Multi-product firms, networks and quality-upgrading

Evidence from China in India

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Motivation

1. Manufacturing-sector growth a key component of many development paths
2. China's expansion over last 20 years a potential threat to this path

   ⇒ 2bn+ people live in large developing countries that have grown large trade deficits with China

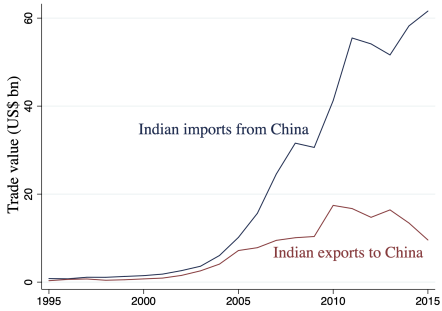
   ⇒ These large deficits generally emerged following China's accession to WTO in 2001

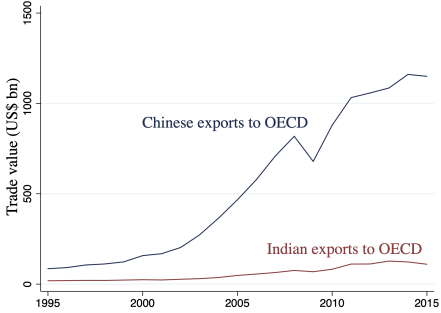
   ⇒ For instance...

Motivation

"Given the limited bilateral trade with China, it is unlikely there will be a significant impact of China's entry into WTO on India's imports"

(Agrawal & Sahoo, Economic & Political Weekly, 2003)

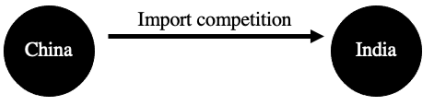




Research question: How, and through which channels, did the China trade shock affect Indian manufacturing firms?

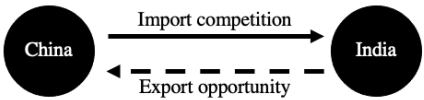
Untangling potential channels

Untangling potential channels



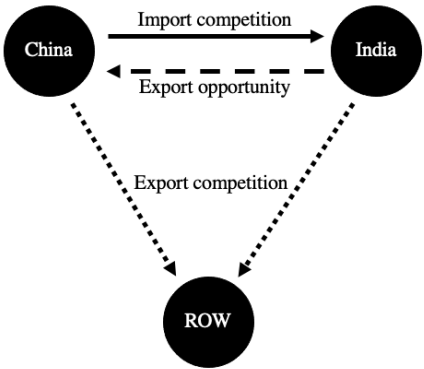
E.g. Autor, Dorn & Hanson 2013 in USA, Iacovone, Rauch & Winters 2013 in Mexico

Untangling potential channels



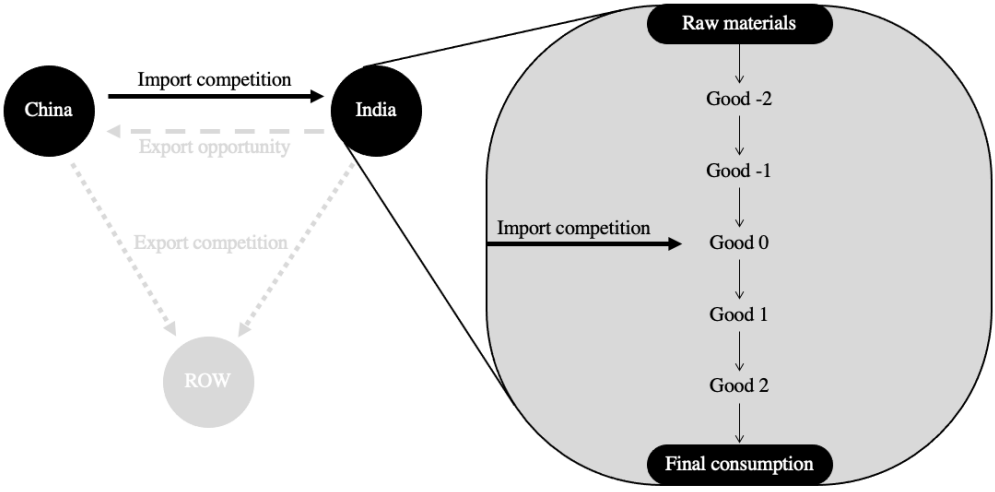
E.g. Costa et al. 2016 in Brazil

Untangling potential channels



E.g. Caselli et al. 2018 in Mexico, Branstetter et al. 2019 in Portugal

Untangling potential channels



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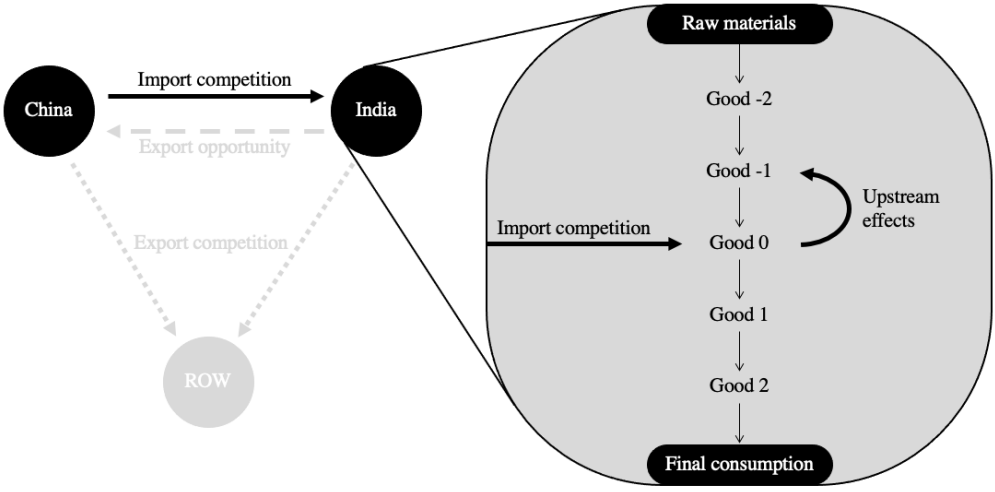

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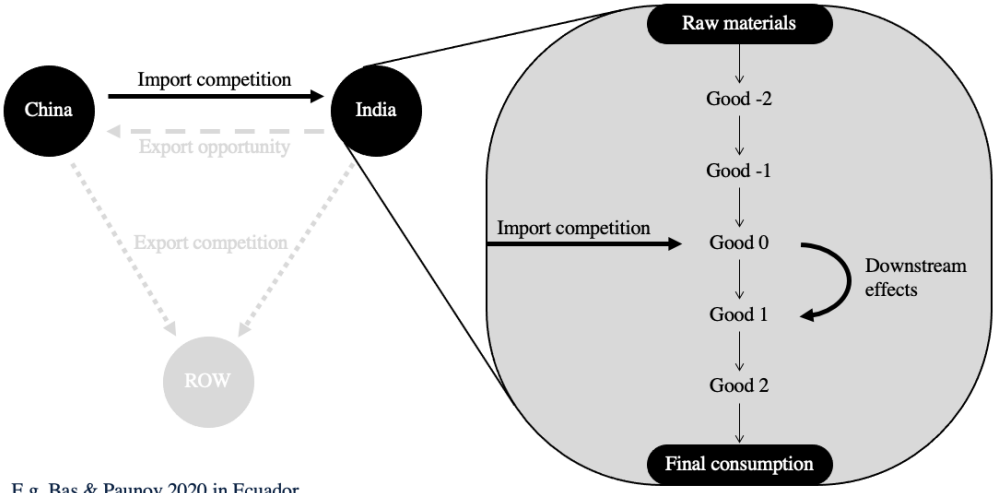
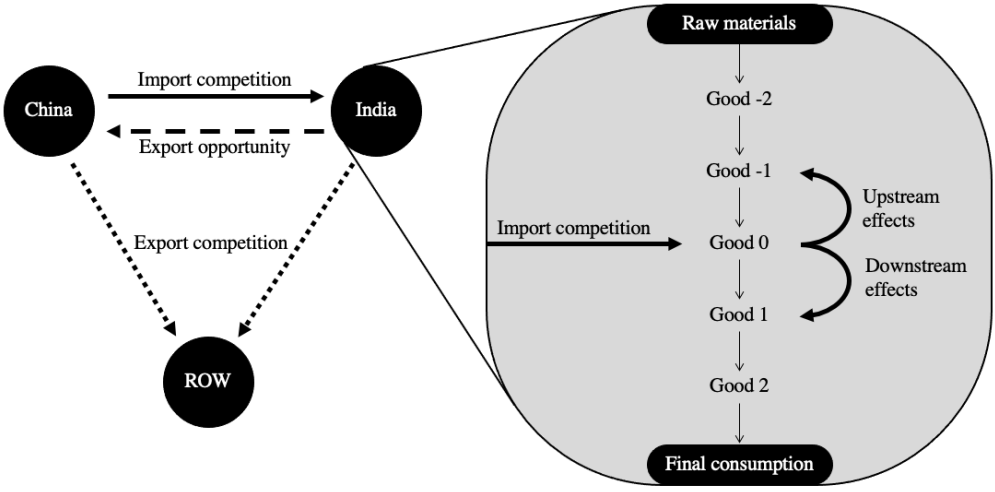


E.g. Bas & Paunov 2020 in Ecuador

Untangling potential channels



This paper

1. Estimates impact on firm outcomes through five main channels
   - ⇒ Downstream effects most significant
   - ⇒ Cheaper, higher-quality imported inputs drive quality upgrading
2. Investigates spillovers of upgrading in two dimensions:
   - ⇒ **Over time:** upgrading persists for at least ten years
   - ⇒ **Across production network:** IO linkages amplify effect by 75%

$\Longrightarrow$ 'Supply-driven quality-upgrading' generates important direct + indirect gains from trade.

Examples of supply-driven quality upgrading

EV startup

Lighter li-ion cells → lighter batteries, longer charge.

Pharma MNC

Fewer impurities in input chemicals → safer products.

▸ Distribution of manufacturing industries

Roadmap

Intro

Theory

Empirics

Direct effects

Spillovers

Conclusion

Stylized model of Indian manufacturing firms

- Heterogenous multi-product firms in monopolistic competition following Manova and Yu (2017)
  - ⇒ Compete on cost or quality depending on the returns to quality (≈ product differentiability)
  - ⇒ Each firm draws firm-wide ability and firm-product-specific expertise, and uses inputs of exogenous price and quality
  - ⇒ Together these determine marginal cost, price and quality of output
- Fits observed distributions of:
  - ⇒ price, revenue, product scope (directly observed)
  - ⇒ markups, marginal costs (using De Loecker et al. 2016)
  - ⇒ quality, quality adjusted prices (using Khandelwal et al. 2013)

Predicted impacts of the China shock

		c_i	q_i	p_i	a_i	x_i	r_i	Ex_i
Import competition	$\uparrow \Omega$	–	–	–	–	$\downarrow$	$\downarrow$	$\uparrow$
Export opportunity	$\uparrow R$	–	–	–	–	$\uparrow$	$\uparrow$	$\downarrow$
Export competition	$\uparrow \Omega$	–	–	–	–	$\downarrow$	$\downarrow$	$\uparrow$
Upstream effects	$\downarrow R$	–	–	–	–	$\downarrow$	$\downarrow$	$\uparrow$
Downstream effects	$\uparrow q_m$	$\uparrow$	$\uparrow$	$\uparrow$	$\downarrow$	$\sim$	$\uparrow$	$\downarrow$

▸ Derivations ▸ Linear demand version ▸ Test fit of the model ▸ Results

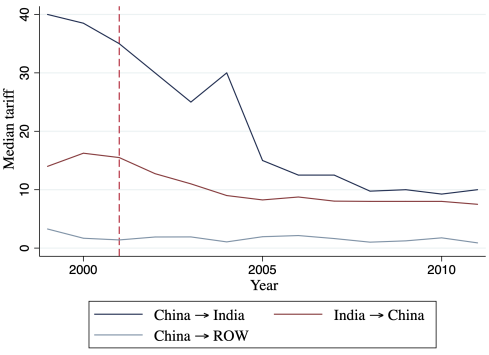
Data sources

▸ Summary statistics

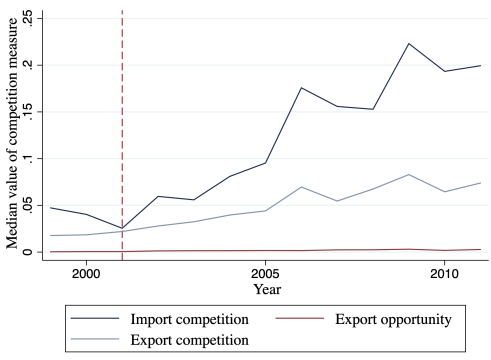
- Firms – Indian Annual Survey of Industries
  - All manufacturing plants larger than 100 workers
  - A representative sample of plants that either a) use electricity and employ more than 10 workers, or b) do not use electricity and employ more than 20 workers
- Tariffs – UNCTAD Trade Analysis Information System
- Imports/exports – UN Comtrade
- 1998/99 Indian input-output table – MoSPI, OECD (robustness)

Underlying variation

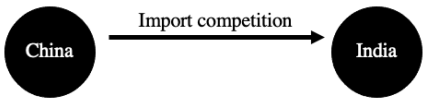
Tariffs



Flows



Measuring the channels



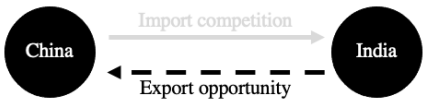
Tariffs:
Indian tariffs on imports from China in 2001

$$CITariff_{j,2001}$$

Flows:
Share of Chinese imports in total Indian imports, following Schott (2002)

$$\frac{M^{Ch}_{Ind,j,t}}{M^{W}_{Ind,j,t}}$$

Measuring the channels



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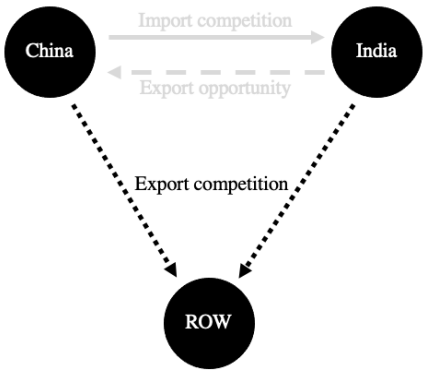


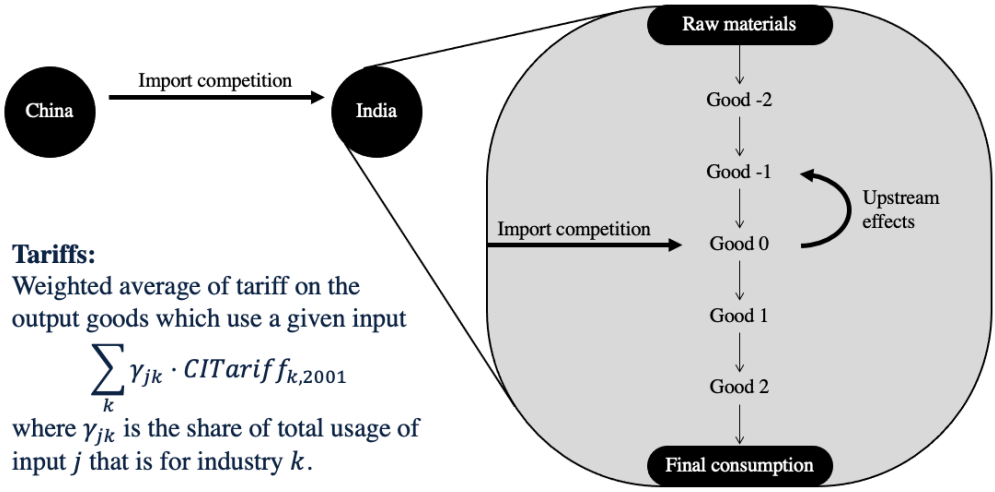
Tariffs:
World* tariffs on exports from China in 2001

$$CRTarif f_{j,2001}$$

Flows:
Share of Chinese imports in total OECD imports

$$\frac{M^{Ch}_{OECD,j,t}}{M^{W}_{OECD,j,t}}$$

Measuring the channels

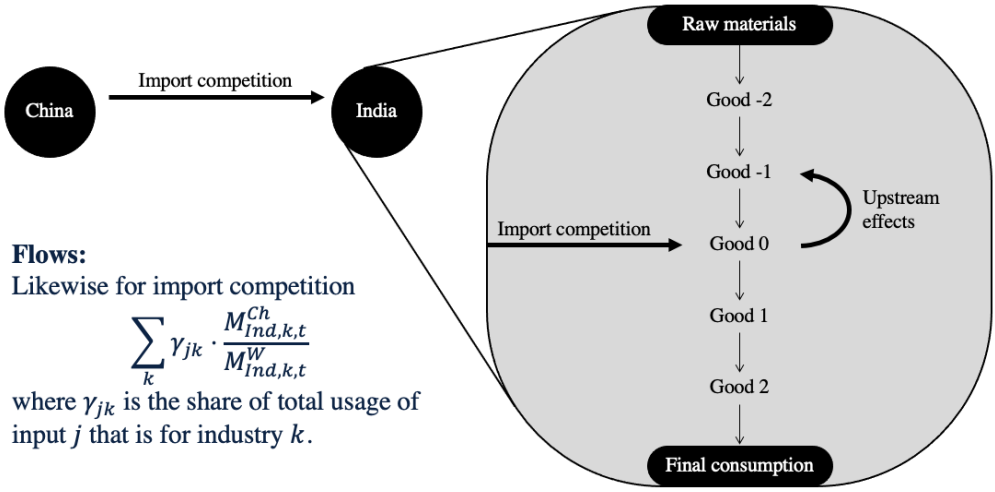


Tariffs:
Weighted average of tariff on the output goods which use a given input

$$\sum_k \gamma_{jk} \cdot CITariff_{k,2001}$$

where γ_{jk} is the share of total usage of input j that is for industry k.

Measuring the channels



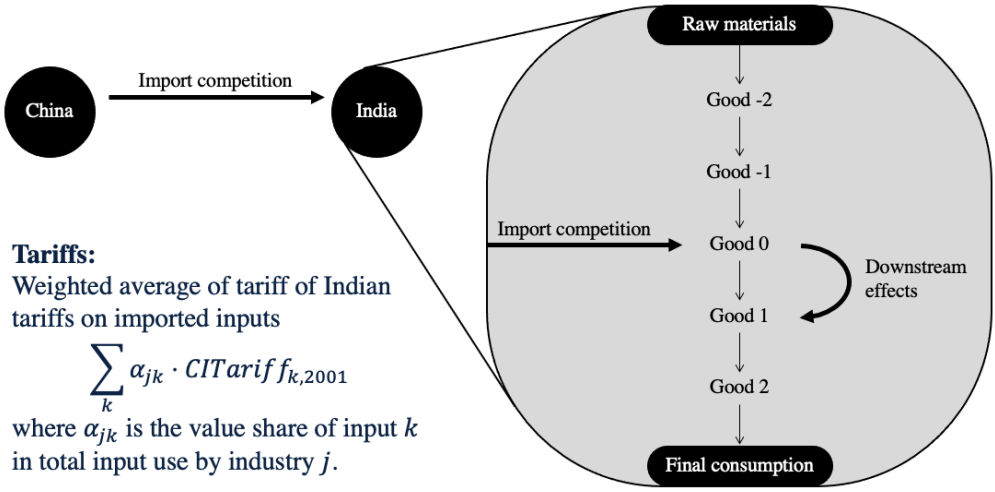
Flows:

Likewise for import competition

$$\sum_k \gamma_{jk} \cdot \frac{M^{Ch}_{Ind,k,t}}{M^{W}_{Ind,k,t}}$$

where γ_{jk} is the share of total usage of input j that is for industry k.

Measuring the channels

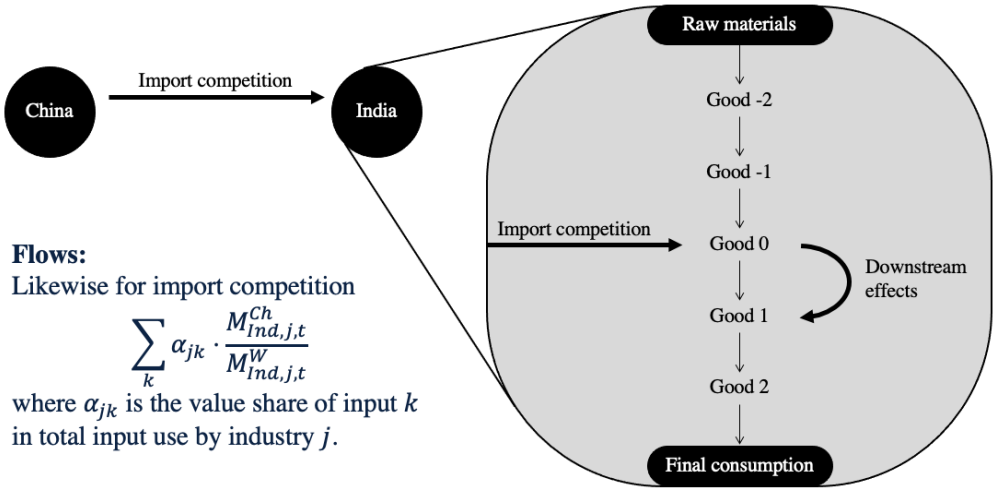


Tariffs:
Weighted average of tariff of Indian tariffs on imported inputs

$$\sum_k \alpha_{jk} \cdot CITarif f_{k,2001}$$

where α_{jk} is the value share of input k in total input use by industry j.

Measuring the channels



Flows:

Likewise for import competition

$$\sum_k \alpha_{jk} \cdot \frac{M^{Ch}_{Ind,j,t}}{M^{W}_{Ind,j,t}}$$

where α_{jk} is the value share of input k in total input use by industry j.

Instrumenting for the flow measures

Indian imports/exports may reflect Indian supply/demand shocks → instrument following (Autor, Dorn and Hanson 2013):[1]

$$impcIV_{j,t} = \sum_{C \in CompSet} \left(\frac{M^{Ch}_{C,j,t}}{M^{W}_{C,j,t}} \right)$$

$$expoIV_{j,t} = \sum_{C \in CompSet} \left(\frac{M^{C}_{Ch,j,t}}{M^{W}_{Ch,j,t}} \right)$$

$$inputcIV_{j,t} = \sum_{k} \alpha_{jk} \cdot \left[\sum_{C \in CompSet} \left(\frac{M^{Ch}_{C,k,t}}{M^{W}_{C,k,t}} \right) \right]$$

$$outputcIV_{j,t} = \sum_{k} \gamma_{jk} \cdot \left[\sum_{C \in CompSet} \left(\frac{M^{Ch}_{C,k,t}}{M^{W}_{C,k,t}} \right) \right]$$

[1] Bangladesh, Indonesia, Malaysia, Philippines, Thailand

Tariff specification

▸ Exogeneity of tariffs

DiD following Lu and Yu (2015):

$$\begin{aligned} y_{ifjt} =& \alpha_{ImpComp} \cdot Post2001_t \cdot \ln CITariff_{j,2001} \\ &+ \alpha_{XOpp} \cdot Post2001_t \cdot \ln ICTariff_{j,2001} \\ &+ \alpha_{ExpComp} \cdot Post2001_t \cdot \ln CRTariff_{j,2001} \\ &+ \alpha_{ImpOut} \cdot Post2001_t \cdot \ln OutTariff_{j,2001} \\ &+ \alpha_{ImpInp} \cdot Post2001_t \cdot \ln InpTariff_{j,2001} \\ &+ \mathbf{X}_{ft}\boldsymbol{\alpha} + a_i + b_f + c_{s,t} + u_{ifjt} \end{aligned}$$

where:

y_{ifjt} = revenue, product exit, quality, price, marginal cost...

$\mathbf{X}_{ft}$ = rural/urban area, private/public/mixed ownership

Flows specification

Repeat all regressions using ADH method:

$$\begin{aligned} y_{ifjt} =& \alpha_M \ln impc_{jt} \\ &+ \alpha_{XOpp} \ln expo_{j,t} \\ &+ \alpha_X \ln expc_{jt} \\ &+ \alpha_{OUT} \ln outputc_{jt} \\ &+ \alpha_{INP} \ln inputc_{jt} \\ &+ \mathbf{X}_{ft}\boldsymbol{\alpha} + a_i + b_f + c_{st} + u_{ifjt} \end{aligned}$$

where the import competition, export opportunity, downstream and upstream channels are instrumented using the basket of southeast Asian countries.

Comparing channels

◂ Predictions from theory

	Revenue	P(Exit)
Import competition	0.198**	0.0106
	(2.29)	(0.49)
Export opportunity	-0.0187	-0.00728
	(-0.42)	(-0.67)
Export competition	-0.0435***	0.00650
	(-2.92)	(1.54)
Upstream spillovers	-0.000777	-0.00526*
	(-0.07)	(-1.78)
Downstream spillovers	0.0704**	-0.0180*
	(2.13)	(-1.95)
FEs	i,f,st	i,f,st
Controls	Yes	Yes
N	175799	161072

Downstream effects

	MCs	Quality	Price	QAP	Quantity	Revenue	P(Exit)
Downstream	0.298**	0.238***	0.194***	-0.0421***	-0.0821	0.0704**	-0.0180*
	(2.57)	(4.27)	(3.72)	(-2.84)	(-1.32)	(2.13)	(-1.95)
FEs	i,f,st	i,f,st	i,f,st	i,f,st	i,f,st	i,f,st	i,f,st
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	34408	165011	165579	165011	165017	175799	161072

Notes: t-statistics in parentheses. * p <0.10, ** p <0.05, *** p <0.01. Standard errors clustered at the firm level. All variables in logs. Downstream = $Post2001_t \cdot \ln InpTariff_{j,2001}$. All regressions include firm, product and state-year FEs, and control for rural/urban location, public/private ownership, and the other four channels (import competition, export opportunity, export competition and upstream spillovers). Quality and quality-adjusted prices are calculated using the procedure of Khandelwal et al. (2013), and marginal costs are calculated using the procedure of De Loecker et al. (2016).

Downstream effects – robustness

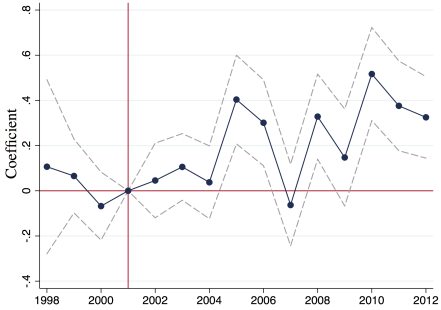
‣ Further robustness checks

	Product-level				Firm-level	
	Quality	Price	Quality	Price	TFP	TFP
Downstream – DiD	0.278**	0.297**				
	(2.02)	(2.22)				
Downstream – ADH			0.684***	0.577**		
			(2.61)	(2.29)		
Downstream – DiD, firm-level					0.107***	
					(18.67)	
Downstream – ADH, firm-level						0.147***
						(28.78)
FEs	i,f,jt,st	i,f,jt,st	i,f,st	i,f,st	f,st	f,st
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	164996	165564	267150	268079	68232	95780

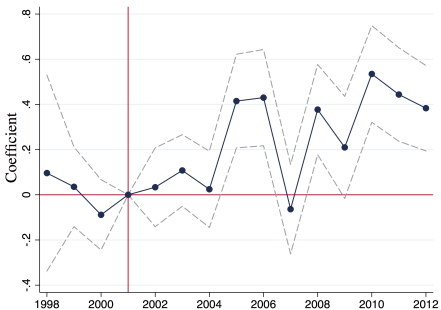
Persistence over time

Interact *Downstream* with year dummies to explore dynamics:

Price



Quality



Persistence over time

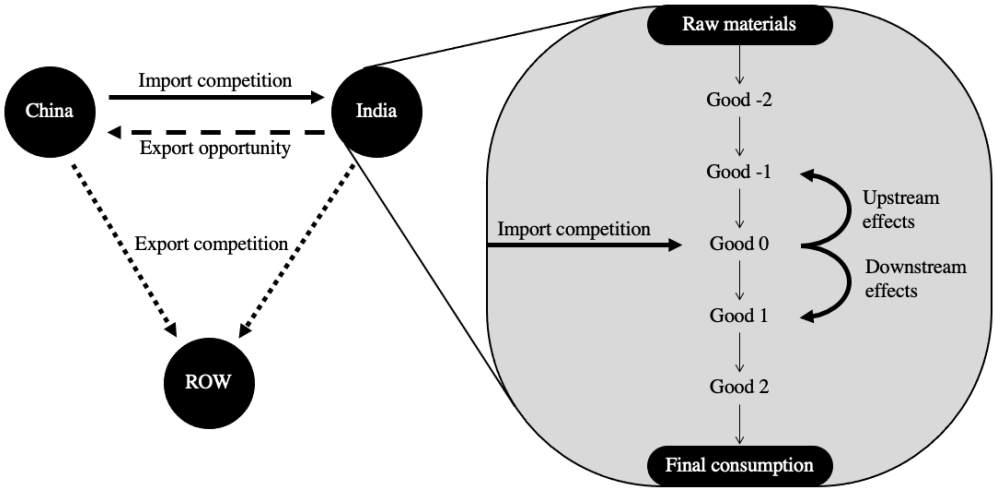
Interact *Downstream* with year dummies to explore dynamics:

Price

Quality

Peak: 10% higher pre-acc. tariff $\Rightarrow$ 5.2% higher price, 5.3% higher quality.

Effect of the production network I: Along supply chain



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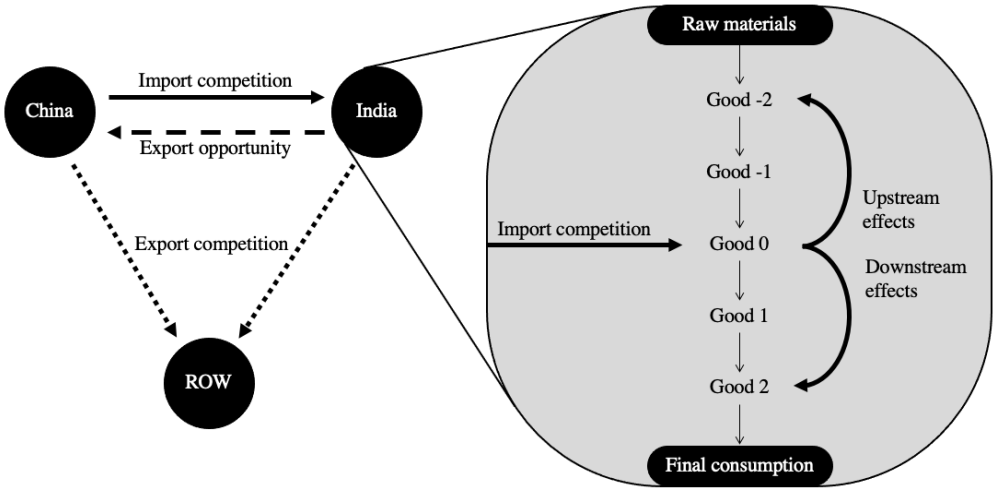


Effect of the production network I: Along supply chain

Find effects at higher degrees by repeatedly summing over input value shares:

First-degree spillovers: $Downstream1_{j,t} = \sum_k \alpha_{jk} \cdot IC_{k,t}$

Effect of the production network I: Along supply chain

Find effects at higher degrees by repeatedly summing over input value shares:

First-degree spillovers: $Downstream1_{j,t} = \sum_k \alpha_{jk} \cdot IC_{k,t}$

Second-degree spillovers: $Downstream2_{j,t} = \sum_l \alpha_{jl} \sum_k \alpha_{lk} \cdot IC_{k,t}$

Effect of the production network I: Along supply chain

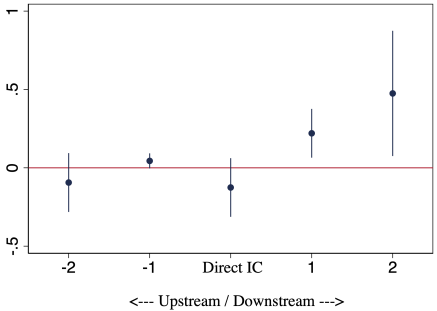
Find effects at higher degrees by repeatedly summing over input value shares:

$$
\begin{aligned}
&\text{First-degree spillovers:} && Downstream1_{j,t} = && \sum_{k} \alpha_{jk} \cdot IC_{k,t} \\
&\text{Second-degree spillovers:} && Downstream2_{j,t} = && \sum_{l} \alpha_{jl} \sum_{k} \alpha_{lk} \cdot IC_{k,t} \\
&\text{Third-degree spillovers:} && Downstream3_{j,t} = && \sum_{m} \alpha_{jm} \sum_{l} \alpha_{ml} \sum_{k} \alpha_{lk} \cdot IC_{k,t} \\
&\vdots && \vdots && \vdots
\end{aligned}
$$

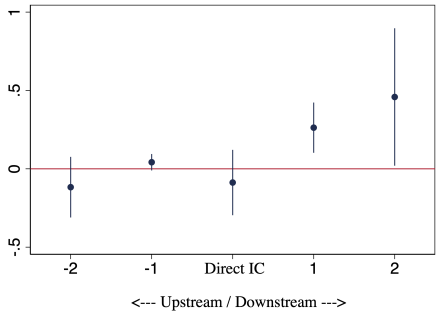
Effect of the production network I: Along supply chain

Effects detectable across two steps – new import competition in Good 1 raises quality of Good 2, which raises quality of Good 3.

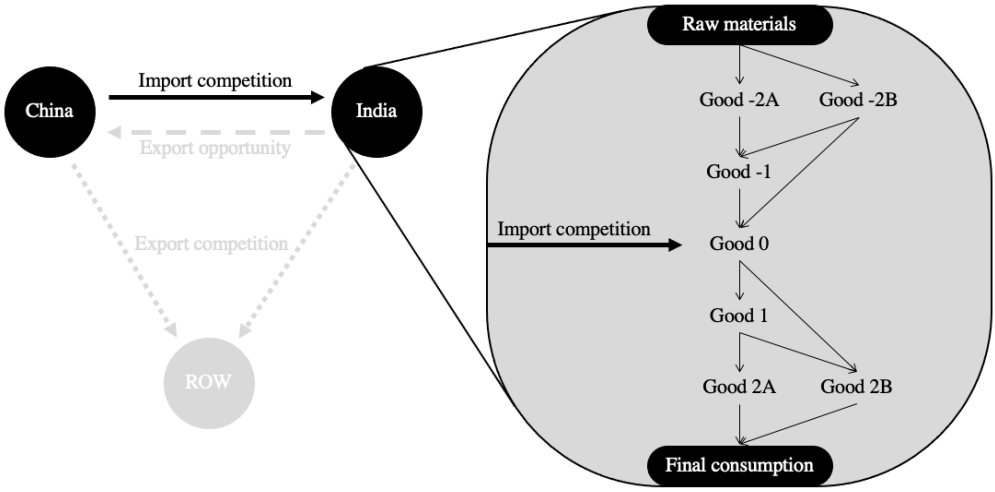
Price



Quality



Effect of the production network II: Total



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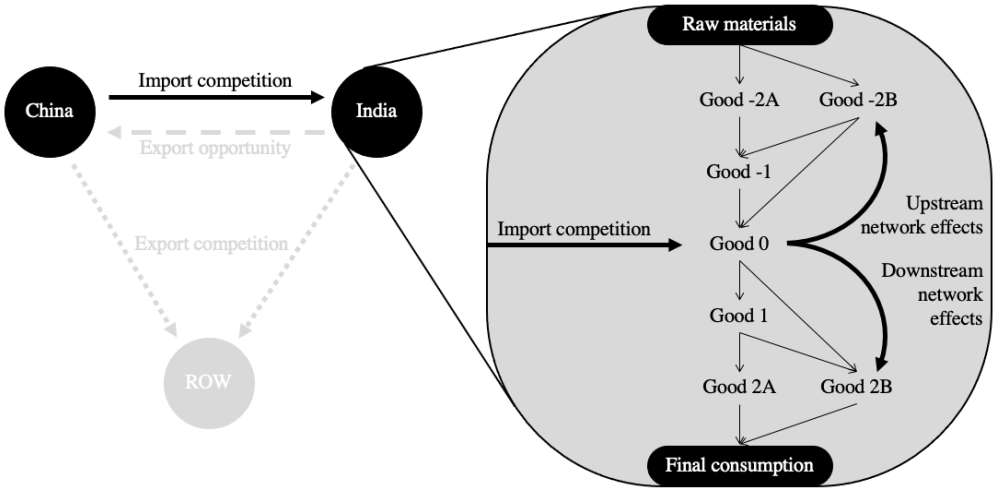
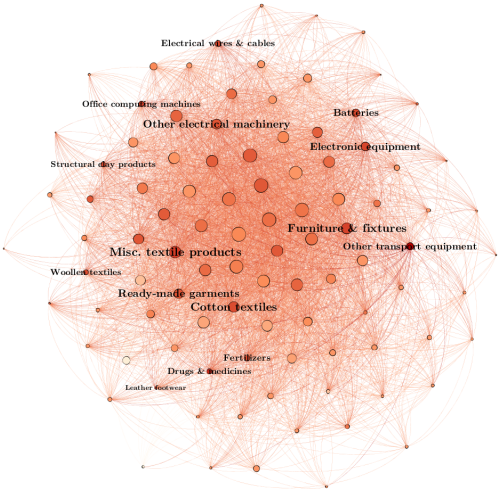


Effect of the production network II: Total

Leontief inverse: one-degree → n-degree upstream & downstream relationships.



$$\mathbf{x} \equiv \mathbf{A}\mathbf{x} + \mathbf{d}$$

$$\mathbf{A} \equiv \begin{bmatrix} \alpha_{11} & \alpha_{12} & \dots & \alpha_{1j} \\ \alpha_{21} & \alpha_{22} & \dots & \alpha_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ \alpha_{j1} & \alpha_{j2} & \dots & \alpha_{jj} \end{bmatrix}$$

$$\mathbf{L} \equiv (\mathbf{I} - \mathbf{A})^{-1}$$

$$\equiv \begin{bmatrix} l_{11} & l_{12} & \dots & l_{1j} \\ l_{21} & l_{22} & \dots & l_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ l_{j1} & l_{j2} & \dots & l_{jj} \end{bmatrix}$$

$$\gamma_{jk} \Rightarrow l_{jk}$$

$$\alpha_{jk} \Rightarrow l_{kj}$$

Effect of the production network II: Total

Find effects at higher degrees by repeatedly summing over input value shares:

First-degree spillovers:	$Downstream1_{j,t} =$	$\sum_k \alpha_{jk} \cdot IC_{k,t}$
Second-degree spillovers:	$Downstream2_{j,t} =$	$\sum_l \alpha_{jl} \sum_k \alpha_{lk} \cdot IC_{k,t}$
Third-degree spillovers:	$Downstream3_{j,t} =$	$\sum_m \alpha_{jm} \sum_l \alpha_{ml} \sum_k \alpha_{lk} \cdot IC_{k,t}$
$\vdots$	$\vdots$	$\vdots$

Effect of the production network II: Total

Find effects at higher degrees by repeatedly summing over input value shares:

$$
\begin{array}{lll}
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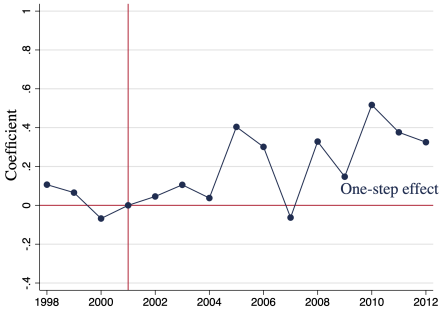
\text{Second-degree spillovers:} & Downstream2_{j,t} = & \sum_l \alpha_{jl} \sum_k \alpha_{lk} \cdot IC_{k,t} \\
\text{Third-degree spillovers:} & Downstream3_{j,t} = & \sum_m \alpha_{jm} \sum_l \alpha_{ml} \sum_k \alpha_{lk} \cdot IC_{k,t} \\
\vdots & \vdots & \vdots \\
\text{Total cumulated spillovers:} & DownstreamT_{j,t} = & \sum_k l_{kj} \cdot IC_{k,t}
\end{array}
$$

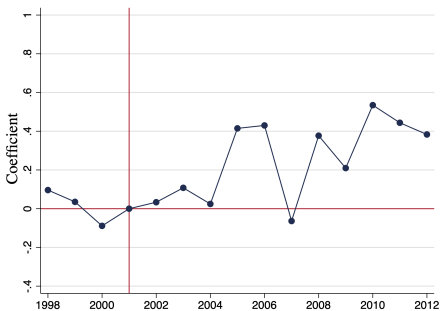
Effect of the production network II: Total

Broader input-output linkages amplify the effect:

Price



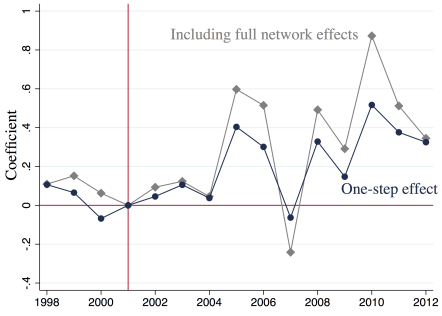
Quality



Effect of the production network II: Total

Broader input-output linkages amplify the effect:

Price



Quality

Conclusion

1. Modelled and estimated impact of China shock on Indian manufacturing firms through five channels
   - ⇒ Most significant: higher-quality inputs raise quality, price & revenue even as quality-adjusted prices fall
   - ⇒ Upgrading persists for at least ten years
   - ⇒ Production network linkages amplify effect by up to 75%
   - ⇒ India received important direct + indirect GfT through supply-driven quality upgrading mechanism.
2. Future research:
   - ⇒ Benefits for other developing country manufacturers, where at similar stage of manufacturing relative to China ▸ Potentials
   - ⇒ Production network + negative input supply shocks (Covid...)

Thank you!

Multi-product firms, networks and quality-upgrading

Evidence from China in India

Alexander Copestake

March 3, 2021

University of Oxford

Contribution to China trade shock literature

Impacts of China shock on:

- USA Autor, Dorn and Hanson (2013, 2016), Autor, Dorn, Hanson and Song (2014), Autor, Dorn, Hanson and Majlesi (2016), **?**), Feenstra and Sasahara (2018*a*), Kuk, Seligsohn and Zhang (2018)
- Canada Murray (2017)
- Europe Balsvik et al. (2015), Dauth et al. (2017), Branstetter et al. (2019)
- East Asia Lu and Yu (2015), Brandt et al. (2017), Amiti et al. (2017), Feenstra and Sasahara (2018*b*)

On India, this paper builds upon Barua (2015, 2016), Chai (2018) by expanding the dataset, measuring impacts through the five channels, and considering impacts on quality.

◂ Back to Motivation

Distribution of manufacturing industries in study

NPCMS Section	NPCMS Sector	Obs.	Fixed Assets (mean, INR million)	Employees (mean)
Agriculture, Forestry, Fisheries	Products of agriculture, horticulture and market gardening	57	42	78
Beverages, Tobacco, Textiles	Beverages	2,668	327	488
	Grain mill products, starches and starch	3,194	131	189
	Knitted or crocheted fabrics; wearing apparel	4,393	98	378
	Leather and leather products; footwear	3,668	58	384
	Textile articles other than apparel	2,275	199	305
	Tobacco products	3,496	22	904
	Yarn and thread; woven and tufted textile fabrics	29,724	368	468
Metals, Machinery and Equipment	Basic metals	4,688	1290	550
	Electrical machinery and apparatus	9,705	195	330
	Fabricated metal products, except machinery and equipment	8,743	229	212
	General-purpose machinery	12,887	172	311
	Medical appliances, precision and optical instruments, watches and clocks	4,319	89	203
	Office, accounting and computing machine	8	20	122
	Radio, television and communication equipment and apparatus	887	423	350
	Special-purpose machinery	4,223	255	260
	Transport equipment	11,645	333	376
Other Transportable Goods	Basic chemicals	12,545	2220	424
	Furniture; other transportable goods n.e.c.	6,210	152	202
	Glass and glass products and other non-metallic products n.e.c.	3,621	313	275
	Other chemical products; man-made fibres	23,454	401	320
	Products of wood, cork, straw and plaiting materials	2,908	40	95
	Pulp, paper and paper products; printed matter and related articles	2,242	228	356
	Rubber and plastics products	21,008	212	194

◂ Motivation ◂ Data

Use of CES preferences

- CES advantages:
  - Relatively tractable
  - Used in literature (e.g. Kugler and Verhoogen 2012)
  - Matches Khandelwal et al. (2013) method of deriving quality measure

- Issue: constant markups – but not severe in this context
- Results also robust to using linear demand, and to inferring implicit impact of quality from observables as in Verhoogen (2008), Kugler and Verhoogen (2012)

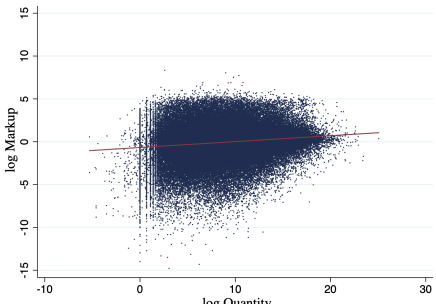


Figure: Quantity sold and markup

Theory

Reduced-form firm cost and quality structure

Advantages:

- Tractable, used in literature
  E.g. Baldwin and Harrigan (2011), Manova and Yu (2017)
- Consistent with evidence elsewhere Verhoogen (2008), Kugler and Verhoogen (2012), Manova and Zhang (2012), Crozet et al. (2012), Iacovone and Javorcik (2010)
- Fits observed pattern in Indian manufacturing sector

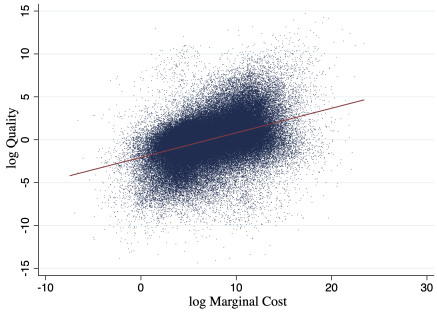


Figure: Marginal cost and quality

Modelled firm behaviour under linear demand

◂ Robustness

Produce i if $\pi_i(\phi_f, \lambda_{fi}) > f_i$. Maximisation gives:

$$p_i(\theta, \lambda_i) = \frac{1}{2}\left[\hat{P}(\phi_f \lambda_{fi})^{1+\theta} + m\phi_f \lambda_{fi}\right] \quad (1)$$

$$x_i(\theta, \lambda_i) = \frac{R}{2\gamma}\left[\hat{P}(\phi_f \lambda_{fi})^{-\theta-1} - m(\phi_f \lambda_{fi})^{-2\theta-1}\right] \quad (2)$$

$$r_i(\theta, \lambda_i) = \frac{R}{4\gamma}\left[\hat{P}^2 - m^2(\phi_f \lambda_{fi})^{-2\theta}\right] \quad (3)$$

$$\mu_i(\theta, \lambda_i) = \frac{1}{2}\left[\frac{\hat{P}(\phi_f \lambda_{fi})^{\theta}}{m} + 1\right] \quad (4)$$

$$\pi_i(\theta, \lambda_i) = \frac{R}{4\gamma}\left[\hat{P} - m(\phi_f \lambda_{fi})^{-\theta}\right]^2 \quad (5)$$

Firm behaviour depends on strength of returns to quality θ:

- $\theta \in (-1, 0)$ compete on cost and price

Modelled impacts of the China shock

Table: Predicted impacts on observables – Linear demand

		c_i	q_i	p_i	x_i	r_i	Ex_i
Import competition	$\uparrow M \rightarrow \downarrow \hat{P}$	–	–	$\downarrow$	$\downarrow$	$\downarrow$	$\uparrow$
Export opportunity	$\uparrow R$	–	–	–	$\uparrow$	$\uparrow$	$\downarrow$
Export competition	$\uparrow M \rightarrow \downarrow \hat{P}$	–	–	$\downarrow$	$\downarrow$	$\downarrow$	$\uparrow$
Upstream effects	$\downarrow R$	–	–	–	$\downarrow$	$\downarrow$	$\uparrow$
Downstream effects	$\uparrow q_m > \uparrow m$	$\uparrow$	$\uparrow$	$\uparrow$	$\sim$	$\uparrow$	$\downarrow$

Back

Testing the fit of the model I

Table: Observables for cost- vs. quality-based competition

			$\theta \in (-1, 0)$	$\theta > 0$
1.	$cov(p_i, r_i)$	across i within f	< 0	> 0
2.	$cov(p_i, r_i)$	across f within i	< 0	> 0
3.	$cov(a_i, r_i)$	across i within f	$< 0 \, \forall \, \theta > -1$	
4.	$cov(a_i, r_i)$	across f within i	$< 0 \, \forall \, \theta > -1$	
5.	$cov(q_i, c_i)$	across f within i	$> 0 \, \forall \, \theta > -1$	
6.	$cov(N, c_i)$	across f within i	$> 0 \, \forall \, \theta > -1$	

◂ Theory

Testing the fit of the model II

	(1) lnPriceDM	(2) lnPrice	(3) lnQAdjP	(4) lnQAdjP	(5) K10Qual	(6) Scope
lnRev	0.0973***	0.102***	-0.168***	-0.367***		
	(14.34)	(52.47)	(-49.88)	(-1847.89)		
Dfftd × lnRev	0.0323***	0.0151***				
	(2.78)	(4.36)				
lnMC					0.496***	0.0331***
					(101.57)	(6.72)
Fixed effects	ft	it	ft	it	it	it
Observations	61553	629999	432705	628359	149671	149675

ASI summary statistics

Mean		Factory-level	Product-level	Trade-level
Number of products		3.8	3.7	3.5
Fixed assets (INR million)		571	595	590
Working capital (INR million)		162	167	165
No. of employees		335	327	337
Ownership (%)	Private	92.2	91.9	93.4
	Joint	5.1	5.4	4.7
	Public	2.7	2.7	1.9
Location (%)	Urban	57.8	56.8	58.2
	Rural	42.2	43.2	41.8
Observations		546,913	353,383	215,287

◂ Data

Generating the quality variable

‣ Full derivation

Follow Khandelwal et al. (2013):

1. Assume preferences are CES across varieties i and regress quantity and price on time and product fixed effects:

$$\ln x_{i,f,j,s,t} + \sigma \ln p_{i,f,j,s,t} = \alpha_t + \alpha_i + u_{i,f,j,s,t} \tag{6}$$

2. Prices are effectively partialled out, leaving 'quantity conditional on price', i.e. quality:

$$\ln \hat{q} = \frac{\hat{u}_{i,f,j,s,t}}{\sigma - 1} \tag{7}$$

3. Quality-adjusted prices are then given by:

$$\ln \widehat{a}_{i,f,j,s,t} = \ln p_{i,f,j,s,t} - \ln \hat{q}_{i,f,j,s,t} \tag{8}$$

Generating the quality variable I

Back

Following Khandelwal et al. (2013), it is possible to derive a measure of quality from observed quantities, prices and the CES utility function assumed above. As above, demand is:

$$x_i = RP^{\sigma-1}q_i^{\sigma-1}p_i^{-\sigma} \tag{9}$$

for expenditure R and price index P. Taking logs and moving prices to the left-hand side gives:

$$\ln x_i + \sigma \ln p_i = (\sigma - 1)\ln q_i + \ln R + (\sigma - 1)\ln P \tag{10}$$

Noting that quantity, quality and price vary with firm f, industry j and state s over time t, and that expenditure R and price level P vary over time, this can be re-written as:

$$\ln x_{i,f,j,s,t} + \sigma \ln p_{i,f,j,s,t} = (\sigma - 1)\ln q_{i,f,j,s,t} + \ln R_t + (\sigma - 1)\ln P_t$$
$$= \alpha_i + \mu_{i,f,j,s,t} \tag{11}$$

Generating the quality variable II

Back

Adding an extra product fixed effect to account for differing units of price or quantity across products gives:

$$\ln x_{i,f,j,s,t} + \sigma \ln p_{i,f,j,s,t} = \alpha_t + \alpha_i + u_{i,f,j,s,t} \tag{12}$$

Thus for a given value of σ, quality $\ln \hat{q}_{i,f,j,s,t} = \frac{\hat{u}_{i,f,j,s,t}}{\sigma - 1}$ can be estimated as the residual in a regression of observable prices and quantities on a time and product fixed effect.[2] Prices are effectively partialled out, leaving 'quantity conditional on price', i.e. quality. Quality-adjusted prices are then given by:

$$\ln \widehat{a}_{i,f,j,s,t} = \ln p_{i,f,j,s,t} - \ln \hat{q}_{i,f,j,s,t} \tag{13}$$

[2]This paper uses $\sigma = 3.7$, the median estimated elasticity of substitution for India calculated by Broda, Greenfield and Weinstein (2006).

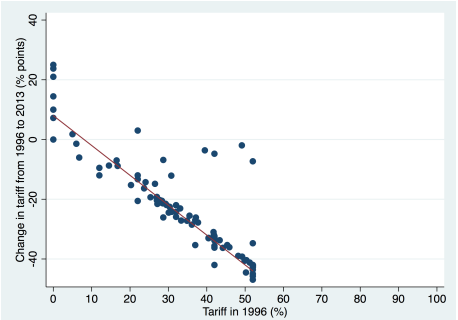
Identifying assumption:

Output/revenue/quality in industries with high initial tariffs would have followed the same path post-2001 as in industries with low tariffs, conditional on observables, had tariffs not changed in 2001.

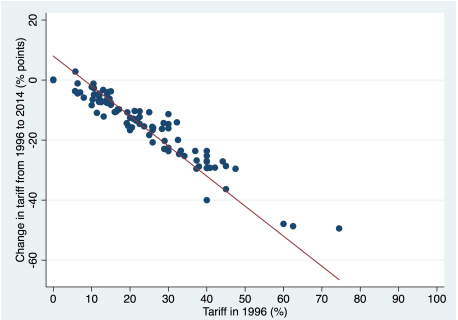
Potential issues:

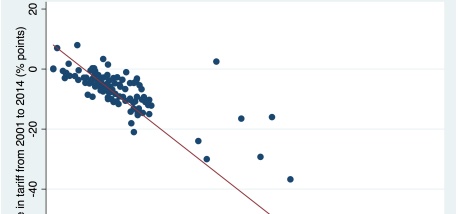
- Tariff changes anticipated → EU May 2000, Mexico Sept 2001
- Reverse causality →
- Misattribution →

Import competition:



Export opportunity:





Exogeneity of tariff changes II

Back

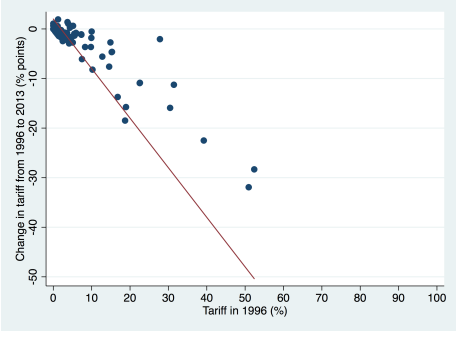
Main threats to exogeneity:

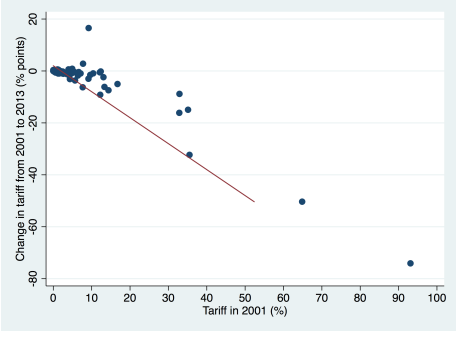
1. Reverse causality – e.g. Indian tariffs lowered only in 'national champion' industries which had rising output/revenue/quality already
2. Misattribution – i.e. the existence of a third set of factors correlated with tariff cuts which affected output/revenue/quality.

However:

- Observed tariff changes in the import competition and export opportunity channels well explained by initial levels of tariffs
- Relationships are almost one-to-one, so reverse causality or omitted variables would have to also explain tariff levels in 1996
- By the end of the period little remaining variation in tariffs across

Lack of tariff variation in export competition channel I





◂ Back to Data ◂ Back to Empirical approach

Lack of tariff variation in export competition channel II

- Substantially less tariff variation in export channel
- Substantial persistence in tariffs over the period, rather than convergence as in other channels – a tariff that is one percent higher in 1996 or 2001 falls by substantially less than one percent more over the period
- Larger share of the initial variation remains in 2013 than in the import competition or export opportunity channels – may be correlated with industry characteristics
- Observed tariffs may miss a more significant mechanism: the removal of uncertainty over US tariffs on Chinese goods with the granting of PNTR status (Pierce and Schott 2016)

Robustness

Back to Results

Robustness:

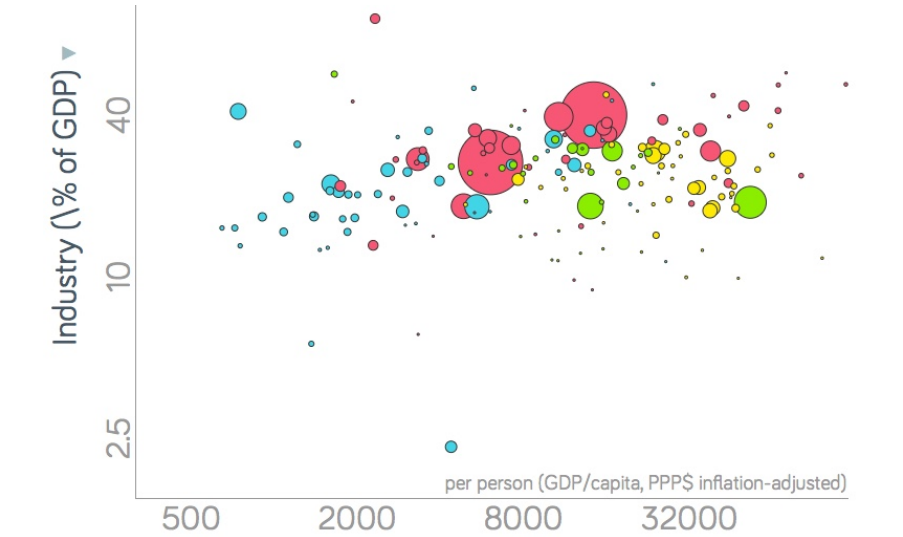
- Linear demand
- Standard TFP measures (Wooldridge 2009)
- Product-level clustering
- Yearly tariffs
- Annual IOTs rather than 1998
- Pre-2005 only

Results using direct measures

	lnQtySold	lnRev
lnimpc	0.989***	0.127
	(3.99)	(0.87)
lnexpo	0.254***	0.0635
	(2.94)	(1.43)
lnexpc	-0.171***	-0.0404
	(-3.76)	(-1.45)
lnoutputcAlpha98	-3.846***	0.627
	(-4.03)	(0.90)
lninputcAlpha98	-0.0648	0.396***
	(-0.33)	(3.36)
N	329458	350058

Table t-statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Standard

Countries by income & manufacturing share



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