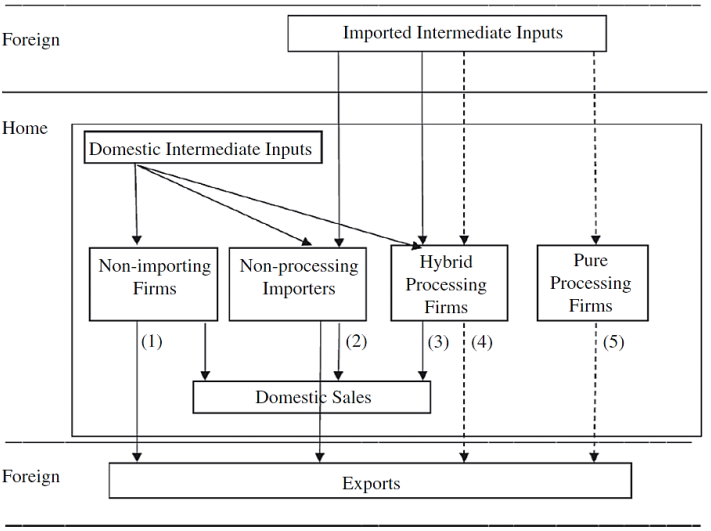


Fig. 3. *Four Types of Chinese Firms*

Note. Dotted lines denote firms' processing imports/exports; solid lines represent firms' non-processing imports/exports.

TFP: Estimation

In the article, the Olley-Pakes TFP is estimated in three ways:

1. TFP^{OP} which is used in the full-sample estimates in columns (1) and (2) in Table 7
2. TFP^{OP1} which separates processing firms and non-processing firms into two groups and uses different control function approaches and is used in columns (3) and (4) in Table 7 and column (1) in Table 8
3. TFP^{OP2} which pools processing firms and non-processing firms together for estimation and is used in column (2) in Table 8

The augmented Olley-Pakes approach assumes that capital responds to the unobserved productivity shock with a Markov process, whereas other input factors respond without any dynamic effects.

However, firms in China might re-optimize their production behavior by adjusting their labor rather than capital. Hence Blundell and Bond (1998) system-GMM approach.

$$\begin{aligned}\ln y_{it}^j =& \gamma_0^j + \gamma_1^j \ln L_{it}^j + \gamma_2^j \ln L_{i,t-1}^j + (\gamma_3^j \ln L_{it}^j + \gamma_4^j \ln L_{i,t-1}^j) PE_{it} \\ &+ \gamma_5^j \ln K_{it}^j + \gamma_6^j \ln K_{i,t-1}^j + (\gamma_7^j \ln K_{it}^j + \gamma_8^j \ln K_{i,t-1}^j) PE_{it} \\ &+ \gamma_9^j \ln M_{it}^j + \gamma_{10}^j \ln M_{i,t-1}^j + (\gamma_{11}^j \ln M_{it}^j + \gamma_{12}^j \ln M_{i,t-1}^j) PE_{it} \\ &+ \gamma_{13}^j \ln y_{i,t-1}^j + \gamma_{14}^j \ln y_{i,t-1}^j PE_{it} + \gamma_{15} PE_{it} + \varsigma_i + \zeta_t + \omega_{it},\end{aligned}$$

Firm-specific Output Tariffs: Definition

Firm-specific Output Tariff index (FOT_{it}): weighted sum.

$$FOT_{it} = \sum_k \omega_i^k \tau_t^k \text{ and } \omega_i^k = \frac{X_{i,\text{initial year}}^k}{\sum_k X_{i,\text{initial year}}^k}$$

Product-level domestic sales would be an ideal proxy for capturing the role of each product within a firm.

1. product-level domestic sales are **not** available.
2. given a product would be sold in home if sold abroad (Melitz, 2003), assume a product is sold domestically and internationally in the **same** proportions.

Firm-specific Output Tariffs: Correction One

Exclude pure domestic firms and pure exporting firms.

1. eg. A firm may sell a product **only** at home but not abroad (i.e. a pure domestic firm).
2. weight for this product $\omega_i^k = 0$ since $X^k_{i,\text{initial year}} = 0$.
3. the firm's output tariff measure fails to capture any **pro-competition** effects
4. same argument holds for firm selling only to abroad (i.e. a pure exporting firm).

my understanding of true motivation: it is NOT consensual to say whether such a pure domestic firm is more productive or less (Lu, 2011).

Firm-specific Output Tariffs: Correction Two

The exported and domestic shares of a product are assumed to be equal.

Note that this is a **strong** assumption as the product composition of exports may be very different from that of domestic sales.

To address such issue indirectly (due to data constrains)

1. since this problem would bias FOT_{it} differently
   - depending on the industry and
   - depending on the intensity of processing firms
2. so further regressions are run across two dimensions
   - **integration** of industries
   - **intensity** of processing firms

All such robustness checks suggest results are still valid even considering such within-firm differences in product composition.

Formulation

$$\begin{aligned}\ln(TFP_{ift}) = \beta_0 &+ \beta_1 FIT_{it} + \beta_2 FOT_{it} + \beta_3 \textbf{ProTrade}_{it} \\ &+ \beta_4 FIT_{it} \times \textbf{ProTrade}_{it} + \beta_5 FOT_{it} \times \textbf{ProTrade}_{it} \\ &+ \theta \mathbf{X}_{it} + \omega_i + \eta_t + \mu_{it}\end{aligned}$$

But $\textbf{ProTrade}_{it}$ =?

1. PE_{it} is not accurate, which may overestimate the role of processing firms.
   - For example, if a firm has only a very small proportion of processing imports over total imports, it is still classified as a processing firm, yet its primary operation remains in ordinary trade.
2. $Pext_{it}$ is not accurate, since the decision to engage in processing trade is endogenous to firms.
   - That is, $\beta_{3,4,5}$ vary across firms. Ie, equation has random coefficients that are correlated with the endogenous extent of processing engagement, so it is a correlated random coefficients (CRC) model (Wooldridge, 2008).
3. $\mathbb{E}[Pext_{it}|\mathbf{Z}_{it}]$ is necessary.
   - Estimate the extent of processing engagement with a Heckman procedure, or type-2 Tobit model, using the exogenous variables Z_{it}

Conclusion One: Industry-level Tariff Pitfall

$\ln(TFP_{ift}^{GMM})$	Output tariffs	Output tariffs × Pext	Input tariffs	Input tariffs × Pext	Pext
industry-level tariff	-1.069***	-0.604***	-1.379**	2.251***	-0.077***
firm-level tariff	-0.315***	-0.234***	-0.572***	2.409***	-0.180***

Notes. Significant at **5% and ***1%.

Firm-level Tariffs tend to **overestimate** effect from tariff reduction.

- tariff reductions for some product in an industry are **not** directly relevant to a firm if the firm never produces such products.
- the pro-competitive effects from output tariff reduction would be overestimated.
- the cost-saving effects from input tariff reduction would be overestimated.

Conclusion One

Conclusion Two: Self-selection to Processing

But low-productivity firms may **self-select** to engage in processing trade. To control for the endogenous selection, employ a type-2 Tobit model or, equivalently, a bivariate sample selection model (Cameron and Trivedi, 2005).

Heckman two-step:		1st Step	2nd Step
		Processing Indicator	Processing Extent
Log TFP,	1-period Lag	-0.126^{***}	-0.176^{***}
Log Labor,	1-period Lag	$+0.152^{***}$	$+0.031^{***}$
SOEs Indicator,	1-period Lag	-0.160^{***}	-0.039
Foreign Indicator,	1-period Lag	$+0.978^{***}$	$+0.299^{***}$
Firm Tenure,	1-period Lag	$+0.004^{***}$	/
Inverse Mills ratio		/	$+0.172^{**}$

Notes. Significant at at *10%, **5% and ***1%. The use of 1-period lag is to accommodate the time for such factors to take effects.

- Generally, low-productivity firms are more likely to engage in processing trade.
- Similarly, large and foreign firms are more likely to engage in processing trade.
- However, SOEs are less likely to become processing firms.
- Finally, firms that were established earlier are more likely to engage in processing trade.

Endogeneity Issues

The first one relates to the measure of firm input tariffs.

- This is because imports and tariffs are strongly correlated.
- This problem is essentially solved by using time-invariant weights in input tariff index.

The second relates to the possible reverse causality between firm productivity and exports.

- This is because exports and productivity grows disproportionally.
- This problem is essentially solved by using time-invariant weights in output tariff index.

IV Estimation using 2SLS

One last but possible reverse causality problem. Piratically, tariffs are still, to some extent, endogenous due to firms negotiation power (Grossman and Helpman, 1994).

1. Employ IV approach using 2SLS fixed-effects estimates.
2. Divide all industries are into two groups (more integrated and less integrated) indicated by Global Supply Chain involvement.
3. Divide all industries are into two groups (high and low intensity of processing firms).

	All sample	GSCs integrated		Processing intensity	
Regressand: ln TFP^{GMM}_{ijt}	(1)	Less (2)	More (3)	Low (4)	High (5)
Firm output tariffs	−1.319***	−0.825***	−1.962***	−1.657**	−1.941***
	(−4.60)	(−2.13)	(−3.66)	(−3.98)	(−4.47)
Firm output tariffs × fitted extent of processing	0.817*	0.802	1.184	1.321	1.765***
	(1.72)	(1.18)	(1.41)	(1.53)	(2.67)
Firm input tariffs	−1.712***	−2.821***	−1.519***	−1.883**	−3.447**
	(−3.46)	(−3.57)	(−2.76)	(−3.50)	(−2.32)
Firm input tariffs × fitted extent of processing	2.460***	2.497*	2.818**	3.478**	3.546*
	(2.54)	(1.75)	(2.71)	(2.65)	(1.72)
Fitted extent of processing	−0.740***	−1.005***	−0.778***	−0.944***	−0.833***
	(−17.66)	(−15.99)	(−10.28)	(−12.28)	(−11.95)

Further Robustness Check

After controlling for reverse causality, reductions in both firm input tariffs and firm output tariffs lead to firm productivity growth.

In directions of industry-aggregation and processing-intensity, results are significant and consistent.

Furthermore, alter definition of *TFP* and introduce more controls.

Again, results are significant and consistent.

Regressand:	$\ln LP_{ijt}$ (1)	$\ln TFP^{LevP}_{ijt}$ (2)	$\ln TFP^{GMM}_{ijt}$ (3)	$\ln TFP^{GMM}_{ijt}$ (4)	Weighted $\ln TFP^{GMM}_{ijt}$ (5)
Firm output tariffs	−1.980***	−1.217**	−1.100***	−1.096***	−1.159***
	(−3.49)	(−2.02)	(−4.51)	(−4.62)	(−4.47)
Firm output tariffs × fitted extent of processing	2.260**	−0.106	0.677	0.675	0.812**
	(2.03)	(−0.08)	(1.63)	(1.47)	(1.96)
Firm input tariffs	−3.866**	−5.069***	−1.380***	−1.378***	−1.589***
	(−2.30)	(−2.69)	(−2.66)	(−2.47)	(−2.57)
Firm input tariffs × fitted extent of processing	8.610***	10.309***	2.448**	2.435**	2.664**
	(2.36)	(2.59)	(2.12)	(2.09)	(2.06)
Fitted extent of processing	−2.737***	−2.901***	−1.251***	−1.251***	−1.311***
	(−22.42)	(−23.00)	(−26.78)	(−23.61)	(−27.83)
SOEs indicator	−0.619***	−0.369***	−0.187***	−0.187***	−0.188***
	(−11.60)	(−5.15)	(−7.71)	(−7.51)	(−7.81)
Foreign ownership indicator	0.493***	0.475***	0.220***	0.220***	0.229***
	(19.38)	(24.15)	(27.24)	(32.40)	(28.84)
Firm size	0.325***	0.559***	0.068***	0.068***	0.072***
	(51.51)	(81.26)	(34.23)	(29.81)	(24.59)

Channels Discussion: Reductions in Output Tariffs

The impact of **input** tariffs on productivity is direct, as lower tariffs induce access to a larger variety of imported intermediate inputs (Helpern et al., 2010).

Reductions in **output** tariffs are found to have a pro-competitive effect (ie, productivity increase). However, it is less clear whether such a pro-competitive effect is

- through improvement in the efficiency of present firms, or
- through weeding out the less-productive firms from the market.

To test,

1. include an always-present indicator
   (i.e. $= 1$ iff the firm is present in all years)
2. include an exit indicator
   (i.e. $= 1$ iff the firm exits the market in the next year)

The always-present indicator has a **positive** and **significant** sign, suggesting that always-present firms are more productive.

The exit indicator has a **insignificant** sign, suggesting that exiters do not have a significant productivity difference.