Input Re-allocation Within Firms

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Motivation

- Trade policy and **within-firm** adjustment
- **input-switching and output-switching** for input-using firms resulting from trade shock on inputs
- E.g. within-firm **reallocation of inputs** and outputs
- Adjustments in within-firm **markups** of input-using firms
- It documents a **new** channel of within-firm adjustments to trade shocks

Relevant Literature

Trade Policy and Firm Exports:

- Mayer, Melitz, Ottaviano (2014)
- Bernard et al. (2011)
- Eckel and Neary (2010)

Trade Policy and Firm Imports:

- Goldberg et al. (2010)
- Gopinath and Neiman (2008)
- Kasahara and Lapham (2013)
- Bown and Tovar (2011)
- Amiti and Konings (2007)
- Halpern, Koren, Seidl (2015)

Intuition and Theory

- An importing firm, faced with **protection on inputs** can:
  - Pay the import duty on the protected input
  - Switch supplier (foreign, domestic) and continue to use the input
  - Use less of the input (or stop using it)
- In all cases, the **marginal cost** is likely to go up
- We build a theory **model** predicting that such an increase in marginal cost results

Input-switching Model

The model has 3 building blocks:

i) Melitz & Ottaviano (2008) consumer preferences
ii) Eckel and Neary (2008): multi-product firms
iii) Halpern, Koren and Seidl (2015); Gopinath & Neiman (2008): sourcing of material inputs

Production

Production of any variety (s) is given by:

$$q(s) = A(s)L^a M^b$$

Where s: variety (firm-product), L: labor input; A(s) productivity at variety level; M: composite material input

$$M = \left[x_1^{\frac{\theta-1}{\theta}} + x_2^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

Production

The composite material input M consist of input 1, 2:

$$M = \left[x_1^{\frac{\theta-1}{\theta}} + x_2^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

Input 2: always sourced domestically

Input 1: sourced domestically or abroad (higher fixed cost of sourcing but lower input price)

θ: elasticity of substitution between input 1 & 2

Price of the Composite Material:

$$p_M(p_{x_1}, p_{x_2}) = \left(p_{x_1}^{1-\theta} + p_{x_2}^{1-\theta}\right)^{\frac{1}{1-\theta}}$$

Variable cost per unit of variety s:

$$c(s) = \frac{1}{A(s)^{a+b}} \left(p_L \left[\frac{a.p_M}{b.p_L}\right]^{\frac{b}{a+b}} + p_M \left[\frac{b.p_L}{a.p_M}\right]^{\frac{a}{a+b}} \right)$$

Preferences

Melitz & Ottaviano (2008) quadratic utility preferences :

$$U = \alpha \int_S q(s)ds - \frac{\beta}{2}[q(s)]^2 ds - \frac{\gamma}{2}\left[\int_S q(s)ds\right]^2 + q_0$$

Which results in linear demand for each variety s:

$$p(s) = \alpha - \beta q(s) - \gamma Q$$

With Q: aggregate product market output;

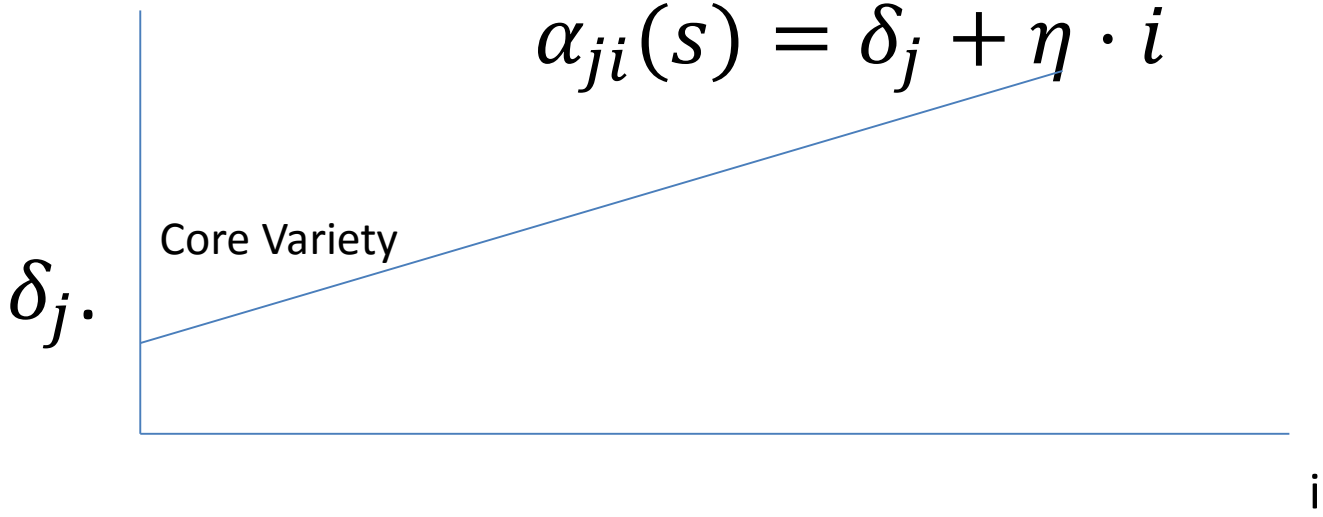
α, β, γ: demand parameters

This gives us an equilibrium price and quantity for each variety s, as a function of marginal cost of variety (c(s))

Multi-product firms

Each variety s, can be considered as a variety i produced by a multi-product firm j. Variety specific unit cost differs as follows:

$$\alpha_{ji}(s) = \delta_j + \eta \cdot i$$



Multi-product firms

Hence, each variety has a different unit cost and different unit productivity in production of q (s):

$$A_{ji}(s) = \frac{1}{\alpha_{ji}(s)}$$

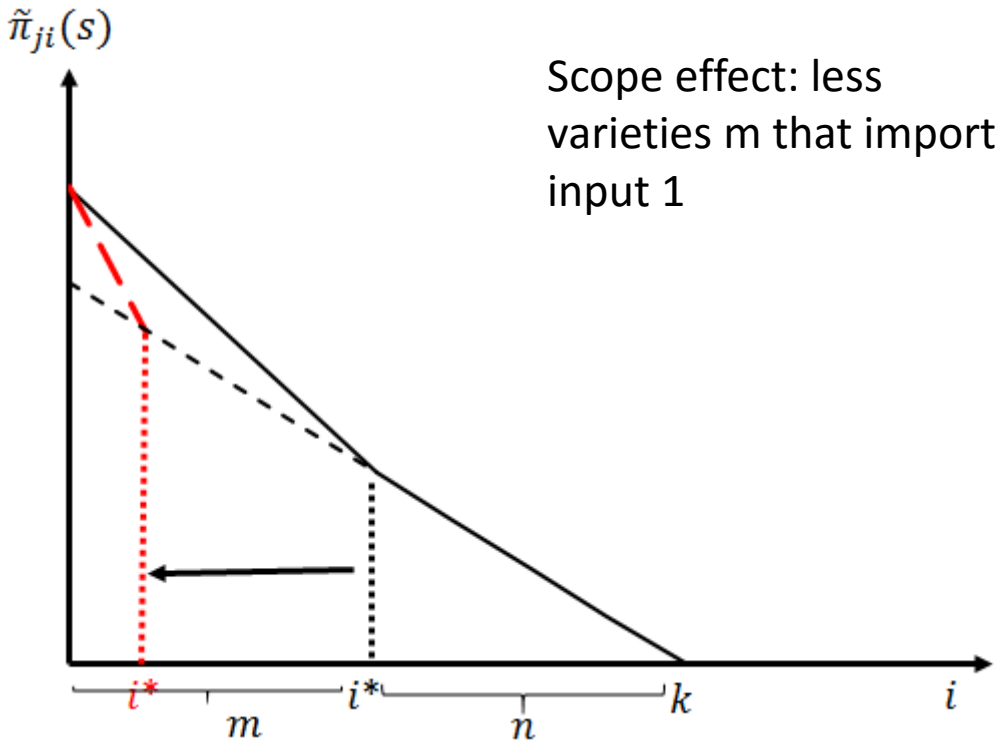
Sourcing

- More productive varieties will source input 1 from abroad (higher fixed cost, lower input price) (variety type m)

- Less productive varieties will source input 1 domestically (variety type n)

Trade Policy

Figure 2: Effect of trade policy on scope of type m and type n varieties



Scope effect: less varieties m that import input 1

Theory Predictions

- **Proposition 1:** Trade protection on imported raw material inputs, results in **input reallocation** with firms using less of the protected raw material input, relative to other raw material inputs in production.

- **Proposition 2:** Trade protection on imported raw material inputs, results in **output reallocation** with firms producing less of the output affected by the protected input, relative to other outputs produced.

- **Proposition 3:** Trade protection on imported material inputs in production, results in a **decrease of markups** of affected outputs, which implies a decrease in firm-level markups for firms that import protected inputs.

Data

- Indian firm-level data with **raw material inputs** that a firm is using:
  - Example: Indian firm that uses "**caustic soda**" as an **input** in production (ànd do not produce caustic soda)
- We construct a unique input-output correspondance at firm-level
- We develop a word algorithm to match inputs in Prowess to the Global Antidumping Database (Bown, 2012)
- Trade Policy shock is at firm-input level (antidumping duties) which allows for disaggregate identification strategies
- Multi-input firms (58.5%) and multi-output firms (56%) in our data

Word Algorithm to match the data sources

Example:

Bown database: Antidumping case on *Caustic Soda*

Matching rule: select input names containing (*Caust* AND *Sod*) OR (*Sod* AND *Hydroxid*) OR (*Lye* AND (*Sod* OR *Caust*))

Prowess database:

Product names identified in firm-product data on raw material inputs

Caustic Soda	Caustic Soda Lye/Flakes	Caustic Soda Lye
Caustic Soda Flakes	Caustic Soda Lye/Flacks	Caustic Soda Solution
Caustic Lye	Caustic Soda Flaks	Caustic Soda/Potash
Soda Ash, Caustic Soda	Sodium/Potassium Hydroxide	Soda Caustic
Sodium Hydroxide Solution	Caustic Soda Lye & Flakes	Caustics Soda Lye/Flakes
Caustic Soda	Caustic Soda/Lye	Caustic Soda Lye (48.5%)
Cuastic Soda Lye	Caustic Lye/Flakes	Sodium Hydroxide

Chemicals Like Caustic Soda, Sodium Silicate Etc.

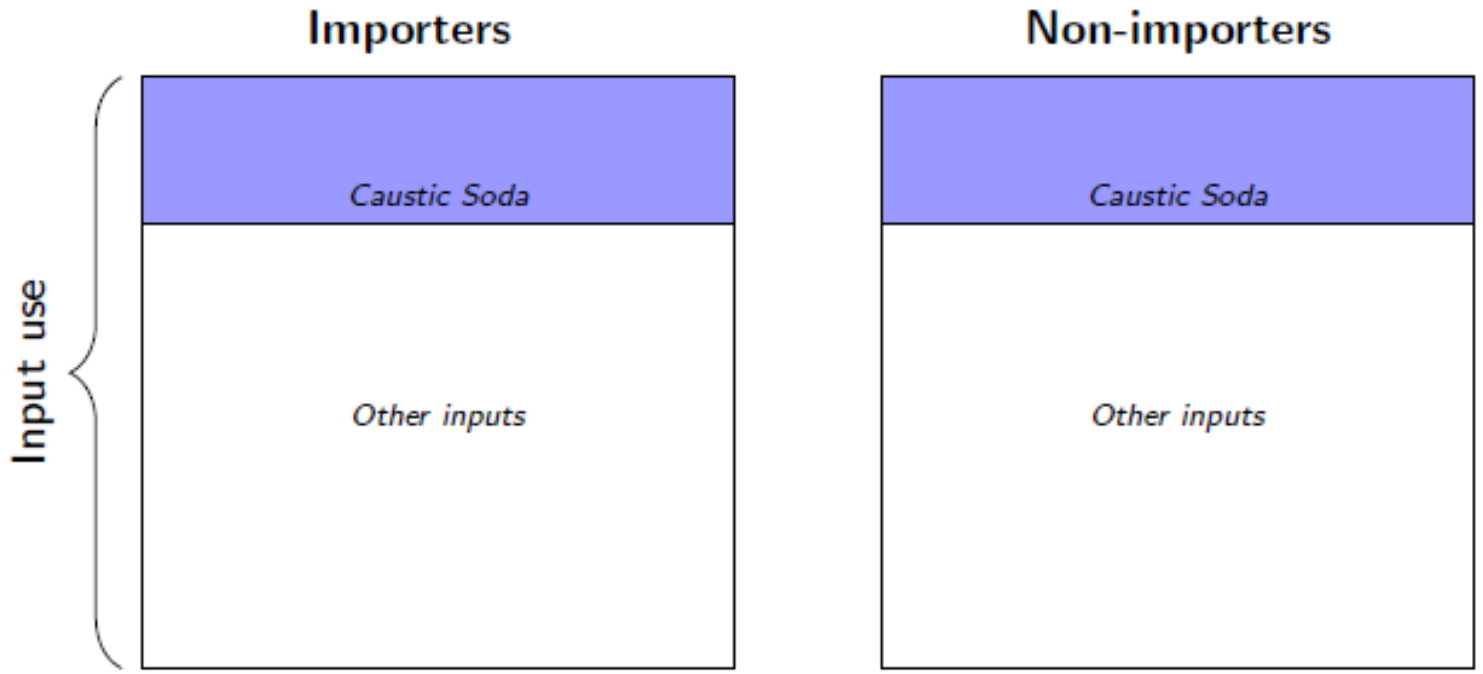
In search of Causality

- Triple difference regressions
  - Treated : the use of treated inputs versus untreated inputs in **protected firms** over time
  - Untreated: the use of “treated” inputs versus untreated inputs in **unprotected** firms over time
- Poisson Pseudo Maximum Likelihood (**PPML** estimator)
  - Input value/quantities enter regression directly (and nog in logartihmic form) **without zeros dropping** out
- Inclusion of **firm-input fixed effects**

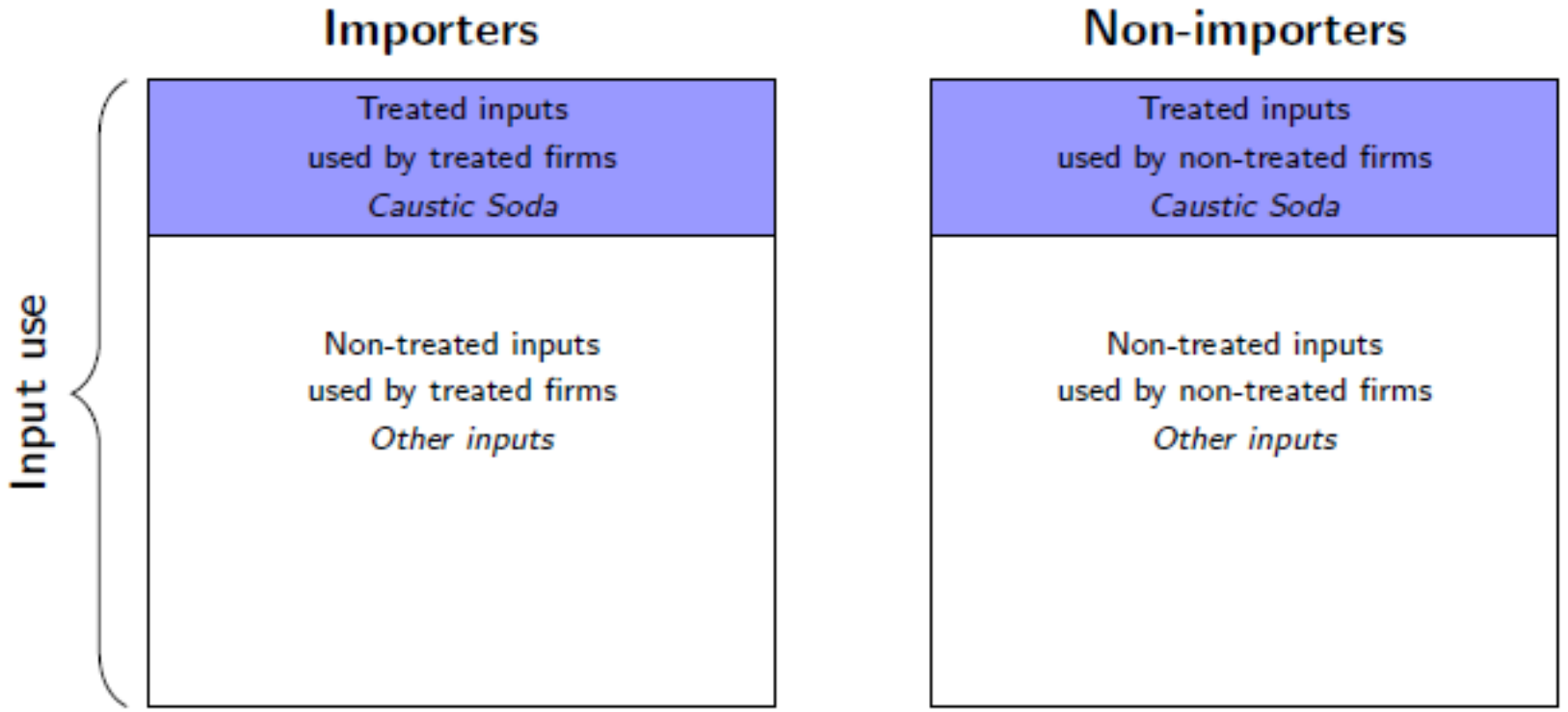
Triple Difference Regressions

Control group: non-importing firms

Example: Antidumping case on *Caustic Soda*



Example: Antidumping case on *Caustic Soda*



Compare importers' use of treated (protected) inputs vis-a-vis other inputs to non-importers' use of treated (protected) inputs vis-a-vis other inputs

Trade Protection and the Intensive Margin

$$INPUT_{ijt} = \exp\Big(\beta \left(AD_{ijt} \times TR_{ij} \times TRFRM_i\right) + \gamma \left(AD_{ijt} \times TRFRM_i\right) + \phi \left(AD_{ijt} \times TR_{ij}\right) + \mu \left(AD_{ijt}\right) + \epsilon_t + \epsilon_{ij} \Big) \epsilon_{ijt}.$$

$INPUT_{ijt}$ is value/quantity of input j used by firm i in year t

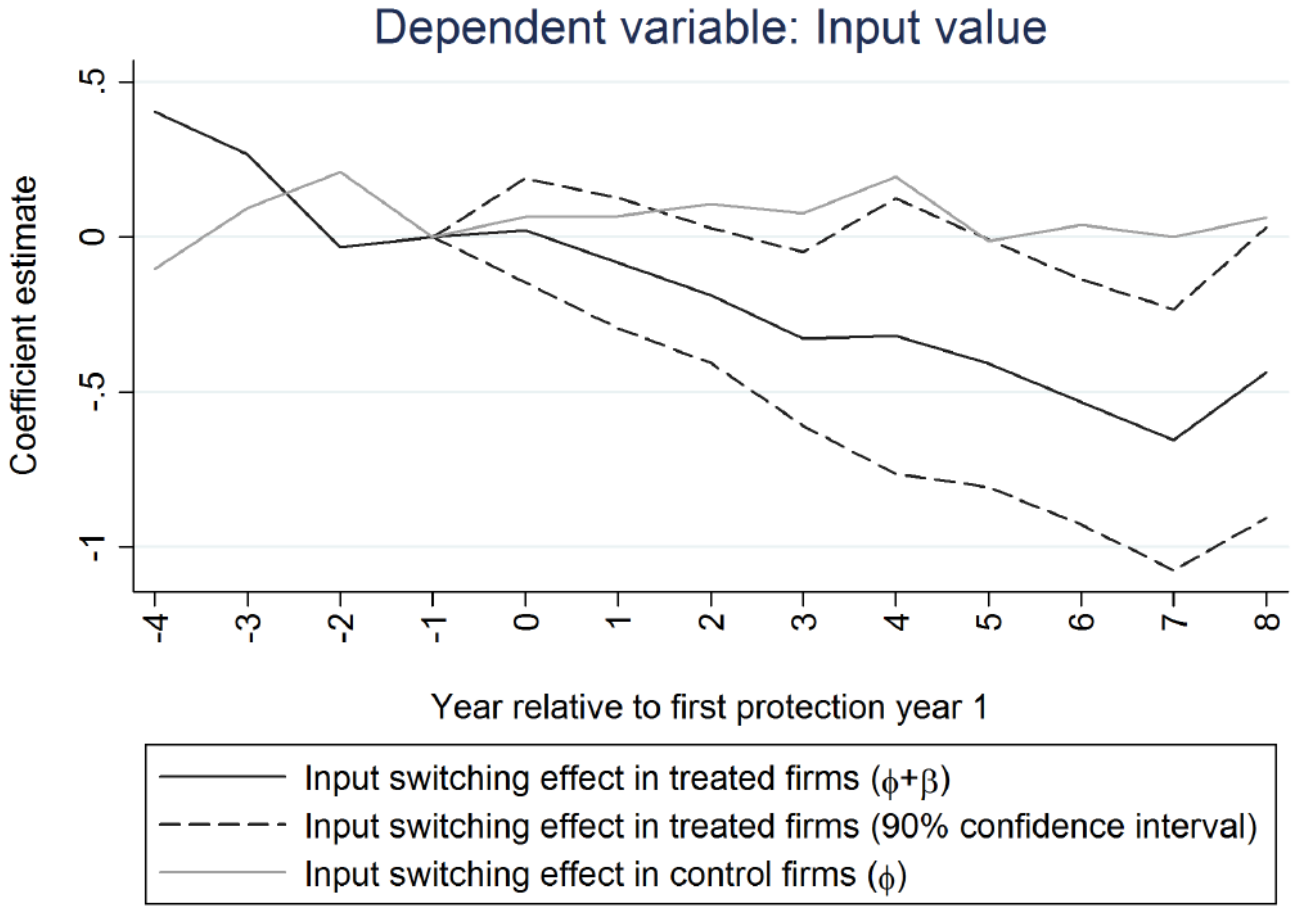
AD_{ijt} is a dummy that marks the treatment (protection) period

TR_{ij} is a dummy that marks treated inputs

$TRFRM_i$ is a dummy that marks treated firms (i.e. importers)

ϵ_t, ϵ_{ij} and ϵ_{ijt} are year fixed effect, firm-input fixed effect and error term respectively

Impact of protection and input use over time (control= non-importers)



Year 1 is the year in which protection is imposed and years on the horizontal axis are relative to that year. Year −4 refers to five or more years before protection is imposed. Year 7 refers to seven or more years of protection in force. Year 8 refers to years after the expiry of protection.

Extensive Margin Adjustment

Analyzes the impact of antidumping protection on the probability to add or drop an input from the input portfolio

$$Pr(drop) = \frac{exp(X\beta_1)}{1+\sum_{k=1}^{2} exp(X\beta_k)}$$

$$Pr(add) = \frac{exp(X\beta_2)}{1+\sum_{k=1}^{2} exp(X\beta_k)}$$

$$Pr(continue) = \frac{1}{1+\sum_{k=1}^{2} exp(X\beta_k)}$$

where

$$\begin{aligned} X\beta_k = \beta_{0k} &+ \beta_{1k} PreAD_{ijt} \times TR_{ij} \times TRFRM_i + \beta_{2k} AD_{ijt} \times TR_{ij} \times TRFRM_i \\ &+ \beta_{3k} PostAD_{ijt} \times TR_{ij} \times TRFRM_i + \beta_{4k} PreAD_{ijt} \times TRFRM_i \\ &+ \beta_{5k} AD_{ijt} \times TRFRM_i + \beta_{6k} PostAD_{ijt} \times TRFRM_i \\ &+ \beta_{7k} TR_{ij} \times TRFRM_i + \beta_{8k} TRFRM_i + \epsilon_{k,t}. \end{aligned}$$

$k = 1$: Input dropped
$k = 2$: Input added

Discussion of Results and Digging deeper

- strong evidence of **input reallocation** towards unprotected inputs
- Results hold for **values, quantities** of individual inputs as well as **share** in total
- robust to **various control** groups (non-importers, matched firms etc) and **protection** measures
- Input reallocation is **permanent** and remains in place after protection ends
- Results do not depend on a particular **sector**
- Results are stronger for **large** firms
- Results are stronger for **multi-product** firms
- Most adjustment comes through the **intensive margin**
- Firms do **not** have a higher probability to **drop an input**, but display a **lower** probability to start **using an input** when the input is under antidumping protection

From input-switching to output-switching

- We identify **firm-outputs** produced with **firm-inputs** under protection

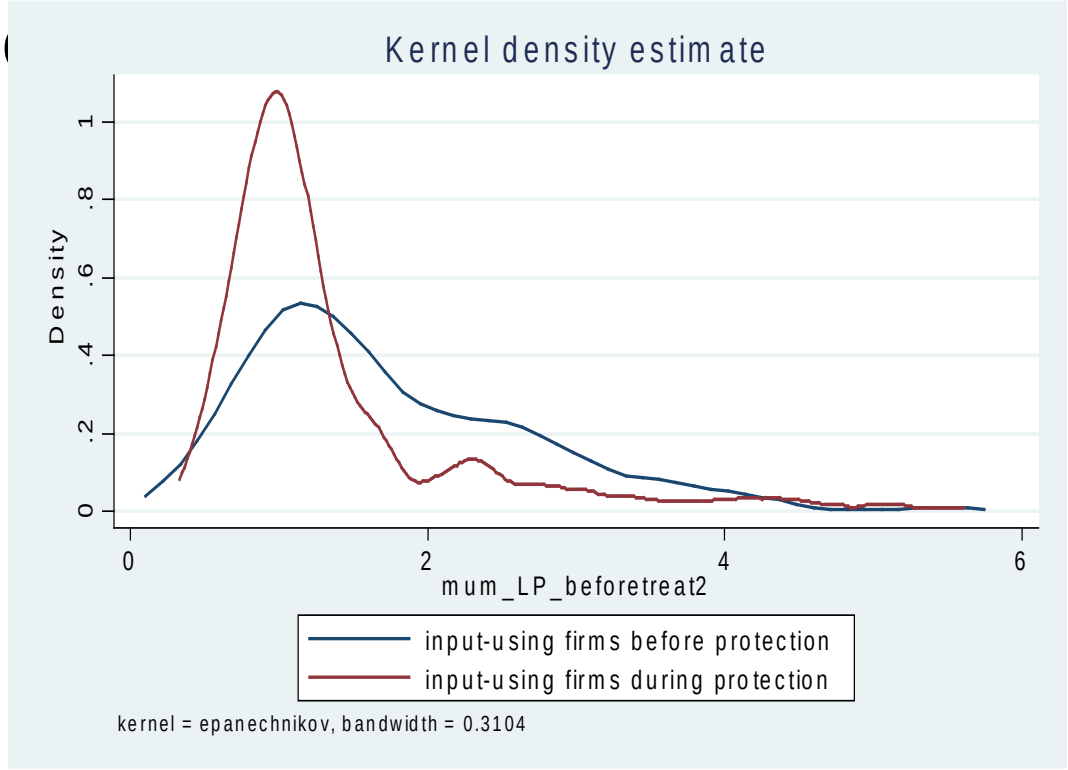
- What happens on the output side after protection on inputs?

Results on output side

- Significant output reallocation
- **Output prices** of products using protected inputs **rise** on average
- This suggests some **pass-through** of higher production costs to consumers
- M**arkups** fall of treated firms e.g. incomplete pass-through of rise in costs on prices

Input switching and Markups

- We use De Loecker and Warzynski (2010) to estimate firm-level markups
- Markups distribution Before and After Trade sh



Correlation of input- and output-mix

- We construct a Finger and Kreinin (1979) index of a firm's existing input-mix and output-mix and how that changes over time
- The more similar a firm's input and output mix from one year to another, the closer the indicators are to 1, the less dynamic the input or output mix over time
- We find a strong positive correlation of input and output dynamics in general (indenpendent of trade policy)

Evidence on Input- and Output-switching

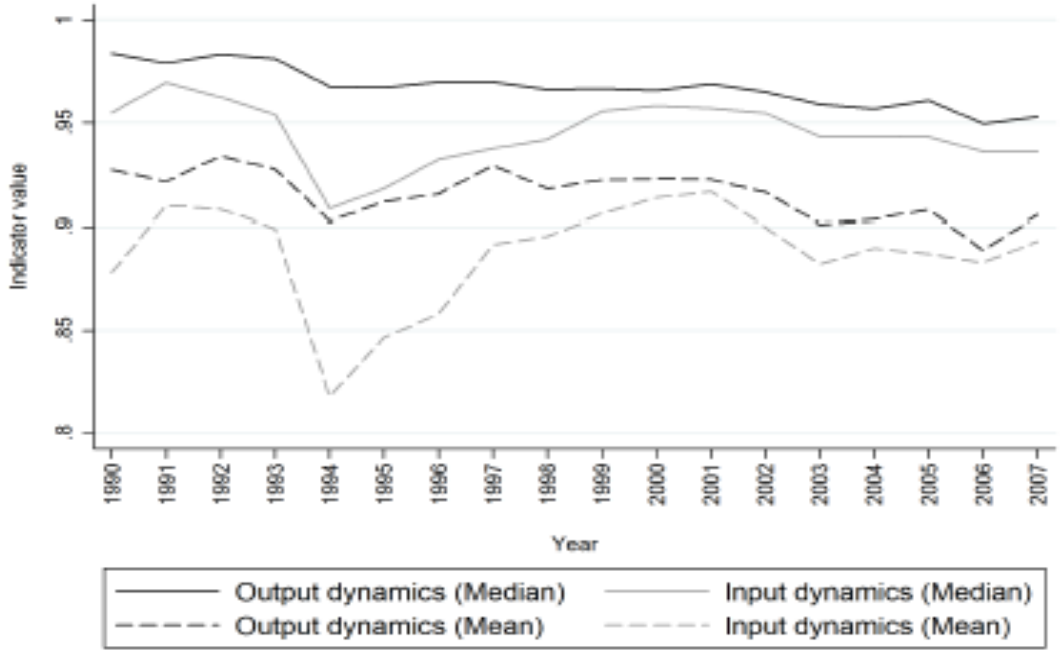
Does input switching come along with output switching?

Input and output dynamics indicator:

$$ID_{it} = \sum_{j=1}^{J_i} \min(i_{ijt}, i_{ij(t-1)}) \text{ and } OD_{it} = \sum_{k=1}^{K_i} \min(x_{ikt}, x_{ik(t-1)})$$

i_{ijt} is share of firm i's input j in total input use of year t

x_{ikt} is share of firm i's output k in total output sales of year t



Input- and output-switching coinciding

$$OD_{it} = \alpha + \beta ID_{it} + \epsilon_i + \epsilon_{it}$$

Sector	Methodology	Estimate (β)	SE	N	Firms	R2
All	OLS	0.233***	0.016	11336	2200	0.06
All	FE	0.173***	0.016	11336	2200	0.04
All	ADJOLS	0.269***	0.017	9312	2131	0.06
All	ADJFE	0.165***	0.014	9312	2131	0.03
Textiles (17)	OLS	0.195***	0.052	1110	193	0.03
Textiles (17)	FE	0.169***	0.052	1110	193	0.02
Textiles (17)	ADJOLS	0.225***	0.055	878	187	0.03
Textiles (17)	ADJFE	0.168***	0.044	878	187	0.02
Chemicals (24)	OLS	0.172***	0.028	2640	508	0.04
Chemicals (24)	FE	0.120***	0.025	2640	508	0.02
Chemicals (24)	ADJOLS	0.222***	0.027	2224	493	0.05
Chemicals (24)	ADJFE	0.126***	0.024	2224	493	0.02
Rubber/Plastics (25)	OLS	0.315***	0.085	600	111	0.10
Rubber/Plastics (25)	FE	0.229***	0.080	600	111	0.06
Rubber/Plastics (25)	ADJOLS	0.376***	0.075	506	108	0.07
Rubber/Plastics (25)	ADJFE	0.176***	0.058	506	108	0.03
Base metals (27)	OLS	0.254***	0.048	1138	227	0.06
Base metals (27)	FE	0.229***	0.049	1138	227	0.06
Base metals (27)	ADJOLS	0.256***	0.056	934	220	0.05
Base metals (27)	ADJFE	0.210***	0.040	934	220	0.04
Other sectors	OLS	0.254***	0.023	5848	1161	0.07
Other sectors	FE	0.186***	0.024	5848	1161	0.04
Other sectors	ADJOLS	0.278***	0.024	4770	1123	0.06
Other sectors	ADJFE	0.172***	0.021	4770	1123	0.03

Conclusion

- This paper shows that there is **within-firm reallocation of inputs** towards unprotected ones in response to trade policy
- Trade policy can affect firms' **input and output** choice sizably
- This results in new channels of firm adjustment on trade policy.